Mill Creek Headwaters Subwatershed TMDL,

Lebanon County, Pennsylvania

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Executive Summary

Mill Creek is a tributary of Tulpehocken Creek in Lebanon County, Central Pennsylvania (PA). A Total Maximum Daily Load (TMDL) for nonpoint sediment loads in the headwaters of Mill Creek was developed to address impairments noted in Pennsylvania's 2016 Section 303(d) and Pennsylvania Integrated Water Quality Monitoring and Assessment Report (Integrated List). The impairments were documented during biological surveys of the aquatic life present in the watershed in 2004. Excessive siltation resulting from agricultural activities has been identified as the cause of these impairments in the basin. Because 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 Mill Creek Subwatershed is 5,160,800 pounds per year, 14,139 pounds per day. Based on a comparison with a similar, unimpaired watershed, Mountain Run, the maximum sediment loading that should allow water quality objectives to be met in the Mill Creek Subwatershed is 1,897,249 pounds per year, 5,198 pounds per day. Allocation of the sediment TMDL is summarized in Table 1.

Table 1. Summary of TMDL for Mill Creek Subwatershed in lbs./yr. & lbs./day

Summary of TMDL for the Mill Creek Watershed, lbs/yr:						
Pollutant	TMDL	MOS	WLA	LA	LNR	ALA
Sediment	1,897,249	189,725	18,972	1,688,552	9,000	1,679,552
Summary of TMDL for the Mill Creek Watershed, lbs/day:						
Pollutant	TMDL	MOS	WLA	LA	LNR	ALA
Sediment	5,198	520	520	4,626	25	4,602

10% of the TMDL value was reserved explicitly as a margin of safety (MOS). 1% of the TMDL value was reserved for a bulk reserve allocation for permitting and comprises the wasteload allocation (WLA). The WLA is that portion of the total load assigned to National Pollutant Discharge Elimination System (NPDES) permitted point source discharges and the bulk reserve. There are two permitted facilities within the TMDL area of the Mill Creek Subwatershed. The load allocation (LA) is the remaining portion of the TMDL after the MOS and WLA are removed. The LA is assigned to nonpoint sources, all sources other than the NPDES permitted point sources of the WLA. The LA is divided into loads not reduced (LNR) and the adjusted load allocation (ALA). LNR equal the sum of the forest, wetland, low intensity development, and medium intensity development loads. The ALA equals the sum of hay/pasture lands, croplands and streambanks. The TMDL established a 63% reduction in the current sediment loading of 5,160,800 pounds per year, 14,139 pounds per day in the Mill Creek Subwatershed.

Watershed reduction goal = ((Existing Load – TMDL) / Existing Load) * 100

Introduction

The Mill Creek Headwaters Subwatershed is currently designated as Trout Stocking Fishes (TSF) and Migratory Fishes (MF), PA Code 25 § 93.9n. Trout Stocking Fishes is defined as: TSF - Maintenance of stocked trout from February 15 to July 31 and maintenance and propagation of fish species and additional flora and fauna which are indigenous to a warm water habitat. Migratory Fishes is defined as: MF- Passage, maintenance and propagation of anadromous and catadromous fishes and other fishes which ascend to flowing waters to complete their life cycle.

This Total Maximum Daily Load (TMDL) calculation has been prepared for segments in the Mill Creek Headwaters Subwatershed, Attachment A. The Mill Creek Watershed is in Lebanon County and makes up approximately 20 stream miles downstream to its confluence with Tulpehocken Creek. The TMDL targeted area is approximately 8.1 square miles and includes headwaters. Stream segments within the watershed are listed as impaired for siltation from agriculture and erosion from derelict land. Land use in this watershed is composed of 11% mixed development, 19% forest and 70% agriculture including 43% croplands and 27% hay/pasture. Agriculture is the dominant land use in the watershed basin.

The watershed is in State Water Plan (SWP) Subbasin 3C and within Hydrologic Unit Code (HUC) 02040203-Schuylkill. The TMDL was completed to address the impairments noted on the 2016 Pennsylvania 303(d) and Integrated Lists, required under the Clean Water Act, and covers the listed segments shown in Table 2 and Attachment D. Siltation from agricultural activities has been listed as causing the impairment. The TMDL addresses siltation from streambanks, hay/pasture lands and croplands.

Table 2. Integrated Water Quality Monitoring and Assessment Report Listed Segments

State Water Plan (SWP) Subbasin: 3C				
HUC: 02040203 – Schuylkill				
Watershed – Mill Creek Headwaters Subwatershed				
Source	EPA 305(b) Cause Code	Miles	Designated Use	Use Designation
Agriculture	Siltation	12	TSF, MF	Aquatic Life
Erosion from Derelict Land	Siltation	9	TSF, MF	Aquatic Life

HUC= Hydrologic Unit Code
TSF= Trout Stocking Fishes
MF= Migratory Fishes
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.

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 BMPs, etc.).

Pennsylvania Clean Streams Law Requirements, Agricultural Operations

All Pennsylvania farmers are required by law to operate within regulatory compliance by implementing the requirements outlined in the Pennsylvania Clean Streams Law, Title 25 Environmental Protection, Part I Department of Environmental Protection, Subpart C Protection of Natural Resources, Article II Water Resources, Chapters: § 91.36 Pollution control and prevention at agricultural operations, § 92a.29 CAFO and § 102.4 Erosion and sediment control requirements. Water quality regulations can be found in Attachment G of this document and at the following website:
http://www.pacode.com/secure/data/025/025toc.html

Agricultural regulations are designed to reduce the amount of sediment and nutrients reaching the streams and ground water in a watershed.

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 superseded SSWAP protocol, the ICE protocol 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 ± 20% (N = 160-240). 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, each pollutant receives a separate and specific TMDL within that stream segment. To make the TMDL process to be most effective, adjoining stream segments with the same source and cause listings 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: MOS + WLA + LA

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

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, best management practice (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 Mill Creek Headwaters Subwatershed 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 impaired watershed. This approach is based on selecting a non-impaired, reference, watershed and estimating its current loading rates for the pollutants of concern. The objective of the process is to reduce loading rates of those pollutants 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 shall 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 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 Protocol (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.

Based on the above criteria, the Mountain Run Headwaters Subwatershed was selected as the reference watershed for developing the Mill Creek Headwaters Subwatershed TMDL. Mountain Run, which flows into the Greene Township Park in eastern Franklin County, Pennsylvania is attaining its designated use, Cold Water Fishes. 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 Mill Creek and Mountain Run Headwaters Subwatersheds		
	Mill Creek Watershed	Mountain Run Watershed
Physiographic Province	85% Ridge and Valley 10% New England 5% Piedmont	60% Ridge and Valley 40% Blue Ridge
Area, ac	5,243	5,968
Land Use Distribution	70% Agriculture 19% Forest 11% Other	42% Agriculture 50% Forest 8% Other
Soils	80% Group C 20% Group B	50% Group C 50% Group B
Surface Geology	75% Carbonate 10% Metamorphic/Igneous 10% Shale 4% Sandstone 1% Conglomerate	70% Carbonate 30% Metamorphic/Igneous
Average Rainfall, inches	40.51, 30 years	40.11, 28 years
Average Runoff, inches	2.87, 30 years	2.04, 28 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 a significant land use category in both the Mill Creek and Mountain Run Headwaters Subwatersheds. The surface geology and soil types are similar between the watersheds thus producing similar influences on the sediment loads among them.

Hydrologic / Water Quality Modeling

Part 1. Model Overview & Data Compilation

The TMDL for this watershed was calculated using the MapShed model.

The MapShed 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.

MapShed 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, but each area is assumed to be homogenous with 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 (SCS-CN) approach with daily weather inputs of temperature and precipitation. 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 sector. 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.

As alluded to previously, the use of GIS software for deriving input data for watershed simulation models such as MapShed is 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 is used to parameterize input data for the MapShed 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 model. Also accessed through the interface are Excel-formatted weather files containing daily temperature and precipitation information. (In the version of MapShed used in Pennsylvania, a statewide weather database was developed that contains about twenty-five years of temperature and precipitation data for seventy-eight 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 MapShed 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 MapShed model. For use in Pennsylvania, MapShed 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 MapShed-formatted weather files are also included for the seventy-eight weather stations around the state.

Table 5 lists GIS datasets and shapefiles used for these TMDL calculations via MapShed and provides explanations of how they were used for development of the input files for the MapShed 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 MapShed 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.

Watershed Assessment and Modeling

The MapShed model was used to establish existing loading conditions for the Mill Creek and Mountain Run Headwaters Subwatersheds. All MapShed data and outputs have been attached to this TMDL as Attachment C. Department staff visited the Mill Creek and Mountain Run Watersheds to get a better understanding of existing conditions that might influence the MapShed model. For general observations, see Figures 1 and 2 on pages 18 and 19. The individual watershed characteristics included:

Mill Creek Headwaters Subwatershed (impaired)

- limited or absent riparian forest buffers in the agricultural areas
- expansive high gradient croplands lacking terracing and/or vegetative breaks

- mowing, tilling and grazing up to the streambank and directly in ephemeral headwater segments
- streambank erosion
- livestock in the stream
- lack of storm water management
- barn yard waste and runoff from animal heavy use areas reporting to the stream

Mountain Run Headwaters Subwatershed (reference)

- established and protected riparian forest buffers
- contour farming practices
- vegetated filter strips and buffers in croplands
- livestock exclusion fencing and rotational grazing
- manure and stormwater BMPs present

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

Mill Creek Watershed

No changes to the model were necessary for Mill Creek Subwatershed.

Mountain Run Watershed

No changes to the model were necessary for Mountain Run Subwatershed.

Figure 1. Cattle with free access to the stream in Mill Creek Watershed

Figure 2. Mature riparian forest buffer in Mountain Run Watershed

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

Table 6. Existing Loading Values for Mill Creek, impaired			
Source	Area ac	Sediment, lbs/yr	Unit Area Load, lbs/ac/yr
Hay/Past	1,411	276,800	196
Cropland	2,259	4,585,400	2,030
Forest	994	3,200	3
Wetland	23	0	0
Low Intensity Mixed Development	541	5,000	9
Medium Intensity Mixed Development	15	800	53
Streambank		289,600	
total	5243	5,160,800	984

Table 7. Existing Loading Values for Mountain Run, reference			
Source	Area, ac	Sediment, lbs/yr	Unit Area Load, lb/ac/yr
Hay/Past	938	93,000	99
Cropland	1,527	1,723,400	1,129
Forest	3,009	4,200	1
Wetland	36	0	0
Developed Open Land	7	200	29
Low Intensity Mixed Development	439	4,200	10
Medium Intensity Mixed Development	10	600	60
High Intensity Mixed Development	2	0	0
Streambank		334,000	
total	5,968	2,159,600	362

For Tables 6 and 7 the "streambank" sediment loads are calculated by MapShed's streambank routine. This routine uses linear streambank miles rather than area.

Development of Sediment TMDL

The target TMDL value for the Mill Creek Headwaters Subwatershed was established based on current loading rates for sediment in the Mountain Run reference watershed. Mountain Run is currently designated as Cold Waters Fishes (CWF) and previous biological assessments have determined that the watershed is attaining its designated uses. Reducing the loading rates of sediment in the Mill Creek Subwatershed, Trout Stocking (TSF), 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 Mountain Run Watershed using the MapShed model. The target TMDL value for sediment was determined by multiplying the unit area loading rates for the Mountain Run Subwatershed by the total watershed area of the Mill Creek Subwatershed, Table 8. TMDL values are commonly expressed as annual loads in this document. To find the daily loads, divide the annual loads by 365 days of the year.

Table 8. TMDL Values for the Mill Creek Subwatershed				
Pollutant	Loading Rate in Reference, lb/ac/yr	Total Area in Impaired Watershed, ac	Target TMDL Value, lb/yr	Target TMDL Value, lb/day
Sediment	362	5,243	1,897,249	5,198

* takes into account the rounding from previous calculations

The target TMDL value was then used as the basis for load allocations and reductions in the Mill Creek Subwatershed as follows:

TMDL = MOS + WLA + LA

LA = ALA + LNR

where:

TMDL = Total Maximum Daily Load

MOS = Margin of Safety

WLA = Wasteload Allocation

LA = Load Allocation

ALA = Adjusted Load Allocation

LNR = Loads Not Reduced

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 Mill Creek.

1,897,249.1 lbs/yr TMDL * 0.1 = 189,724.9 lbs/yr MOS

Wasteload Allocation

The wasteload allocation (WLA) portion of the TMDL equation is the sum of the pollutant loading assigned to permitted point sources and a bulk reserve. Each point source discharge in a watershed is assigned pollutant limits found in its accompanying National Pollutant Discharge Elimination System (NPDES) permit. These limits are used to calculate the sediment loadings included in the WLA. The bulk reserve is explicit and is calculated as one percent of the targeted TMDL. This bulk reserve enables the TMDL to account for the dynamic nature of permit activity. There are currently two NPDES permitted discharges of the pollutants of concern in the Mill Creek Headwaters Subwatershed. However, these discharges are discounted as diminutive in expected flow, therefore only the bulk reserve is factored into the total WLA, Table 9.

1,897,249.1 lbs/yr TMDL * 0.01 = 18,972.5 lbs/yr bulk reserve + permitted loads = 18,972.5 lbs/yr WLA

Table 9. Wasteload Allocation for the Mill Creek Watershed

	Facility Name	Load, lb/yr	Load, lb/day
Bulk Reserve	NA	18,972	52
PAC380025	Lamar Weaver	NA	NA
PAC380067	Andrew Moyer	NA	NA

NA = Not Applicable

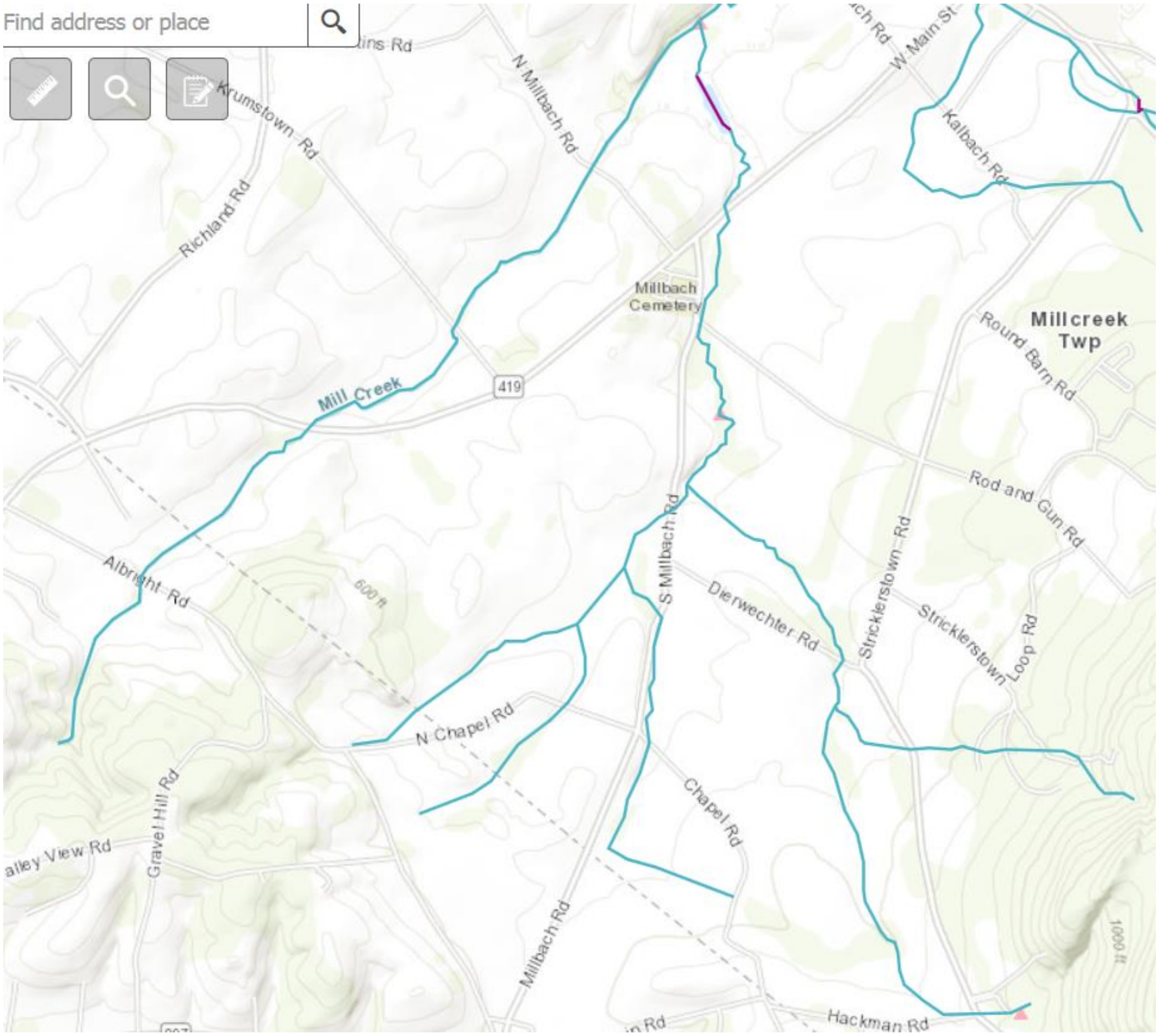

Figure 3. Triangles indicate permitted discharges in the Mill Creek Headwaters Subwatershed

Load Allocation

The load allocation (LA) is the portion of the TMDL assigned to nonpoint sources, all sources other than permitted sources. The LA contains loads targeted for reduction and background loads that are not targeted for reduction. The LA for sediment was computed by subtracting the MOS and WLA values from the TMDL value.

1,897,249.1 lbs/yr TMDL – (189,724.9 lbs/yr MOS + 18,972.5 lbs/yr WLA) =

1,688,551.7 lbs/yr LA

Loads Not Reduced and Adjusted Load Allocation

The load allocation (LA) is comprised of loads not reduced (LNR) and the adjusted load allocation (ALA). The loads not reduced (LNR) are the nonpoint source loads in the watershed that are not targeted for reduction. The ALA is made up of the nonpoint source loads targeted to receive reductions to attain the TMDL reduction goal for the watershed. The ALA is the base TMDL element that all non-point source loads being reduced must collectively not exceed and is calculated as follows:

The sum of the LNR is calculated first.

3,200.0 lbs/yr Forest + 5,000.0 lbs/yr Low Intensity Mixed Development + 800.0 lbs/yr Medium Intensity Mixed Development = 9,000.0 lbs/yr LNR

Then the sum of the LNR is subtracted from the LA to determine the ALA, Table 10.

Table 10. Load Allocation, Loads Not Reduced and Adjusted Load Allocation

	Sediment, lbs/yr	Sediment, lbs/day
Load Allocation (LA)	1,688,551.7	4,626.2
Loads Not Reduced (LNR):		
Forest	3,200.0	8.8
Low Intensity Mixed Development	5,000.0	13.7
Medium Intensity Mixed Development	800.0	2.2
Adjusted Load Allocation (ALA)	1,679,551.7	4,601.5

1,688,551.7 lbs/yr LA – 9,000.0 lbs/yr LNR = 1,679,551.7 lbs/yr ALA

The ALA is further analyzed using the Equal Marginal Percent Reduction (EMPR) allocation method described in Attachment B. EMPR calculates the sediment load reductions per targeted sources necessary to meet the TMDL. Although the Mill Creek Watershed TMDL was developed to address impairments caused by agricultural activities such as hay/pastureland and cropland, these sources were not the only sources considered for reductions. Streambanks are also significant contributors to the sediment load in the watershed and were included into the ALA and targeted for reduction, Tables 11 and 12.

Calculation of Sediment Load Reductions

The adjusted load allocation (ALA) established in the previous section represents the sediment load that is available for allocation between Hay/Pasture, Cropland and streambanks in the Mill Creek Subwatershed. 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 two land use types and streambanks. The process is summarized below:

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 exceeded the ALA.

2. After any necessary reductions have been made in the baseline, the multiple analyses are run. The multiple analyses will sum 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 25% reduction for all the land uses/sources except cropland which received a 73% reduction. The aggregated reduction goal to the sources making up the ALA is 67%.

Tables 11 and 12 contain the results of the EMPR for Hay/Pasture, Cropland and streambanks in the Mill Creek Subwatershed. The load allocation for each land use is shown along with the percent reduction of current loads necessary to reach the targeted ALA.

Table 11. Sediment Load Allocations for source sectors in Mill Creek Watershed, Annual Values						
		Allowable Loading	Load Allocation	Current Loading	Current Load	Reduction Goal
Land Use	Acres	lbs/acre/yr	lbs./yr	lbs/acre/yr	lbs/yr	
CROPLAND	2,259	556	1,255,990	2,030	4,585,400	73%
HAY/PASTURE	1,411	147	206,995	196	276,800	25%
STREAMBANK			216,567		289,600	25%
AGGREGATE		ALA	1,679,552		5,151,800	67%

Table 12. Sediment Load Allocations for source sectors in Mill Creek Watershed, Daily Values						
		Allowable Loading	Load Allocation	Current Loading	Current Load	Reduction Goal
Land Use	Acres	lbs/acre/day	lbs/day	lbs./acre/day	lbs/day	
CROPLAND	2,259	1.5	3,441.1	5.6	12,562.7	73%
HAY/PASTURE	1,411	0.4	567.1	0.5	758.4	25%
STREAMBANK			593.3		793.4	25%
AGGREGATE		ALA	4,601.5		14,114.5	67%

TMDL Summary

The sediment TMDL established for the Mill Creek Watershed consists of a Margin of Safety (MOS), Wasteload Allocation (WLA) and Load Allocation (LA). The LA is broken into Loads Not Reduced (LNR) and Adjusted Load Allocation (ALA) for further analysis. The individual components of the Mill Creek Watershed TMDL are summarized in Table 13. Daily expressions of the TMDLs are based on dividing the annual load by 365 days.

Table 13. TMDL Components for the Mill Creek Subwatershed		
Component	Sediment (lbs./yr.)	Sediment (lbs./day)
TMDL (Total Maximum Daily Load)	1,897,249	5,198
WLA (Wasteload Allocation)	18,972	52
MOS (Margin of Safety)	189,725	520
LA (Load Allocation)	1,688,552	4,626
LNR Loads Not Reduced)	9,000	25
ALA (Adjusted Load Allocation)	1,679,552	4,602

Consideration of Critical Conditions

The MapShed 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 accounted for in the 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 MapShed model accounts for all landuses within the watershed and their respective contributions to the sediment load. The background sources of sediment within the watershed would be from low and medium intensity development as well as from forested lands, wetlands and open lands. There are no additional upstream sources of sediment to this watershed. The landuses in this TMDL that are targeted for reductions are significant and anthropogenic sources of sediment to the watershed, thus will not be considered background. They include streambanks, hay/pasture and cropland.

Recommendations

From an agricultural perspective, reductions in the amount of sediment reaching the streams in the watershed can be made through the implementation of the farmers required Erosion and Sediment Control Plan (Pennsylvania Clean Streams Law, Title 25 Environmental Protection, Chapter 102.4) and through the right combination of BMPs including, but not limited to: establishment of cover crops, strip cropping, vegetated filter strips, residue management, no till, crop rotation, contour farming, terracing, stabilizing heavy use areas and proper management of storm water. Vegetated or forested buffers are acceptable BMPs to intercept any runoff from farm fields. For the pasturing of farm animals and animal heavy use areas, acceptable BMPs may include: critical area planting, waste water treatment strips, constructed wetlands, animal trails and walkways, diversions, roof runoff structures, manure storage, rotational grazing, livestock exclusion fencing and riparian forest buffers. Some of these BMPs were observed in the Mill Creek Subwatershed; however, they were more extensively used in the unimpaired reference watershed, Mountain Run. Since both watersheds have a significant amount of agricultural activities, it is apparent that the greater use of BMPs in the reference watershed has contributed to its ability to maintain its attainment status.

Streambanks contribute a significant sediment load in the Mill Creek Subwatershed because of the high percentage of agriculture as well as legacy sediments from historic mill dams in the watershed. Stream restoration projects that include grading the streambanks and the reestablishment of wetlands, riparian forest buffers and a stable stream sinuosity are the recommended BMPs for the eroded streambanks in the watershed. Grading the streambanks to reconnect the floodplain within a stable stream sinuosity is the most important first step to stream restoration in watersheds effected by legacy sediments. If this is not done, any trees planted on the entrenched banks will likely fall into the stream as erosion continues to etch away at the unmitigated pillow of legacy sediments filling the stream valley. The reestablishment of wetlands and riparian forest buffers must also be a part of any stream restoration project as they provide connectivity of land and water while directly assimilating and reducing the pollutants of concern. The restored stream and wetlands also provide critical nesting and nursery sites as well as shade and stable temperatures that ensure viable habitat is available to maintain a healthy ecosystem and fishery.

Once reestablished, wetlands and riparian forest buffers naturally act as nutrient and sediment sinks while the associated root structures and vegetative matter protect streambanks from the ravages of increasingly numerous and intense flooding events associated with anthropogenic land use change and climate change. Furthermore, the stable, diverse and concentrated biological communities maintained within the wetlands and riparian forest buffers will assimilate and remove nutrients and sediment from the water column instead of allowing them to pass downstream unchecked, thus wetlands and riparian forest buffers work directly toward attaining the goals of the TMDL by reducing pollutant loads and stabilizing streambanks all while beneficially protecting the property, livestock and assets of the farm. Wetlands and riparian forest buffers provide critical habitat to rare and sensitive aquatic, amphibious and terrestrial organisms as well as migratory species and they help to provide large scale ecological remediation by restoring connectivity to fractured ecosystems. Also of note, native macroinvertebrate species are dependent on native plant species and their associated leaf material for food. Macroinvertebrate colonies thrive in streams with riparian forest buffers that are populated by native plant species. To maintain the designated uses of this watershed, riparian conditions and macroinvertebrate colonies must improve.

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

Public Participation

Public notice of the draft TMDL was published in the *Pennsylvania Bulletin* on 6/22/2019 to foster public comment on the allowable loads calculated. Comments can be found in Attachment F.

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 *MapShed Version 7.1 Users Guide*; University Park, PA, 2007.

Attachment A

Maps of Impaired and Reference Watersheds

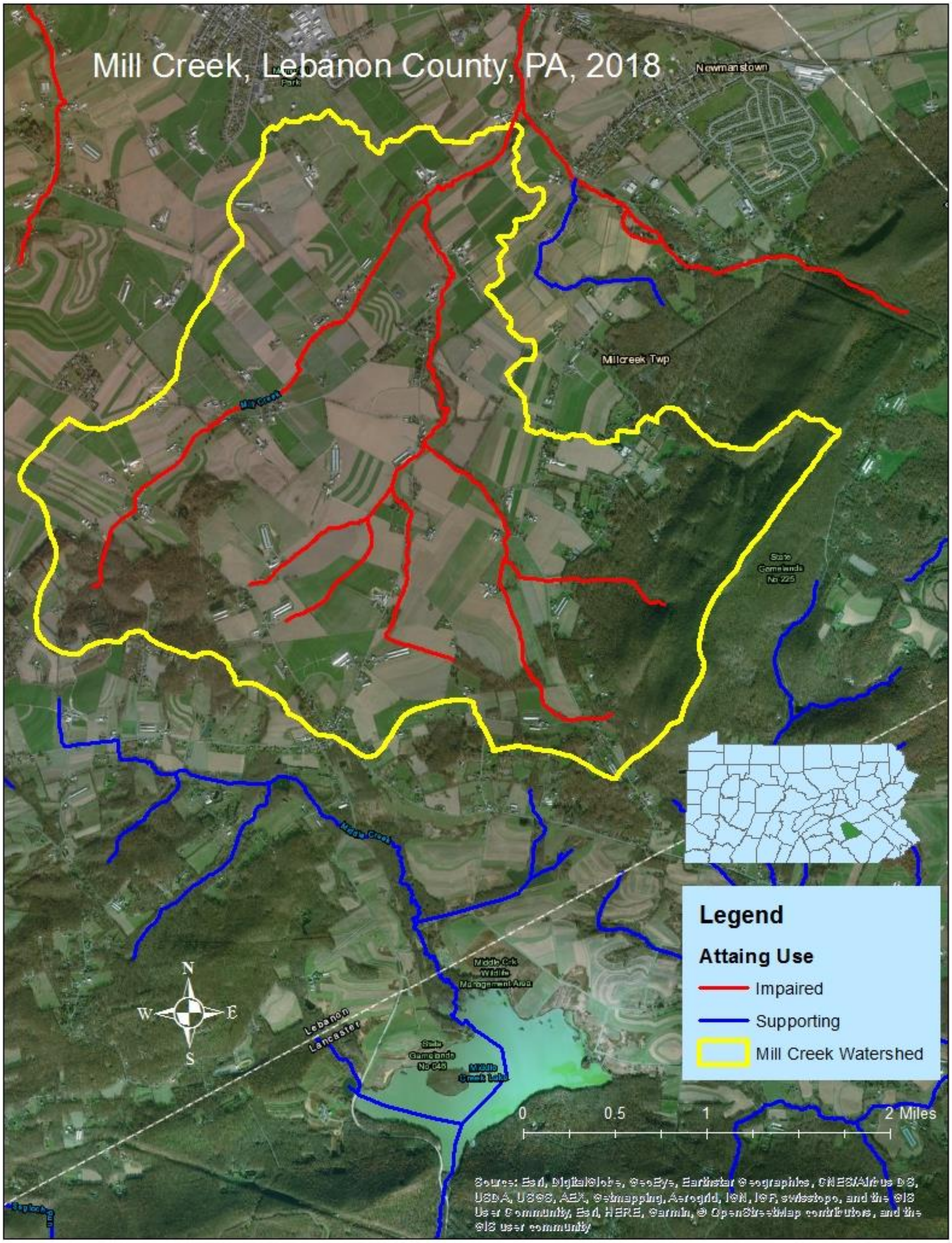

Figure A1. Mill Creek Subwatershed, Lebanon County

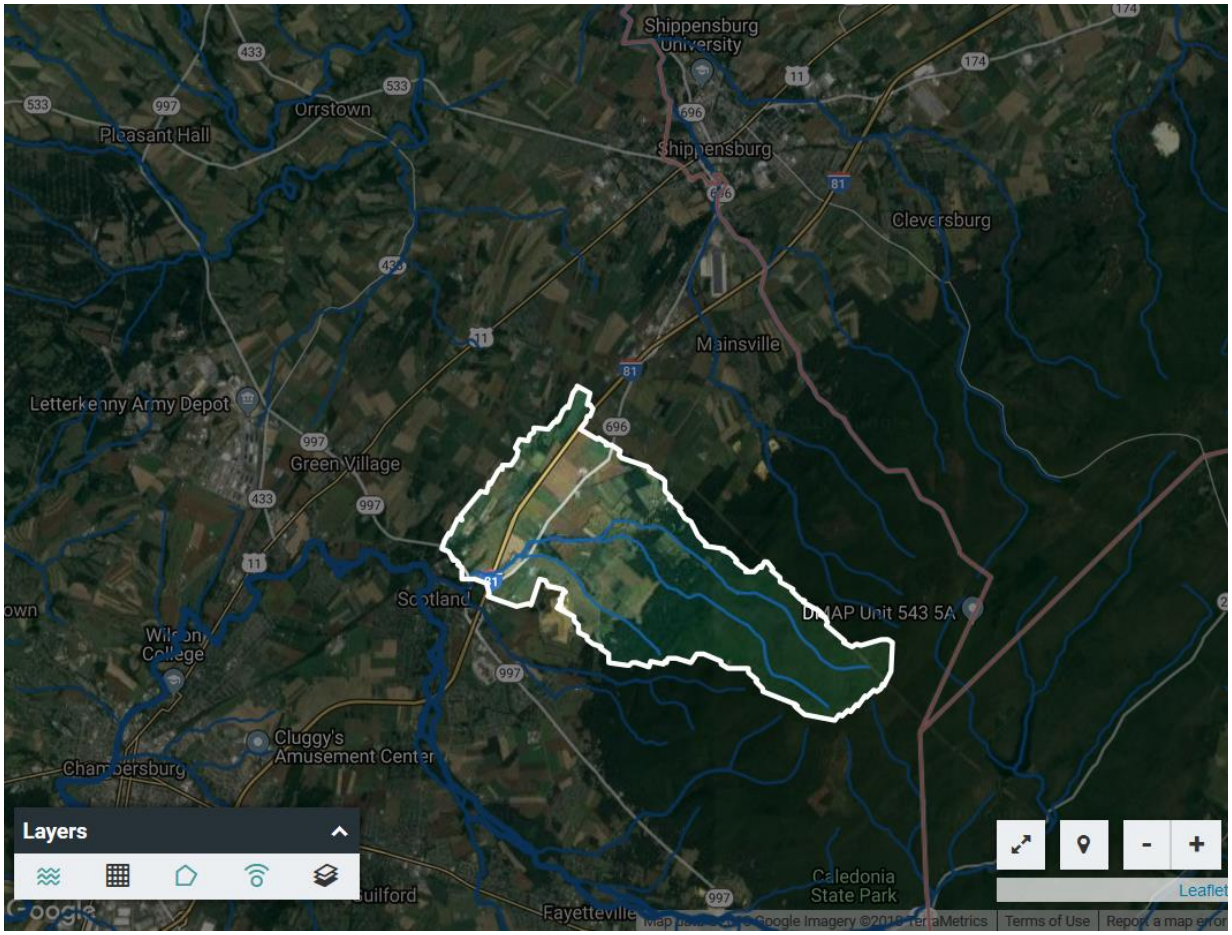

Figure A2. Mountain Run Subwatershed, Franklin County

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 the Adjusted Load Allocation (ALA) 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, MOS, WLA 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 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 percent reduction for each pollutant source.

1	TMDL				2	ALA = TMDL total load - (MOS + WLA + loads not reduced)						
	TMDL = Sediment loading rate in ref. * Impaired Acres					1679551.7	1679551.7					
	1897249.1											
		Annual				Recheck	% reduction	Load			Allowable	%
3		Avg. Load	Load Sum	Check	Initial Adjust	Adjust	allocation	Reduction	Initial LA	Acres	Loading Rate	Reduction
	CROPLAND	4585400.0	5151800.0	bad	1679551.7		0.7	423561.2	1255990.5	2259.0	556.0	72.6%
	HAY/PASTURE	276800.0		good	276800.0	566400.0	0.1	69805.4	206994.6	1411.0	146.7	25.2%
	STREAMBANK	289600.0		good	289600.0		0.1	73033.4	216566.6			25.2%
					2245951.7		1.0		1679551.7			
4	All Ag. Loading Rate	398.63										
			Allowable		Current	Current	**Reduction**					
	Land Use	Acres	loading rate	Final LA	Loading Rate	Load	**Goal**			CURRENT LOAD	LOAD ALLOCATION	
5	CROPLAND	2,259	556	1,255,990	2,030	4,585,400	**73%**		HAY/PASTURE	276,800	206,995	
	HAY/PASTURE	1,411	147	206,995	196	276,800	**25%**		STREAMBANK	289,600	216,567	
	STREAMBANK			216,567		289,600	**25%**		CROPLAND	4,585,400	1,255,990	
	AGGREGATE		ALA	1,679,552		5,151,800	**67%**		AGGREGATE	5,151,800	1,679,552	

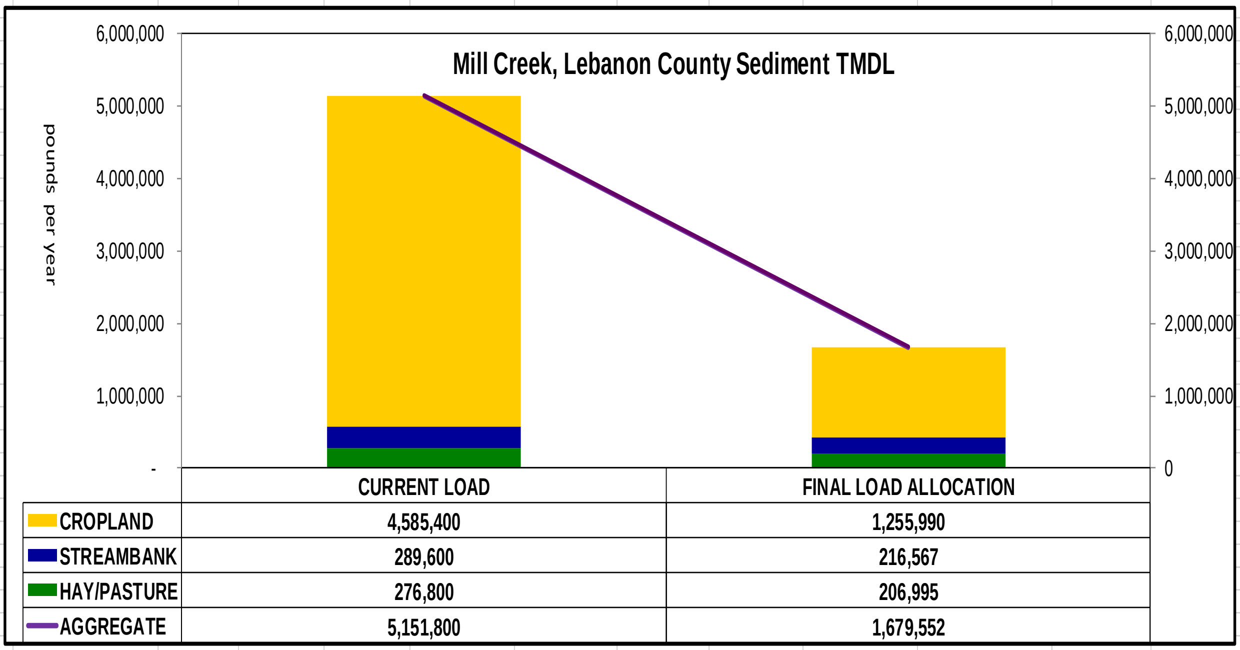

Table B1. Equal Marginal Percent Reduction calculations for Mill Creek Subwatershed

Attachment C
MapShed Generated Data Tables

GWLF Total Loads for file: NoBMPs-0 Period of analysis: 30 years from 1961 to 1990

Source	Area (Acres)	Runoff (in)	Tons: Erosion	Tons: Sediment	Total Loads (Pounds): Dissolved N	Total Loads (Pounds): Total N	Total Loads (Pounds): Dissolved P	Total Loads (Pounds): Total P
Hay/Pasture	1411	1.7	811.7	138.4	527.7	841.2	163.2	361.6
Cropland	2259	3.6	13443.5	2292.7	5232.2	10425.4	539.4	3824.9
Forest	994	1.9	9.6	1.6	81.0	84.7	4.3	6.6
Wetland	23	8.2	0.3	0.0	8.2	8.3	0.4	0.5
Disturbed	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Turfgrass	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Open Land	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bare Rock	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sandy Areas	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Unpaved Roads	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LD Mixed	541	4.1	0.0	2.5	45.9	139.2	6.2	15.6
MD Mixed	15	9.7	0.0	0.4	4.8	14.5	0.6	1.5
HD Mixed	0	13.4	0.0	0.0	0.2	0.5	0.0	0.0
LD Residential	0	4.1	0.0	0.0	0.0	0.0	0.0	0.0
MD Residential	0	6.3	0.0	0.0	0.0	0.0	0.0	0.0
HD Residential	0	8.4	0.0	0.0	0.0	0.0	0.0	0.0
Farm Animals						18576.7		4874.3
Tile Drainage				0.0		0.0		0.0
Stream Bank				144.8		81.6		52.9
Groundwater					120918.7	120918.7	940.8	940.8
Point Sources					0.0	0.0	0.0	0.0
Septic Systems					45.6	45.6	0.0	0.0
Totals	5243.3	2.90	14265.0	2580.6	126864.3	151136.4	1654.9	10078.8

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Table C1. Outputs for Mill Creek Subwatershed

GWLF Total Loads for file: MtRnNoBMPs-0 Period of analysis: 28 years from 1963 to 1990

Source	Area (Acres)	Runoff (in)	Tons: Erosion	Tons: Sediment	Total Loads (Pounds): Dissolved N	Total N	Dissolved P	Total P
Hay/Pasture	938	1.5	278.0	46.5	308.7	528.3	111.5	196.1
Cropland	1527	3.3	5156.7	861.7	3224.0	7297.6	386.6	1954.5
Forest	3009	1.3	12.5	2.1	165.7	175.6	8.7	12.5
Wetland	36	3.2	0.1	0.0	4.9	4.9	0.3	0.3
Disturbed	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Turfgrass	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Open Land	7	2.7	0.4	0.1	2.2	2.5	0.0	0.2
Bare Rock	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sandy Areas	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Unpaved Roads	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LD Mixed	439	3.7	0.0	2.1	38.1	115.4	5.2	12.9
MD Mixed	10	9.0	0.0	0.3	3.4	10.4	0.4	1.1
HD Mixed	2	12.4	0.0	0.0	0.6	1.8	0.1	0.2
LD Residential	0	3.7	0.0	0.0	0.0	0.0	0.0	0.0
MD Residential	0	5.8	0.0	0.0	0.0	0.0	0.0	0.0
HD Residential	0	7.8	0.0	0.0	0.0	0.0	0.0	0.0
Farm Animals						12815.7		2926.1
Tile Drainage				0.0		0.0		0.0
Stream Bank				167.0		198.4		75.0
Groundwater					82532.0	82532.0	727.9	727.9
Point Sources					0.0	0.0	0.0	0.0
Septic Systems					31.6	31.6	0.0	0.0
Totals	5967.6	2.00	5447.7	1079.8	86311.2	103714.3	1240.6	5906.6

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

Table C2. Outputs for Mountain Run Subwatershed

Attachment D

Streams, Category 5 Waterbodies, Pollutants Requiring a TMDL

Stream Name	Source	Cause	Date Listed	Assessment ID	Reachcode	COMID	Length (miles)
Mill Creek	Erosion from Derelict Land	Siltation	2004	3443	02040203000370	25993546	2.1
Mill Creek	Agriculture	Siltation	2004	3443	02040203000370	25993546	2.1
Mill Creek	Erosion from Derelict Land	Siltation	2004	3443	02040203000370	26003916	1.0
Mill Creek	Agriculture	Siltation	2004	3443	02040203000370	26003916	1.0
Mill Creek	Erosion from Derelict Land	Siltation	2004	3494	02040203000369	26003888	0.8
Mill Creek	Agriculture	Siltation	2004	3494	02040203000369	26003888	0.8
Mill Creek UNT (ID:26003892)	Erosion from Derelict Land	Siltation	2004	3504	02040203000824	26003892	0.2
Mill Creek UNT (ID:26003892)	Agriculture	Siltation	2004	3504	02040203000824	26003892	0.2
Mill Creek UNT (ID:26003892)	Agriculture	Siltation	2004	3504	02040203000824	26003924	1.3
Mill Creek UNT (ID:26003892)	Erosion from Derelict Land	Siltation	2004	3504	02040203000824	26003924	1.3
Mill Creek UNT (ID:26003932)	Agriculture	Siltation	2004	3504	02040203000824	26003932	0.9
Mill Creek UNT (ID:26003932)	Erosion from Derelict Land	Siltation	2004	3504	02040203000824	26003932	0.9
Mill Creek UNT (ID:26003932)	Agriculture	Siltation	2004	3504	02040203000824	26003944	1.3
Mill Creek UNT (ID:26003932)	Erosion from Derelict Land	Siltation	2004	3504	02040203000824	26003944	1.3
Mill Creek UNT (ID:26003892)	Erosion from Derelict Land	Siltation	2004	3504	02040203000824	26004144	0.2
Mill Creek UNT (ID:26003892)	Agriculture	Siltation	2004	3504	02040203000824	26004144	0.2
Mill Creek UNT (ID:26003892)	Erosion from Derelict Land	Siltation	2004	3504	02040203003819	26003928	0.3
Mill Creek UNT (ID:26003892)	Agriculture	Siltation	2004	3504	02040203003819	26003928	0.3
Mill Creek UNT (ID:26003940)	Erosion from Derelict Land	Siltation	2004	3504	02040203003821	26003940	1.0
Mill Creek UNT (ID:26003940)	Agriculture	Siltation	2004	3504	02040203003821	26003940	1.0
Mill Creek UNT (ID:26003892)	Agriculture	Siltation	2004	3508	02040203003411	25993548	0.5
Mill Creek UNT (ID:26003892)	Agriculture	Siltation	2004	3508	02040203003411	26003820	0.3
Mill Creek UNT (ID:26003936)	Agriculture	Siltation	2004	3508	02040203003412	25993550	0.2
Mill Creek UNT (ID:26003936)	Agriculture	Siltation	2004	3508	02040203003412	26003936	0.6
Mill Creek UNT (ID:26003892)	Agriculture	Siltation	2004	3508	02040203003820	26003930	0.2
Mill Creek UNT (ID:26003942)	Agriculture	Siltation	2004	3508	02040203003822	26003942	1.3
UNT = Unnamed Tributary						**Total**	**21.0**

Attachment E

Justification of Changes to 303(d) Lists 1998 to Present

The following are excerpts from the Pennsylvania DEP Section 303(d) narratives that justify changes in listings between the 1996-2002 303(d) Lists and the 2004 to present Integrated Water Quality Monitoring and Assessment Reports. 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. Because 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 manage 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 comments were received.

Attachment G

Water Quality Regulations for Agricultural Operations

§ 102.4. Erosion and sediment control requirements.

(a) For agricultural plowing or tilling activities or for animal heavy use areas, the following erosion and sediment control requirements apply:

(1) The implementation and maintenance of erosion and sediment control BMPs are required to minimize the potential for accelerated erosion and sedimentation, including for those activities which disturb less than 5,000 square feet (464.5 square meters).

(2) Written E&S Plans are required for the following activities that disturb 5,000 square feet (464.5 square meters) or more of land:

(i) Agricultural plowing or tilling activities.

(ii) Animal heavy use areas.

(3) The landowner, and any lessee, renter, tenant or other land occupier, conducting or planning to conduct agricultural plowing or tilling activities, or operating an animal heavy use area, are jointly and individually responsible for developing a written E&S Plan and implementing and maintaining BMPs, including those identified in the E&S Plan.

(4) The E&S Plan must include cost-effective and reasonable BMPs designed to minimize the potential for accelerated erosion and sedimentation from agricultural plowing or tilling activities and animal heavy use areas.

(i) For agricultural plowing or tilling activities, the E&S Plan must, at a minimum, limit soil loss from accelerated erosion to the soil loss tolerance (T) over the planned crop rotation.

(ii) For agricultural plowing and tilling activities that will occur on fields with less than 25% plant cover or crop residue cover and within 100 feet of a river, or perennial or intermittent stream, additional BMPs shall be implemented to minimize accelerated erosion and sedimentation.

(iii) For animal heavy use areas, the E&S Plan must identify BMPs to minimize accelerated erosion and sedimentation. BMPs and their design standards are listed in the current amended and updated version of the appropriate National Resources Conservation Service conservation practice standards such as Heavy Use Area Protection, Critical Area Planting, Fencing, Wastewater Treatment Strip, Constructed Wetland, Use Exclusion, Animal Trails and Walkways, Diversions and Roof Runoff Structure.

(5) The E&S Plan must contain plan maps that show the location of features including surface waters of this Commonwealth, and drainage patterns, field and property boundaries, buildings and farm structures, animal heavy use areas, roads and crossroads, and BMPs; soils maps; and a description of BMPs including animal heavy use area practices and procedures, tillage systems, schedules, and crop rotations. The plan must be consistent with the current conditions and activities on the agricultural operation.

(6) The E&S Plan must contain an implementation schedule. The plan shall be implemented according to the schedule, and the BMPs shall be operated and maintained as long as there are agricultural plowing or tilling activities or animal heavy use areas, on the agricultural operation.

(7) The portion of a conservation plan that identifies BMPs utilized to minimize accelerated erosion and sedimentation from agricultural plowing or tilling activities, or from operation of animal heavy use areas, may be used to satisfy the E&S Plan requirements of this subsection if it meets the requirements of paragraphs (4)—(6).

(8) The E&S Plan shall be available for review and inspection at the agricultural operation.

(9) Nothing in this section negates the requirements under other provisions of this chapter, such as those applicable to construction activities.

(b) For earth disturbance activities other than agricultural plowing or tilling or animal heavy use areas, the following erosion and sediment control requirements apply:

(1) The implementation and maintenance of E&S BMPs are required to minimize the potential for accelerated erosion and sedimentation, including those activities which disturb less than 5,000 square feet (464.5 square meters).

(2) A person proposing earth disturbance activities shall develop and implement a written E&S Plan under this chapter if one or more of the following criteria apply:

(i) The earth disturbance activity will result in a total earth disturbance of 5,000 square feet (464.5 square meters) or more.

(ii) The person proposing the earth disturbance activities is required to develop an E&S Plan under this chapter or under other Department regulations.

(iii) The earth disturbance activity, because of its proximity to existing drainage features or patterns, has the potential to discharge to a water classified as a High Quality or Exceptional Value water under Chapter 93 (relating to water quality standards).

(3) The E&S Plan shall be prepared by a person trained and experienced in E&S control methods and techniques applicable to the size and scope of the project being designed.

(4) Unless otherwise authorized by the Department or conservation district after consultation with the Department, earth disturbance activities shall be planned and implemented to the extent practicable in accordance with the following:

(i) Minimize the extent and duration of the earth disturbance.

(ii) Maximize protection of existing drainage features and vegetation.

(iii) Minimize soil compaction.

(iv) Utilize other measures or controls that prevent or minimize the generation of increased stormwater runoff.

(5) The E&S Plan must contain drawings and narrative which describe the following:

(i) The existing topographic features of the project site and the immediate surrounding area.

(ii) The types, depth, slope, locations and limitations of the soils.

(iii) The characteristics of the earth disturbance activity, including the past, present and proposed land uses and the proposed alteration to the project site.

(iv) The volume and rate of runoff from the project site and its upstream watershed area.

(v) The location of all surface waters of this Commonwealth which may receive runoff within or from the project site and their classification under Chapter 93.

(vi) A narrative description of the location and type of perimeter and onsite BMPs used before, during and after the earth disturbance activity.

(vii) A sequence of BMP installation and removal in relation to the scheduling of earth disturbance activities, prior to, during and after earth disturbance activities that ensure the proper functioning of all BMPs.

(viii) Supporting calculations and measurements.

(ix) Plan drawings.

(x) A maintenance program which provides for the operation and maintenance of BMPs and the inspection of BMPs on a weekly basis and after each stormwater event, including the repair or replacement of BMPs to ensure effective and efficient operation. The program must provide for completion of a written report documenting each inspection and all BMP repair, or replacement and maintenance activities.

(xi) Procedures which ensure that the proper measures for the recycling or disposal of materials associated with or from the project site will be undertaken in accordance with this title.

(xii) Identification of the naturally occurring geologic formations or soil conditions that may have the potential to cause pollution during earth disturbance activities and include BMPs to avoid or minimize potential pollution and its impacts from the formations.

(xiii) Identification of potential thermal impacts to surface waters of this Commonwealth from the earth disturbance activity including BMPs to avoid, minimize or mitigate potential pollution from thermal impacts.

(xiv) The E&S Plan shall be planned, designed and implemented to be consistent with the PCSM Plan under § 102.8 (relating to PCSM requirements). Unless otherwise approved by the Department, the E&S Plan must be separate from the PCSM Plan and labeled ''E&S'' or ''Erosion and Sediment Control Plan'' and be the final plan for construction.

(xv) Identification of existing and proposed riparian forest buffers.

(6) To satisfy the antidegradation implementation requirements in § 93.4c(b) (relating to implementation of antidegredation requirements), for an earth disturbance activity that requires a permit under this chapter and for which any receiving surface waters of this Commonwealth is classified as High Quality or Exceptional Value under Chapter 93, the person proposing the activity shall, in the permit application, do the following:

(i) Evaluate and include nondischarge alternatives in the E&S Plan, unless a person demonstrates that nondischarge alternatives do not exist for the project.

(ii) If the person makes the demonstration in subparagraph (i) that nondischarge alternatives do not exist for the project, the E&S Plan must include ABACT, except as provided in § 93.4c(b)(1)(iii).

(iii) For purposes of this chapter, nondischarge alternatives and ABACT and their design standards are listed in the *Erosion and Sediment Pollution Control Program Manual*, Commonwealth of Pennsylvania, Department of Environmental Protection, No. 363-2134-008 (April 2000), as amended and updated.

(7) The Department may approve alternative BMPs which will maintain and protect existing water quality and existing and designated uses.

(8) The E&S Plan, inspection reports and monitoring records shall be available for review and inspection by the Department or the conservation district at the project site during all stages of the earth disturbance activity.

(9) Upon complaint or site inspection, the Department or conservation district may require that the E&S Plan be submitted for review and approval to ensure compliance with this chapter.

(c) The Department may require, or the conservation district after consultation with the Department may require, other information necessary to adequately review a plan, or may require alternative BMPs, on a case-by-case basis, when necessary to ensure the maintenance and protection of water quality and existing and designated uses.

(d) A person proposing or conducting an earth disturbance activity shall obtain the other necessary permits and authorizations from the Department or conservation district, related to the earth disturbance activity, before commencing the earth disturbance activity.

(e) Persons proposing an earth disturbance activity that requires permit coverage under § 102.5 (relating to permit requirements) shall have permit coverage prior to commencing the earth disturbance activity.

§ 92a.29. CAFO.

(a) Except as provided in subsections (b)—(d), each CAFO shall have applied for an NPDES permit on the following schedule, and shall have obtained a permit:

(1) By May 18, 2001, for any CAFO in existence on November 18, 2000, with greater than 1,000 AEUs.

(2) By February 28, 2002, for any other CAFO in existence on November 18, 2000.

(3) Prior to beginning operation, for any new or expanded CAFO that began operation after November 18, 2000, and before October 22, 2005.

(b) A poultry operation that is a CAFO, which is in existence on October 22, 2005, and that is not using liquid manure handling systems, shall apply for an NPDES permit no later than the following, and shall obtain a permit:

(1) By April 24, 2006, for operations with 500 or more AEUs.

(2) By January 22, 2007, for all other operations.

(c) After October 22, 2005, a new operation, and an existing operation that will become a CAFO due to changes in operations such as additional animals or loss of land suitable for manure application, shall do the following:

(1) Apply for an NPDES permit at least 180 days before the operation commences or changes.

(2) Obtain an NPDES permit prior to commencing operations or making changes, as applicable.

(d) Other operations not described in subsections (a)—(c) that will become newly regulated as a CAFO for the first time due to the changes in the definition of a CAFO in § 92a.2 (relating to definitions) shall apply for a permit by April 24, 2006, and obtain a permit.

(e) The NPDES permit application requirements include, but are not limited to, the following:

(1) A nutrient management plan meeting the requirements of Chapter 83, Subchapter D (relating to nutrient management) and approved by the county conservation district or the State Conservation Commission. The plan must include:

(i) Manure application setbacks for the CAFO of at least 100 feet, or vegetated buffers at least 35 feet in width.

(ii) A statement that manure that is stockpiled for 15 consecutive days or longer shall be under cover or otherwise stored to prevent discharge to surface water during a storm event up to and including the appropriate design storm for that type of operation under § 91.36(a)(1) and (5) (relating to pollution control and prevention at agricultural operations).

(2) An erosion and sediment control plan meeting the requirements of Chapter 102 (relating to erosion and sediment control).

(3) When required under § 91.36(a), a water quality management permit, permit application, approval or engineer's certification, as required.

(4) A preparedness, prevention and contingency plan for pollutants related to the CAFO operation.

(5) A water quality management permit application as required under this chapter and Chapter 91 (relating to general provisions), when treatment facilities that would include a treated wastewater discharge are proposed.

(6) Measures to be taken to prevent discharge to surface water from storage of raw materials such as feed and supplies. These measures may be included in the nutrient management plan.

§ 91.36. Pollution control and prevention at agricultural operations.

(a) *Animal manure storage facilities.*

(1) Except when more stringent requirements are contained in paragraphs (2)—(5), a manure storage facility shall be designed, constructed, operated and maintained in accordance with current engineering

and agronomic practices to ensure that the facility is structurally sound, water-tight, and located and sized properly, to prevent pollution of surface water and groundwater, including design to prevent discharges to surface waters during a storm up to and including a 25-year/24-hour storm.

(i) The Manure Management Manual and the Pennsylvania Technical Guide contain current engineering and agronomic practices which can be used to comply with the requirements in paragraph (1).

(ii) If the criteria in the Manure Management Manual and the Pennsylvania Technical Guide are not followed, the owner or operator shall obtain a water quality management permit or other approval from the Department for the manure storage facility.

(2) For liquid or semisolid manure storage facilities constructed after January 29, 2000, the owner or operator shall obtain a water quality management permit from the Department for the manure storage facility unless the design and construction of the facility are certified to meet the ''Manure Management Manual'' and ''Pennsylvania Technical Guide'' by a registered professional engineer. The owner or operator shall retain a copy of the certification at the operation and provide a copy to the Department upon request.

(3) In the case of a new or expanded liquid or semisolid manure storage facility located at an animal operation with over 1,000 AEUs for the first time after January 29, 2000, a water quality management permit is required.

(4) For a new or expanded liquid or semisolid manure storage facility after October 22, 2005:

(i) Where the manure storage capacity is between 1 million and 2.5 million gallons, a water quality management permit is required for any manure storage facility that is a pond and one of the following applies:

(A) The nearest downgradient stream is classified as a High Quality or Exceptional Value water under Chapter 93 (relating to water quality standards).

(B) The nearest downgradient stream has been determined by the Department to be impaired from nutrients from agricultural activities.

(ii) Where the manure storage capacity is 2.5 million gallons or more, a water quality management permit is required.

(5) For new or expanded CAFOs that commenced operations after April 13, 2003, and that include swine, poultry or veal calves, the CAFO shall prevent discharges to surface waters during a storm event up to and including a 100-year/24-hour storm from manure storage facilities that contain manure from those swine, poultry or veal calves.

(6) For a liquid or semisolid manure storage facility, the following minimum freeboard requirements apply and shall be maintained:

(i) For an agricultural operation with over 1,000 AEUs that was a new or expanded operation after January 29, 2000, a minimum 24-inch freeboard, except for enclosed facilities that are not exposed to rainfall, which must have a minimum freeboard of 6 inches.

(ii) For all other facilities, a minimum 12-inch freeboard for manure storage facilities that are ponds, and a minimum 6-inch freeboard for all other manure storage facilities.

(7) The requirements in this section are in addition to and do not replace any more stringent requirements in Chapter 83, Subchapter D (relating to nutrient management).

(b) *Land application of animal manure and agricultural process wastewater; setbacks and buffers.*

(1) The land application of animal manures and agricultural process wastewater requires a permit or approval from the Department unless the operator can demonstrate that the land application meets one of the following:

(i) The land application follows current standards for development and implementation of a plan to manage nutrients for water quality protection, including soil and manure testing and calculation of proper levels and methods of nitrogen and phosphorus application. The Manure Management Manual contains current standards for development and implementation of a plan to manage nutrients for water quality protection which can be used to comply with the requirements in paragraph (1).

(ii) For CAOs, the land application is in accordance with an approved nutrient management plan under Chapter 83, Subchapter D.

(iii) For CAFOs, the land application is in accordance with a CAFO permit as described in § 92.5a (relating to CAFOs).

(2) Unless more stringent requirements are established by statute or regulation, the following agricultural operations may not mechanically land apply manure within 100 feet of surface water, unless a vegetated buffer of at least 35 feet in width is used, to prevent manure runoff into surface water:

(i) A CAO.

(ii) An agricultural operation receiving manure from a CAO directly, or indirectly through a broker or other person.

(iii) An agricultural operation receiving manure from a CAFO directly, or indirectly through a broker or other person.

(3) CAFOs shall meet the setback requirements in § 92.5a(e)(1)(i).

(4) For purposes of paragraph (2) only, ''surface water'' means a perennial or intermittent stream with a defined bed and bank, a lake or a pond.

(c) *Discharge of pollutants.*

(1) It is unlawful for agricultural operations to discharge pollutants to waters of this Commonwealth except as allowed by regulations or a permit administered by the Department. The Department is authorized to take an enforcement action against any agricultural operation in violation of this requirement.

(2) An operation that has a discharge that is not authorized under the act and that meets the definition of either a medium or small CAFO under 40 CFR 122.23 (relating to concentrated animal

feeding operations (applicable to State NPDES programs, see 123.25)) is considered to have an illegal discharge and is subject to enforcement action under the act.

(3) When an agricultural operation is found to be in violation of the act, the Department may require the agricultural operation to develop and implement a nutrient management plan under Chapter 83, Subchapter D, for abatement or prevention of the pollution.