Silver Creek Watershed TMDL

Snyder County, Pennsylvania

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DEPARTMENT OF ENVIRONMENTAL PROTECTION

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Executive Summary

Silver Creek is a tributary of the Susquehanna River in Snyder County, Pennsylvania (PA). The stream and all of its headwaters are located in Union Township, eastern Snyder County.

Silver Creek, including all headwater tributaries, makes up approximately 9.06 stream miles downstream to the mouth located near Port Treverton, PA. The entire watershed basin is approximately 5.91 square miles with multiple stream segments listed as impaired by agriculture. Land use in this watershed is composed of forestland, transitional land, low intensity development, and agriculture including croplands and hay/pasture. The Silver Creek Watershed is currently designated as Warm Water Fishes (WWF).

A Total Maximum Daily Load (TMDL) for sediment was developed to address impairments first noted in Pennsylvania's 2002 Section 303(d) list. The impairments were documented during biological surveys of the aquatic life present in the watershed (11/18/1999). Excessive siltation resulting from grazing related agricultural activities has been identified as the cause of these impairments in the basin.

Pennsylvania does not currently have water quality criteria for sediment. A TMDL endpoint for sediment was identified using a reference watershed approach. The existing sediment loading in the Silver Creek Watershed is 3,129,000 pounds per year (8,573 pounds per day). Based on a comparison to a similar, unimpaired watershed, Monongahela Creek (see Table 1 below), the maximum sediment loading that should still allow water quality objectives to be met in the Silver Creek Watershed is 1,591,811 pounds per year (4,361 pounds per day). Allocation of the sediment TMDL is summarized in Table 1 below:

Table 1. Summary of TMDL for the Silver Creek Watershed in lbs./yr. & lbs./day						
Summary of TMDL for the Silver Creek Watershed (lbs./yr.)						
Pollutant	TMDL	WLA	MOS	LA	LNR	ALA
Sediment	1,591,811	15,918	159,181	1,416,712	19,200	1,397,512
Summary of TMDL for the Silver Creek Watershed (lbs./day)						
Pollutant	TMDL	WLA	MOS	LA	LNR	ALA
Sediment	4,361	44	436	3,881	53	3,829

The Silver Creek Watershed TMDL is allocated to nonpoint sources, with 10% of the TMDL reserved explicitly as a margin of safety (MOS) and 1% reserved for a bulk wasteload allocation. The wasteload allocation (WLA) is that portion of the total load assigned to point sources. A search of the Pennsylvania Department of Environmental Protection's (Department) efacts permit database identified no permitted, point sources within the Silver Creek Watershed. The load allocation (LA) is that portion of the total load assigned to nonpoint sources. Loads not reduced (LNR) are the portion of the LA associated with nonpoint sources other than agricultural (croplands, hay/pasture), transition and stream bank and is equal to the sum of forested and low intensity development loadings. The adjusted load allocation (ALA) represents the remaining portion of the LA to be distributed among agricultural, transitional land and stream bank uses receiving load reductions. The TMDL developed for the Silver Creek Watershed established a 55% reduction in the current sediment loading of the targeted land uses resulting in a 49% overall reduction in the watershed.

Introduction

This Total Maximum Daily Load (TMDL) calculation has been prepared for all impaired segments in the Silver Creek Watershed (Attachment A). The stream is located in Union Township, eastern Snyder County. Silver Creek, including all headwater tributaries, makes up approximately 9.06 stream miles downstream to the mouth located near Port Treverton, PA. The entire watershed basin is approximately 5.91 square miles (3782.4 acres, 1530.68 hectares) and multiple stream segments of the watershed are listed as impaired. The watershed is located in State Water Plan (SWP) Subbasin 06A and within Hydrologic Unit Code (HUC) 02050301-Lower Susquehanna. Silver Creek is located in the Ridge and Valley physiographic province with an elevation range of over 270 feet to less than 190 feet above sea level over 9.06 stream miles which include all tributaries. The TMDL was completed to address the impairments noted on the 2002 Pennsylvania 303(d) list, required under the Clean Water Act, and covers the listed segments shown in Table 2 below. Siltation from grazing related agriculture has been listed as causing the impairment. The TMDL addresses siltation from cropland, hay/pasture lands, transitional lands and streambanks.

Table 2. Integrated Water Quality Monitoring and Assessment Report Listed Segments				
State Water Plan (SWP) Subbasin: 06A				
HUC: 02050301– Lower Susquehanna				
Watershed – Silver Creek				
Source	EPA 305(b) Cause Code	Miles	Designated Use	Use Designation
Grazing Related Agriculture	Siltation	7.96	WWF	Aquatic Life

The use designations for the stream segments in this TMDL can be found in PA Title 25 Chapter 93.
See Attachments D & E, for more information on the listings and listing process.
WWF= Warm Water Fishes

Clean Water Act Requirements

Section 303(d) of the 1972 Clean Water Act requires states, territories, and authorized tribes to establish water quality standards. The water quality standards identify the uses for each waterbody and the scientific criteria needed to support that use. Uses can include designations for drinking water supply, contact recreation (swimming), and aquatic life support. Minimum goals set by the Clean Water Act require that all waters be “fishable” and “swimmable.”

Additionally, the federal Clean Water Act and the United States Environmental Protection Agency’s (EPA) implementing regulations (40 CFR 130) require:

- States to develop lists of impaired waters for which current pollution controls are not stringent enough to meet water quality standards (the list is used to determine which streams need TMDLs);

- States to establish priority rankings for waters on the lists based on severity of pollution and the designated use of the waterbody; states must also identify those waters for which TMDLs will be developed and a schedule for development;
- States to submit the list of waters to EPA every two years (April 1 of the even numbered years);
- States to develop TMDLs, specifying a pollutant budget that meets state water quality standards and allocate pollutant loads among pollution sources in a watershed, e.g., point and nonpoint sources; and
- EPA to approve or disapprove state lists and TMDLs within 30 days of final submission.

Despite these requirements, states, territories, authorized tribes, and EPA have not developed many TMDLs since 1972. Beginning in 1986, organizations in many states filed lawsuits against EPA for failing to meet the TMDL requirements contained in the federal Clean Water Act and its implementing regulations. While EPA has entered into consent agreements with the plaintiffs in several states, many lawsuits still are pending across the country.

In the cases that have been settled to date, the consent agreements require EPA to backstop TMDL development, track TMDL development, review state monitoring programs, and fund studies on issues of concern (e.g., Abandoned Mine Drainage (AMD), implementation of nonpoint source Best Management Practices (BMPs), etc.).

Pennsylvania Clean Streams Law Requirements and Agricultural Operations

All Pennsylvania farmers are subject to the water quality regulations authorized under the Pennsylvania Clean Streams Law, Title 25 Environmental Protection, and found within Chapters 91-93, 96, 102 and 105. These regulations include topics such as manure management, Concentrated Animal Operations (CAOs), Concentrated Animal Feeding Operations (CAFOs), Pollution Control and Prevention at Agricultural Operations, Water Quality Standards, Water Quality Standards Implementation, Erosion and Sediment Control Requirements, and Dam Safety and Waterway Management. To review these regulations, please refer to http://pacode.com/ or the Pennsylvania Water Quality Action Packet for Agriculture which is supplied by the County Conservation Districts. To find your County Conservation District's contact information, please refer to http://pacd.org/ or call any DEP office or the Pennsylvania Conservation Districts Headquarters at 717-238-7223.

Integrated Water Quality Monitoring and Assessment Report, List 5, 303(d), Listing Process

Prior to developing TMDLs for specific waterbodies, there must be sufficient data available to assess which streams are impaired and should be listed in the Integrated Water Quality Monitoring and Assessment Report. Prior to 2004 the impaired waters were found on the 303(d) List; from 2004 to present, the 303(d) List was incorporated into the Integrated Water Quality Monitoring and Assessment Report and found on List 5. Please see Table 3 below for a breakdown of the changes to listing documents and assessment methods through time.

With guidance from EPA, the states have developed methods for assessing the waters within their respective jurisdictions. From 1996-2006, the primary method adopted by the Pennsylvania Department of Environmental Protection for evaluating waters found on the 303(d) lists (1998-

2002) or in the Integrated Water Quality Monitoring and Assessment Report (2004-2006) was the Statewide Surface Waters Assessment Protocol (SSWAP). SSWAP was a modification of the EPA Rapid Bioassessment Protocol II (RPB-II) and provided a more consistent approach to assessing Pennsylvania’s streams.

The assessment method required selecting representative stream segments based on factors such as surrounding land uses, stream characteristics, surface geology, and point source discharge locations. The biologist selected as many sites as necessary to establish an accurate assessment for a stream segment; the length of the stream segment could vary between sites. All the biological surveys included kick-screen sampling of benthic macroinvertebrates, habitat surveys, and measurements of pH, temperature, conductivity, dissolved oxygen, and alkalinity. Benthic macroinvertebrates were identified to the family level in the field.

The listings found in the Integrated Water Quality Monitoring and Assessment Reports from 2008 to present were derived based on the Instream Comprehensive Evaluation protocol (ICE). Like the SSWAP protocol that preceded the ICE protocol, the method requires selecting representative segments based on factors such as surrounding land uses, stream characteristics, surface geology, and point source discharge locations. The biologist selects as many sites as necessary to establish an accurate assessment for a stream segment; the length of the stream segment could vary between sites. All the biological surveys include D-frame kicknet sampling of benthic macroinvertebrates, habitat surveys, and measurements of pH, temperature, conductivity, dissolved oxygen, and alkalinity. Collected samples are returned to the laboratory where the samples are then subsampled to obtain a benthic macroinvertebrate sample of 200 + or – 20% (160 to 240). The benthic macroinvertebrates in this subsample were then identified to the generic level. The ICE protocol is a modification of the EPA Rapid Bioassessment Protocol III (RPB-III) and provides a more rigorous and consistent approach to assessing Pennsylvania’s streams than the SSWAP.

After these surveys (SSWAP, 1998-2006 lists or ICE, 2008-present lists) were completed, the biologist determined the status of the stream segment. The decision was based on the performance of the segment using a series of biological metrics. If the stream segment was classified as impaired, it was then listed on the state’s 303(d) List or presently the Integrated Water Quality Monitoring and Assessment Report with the source and cause documented.

Once a stream segment is listed as impaired, a TMDL must be developed for it. A TMDL addresses only one pollutant. If a stream segment is impaired by multiple pollutants, all of those pollutants receive separate and specific TMDLs within that stream segment. In order for the TMDL process to be most effective, adjoining stream segments with the same source and cause listing are addressed collectively on a watershed basis.

Table 3. Impairment Documentation and Assessment Chronology

Listing Date	Listing Document	Assessment Method
1998	303(d) List	SSWAP
2002	303(d) List	SSWAP
2004	Integrated List	SSWAP
2006	Integrated List	SSWAP
2008-Present	Integrated List	ICE

Integrated List= Integrated Water Quality Monitoring and Assessment Report
SSWAP= Statewide Surface Waters Assessment Protocol
ICE= Instream Comprehensive Evaluation Protocol

Basic Steps for Determining a TMDL

Although all watersheds must be handled on a case-by-case basis when developing TMDLs, there are basic processes or steps that apply to all cases. They include:

1. Collection and summarization of pre-existing data (watershed characterization, inventory contaminant sources, determination of pollutant loads, etc.);
2. Calculate TMDL for the waterbody using EPA approved methods and computer models;
3. Allocate pollutant loads to various sources;
4. Determine critical and seasonal conditions;
5. Submit draft report for public review and comments; and
6. EPA approval of the TMDL.

TMDL Elements (WLA, LA, MOS)

A TMDL equation consists of a wasteload allocation, load allocation and a margin of safety. The wasteload allocation (WLA) is the portion of the load assigned to point sources (National Pollutant Discharge Elimination System (NPDES) permitted discharges). The load allocation (LA) is the portion of the load assigned to nonpoint sources (non-permitted). The margin of safety (MOS) is applied to account for uncertainties in the computational process. The MOS may be expressed implicitly (documenting conservative processes in the computations) or explicitly (setting aside a portion of the allowable load).

Future TMDL Modifications

In the future, the Department may adjust the load and/or wasteload allocations in this TMDL to account for new information or circumstances that are developed or discovered during the implementation of the TMDL when a review of the new information or circumstances indicate that such adjustments are appropriate. Adjustment between the load and wasteload allocation will only be made following an opportunity for public participation. A wasteload allocation adjustment will be made consistent and simultaneous with associated permit(s) revision(s)/reissuances (i.e., permits for revision/reissuance in association with a TMDL revision will be made available for public comment concurrent with the related TMDLs availability for public comment). New information generated during TMDL implementation may include among other things, monitoring data, BMP effectiveness information, and land use information. All changes in the TMDL will be tallied and once the total changes exceed 1% of the total original TMDL allowable load, the TMDL will be revised. The adjusted TMDL, including its LAs and WLAs, will be set at a level necessary to implement the applicable water quality standards (WQS) and any adjustment increasing a WLA will be supported by reasonable assurance demonstration that load allocations will be met. The Department will notify EPA of any adjustments to the TMDL within 30 days of its adoption and will maintain current tracking mechanisms that contain accurate loading information for TMDL waters.

Changes in TMDLs That May Require EPA Approval

- Increase in total load capacity.

- Transfer of load between point (WLA) and nonpoint (LA) sources.
- Modification of the margin of safety (MOS).
- Change in water quality standards (WQS).
- Non-attainment of WQS with implementation of the TMDL.
- Allocation transfers in trading programs.

Changes in TMDLs That May Not Require EPA Approval

- Total loading shift less than or equal to 1% of the total load.
- Increase of WLA results in greater LA reductions provided reasonable assurance of implementation is demonstrated (a compliance/implementation plan and schedule).
- Changes among WLAs with no other changes; TMDL public notice concurrent with permit public notice.
- Removal of a pollutant source that will not be reallocated.
- Reallocation between LAs.
- Changes in land use.

TMDL Approach

The TMDL developed for the Silver Creek Watershed addresses sediment. Because neither Pennsylvania nor EPA has water quality criteria for sediment, a method was developed to determine water quality objectives for this pollutant that should result in the impaired stream segments attaining their designated uses. The method employed for this TMDL is termed the “Reference Watershed Approach”.

Selection of the Reference Watershed

The reference watershed approach was used to estimate the appropriate sediment loading reduction necessary to restore healthy aquatic communities to the Silver Creek Watershed. This approach is based on selecting a non-impaired, or reference, watershed and estimating its current loading rates for the pollutants of interest. The objective of the process is to reduce loading rates of those pollutants identified as causing impairment to a level equivalent to or lower than the loading rates in the reference watershed. Achieving the appropriate load reductions should allow the return of a healthy biological community to affected stream segments.

First, there are three factors that should be considered when selecting a suitable reference watershed: impairment status, similarity of physical properties, and size of the watershed. A watershed that the Department has assessed and determined to be attaining water quality standards should be used as the reference. Second, a watershed that closely resembles the impaired watershed in physical properties such as land use/land cover, physiographic province, elevation, slope and geology should be chosen. Finally, the size of the reference watershed should be within 20-30% of the impaired watershed area.

The search for a reference watershed that would satisfy the above characteristics was done by means of a desktop screening using several GIS shapefiles, including a watershed layer, geologic formations layer, physiographic province layer, soils layer, Landsat-derived land cover/use grid, and the stream assessment information found on the Department’s Instream Comprehensive Evaluation

(ICE) GIS-based website. The suitability of the chosen watershed was confirmed through discussions with Department staff as well as through field verification of conditions.

A portion of Monongahela Creek was selected as the reference watershed for developing the Silver Creek Watershed TMDL. Monongahela Creek is a tributary to Penns Creek. The portion used as the reference watershed encompasses the headwaters. This portion of Monongahela Creek is located in parts of Jackson, Middlecreek and Penn Townships in Snyder County, Pennsylvania. The watershed is located in the Ridge and Valley physiographic province in State Water Plan (SWP) sub-basin 06A. Unless otherwise noted, any reference to the "Monongahela Creek Watershed" in this document refers only to this headwaters portion of the watershed. Monongahela Creek is identified in ICE as attaining its designated uses. The attainment of designated uses is based on biological sampling done by the Department.

Table 4 compares the two watersheds in terms of size, location, and other physical characteristics.

Table 4. Comparison of the Silver Creek & Monongahela Creek Watersheds

	Silver Creek Watershed	Monongahela Creek Watershed
Physiographic Province	Ridge and Valley	Ridge and Valley
Area (acres)	2858	2657
Land Use Distribution		
% Agriculture	76	74
% Forest	15	19
% Other	9	7
Soils		
Dominant Group C	100	100
Surface Geology		
Interbedded Sedimentary	89	100
Sandstone	11	
Average Rainfall (in.)	42.11, 23 years	42.11, 23 years
Average Runoff (in.)	3.66, 23 years	3.56, 23 years

The analysis of value counts for each pixel of the Multi-Resolution Land Characterization (MRLC) grid revealed that land cover/use distributions in both watersheds are similar. Agriculture is the dominant land use category in the Silver Creek and Monongahela Creek watersheds, 76% and 74%, respectively.

Silver Creek and Monongahela Creek lie within the Ridge and Valley Physiographic Province. Surface geology in the watershed consists mainly of Interbedded Sedimentary.

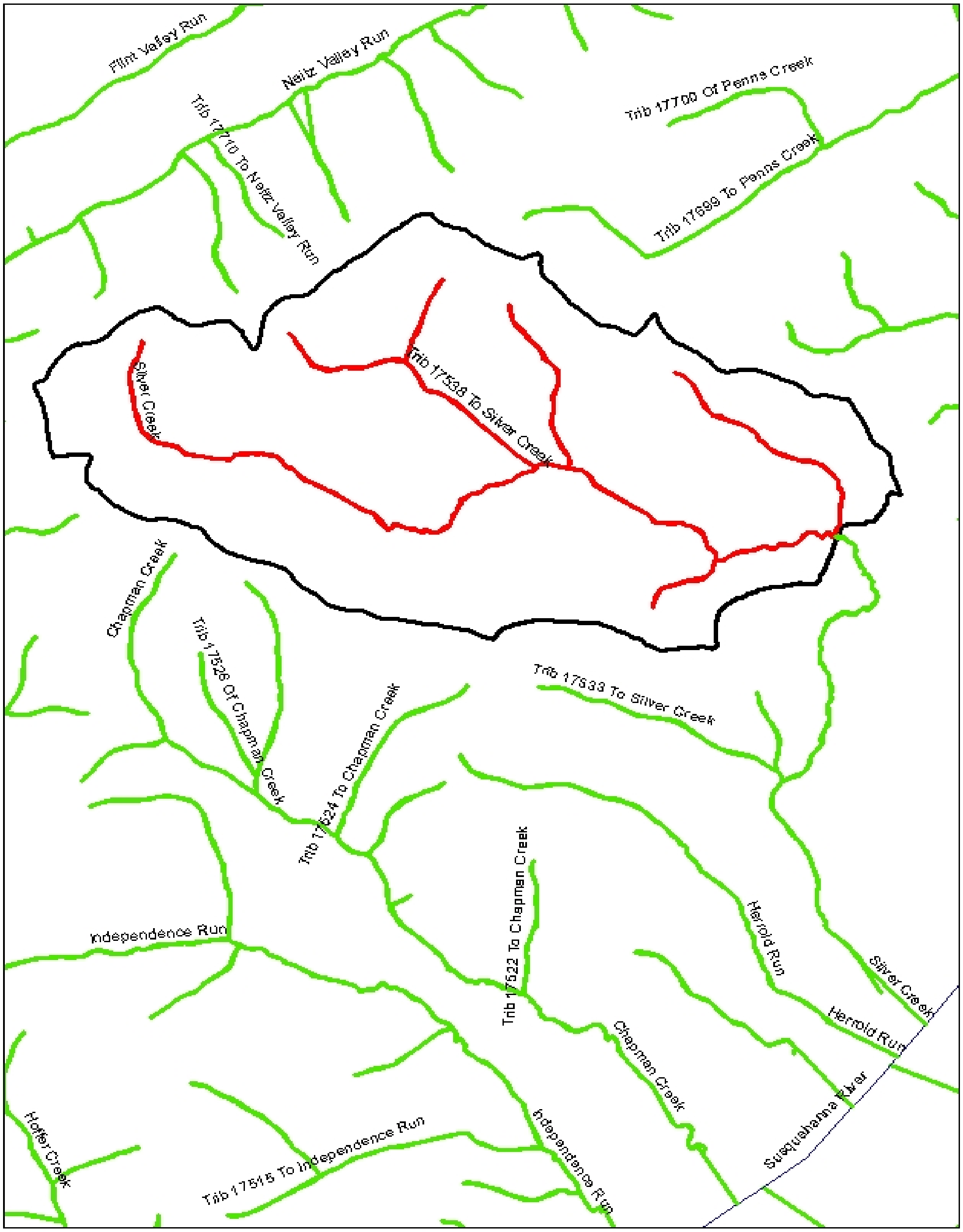


Figure 1. Impaired Portion of Silver Creek Watershed

Figure 2. Reference Portion of Monongahela Creek Watershed

Hydrologic / Water Quality Modeling

Part 1. Model Overview & Data Compilation

The TMDL for this watershed was calculated using the ArcView Generalized Watershed Loading Function (AVGWLF) Interface for Windows, version 7.2.3. The remaining paragraphs in this section are excerpts from the GWLF User's Manual (Haith et al., 1992).

The core watershed simulation model for the AVGWLF software application is the GWLF (Generalized Watershed Loading Function) model developed by Haith and Shoemaker. The original DOS version of the model was re-written in Visual Basic by Evans et al. (2002) to facilitate integration with ArcView, and tested extensively in the U.S. and elsewhere.

The GWLF model provides the ability to simulate runoff and sediment load from a watershed given variable-size source areas (i.e., agricultural, forested, and developed land). It 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 on the daily water balance accumulated to monthly values.

GWLF is considered to be a combined distributed/lumped parameter watershed model. For surface loading, it is distributed in the sense that it allows multiple land use/cover scenarios, but 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 simply aggregates the loads from each source 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 simply computed as the difference between precipitation and snowmelt minus surface runoff plus evapotranspiration.

With respect to the major processes simulated, GWLF models surface runoff using the Soil Conservation Service Curve Number, or 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 (i.e., 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 the conservation practices factor (P). A sediment delivery ratio based on watershed size and transport capacity, which is based on average daily runoff, is then applied to the calculated erosion to determine sediment yield for each source 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.

For execution, the model requires two separate input files containing transport and weather-related data. The transport (transport.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 weather (weather.dat) file contains daily average temperature and total precipitation values for each year simulated.

Since its initial incorporation into AVGWLF, the GWLF model has been revised to include a number of routines and functions not found in the original model. For example, a significant revision in one of the earlier versions of AVGWLF was the inclusion of a streambank erosion routine. This routine is based on an approach often used in the field of geomorphology in which monthly streambank erosion is estimated by first calculating a watershed-specific lateral erosion rate (LER). After a value for LER has been computed, the total sediment load generated via streambank erosion is then calculated by multiplying the above erosion rate by the total length of streams in the watershed (in meters), the average streambank height (in meters), and the average soil bulk density (in kg/m3).

The inclusion of the various model enhancements mentioned above has necessitated the need for several more input files than required by the original GWLF model, including a “scenario” (*.scn) file, an animal data (animal.dat) file. Also, given all of the new and recent revisions to the model, it has been renamed “GWLF-E” to differentiate it from the original model.

As alluded to previously, the use of GIS software for deriving input data for watershed simulation models such as GWLF is becoming fairly standard practice due to the inherent advantages of using GIS for manipulating spatial data. In this case, a customized interface developed by Penn State University for ArcView GIS software (versions 3.2 or 3.3) is used to parameterize input data for the GWLF-E model. In utilizing this interface, the user is prompted to load required GIS files and to provide other information related to various “non-spatial” model parameters (e.g., beginning and end of the growing season; the months during which manure is spread on agricultural land, etc.). This information is subsequently used to automatically derive values for required model input parameters which are then written to the appropriate input files needed to execute the GWLF-E model. Also accessed through the interface are Excel-formatted weather files containing daily temperature and precipitation information. (In the version of AVGWLF used in Pennsylvania, a statewide weather database was developed that contains about twenty-five (25) years of temperature and precipitation data for seventy-eight (78) weather stations around the state). This information is used to create the necessary weather.dat input file for a given watershed simulation.

Part 2. GIS Based Derivation of Input Data

The primary sources of data for this analysis were geographic information system (GIS) formatted databases and shapefiles. In using the AVGWLF 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 growing season, manure spreading period, etc.). This information is subsequently used to automatically derive values for required model input parameters, which are then written to the TRANSPRT.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 cropping practices. Complete GWLF-formatted weather files are also included for the seventy-eight weather stations around the state.

Table 5 lists GIS datasets and shapefiles used for the Silver Creek TMDL calculations via AVGWLF and provides explanations of how they were used for development of the input files for the GWLF model.

Table 5. GIS Datasets	
DATASET	**DESCRIPTION**
county.shp	The county boundaries coverage lists data on conservation practices which provides C and P values in the Universal Soil Loss Equation (USLE).
padem	100 meter digital elevation model; this is used to calculate landslope and slope length.
palumrlc	A satellite image derived land cover grid which is classified into 15 different landcover categories. This dataset provides landcover loading rates for the different categories in the model.
physprov.shp	A shapefile of physiographic provinces. This is used in rainfall erosivity calculations.
smallsheds.shp	A coverage of watersheds derived at 1:24,000 scale. This coverage is used with the stream network to delineate the desired level watershed.
streams.shp	The 1:24,000 scale single line stream coverage of Pennsylvania. Provides a complete network of streams with coded stream segments.
PAgeo	A shapefile of the surface geology used to compare watersheds of similar qualities.
weathersta.shp	Historical weather files for stations around Pennsylvania to simulate flow.
soils.shp	A shapefile providing soil characteristics data. This is used in multiple calculations.
zipcodes.shp	This shapefile provides animal density numbers used in the LER calculation.

In the GWLF model, the nonpoint source load calculated is affected by terrain conditions such as amount of agricultural land, land slope, and inherent soil erodibility. It is also affected by farming practices utilized in the area. Various parameters are included in the model to account for these conditions and practices. Some of the more important parameters are summarized below:

Areal extent of different land use/cover categories: This is calculated directly from a GIS layer of land use/cover.

Curve number: This determines the amount of precipitation that infiltrates into the ground or enters surface water as runoff. It is based on specified combinations of land use/cover and hydrologic soil type, and is calculated directly using digital land use/cover and soils layers.

K factor: This factor relates to inherent soil erodibility, and affects the amount of soil erosion taking place on a given unit of land.

LS factor: This factor signifies the steepness and length of slopes in an area and directly affects the amount of soil erosion.

C factor: This factor is related to the amount of vegetative cover in an area. In agricultural areas, the crops grown and the cultivation practices utilized largely control this factor. Values range from 0 to 1.0, with larger values indicating greater potential for erosion.

P factor: This factor is directly related to the conservation practices utilized in agricultural areas. Values range from 0 to 1.0, with larger values indicating greater potential for erosion.

Sediment delivery ratio: This parameter specifies the percentage of eroded sediment that is delivered to surface water and is empirically based on watershed size.

Unsaturated available water-holding capacity: This relates to the amount of water that can be stored in the soil and affects runoff and infiltration. It is calculated using a digital soils layer.

Other less important factors that can affect sediment loads in a watershed are also included in the model.

The above parameter descriptions were taken from the *AVGWLF Version 7.1 Users Guide* (Evans et al., 2007).

Watershed Assessment and Modeling

The AVGWLF model was used to establish existing loading conditions for the Silver Creek and the Monongahela Creek Watersheds. All AVGWLF data and outputs have been attached to this TMDL as Attachment C. Department staff visited the Silver Creek Watershed and the Monongahela Creek Watershed to get a better understanding of existing conditions that might influence the AVGWLF model. General observations of the individual watershed characteristics included:

Silver Creek Watershed (impaired)

- limited or absent riparian buffers in the agricultural areas
- tilled agricultural areas
- mowing up to the stream bank
- excessive sediment deposits on streambeds
- streambank erosion
- livestock in the stream

Monongahela Creek Watershed (reference)

- extensive forested riparian buffers
- grass planted in contours of hills to prevent erosion
- contour cropping

Based on field observations adjustments may be made to specific parameters used in the AVGWLF model. These adjustments were as follows:

Silver Creek Watershed

- No changes to the model were necessary for the Silver Creek Watershed.

Monongahela Creek Watershed

- No changes to the model were necessary for the Monongahela Creek Watershed.

Figure 3. Streambank erosion evident in Silver Creek

Figure 4. Livestock access to Silver Creek

Figure 5. Agricultural erosion channels evident in Silver Creek

Figure 6. Cover cropping and grass strips in Monongahela Creek Watershed

Figure 7. Forested riparian buffers in the Monongahela Creek Watershed

The AVGWLF model produced area information and sediment loading based on land use (Tables 6 and 7).

Table 6. Existing Loading Values for Silver Creek (impaired)			
Source	Area (ac)	Sediment (lbs)	Unit Area Load (lbs/ac/yr)
HAY/PAST	1,137	108,000	95
CROPLAND	890	2,834,200	3,186
FOREST	400	2,200	5
TRANSITION	12	26,600	2,145
LO_INT_DEV	225	17,000	76
Stream Bank		141,000	
total	2,664	3,129,000	1,175

Table 7. Existing Loading Values for Monongahela Creek (reference)			
Source	Area (ac)	Sediment (lbs.)	Unit Area Load (lb/ac/yr)
HAY/PAST	1,048	78,600	75
CROPLAND	801	1,253,800	1,566
FOREST	467	4,200	9
WETLAND	3	0	0
TRANSITION	5	9,400	1,918
LO_INT_DEV	158	16,400	104
Stream Bank		120,000	
total	2,481	1,482,400	598

For Tables 6 and 7 the "stream bank" sediment loads are calculated by AVGWLF's stream bank routine. This routine uses stream bank (linear) miles rather than area.
Unit area Loads are calculated using rounded values.

Development of Sediment TMDL

The target TMDL value for the Silver Creek Watershed was established based on current loading rates for sediment in the Monongahela Creek reference watershed. Monongahela Creek is currently designated as a Warm Water Fishes (WWF) and previous biological assessments have determined that the portion of the basin used as a reference is attaining its designated uses. Reducing the loading rates of sediment in the Silver Creek Watershed to levels equal to, or less than, the reference watershed should allow for the reversal of current use impairments.

As described in the previous section, sediment loading rates were computed for the Monongahela Creek Watershed using the AVGWLF model. The target TMDL value for sediment was determined by multiplying the unit area loading rates for the Monongahela Creek Watershed by the total watershed area of the Silver Creek Watershed (Table 8).

Table 8. TMDL Values for the Silver Creek Watershed				
Pollutant	Loading Rate in Reference (lb/ac-yr)	Total Area in Silver Creek Watershed (ac)	Target TMDL Value (lb/yr)	Target TMDL Value (lb/day)
Sediment	598	2,664	1,591,811*	4,361

* takes into account rounding in previous calculations

The target TMDL value was then used as the basis for load allocations and reductions in the Silver Creek Watershed, using the following two equations:

1. TMDL = WLA + LA + MOS
2. LA = ALA + LNR

where:

TMDL = Total Maximum Daily Load
WLA = Waste Load Allocation (Point Sources)
LA = Load Allocation (Nonpoint Sources)
MOS = Margin of Safety
ALA = Adjusted Load Allocation
LNR = Loads Not Reduced

Waste Load Allocation

The waste load allocation (WLA) portion of the TMDL equation is the total loading of a pollutant that is assigned to point sources. There are no permitted discharges in the Silver Creek Watershed. A bulk reserve allocation of 1.0% of the TMDL is set to account for the dynamic nature of future permit activity.

Margin of Safety

The margin of safety (MOS) is that portion of the pollutant loading that is reserved to account for any uncertainty in the data and computational methodology used for the analysis. For this analysis, the MOS is explicit. Ten percent of the targeted TMDL for sediment was reserved as the MOS. Using 10% of the TMDL load is based on professional judgment and will provide an additional level of protection to the designated uses of Silver Creek. The MOS used for the sediment TMDL was set at 159,181 lbs./yr.

MOS = 1,591,811 lbs./yr. (TMDL) * 0.1 = 159,181 lbs./yr.
or
MOS = 4,361 lbs./day (TMDL) * 0.1 = 436 lbs./day

Load Allocation

The load allocation (LA) is that portion of the TMDL that is assigned to nonpoint sources. The LA for sediment was computed by subtracting the MOS value and the WLA from the TMDL value. The LA for sediment was 1,416,712 lbs./yr.

LA = 1,591,811 lbs./yr. (TMDL) – 159,181 lbs./yr. (MOS) – 15,918 lbs./yr. (WLA)= 1,416,712 lbs./yr.

or

LA = 4,361 lbs./day (TMDL) – 436 lbs./day (MOS) – 44 lbs./day (WLA)= 3,881 lbs./day

Adjusted Load Allocation

The adjusted load allocation (ALA) is the actual portion of the LA distributed among those nonpoint sources receiving reductions. It is computed by subtracting those nonpoint source loads that are not being considered for reductions (loads not reduced (LNR)) from the LA. While the Silver Creek Watershed TMDL was developed to address impairments caused by agricultural activities including, hay/pastureland (Hay/Past) and Cropland, they were not the only land uses considered for reductions. Transitional land and stream banks noted in the Silver Creek Watershed were believed to also be a contributor to the sediment load in the watershed. Land uses/source loads not reduced (LNR) were carried through at their existing loading values (Table 9).

Table 9. Load Allocations, Loads Not Reduced and Adjusted Load Allocations

	Sediment (lbs./yr.)	Sediment (lbs./day)
Load Allocation	1,416,712	3,881
Loads Not Reduced: Forest Low Intensity Development	 2,200 17,000	 6 47
Adjusted Load Allocation	1,397,512	3,829

TMDL Summary

The sediment TMDL established for the Silver Creek Watershed consists of a Load Allocation (LA) a Margin of Safety (MOS) and a Waste Load Allocation (WLA). The individual components of the Silver Creek Watershed TMDL are summarized in Table 10.

Table 10. TMDL Components for the Silver Creek Watershed

Component	Sediment (lbs./yr.)	Sediment (lbs./day)
TMDL (Total Maximum Daily Load)	1,591,811	4,361
WLA (Waste Load Allocation)	15,918	44
MOS (Margin of Safety)	159,181	436
LA (Load Allocation)	1,416,712	3,881
LNR Loads Not Reduced)	19,200	53
ALA (Adjusted Load Allocation)	1,397,512	3,829

Calculation of Sediment Load Reductions

The adjusted load allocation established in the previous section represents the sediment load that is available for allocation between Hay/Pasture, Cropland, transitional land and stream banks in the Silver Creek Watershed. Data needed for load reduction analyses, including land use distribution, were obtained by GIS analysis. The Equal Marginal Percent Reduction (EMPR) allocation method, Attachment B, was used to distribute the ALA between the three land use types and stream banks. The process is summarized on the following page:

1. Each land use/source load is compared with the total allocable load to determine if any contributor would exceed the allocable load by itself. The evaluation is carried out as if each source is the only contributor to the pollutant load to the receiving waterbody. If the contributor exceeds the allocable load, that contributor would be reduced to the allocable load. This is the baseline portion of EMPR. For this evaluation Cropland was in excess of the adjusted load allocation (ALA).

2. 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 total allocable load. If the allocable load 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. For this evaluation the allocable load was exceeded. The equal percent reduction, i.e., the ALA divided by the summation of the baselines, worked out to a 59% reduction for Cropland and a 16% reduction for the remaining land uses/sources.

Tables 11 and 12 contain the results of the EMPR for Hay/Pasture, Cropland, transitional land and stream banks in the Silver Creek Watershed. The load allocation for each land use is shown along with the percent reduction of current loads necessary to reach the targeted LA.

Table 11. Sediment Load Allocations/Reductions for Land Uses and Stream Banks in the Silver Creek Watershed (Annual Values)

		Current Loading	**Allowable Loading**	**Current Load**	**Load Allocation**	
Land Use	Acres	(lbs./acre/yr.)	(lbs./acre/yr.)	(lbs./yr.)	(lbs./yr.)	% Reduction
Cropland	890	3,185.93	1,312.17	2,834,200	1,167,310	59
Hay/Pasture	1,137	95.01	79.36	108,000	90,210	16
Transitional	12	2,145.16	1,791.80	26,600	22,218	16
Stream banks				141,000	117,774	16

Table 12. Sediment Load Allocations/Reductions for Land Uses and Stream Banks in the Silver Creek Watershed (Daily Values)

		Current Loading	**Allowable Loading**	**Current Load**	**Load Allocation**	
Land Use	Acres	(lbs./acre/day)	(lbs./acre/day)	(lbs./day)	(lbs./day)	% Reduction
Cropland	890	8.73	3.60	7,765	3,198	59
Hay/Pasture	1,137	0.26	0.22	296	247	16
Transitional	12	5.88	4.91	73	61	16
Stream banks				386	323	16

Consideration of Critical Conditions

The AVGWLF model is a continuous simulation model, which uses daily time steps for weather data and water balance calculations. Monthly calculations are made for sediment loads, based on daily water balance accumulated in 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 this TMDL using average annual conditions is protective of the waterbody.

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.

Consideration of Background Contributions

The AVGWLF model accounts for all landuses within the watershed and their respective contributions to the sediment load. The only background sources of sediment within the watershed would be from forested areas. There are no additional “upstream” sources of sediment to this watershed as the Silver Creek Watershed including all headwaters was assessed and modeled. The remaining landuses are anthropogenic sources of sediment to the watershed, thus will not be considered background.

Recommendations

Sediment reduction in the TMDL is allocated to nonpoint sources in the watershed including: agricultural activities, transitional land and stream banks. Implementation of best management practices (BMPs) in the affected areas should achieve the loading reduction goals established in the TMDL. The Department will assure that cost-effective and reasonable best management practices for nonpoint source control are achieved.

From an agricultural perspective, reductions in the amount of sediment reaching the streams in the watershed can be made through the right combination of BMPs including, but not limited to: establishment of cover crops, strip cropping, residue management, no till, crop rotation, contour farming, terracing, stabilizing heavy use areas and proper management of storm water. Vegetated or forested buffers would be acceptable BMPs to intercept any runoff from farm fields. For the pasturing of farm animals and animal heavy use areas, acceptable BMPs may include: manure storage, rotational grazing, livestock exclusion fencing and forested riparian buffers. Some of these BMPs were observed in the Silver Creek Watershed; however, they were more extensively used in the Monongahela Creek Watershed. Being that both watersheds have a considerable amount of agricultural activities, it is apparent that the greater use of these BMPs in the reference watershed has contributed to its ability to maintain its attainment status as an unimpaired stream.

Stream banks contribute to the sediment load in Silver Creek. Stream bank stabilization projects would be acceptable BMPs for the eroded stream banks in the area. However, the establishment of forested riparian buffers is the most economical and effective BMP at providing stream bank stabilization and protection of the banks from freeze/thaw erosion and scouring flows. Forested riparian buffers also provide important natural and durable connectivity of land and water. This connectivity is necessary to provide cover, nesting and nursery sites, shade and stable temperatures, and viable substrate for aquatic organisms of all layers of the food web.

Important to TMDLs, established forested riparian buffers act as nutrient and sediment sinks. This is because the highly active and concentrated biological communities they maintain will assimilate and remove nutrients and sediment from the water column instead of allowing them to pass downstream, thus forested riparian buffers work directly toward attaining the goals of the TMDL by reducing pollutant loads. Forested riparian buffers also provide critical habitat to rare and sensitive amphibious and terrestrial organisms as well as migratory species. While forested riparian buffers are considered the most effective BMP, other possibilities for attaining the desired reductions may exist for the agricultural usages, as well as for the stream banks.

For both the agricultural landuses, further ground truthing should be performed in order to assess both the extent of existing BMPs, and to determine the most cost effective and environmentally protective combination of BMPs required for meeting the sediment reductions outlined in this report. A combined effort involving key personnel from the regional DEP office, the Snyder County Conservation District, Susquehanna River Basin Commission (SRBC) and other state and local agencies and/or watershed groups would be the most effective in accomplishing any ground truthing exercises. Development of a more detailed watershed implementation plan is recommended.

Public Participation

Public notice of the draft TMDL was published in the *Pennsylvania Bulletin* on June 4, 2011 to foster public comment on the allowable loads calculated.

Literature Cited

Haith, D. A.; Mandel, R.; Wu, R. S. for Cornell University *Generalized Watershed Loading Functions Version 2.0 User's Manual*; Ithaca, NY, 1992.

Evans, B. M.; Lehning, D. W.; Corradini, K. J. for The Pennsylvania State University *AVGWLF Version 7.1 Users Guide*; University Park, PA, 2007.

Attachment A
Maps of Silver Creek Watershed

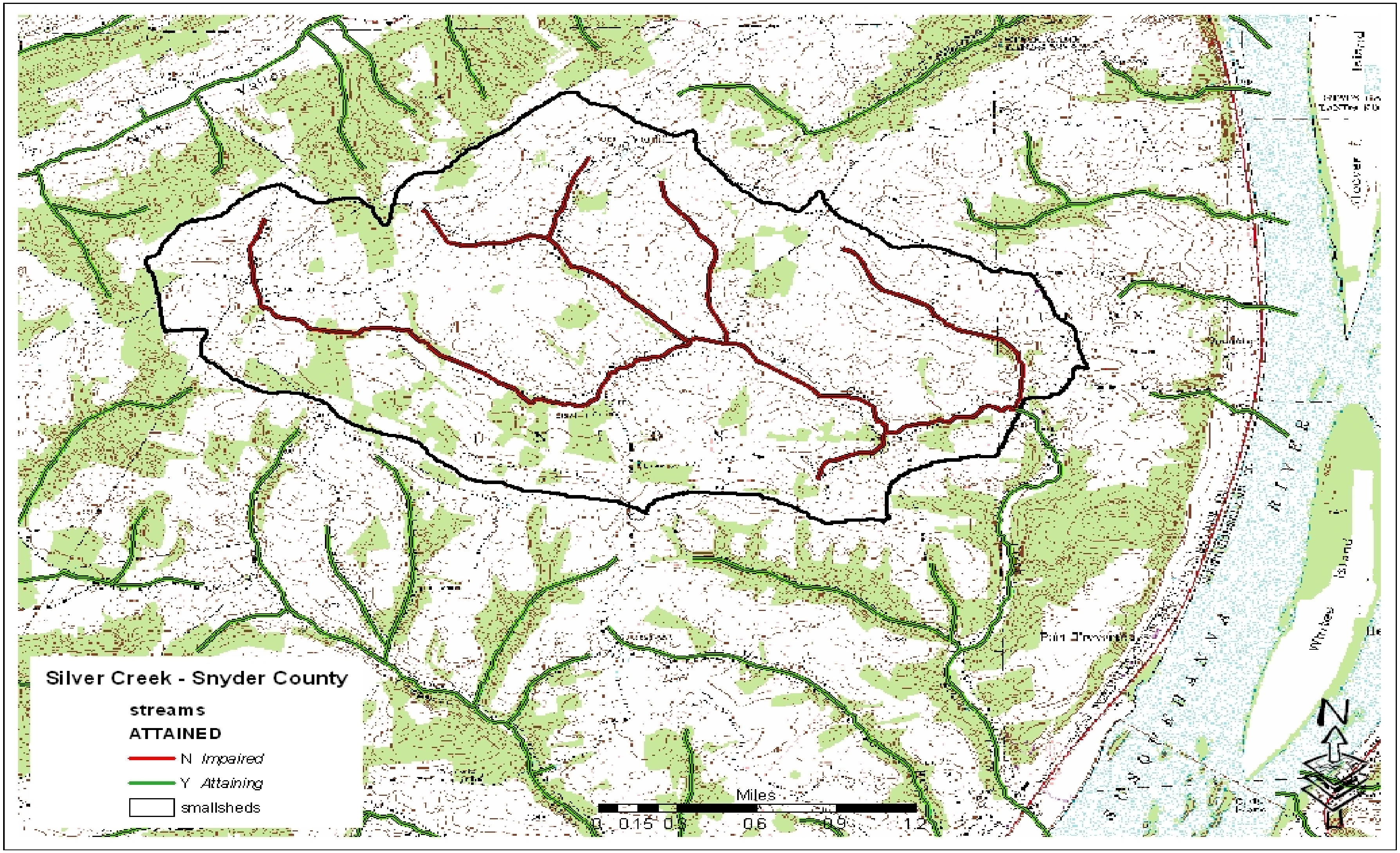


Figure A1. Silver Creek Watershed

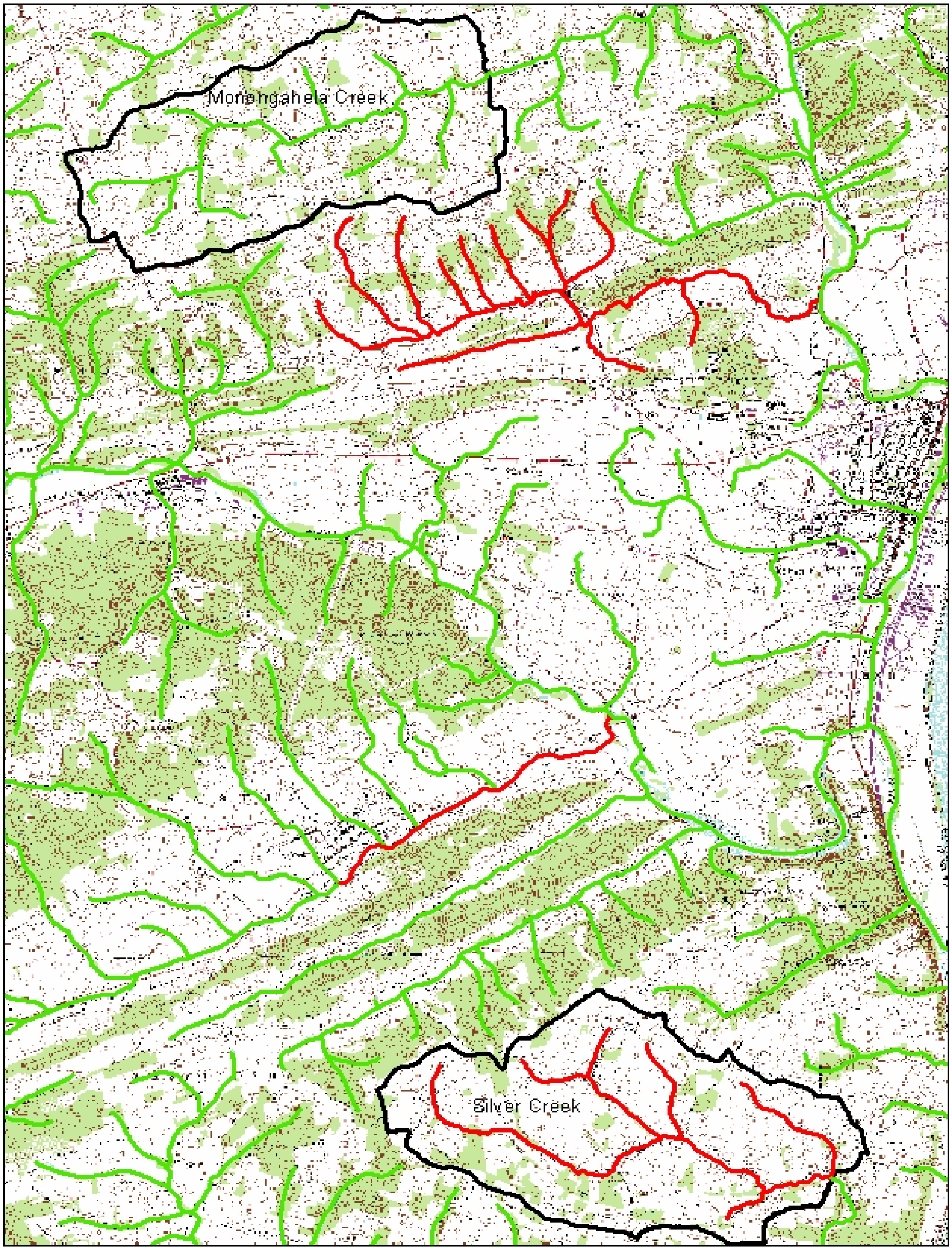


Figure A2. Silver Creek Watershed & Reference Watershed (Monongahela Creek)

Attachment B
Equal Marginal Percent Reduction Method

Equal Marginal Percent Reduction (EMPR) (An Allocation Strategy)

The Equal Marginal Percent Reduction (EMPR) allocation method was used to distribute Adjusted Load Allocations (ALAs) between the appropriate contributing nonpoint sources. The load allocation and EMPR procedures were performed using a MS Excel spreadsheet. 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.

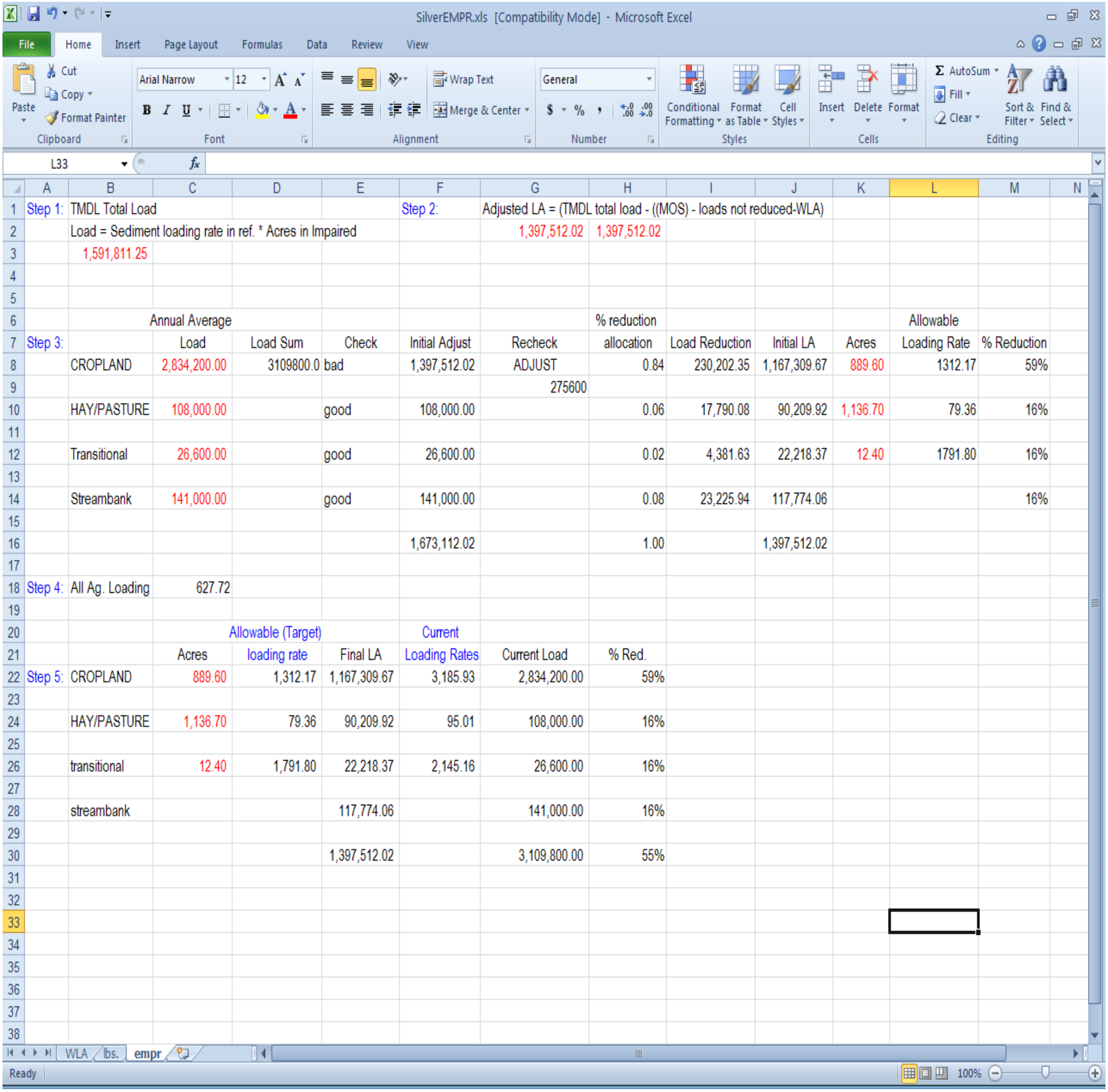
Step 3: Actual EMPR Process:

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 waterbody. 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.

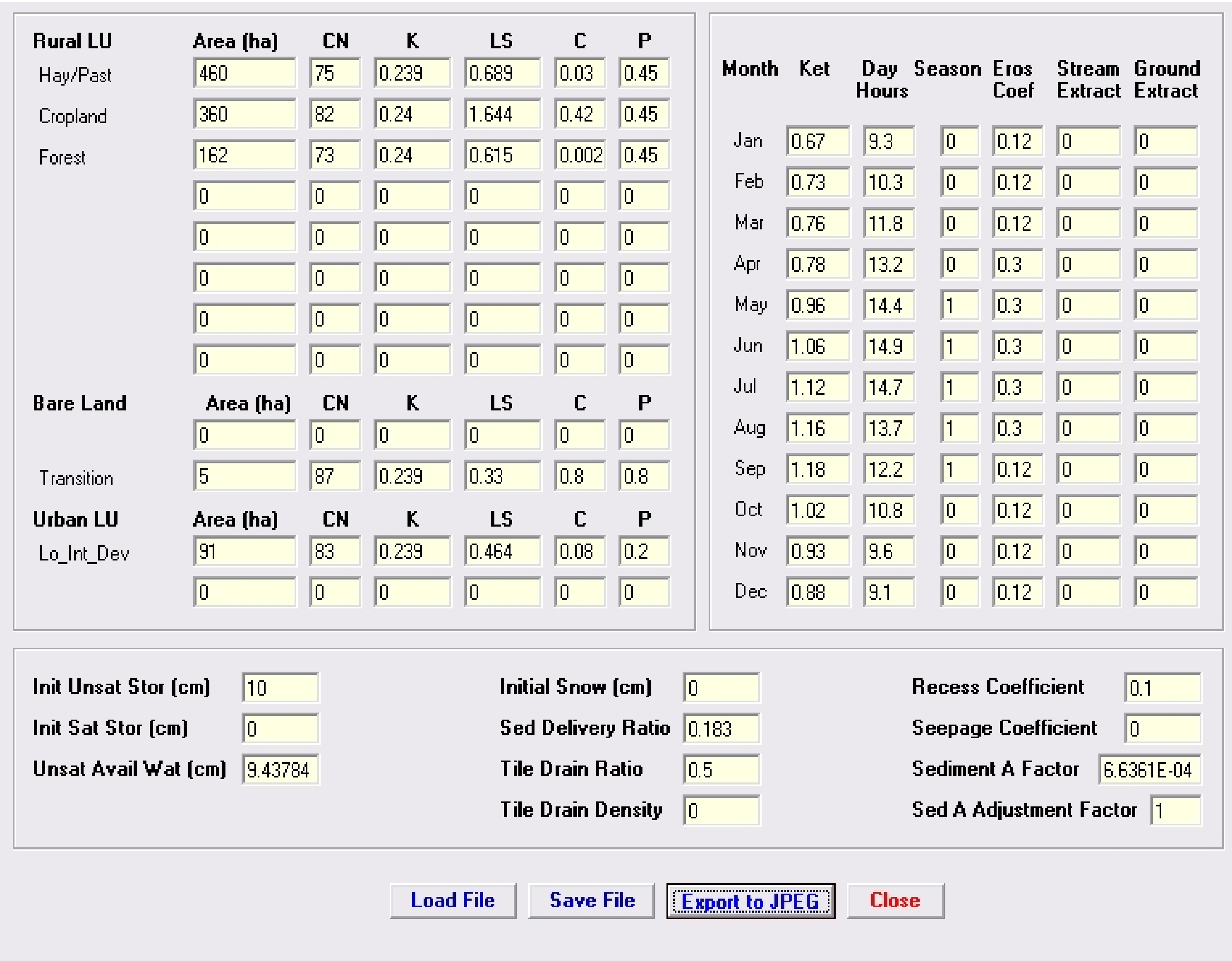
Step 5: Summary of existing loads, final load allocations, and % reduction for each pollutant source.



	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Step 1:	TMDL Total Load				Step 2:	Adjusted LA = (TMDL total load - ((MOS) - loads not reduced-WLA)						
2		Load = Sediment loading rate in ref. * Acres in Impaired					1,397,512.02	1,397,512.02					
3		1,591,811.25											
6			Annual Average					% reduction				Allowable	
7	Step 3:		Load	Load Sum	Check	Initial Adjust	Recheck	allocation	Load Reduction	Initial LA	Acres	Loading Rate	% Reduction
8		CROPLAND	2,834,200.00	3109800.0	bad	1,397,512.02	ADJUST	0.84	230,202.35	1,167,309.67	889.60	1312.17	59%
9							275600						
10		HAY/PASTURE	108,000.00		good	108,000.00		0.06	17,790.08	90,209.92	1,136.70	79.36	16%
12		Transitional	26,600.00		good	26,600.00		0.02	4,381.63	22,218.37	12.40	1791.80	16%
14		Streambank	141,000.00		good	141,000.00		0.08	23,225.94	117,774.06			16%
16						1,673,112.02		1.00		1,397,512.02			
18	Step 4:	All Ag. Loading	627.72										
20				Allowable (Target)		Current							
21			Acres	loading rate	Final LA	Loading Rates	Current Load	% Red.					
22	Step 5:	CROPLAND	889.60	1,312.17	1,167,309.67	3,185.93	2,834,200.00	59%					
24		HAY/PASTURE	1,136.70	79.36	90,209.92	95.01	108,000.00	16%					
26		transitional	12.40	1,791.80	22,218.37	2,145.16	26,600.00	16%					
28		streambank			117,774.06		141,000.00	16%					
30					1,397,512.02		3,109,800.00	55%					

Table B1. Equal Marginal Percent Reduction calculations for Silver Creek

Attachment C
AVGWLF Generated Data Tables



Rural LU	Area (ha)	CN	K	LS	C	P
Hay/Past	460	75	0.239	0.689	0.03	0.45
Cropland	360	82	0.24	1.644	0.42	0.45
Forest	162	73	0.24	0.615	0.002	0.45
	0	0	0	0	0	0
	0	0	0	0	0	0
	0	0	0	0	0	0
	0	0	0	0	0	0
	0	0	0	0	0	0
Bare Land	**Area (ha)**	**CN**	**K**	**LS**	**C**	**P**
	0	0	0	0	0	0
Transition	5	87	0.239	0.33	0.8	0.8
Urban LU	**Area (ha)**	**CN**	**K**	**LS**	**C**	**P**
Lo_Int_Dev	91	83	0.239	0.464	0.08	0.2
	0	0	0	0	0	0

Month	Ket	Day Hours	Season	Eros Coef	Stream Extract	Ground Extract
Jan	0.67	9.3	0	0.12	0	0
Feb	0.73	10.3	0	0.12	0	0
Mar	0.76	11.8	0	0.12	0	0
Apr	0.78	13.2	0	0.3	0	0
May	0.96	14.4	1	0.3	0	0
Jun	1.06	14.9	1	0.3	0	0
Jul	1.12	14.7	1	0.3	0	0
Aug	1.16	13.7	1	0.3	0	0
Sep	1.18	12.2	1	0.12	0	0
Oct	1.02	10.8	0	0.12	0	0
Nov	0.93	9.6	0	0.12	0	0
Dec	0.88	9.1	0	0.12	0	0

Init Unsat Stor (cm)	10	Initial Snow (cm)	0	Recess Coefficient	0.1
Init Sat Stor (cm)	0	Sed Delivery Ratio	0.183	Seepage Coefficient	0
Unsat Avail Wat (cm)	9.43784	Tile Drain Ratio	0.5	Sediment A Factor	6.6361E-04
		Tile Drain Density	0	Sed A Adjustment Factor	1

Table C1. Data contained in TRANSPRT.DAT for Silver Creek Watershed

GWLF Total Loads for file: SilverCreek2010-0

Period of analysis: 23 years from 1976 to 1998

			Tons		Total Loads (Pounds)			
Source	Area (Acres)	Runoff (in)	Erosion	Sediment	Dis N	Total N	Dis P	Total P
Hay/Past	1136.7	2.8	295.1	54.0	1868.2	2192.2	210.7	304.8
Cropland	889.6	4.9	7743.9	1417.1	2540.5	11043.3	286.9	2755.6
Forest	400.3	2.4	6.2	1.1	41.2	48.0	1.3	3.3
Transition	12.4	7.4	72.8	13.3	60.2	140.2	4.1	27.4
Lo_Int_Dev	224.9	5.3	46.5	8.5	0.0	110.4	0.0	14.7
Farm Animals						0.0		0.0
Tile Drainage				0.0		0.0		0.0
Stream Bank				70.5		7.1		3.1
Groundwater					25440.4	25440.4	274.5	274.5
Point Sources					0.0	0.0	0.0	0.0
Septic Systems					128.4	128.4	22.5	22.5
Totals	2663.8	3.70	8164.6	1564.6	30078.9	39109.9	800.2	3405.9

Go Back | Pathogen Loads | Export to JPEG | Print | Close

Table C2. Outputs for Silver Creek Watershed

Rural LU	Area (ha)	CN	K	LS	C	P
Hay/Past	424	75	0.238	0.544	0.03	0.45
Cropland	324	82	0.238	0.811	0.42	0.45
Forest	189	73	0.239	0.986	0.002	0.45
Wetland	1	87	0.24	0.682	0.01	0.1
	0	0	0	0	0	0
	0	0	0	0	0	0
	0	0	0	0	0	0
	0	0	0	0	0	0
Bare Land	**Area (ha)**	**CN**	**K**	**LS**	**C**	**P**
	0	0	0	0	0	0
Transition	2	87	0.239	0.29	0.8	0.8
Urban LU	**Area (ha)**	**CN**	**K**	**LS**	**C**	**P**
Lo_Int_Dev	64	83	0.239	0.635	0.08	0.2
	0	0	0	0	0	0

Month	Ket	Day Hours	Season	Eros Coef	Stream Extract	Ground Extract
Jan	0.67	9.3	0	0.12	0	0
Feb	0.73	10.3	0	0.12	0	0
Mar	0.76	11.8	0	0.12	0	0
Apr	0.78	13.2	0	0.3	0	0
May	0.96	14.4	1	0.3	0	0
Jun	1.06	14.9	1	0.3	0	0
Jul	1.12	14.7	1	0.3	0	0
Aug	1.16	13.7	1	0.3	0	0
Sep	1.18	12.2	1	0.12	0	0
Oct	1.02	10.8	0	0.12	0	0
Nov	0.93	9.6	0	0.12	0	0
Dec	0.88	9.1	0	0.12	0	0

Init Unsat Stor (cm)	10	**Initial Snow (cm)**	0	**Recess Coefficient**	0.1
Init Sat Stor (cm)	0	**Sed Delivery Ratio**	0.184	**Seepage Coefficient**	0
Unsat Avail Wat (cm)	9.67917	**Tile Drain Ratio**	0.5	**Sediment A Factor**	5.9579E-04
		Tile Drain Density	0	**Sed A Adjustment Factor**	1

Load File | Save File | Export to JPEG | Close

Table C3. Data contained in TRANSPRT.DAT for Monongahela Creek Watershed

GWLF Total Loads for file: SilverRefMonongahela2010-7180

Period of analysis: 23 years from 1976 to 1998

Source	Area (Acres)	Runoff (in)	Tons: Erosion	Tons: Sediment	Total Loads (Pounds): Dis N	Total Loads (Pounds): Total N	Total Loads (Pounds): Dis P	Total Loads (Pounds): Total P
Hay/Past	1047.7	2.8	213.7	39.3	1722.0	1957.9	194.6	266.4
Cropland	800.6	4.9	3407.3	626.9	2286.5	6048.2	258.8	1402.3
Forest	467.0	2.4	11.6	2.1	48.1	60.8	1.5	5.4
Wetland	2.5	7.4	0.0	0.0	0.8	0.8	0.0	0.0
Transition	4.9	7.4	25.6	4.7	24.1	52.4	1.7	10.3
Lo_Int_Dev	158.1	5.3	44.8	8.2	0.0	77.6	0.0	10.4
Farm Animals						0.0		0.0
Tile Drainage				0.0		0.0		0.0
Stream Bank				60.0		6.0		2.6
Groundwater					23513.7	23513.7	254.5	254.5
Point Sources					0.0	0.0	0.0	0.0
Septic Systems					67.0	67.0	9.4	9.4
Totals	2480.9	3.60	3703.1	741.4	27662.2	31784.5	720.4	1961.2

Go Back | Pathogen Loads | Export to JPEG | Print | Close

Table C4. Outputs for Monongahela Creek Watershed

Attachment D
Pennsylvania Integrated Water Quality Monitoring and Assessment Report: Streams, Category 5 Waterbodies, Pollutants Requiring a TMDL

Stream Name Use Designation (Assessment ID) Source	Cause	Date Listed	TMDL Date

Hydrologic Unit Code: 02050301 - Lower Susquehanna-Penns

Silver Creek
HUC: 02050301

Aquatic Life (254) - 3.89 miles; 5 Segment(s)*			
Grazing Related Agric	Siltation	2002	2015

Silver Creek (Unt 17535)
HUC: 02050301

Aquatic Life (254) - 1.14 miles; 1 Segment(s)*			
Grazing Related Agric	Siltation	2002	2015

Silver Creek (Unt 17536)
HUC: 02050301

Aquatic Life (254) - 0.39 miles; 1 Segment(s)*			
Grazing Related Agric	Siltation	2002	2015

Silver Creek (Unt 17537)
HUC: 02050301

Aquatic Life (254) - 0.83 miles; 1 Segment(s)*			
Grazing Related Agric	Siltation	2002	2015

Silver Creek (Unt 17538)
HUC: 02050301

Aquatic Life (254) - 1.14 miles; 2 Segment(s)*			
Grazing Related Agric	Siltation	2002	2015

Silver Creek (Unt 17539)
HUC: 02050301

Aquatic Life (254) - 0.57 miles; 2 Segment(s)*			
Grazing Related Agric	Siltation	2002	2015

Report Summary

Watershed Summary

	Stream Miles	Assessment Units	Segments (COMIDs)
Watershed Characteristics	9.06	1	13

Impairment Summary

Source	Cause	Miles	Assessment Units	Segments (COMIDs)
Grazing Related Agric	Siltation	7.96	1	12

*Segments are defined as individual COM IDs.

Attachment E
Excerpts Justifying Changes between the 1996, 1998, and 2002 Section 303(d) Lists and the 2004 and 2006 Integrated Water Quality Reports

The following are excerpts from the Pennsylvania DEP Section 303(d) narratives that justify changes in listings between the 1996, 1998, and 2002 303(d) Lists and the 2004 and 2006 Integrated Water Quality Report. The Section 303(d) listing process has undergone an evolution in Pennsylvania since the development of the 1996 list.

In the 1996 Section 303(d) narrative, strategies were outlined for changes to the listing process. Suggestions included, but were not limited to, a migration to a Global Information System (GIS), improved monitoring and assessment, and greater public input.

The migration to a GIS was implemented prior to the development of the 1998 Section 303(d) list. As a result of additional sampling and the migration to the GIS some of the information appearing on the 1996 list differed from the 1998 list. Most common changes included:

1. mileage differences due to recalculation of segment length by the GIS;
2. slight changes in source(s)/cause(s) due to new EPA codes;
3. changes to source(s)/cause(s), and/or miles due to revised assessments;
4. corrections of misnamed streams or streams placed in inappropriate SWP subbasins; and
5. unnamed tributaries no longer identified as such and placed under the named watershed listing.

Prior to 1998, segment lengths were computed using a map wheel and calculator. The segment lengths listed on the 1998 Section 303(d) list were calculated automatically by the GIS (ArcInfo) using a constant projection and map units (meters) for each watershed. Segment lengths originally calculated by using a map wheel and those calculated by the GIS did not always match closely. This was the case even when physical identifiers (e.g., tributary confluence and road crossings) matching the original segment descriptions were used to define segments on digital quad maps. This occurred to some extent with all segments, but was most noticeable in segments with the greatest potential for human errors using a map wheel for calculating the original segment lengths (e.g., long stream segments or entire basins).

Migration to National Hydrography Data (NHD)

New to the 2006 report is use of the 1/24,000 National Hydrography Data (NHD) streams GIS layer. Up until 2006 the Department relied upon its own internally developed stream layer. Subsequently, the United States Geologic Survey (USGS) developed 1/24,000 NHD streams layer for the Commonwealth based upon national geodatabase standards. In 2005, DEP contracted with USGS to add missing streams and correct any errors in the NHD. A GIS contractor transferred the old DEP stream assessment information to the improved NHD and the old DEP streams layer was archived. Overall, this marked an improvement in the quality of the streams layer and made the stream assessment data compatible with national standards but it necessitated a change in the Integrated Listing format. The NHD is not attributed with the old DEP five digit stream codes so segments can no longer be listed by stream code but rather only by stream name or a fixed combination of NHD fields known as reachcode and ComID. The NHD is aggregated by Hydrologic Unit Code (HUC) watersheds so HUCs rather than the old State Water Plan (SWP) watersheds are now used to group streams together. A more basic change was the shift in data management philosophy from one of “dynamic segmentation” to “fixed segments”. The dynamic segmentation records were proving too difficult to mange from an historical tracking perspective. The fixed segment methods will remedy that problem. The stream assessment data management has gone through many changes over the years as system requirements and software changed. It is hoped that with the shift to the NHD and OIT’s (Office of

Information Technology) fulltime staff to manage and maintain SLIMS the systems and formats will now remain stable over many Integrated Listing cycles.

Attachment F
Comment and Response

No public comments were received for the Silver Creek TMDL.