Headwaters of Evitts Creek TMDL

Bedford County, Pennsylvania

March 2019

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Bedford County, PA

Executive Summary

Total Maximum Daily Loads (TMDLs) for sediment and nutrients (total phosphorus) were developed to address impairments in the Headwaters of Evitts Creek Subwatershed as noted in Pennsylvania's 2016 Integrated Water Quality Monitoring and Assessment Report (Integrated List). Stream segments were added to this list of impaired waters of the commonwealth in 2002 and 2008. Headwaters of Evitts Creek is a High Quality, Cold-Water Fishery (HQ-CWF) in Cumberland Valley Township, Bedford County. Evitts Creek is a tributary in the Hydrologic Unit Code (HUC) 02070002, North Branch Potomac River, in the Chesapeake Bay Watershed. The impairments were documented during biological surveys of the aquatic life present in the watershed. Excessive siltation and nutrient loading from agriculture has been identified as the cause of these impairments in the Headwaters of Evitts Creek Subwatershed. Because Pennsylvania does not currently have water quality criteria for siltation or nutrients, a TMDL endpoint for sediment and total phosphorus was identified using a reference watershed approach. Based on a comparison to the similar, non-impaired Headwaters of Town Creek Subwatershed in Bedford County, (Figure 1) the maximum loading for sediment and total phosphorus that should allow water quality objectives to be met in the impaired segments of Headwaters of Evitts Creek was developed. Allocation of the sediment and total phosphorus TMDLs is summarized below:

Table 1. Summary of TMDL for Headwaters of Evitts Creek in lbs/yr

Pollutant	TMDL	WLA	MOS	LA
Sediment	1,597,711.5	17,110.2	159,771.2	1,420,830.2
Total Phosphorus	1,538.9	242.4	153.9	1,142.6

The Headwaters of Evitts Creek TMDL is allocated to non-point sources, with 10% of the TMDL reserved explicitly as a margin of safety (MOS). The waste load allocation (WLA) is that portion of the total load assigned to National Pollutant Discharge Elimination System (NPDES) permitted point source discharges plus an additional allocation of 1% of the TMDL as a bulk reserve to take in account the dynamic nature of future permit activity. The load allocation (LA) is that portion of the total load assigned to non-point sources, all sources other than NPDES permitted point sources. The LA contains background loads from non-targeted sources such as forests and wetlands as well as the agricultural loads that are targeted for reductions. The TMDL developed for Headwaters of Evitts Creek subwatershed established a reduction in the current sediment loading of 30% and a 51% reduction in the current total phosphorus loading.

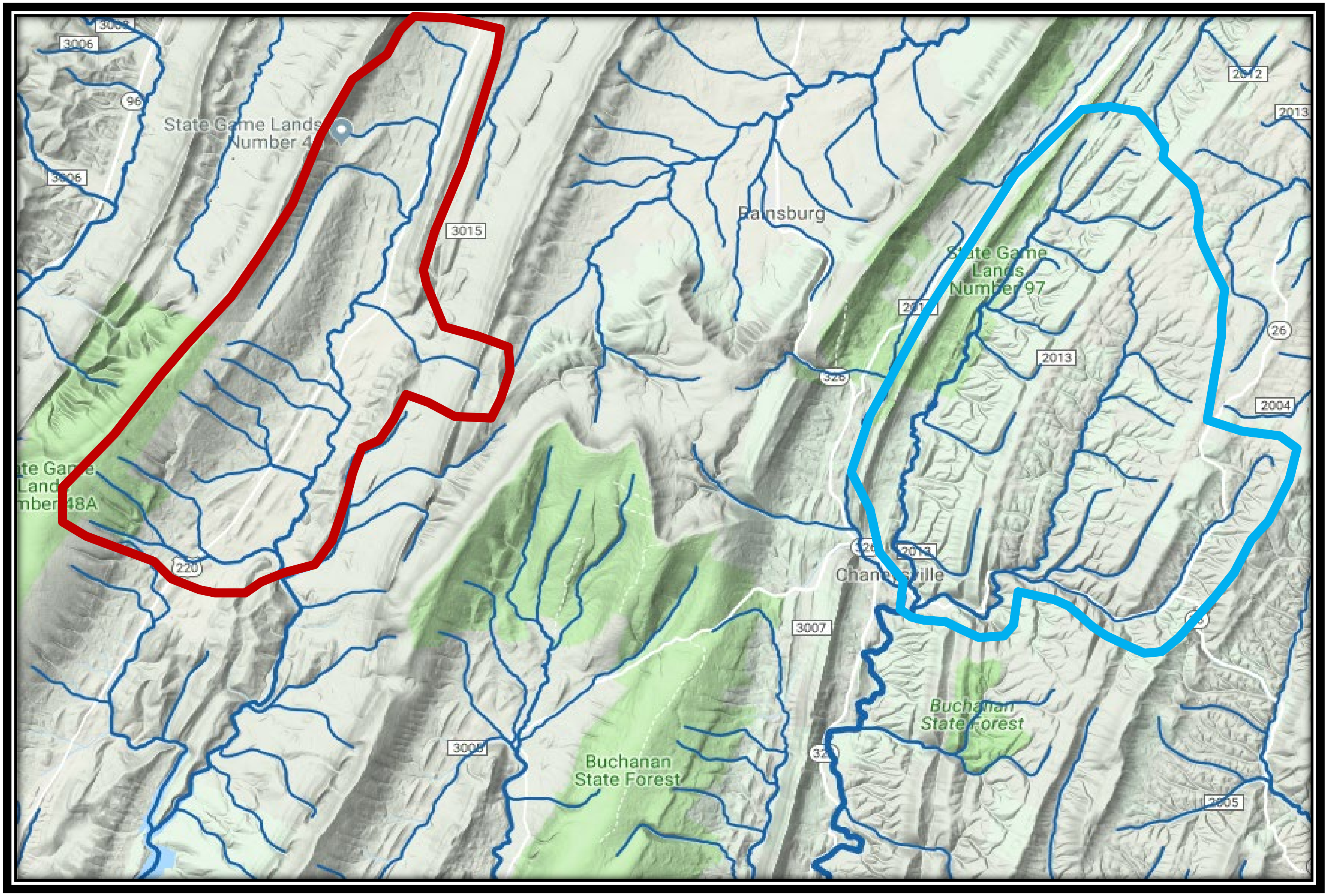

Figure 1. Headwaters of Evitts Creek (impaired, red outline) and Town Creek (non-impaired, blue outline)

Introduction

Headwaters of Evitts Creek is currently designated as High-Quality waters (HQ), which are considered surface waters having quality which exceeds levels necessary to support the propagation of fish, shellfish, and wildlife as well as recreation in and on the water (§93.4b(a)). In this case, the watershed is additionally a Cold-Water Fishery (CWF), which also provides for the maintenance or propagation, or both, of fish species including the family Salmonidae and additional flora and fauna which are indigenous to a cold-water habitat. It is also designated as Migratory Fishes (MF) which provides the passage, maintenance and propagation of anadromous and catadromous fishes and other fishes which move to or from flowing waters to complete their life cycle in other waters. It is biologically impaired for not meeting HQ-CWF attributes on 4.24 miles of its lower mainstem area within the deforested agricultural sector pictured on Figure 2**.**

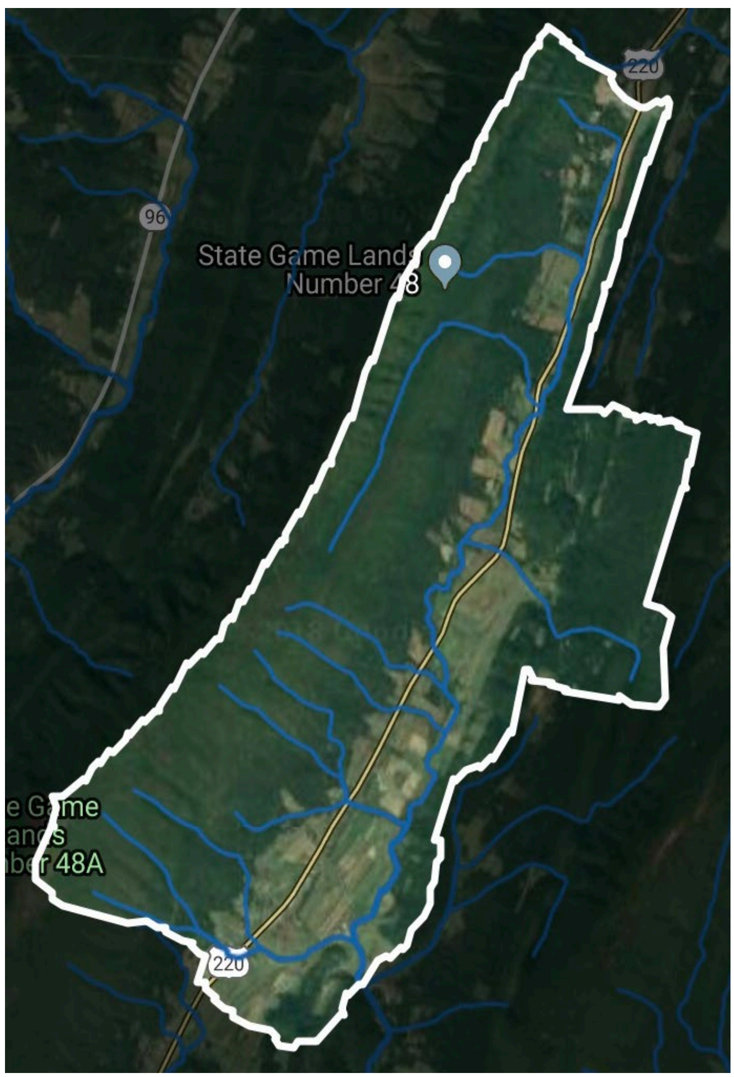

Figure 2. Satellite image of the Headwaters of Evitts Creek Subwatershed

Land Use

The headwaters flow northeast to southewest (adjacent to I-220) in Cumberland Valley, between Wills Mountain and Evitts Mountain. Most tributaries are meeting there aquatic life use of HQ-CWF. The target area encompasses approximately 12,895 acres. Land use in this watershed is composed of agriculture (18%), including croplands and hay/pasture, forestland (75%) and other (7%) including low intensity development, Figure 3.

Green	Forest
Yellow	Hay/Pasture
Brown	Cropland

Figure 3. Land uses in Headwaters of Evitts Creek, impaired, and Town Creek, reference

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.

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.

The TMDL was completed to address the impairments noted on the Pennsylvania 303(d) list and 2016 Integrated Water Quality Monitoring and Assessment Report required under the Clean Water Act. Excessive siltation and nutrient loading from agriculture has been identified as the cause of the impairments in Headwaters of Evitts Creek, Table 2.

Table 2. 2016 Integrated Water Quality Monitoring and Assessment Report Listings						
Stream Name	Listed	Source	Cause	Assessment ID	COMID	Length (miles)
Evitts Creek	2002	Agriculture	Nutrients	1341	45642493	0.02
Evitts Creek	2002	Agriculture	Nutrients	1341	45642523	0.08
Evitts Creek	2002	Agriculture	Nutrients	1341	45642473	0.01
Evitts Creek	2002	Agriculture	Nutrients	1341	45642491	0.04
Evitts Creek	2002	Agriculture	Nutrients	1341	45642465	0.33
Evitts Creek	2002	Agriculture	Nutrients	1341	45642425	0.10
Evitts Creek	2002	Agriculture	Nutrients	1341	45642167	0.28
Evitts Creek	2002	Agriculture	Nutrients	1341	45642577	0.15
Evitts Creek	2002	Agriculture	Nutrients	1341	45642495	0.03
Evitts Creek	2002	Agriculture	Nutrients	1341	45642417	0.03
Evitts Creek	2002	Agriculture	Nutrients	1341	45642301	1.06
Evitts Creek	2002	Agriculture	Nutrients	1341	45642129	0.12
Evitts Creek	2002	Agriculture	Nutrients	1341	45642483	0.03
Evitts Creek	2002	Agriculture	Nutrients	1341	45642537	0.08
Evitts Creek	2002	Agriculture	Nutrients	1341	45642409	0.86
Evitts Creek	2002	Agriculture	Nutrients	1341	45642121	0.30
Evitts Creek	2008	Agriculture	Siltation	13171	45642489	0.05
UNT Evitts Creek (ID:45642499)	2008	Agriculture	Siltation	13171	45642455	0.02
UNT Evitts Creek (ID:45642497)	2008	Agriculture	Siltation	13171	45642497	0.14
UNT Evitts Creek (ID:45642503)	2008	Agriculture	Siltation	13171	45642503	0.02
Evitts Creek	2008	Agriculture	Siltation	13171	45642501	0.20
Evitts Creek	2008	Agriculture	Siltation	13171	45642521	0.06
Evitts Creek	2008	Agriculture	Siltation	13171	45642505	0.05
UNT Evitts Creek (ID:45642499)	2008	Agriculture	Siltation	13171	45642499	0.15
					Total:	4.24

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 Table 2. 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 kick net 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 waste load allocation, load allocation and a margin of safety. The waste load 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 waste load 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 waste load allocation will only be made following an opportunity for public participation. A waste load 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 info. 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 Endpoints

Pennsylvania does not currently have water quality criteria for sediment and nutrients. Therefore, sediment and nutrient TMDL endpoints were identified using a reference watershed approach. To meet the designated uses of the Headwaters of Evitts Creek watershed for attainment and maintenance, for all waterbodies, Pennsylvania utilizes its narrative water quality criteria, which state that:

> *Water may not contain substances attributable to point or nonpoint source discharges in concentration or amounts sufficient to be inimical or harmful to the water uses to be protected or to human, animal, plant or aquatic life. (25 PA Code Chapter 93.6 (a)); and,*

> *In addition to other substances listed within or addressed by this chapter, specific substances to be controlled include, but are not limited to, floating materials, oil, grease, scum and substances which produce color, tastes, odors, turbidity or settle to form deposits. (25 PA Code, Chapter 93.6 (b)).*

Defining Excess Sedimentation and Nutrient Contribution

Sedimentation and nutrient contribution is an essential component of aquatic ecosystems, as it often contains minerals used by many aquatic organisms, and provides habitat. Sedimentation is a natural process that is caused by the weathering of landscape, whereby wind and water erode the surfaces of rocks and soils creating small particles. When these particles enter streams, they may flow with the current (suspended solids), or be deposited on the streambed.

Typically, natural inputs of sediment and the nutrient components do not cause problems, rather influence the dynamics and biology of hydrologic systems; however, when landscape is modified, excessive amounts of sediment can enter streams or erode from streams and cause undesirable effects, related to unbalanced uptake of total phosphorus (Bryan and Rutherford 1995).

Agricultural practices such as row cropping involve the tilling of landscapes to make the soil porous and fertile, which consequently loosens soil directly, as well as indirectly by removing plants whose roots once held soil in place. During rain events, loosened soil is directed toward nearby streams via overland runoff, and depending upon the density of vegetation along the shoreline, sediment enters into the water. The soil of pasture land is often more stable than that of cropland, yet in-stream sedimentation issues arise from the surface runoff associated with this land use. If the pasture land is grazed, the soil becomes compacted from the constant trampling by livestock, and therefore precipitation leaves the area via surface runoff and enters streams instead of infiltrating into the soil.

In addition, because vegetation within pasture land typically has shallow roots and little water retention ability, precipitation that does infiltrate the soil saturates the soil quickly, which consequently reduces absorbance and increases surface runoff. The sudden increase in water volume in a stream raises the velocity of the flow to a point where soil from the stream banks begins to erode into the channel. Runoff volume from this land use is further increased in areas with steep topography, and areas in which cattle have overgrazed the vegetation. In addition to facilitating hydrology-related sedimentation issues, the overgrazing and trampling of vegetation in riparian zones leads to loosened soil that directly enters streams.

Eroded sediment can cause numerous problems for aquatic organisms. Suspended sediment causes turbidity, which can interfere with predation efficiency; cause respiration problems by clogging gills of aquatic organisms (Horne and Goldman 1994); and also reduces sunlight penetration, which affects plant photosynthesis (Waters 1995). Causing a higher magnitude of problems, deposited sediment can 1) suffocate eggs of fish and other organisms, 2) suffocate small organisms, 3) severely reduce habitat and habitat diversity, and 4) alter flow patterns (USEPA 1999). Because neither Pennsylvania nor EPA has water quality criteria for siltation and total phosphorus (nutrients), 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 and total phosphorus (nutrients) loading reduction necessary to restore healthy aquatic communities to the Headwaters of Evitts Creek. 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 an 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 30% of the impaired watershed area, Table 4.

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.

The Headwaters of Town Creek were selected as the reference for developing the Headwaters of Evitts Creek TMDL. The watershed has a total drainage area of 15,698 acres and is also a tributary to the Tonoloway River. The headwaters flow west from Sidling Hill ridge (near Route 643 and Flickerville Road) to Sipes Mill Road (west of its intersection with Interstate 522), Belfast Township, Bedford County, Figure 4.

Land use in this watershed is composed of agriculture (12%) including croplands and hay/pasture, forestland (83%), and other (5%). Headwaters of Town Creek is also designated as a High Quality, Cold-Water Fishery like Headwaters of Evitts Creek, but is attaining its designated aquatic life uses based on biological sampling initially done by the Department in 1998.

<table>
<tr><td colspan="3">Table 4. Comparison of Headwaters of Evitts Creek (impaired) & Headwaters of Town Creek (reference)</td></tr>
<tr><td>Physiographic</td><td>Headwaters of Evitts Creek</td><td>Headwaters of Town Creek</td></tr>
<tr><td>Province:</td><td>Ridge and Valley Plateaus</td><td>Ridge and Valley Plateaus</td></tr>
<tr><td>Area (acres):</td><td>12,895.4</td><td>15,698.3</td></tr>
<tr><td>Land Use Distribution:</td><td>Agriculture 18%
Forest 75%
Other 7%</td><td>Agriculture 12%
Forest 83%
Other 5%</td></tr>
<tr><td>Dominant Soils:</td><td>A: High Infiltration 8%
B: Moderate Infiltration 28%
C: Slow Infiltration 52%
D: Very Slow Infiltration 13%</td><td>A: High Infiltration 13%
B: Moderate Infiltration 36%
C: Slow Infiltration 10%
D: Very Slow Infiltration 41%</td></tr>
<tr><td>Surface Geology:
Shale
Sandstone
Interbedded Sed.</td><td>
< 50%
< 35%
< 15%</td><td>
< 5%
< 20%
< 75%</td></tr>
<tr><td>Hydrology:</td><td>
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<tr><th>Month</th><th>Precip (cm)</th><th>ET (cm)</th><th>Surface Runoff (cm)</th><th>Subsurface Flow (cm)</th></tr>
<tr><td>Jan</td><td>6.98</td><td>0.58</td><td>0.96</td><td>3.56</td></tr>
<tr><td>Feb</td><td>7.13</td><td>0.88</td><td>0.76</td><td>4.96</td></tr>
<tr><td>Mar</td><td>7.70</td><td>2.70</td><td>0.51</td><td>5.56</td></tr>
<tr><td>Apr</td><td>8.42</td><td>6.05</td><td>0.14</td><td>4.73</td></tr>
<tr><td>May</td><td>11.53</td><td>11.17</td><td>0.54</td><td>2.99</td></tr>
<tr><td>Jun</td><td>9.38</td><td>13.57</td><td>1.38</td><td>1.61</td></tr>
<tr><td>Jul</td><td>8.70</td><td>9.95</td><td>0.25</td><td>0.43</td></tr>
<tr><td>Aug</td><td>8.41</td><td>8.56</td><td>0.22</td><td>0.08</td></tr>
<tr><td>Sep</td><td>8.96</td><td>5.73</td><td>1.07</td><td>0.02</td></tr>
<tr><td>Oct</td><td>8.00</td><td>4.13</td><td>0.67</td><td>0.39</td></tr>
<tr><td>Nov</td><td>8.48</td><td>2.41</td><td>0.49</td><td>0.50</td></tr>
<tr><td>Dec</td><td>8.23</td><td>1.14</td><td>0.63</td><td>2.29</td></tr>
<tr><td>Total</td><td>101.92</td><td>66.87</td><td>7.62</td><td>27.12</td></tr>
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<table>
<tr><th>Month</th><th>Precip (cm)</th><th>ET (cm)</th><th>Surface Runoff (cm)</th><th>Subsurface Flow (cm)</th></tr>
<tr><td>Jan</td><td>6.98</td><td>0.55</td><td>1.14</td><td>4.63</td></tr>
<tr><td>Feb</td><td>7.13</td><td>0.84</td><td>0.91</td><td>5.22</td></tr>
<tr><td>Mar</td><td>7.70</td><td>2.58</td><td>0.61</td><td>5.67</td></tr>
<tr><td>Apr</td><td>8.42</td><td>5.77</td><td>0.17</td><td>4.81</td></tr>
<tr><td>May</td><td>11.53</td><td>10.40</td><td>0.64</td><td>3.11</td></tr>
<tr><td>Jun</td><td>9.38</td><td>10.39</td><td>1.50</td><td>1.65</td></tr>
<tr><td>Jul</td><td>8.70</td><td>8.75</td><td>0.30</td><td>0.44</td></tr>
<tr><td>Aug</td><td>8.41</td><td>8.33</td><td>0.27</td><td>0.08</td></tr>
<tr><td>Sep</td><td>8.96</td><td>5.65</td><td>1.19</td><td>0.14</td></tr>
<tr><td>Oct</td><td>8.00</td><td>4.00</td><td>0.77</td><td>0.90</td></tr>
<tr><td>Nov</td><td>8.48</td><td>2.30</td><td>0.58</td><td>1.56</td></tr>
<tr><td>Dec</td><td>8.23</td><td>1.08</td><td>0.75</td><td>4.09</td></tr>
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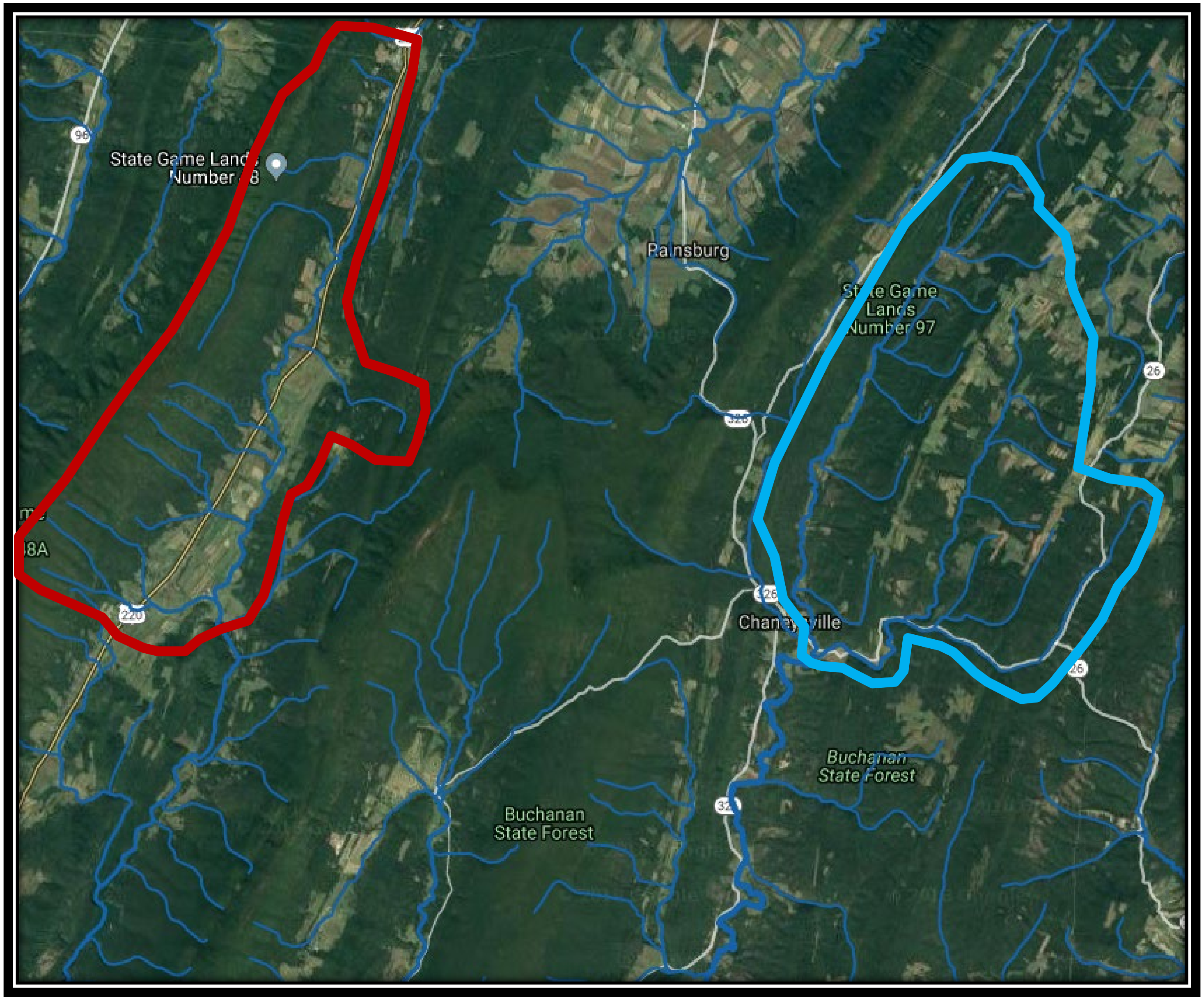

Figure 4. Impaired (red) Headwaters of Evitts Creek and reference (blue) Headwaters of Town Creek

Watershed Assessment and Modeling

The MAPSHED model was used to establish existing loading conditions for the impaired (siltation and total phosphorus (nutrients)) Headwaters of Evitts Creek and the corresponding non-impaired, reference Headwaters of Town Creek. All MAPSHED data and outputs have been attached to this TMDL as Attachment B. Department staff visited the listed watersheds to get a better understanding of existing conditions that might influence the MAPSHED model. General observations (show with the following maps, photos, and notes) of the individual watershed characteristics of included:

<u>Headwaters of Evitts Creek (impaired)</u>

- Agricultural runoff reporting to streams
- Mowed riparian zone
- Sediment layering in pool habitats
- Livestock with free access to the stream
- Minimal riparian buffers

<u>Headwaters of Town Creek (reference)</u>

- Riparian forest buffers common
- Minimal sediment layering of benthic substrate
- Healthy variety of benthic habitats
- Tributaries with extensive forested slopes

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

<u>Headwaters of Evitts Creek</u>

- No changes to the model were necessary.

<u>Headwaters of Town Creek (reference)</u>

- No changes to the model were necessary.

Hydrologic / Water Quality Modeling

Part 1. Model Overview & Data Compilation

The TMDL for this watershed was calculated using the ArcView Generalized Watershed Loading Function (MAPSHED) 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 MAPSHED 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 corresponding sediment and total phosphorus (nutrients) loading 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/phosphorus 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 MAPSHED, 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 MAPSHED 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 MAPSHED 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 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 GWLF 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 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 Headwaters of Evitts Creek TMDL calculations via MAPSHED 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 land slope 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.

The MAPSHED model produced area information and loading for sediment and total phosphorus based on land use (Table 6. for impaired segments and Table 7. for reference segments).

Table 6. Existing Loading Values for Headwaters of Evitts Creek (impaired)

Source	Area (ac.)	Sediment (lbs.)	Unit Area Load (lbs./ac./yr.) Sediment	Total Phosphorus (lbs.)	Unit Area Load (lbs./ac./yr.) Total P
HAY/PAST	1,634.0	256,400.0	156.9	573.6	0.35
CROPLAND	692.0	656,400.0	948.6	947.8	1.37
FOREST	9,731.0	54,600.0	5.6	79.2	0.008
LO DEVELOP.	827.0	8,200.0	9.9	25.4	0.03
MD DEVELOP.	11.0	600.0	54.5	1.3	0.12
HI DEVELOP.	1.0	0.0	0.0	0.2	0.20
STREAMBANKS	-	1,314,400.0	-	363.8	-
POINT SOURCES	-	1,133.10	-	227.0	-
FARM ANIMALS	-	-	-	894.5	-
Total	12,896.0	2,291,733.1	177.7	3,112.8	0.24

Table 7. Existing Loading Values for Headwaters of Town Creek (reference)					
Source	Area (ac)	Sediment (lbs.)	Unit Area Load (lbs./ac./yr.) Sediment	Total Phosphorus (lbs.)	Unit Area Load (lbs./ac./yr.) Total P
HAY/PAST	1,689.0	255,200.0	151.1	610.9	0.36
CROPLAND	193.0	174,000.0	901.6	232.9	1.21
FOREST	12,976.0	48,000.0	3.7	116.7	0.01
OPEN LAND	69.0	14,800.0	214.5	14.5	0.21
BARE ROCK	5.0	0.0	0.0	0.1	0.02
LO DEVELOP.	764.0	7,000.0	9.2	21.8	0.03
MD DEVELOP.	1.0	0.0	0.0	0.1	0.10
STREAM BANKS	-	1,444,600.0	-	339.5	-
POINT SOURCES	-	1,133.1	-	227.0	-
FARM ANIMALS	-	-	-	309.6	-
Total	15,697.0	1,944,733.1	123.9	1,873.1	0.12

Development of a Sediment and Total Phosphorus TMDL

The target TMDL value for the impaired Headwaters of Evitts Creek was established based on current loading rates for sediment and total phosphorus (nutrients) in the reference headwaters of Town Creek. Reducing the loading rates in the Headwaters of Evitts Creek to levels equal to or less than the reference watershed should allow for the reversal of current use impairments and maintain its HQ-CWF designated use. As described in the previous section, loading rates were computed for the reference stream using the MAPSHED model. The target TMDL value for sediment was determined by multiplying the unit area loading rates for the reference stream by the total area of impaired stream, Table 8.

Table 8. TMDL Values for Headwaters of Evitts Creek				
Pollutant	Loading Rate in Reference (lbs./ac-yr.)	Total Area Impaired Watershed (ac)	Target TMDL Value (lbs./yr.)	Target TMDL Value (lbs./day)
Sediment	123.9	12,896.0	1,597,711.5	4,377.3
Phosphorus	0.1	12,896.0	1,538.9	4.2

The target TMDL value was then used as the basis for load allocations and reductions in the headwaters of Evitts Creek, using the following equation:

TMDL = MOS + WLA + LA

TMDL = Total Maximum Daily Load

MOS = Margin of Safety

WLA = Waste Load Allocation

LA = Load Allocation

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 Headwaters of Evitts Creek. The MOS used for the Sediment TMDL was set at 159,771.2 lbs./yr. and at 153.9 lbs./yr. for the Total Phosphorus (Nutrients) TMDL.

Headwaters of Evitts Creek Sediment TMDL:

MOS = 1,597,711.5 lbs./yr. TMDL * 0.1 = 159,771.2 lbs./yr. or 4,377.3 lbs./day

Headwaters of Evitts Creek Nutrients (Total Phosphorus) TMDL:

MOS = 1,538.9 lbs./yr. TMDL * 0.1 = 153.9 lbs./yr. or 0.4 lbs./day

Waste Load Allocation

The waste load allocation (WLA) portion of the TMDL equation includes a bulk reserve of 1% of the TMDL in addition to the existing load limits from permits in the watershed. This helps to account for the dynamic nature of permit activity and provide flexibility for future growth and change.

A search of the Pennsylvania Department of Environmental Protection's database identified one permittee with sediment and total phosphorus limits within the headwaters of Evitts Creek and one permittee in the headwaters of Town Creek, Table 9.

Table 9. NPDES Permits in Headwaters of Evitts Creek and Headwaters Town Creek				
Headwaters Evitts Creek Permits				
Number	Sediment Load (lbs)		Total Phosphorus Load (lbs)	
	Annual	Daily	Annual	Daily
PA0082007	1,133.1	3.1	227.0	0.62
Headwaters Town Creek				
Number	Sediment Load (lbs)		Total Phosphorus Load (lbs)	
	Annual	Daily	Annual	Daily
PA0086819	1,133.1	3.1	227.0	0.62

Headwaters of Evitts Creek Sediment TMDL:

WLA = (1,597,711.5 TMDL * 0.01 Bulk Reserve) + 1,133.1 Permit Limit = 17.110.2 lbs./yr. lbs./yr. or 46.9 lbs./day

Headwaters of Evitts Creek Nutrients (Total Phosphorus) TMDL:

WLA = (1,538.9 TMDL * 0.01 Bulk Reserve) + 227.0 Permit Limit = 242.4 lbs./yr. lbs./yr. or 0.7 lbs./day

Load Allocation

The load allocation (LA) is the portion of the TMDL that is assigned to nonpoint sources. The LA for the Sediment TMDL and Total Phosphorus (Nutrients) TMDL was computed by subtracting the MOS value and the WLA from the TMDL value. The LA for Sediment TMDL was set at 1,420,830.2 lbs./yr. and at 1,142.6 lbs./yr. for the Total Phosphorus (Nutrients).

Headwaters of Evitts Creek Sediment TMDL:

LA = 1,597,711.5 lbs./yr. TMDL – 159,771.2 lbs./yr. MOS – 17,110.2 lbs./yr. WLA = 1,420,830.2 lbs./yr. or 3,892.7 lbs./day

Headwaters of Evitts Creek Nutrients (Total Phosphorus) TMDL:

LA = 1,538.9 lbs./yr. TMDL – 153.9 lbs./yr. MOS – 242.4 lbs./yr. WLA = 1,142.6 lbs./yr. or 3.1 lbs./day

Adjusted Load Allocation

The adjusted load allocation (ALA) is the portion of the LA distributed among the nonpoint sources receiving reductions. It is computed by subtracting the nonpoint source loads that are not being considered for reductions (loads not reduced (LNR)) from the LA. The Headwaters of Evitts Creek TMDL was developed to address impairments caused by agricultural activities, including hay/pastureland and cropland. Associated stream banks and farm animals are also considered contributors to the sediment and/or phosphorus loading in the watershed. Land uses/source loads not reduced (LNR) were carried through at their existing loading values, Table 10.

Table 10. Load Allocation, Loads Not Reduced and Adjusted Load Allocation		
	Sediment (lbs./yr.)	Total P (lbs./yr)
Load Allocation	1,420,830.2	1,142.6
Loads Not Reduced:	63,400.0	106.1
Forest	54,600.0	79.2
Low Intensity Development	8,200.0	25.4
Mid Intensity Development	600.0	1.3
High Intensity Development	0.0	0.2
Adjusted Load Allocation	1,357,430.2	1,036.5

TMDL Summary

The Sediment TMDL and Nutrients (Total Phosphorus) TMDL components of the Headwaters of Evitts Creek TMDL are summarized in Table 11.

Table 11. TMDL Components for Headwaters of Evitts Creek				
	Sediment (lbs./yr.)	Sediment (lbs./day)	Total Phosphorus (lbs./yr.)	Total Phosphorus (lbs./day)
TMDL (Total Maximum Daily Load)	1,597,711.5	4,377.3	1,538.9	4.2
WLA (Waste Load Allocation)	17,110.2	46.9	242.4	0.7
MOS (Margin of Safety)	159,771.2	437.7	153.9	0.4
LA (Load Allocation)	1,420,830.2	3,892.7	1,142.6	3.1
LNR Loads Not Reduced)	63,400.0	173.7	106.1	0.3
ALA (Adjusted Load Allocation)	1,357,430.2	3,719.0	1,036.5	2.8

Calculation of Sediment and Nutrient (Total Phosphorus) Load Reductions

The adjusted load allocation (ALA) established in the previous section represents the sediment and total phosphorus (nutrients) loads that are available for allocation between agricultural activities (cropland and hay/pastureland), adjacent stream banks and farm animals in the Headwaters of Evitts Creek. 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 these sources. The process is summarized below: 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 sector 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.

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 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 39.1**%** reduction in current sediment loading and a 62.7% reduction in the current total phosphorus loading for the targeted source sectors receiving reductions within the watershed.

Tables 12. (Annual Values) and Table 13. (Daily Values) contain the results of the EMPR in sediment loading and Table 14. (Annual Values) and Table 15. (Daily Values) contains the results of the EMPR in current phosphorus loading for the respective land use in Headwaters of Evitts Creek.

Table 12. Sediment Load Allocations in the Headwaters of Evitts Creek (Annual Values)

		Current Loading	Allowable Loading	Current Load	Load Allocation	
Land Use	Acres	(lbs./ac./yr.)	(lbs./ac./yr.)	(lbs./yr.)	(lbs./yr.)	% Reduction
Cropland	692.0	948.55	578.12	656400.0	400061.6	39.1%
Hay/Pasture	1634.0	156.92	95.64	256400.0	156270.2	39.1%
Stream Banks				1314400.0	801098.3	39.1%

Table 13. Sediment Load Allocations in the Headwaters of Evitts Creek (Daily Values)						
		Current Loading	Allowable Loading	Current Load	Load Allocation	
Land Use	Acres	(lbs./acre/d.)	(lbs./acre/d.)	(lbs./d.)	(lbs./d.)	% Reduction
Cropland	692.0	2.599	1.584	1798.356	1096.059	39.1%
Hay/Pasture	1634.0	0.430	0.262	702.466	428.138	39.1%
Stream Banks				3601.096	2194.790	39.1%

Table 14. Total Phosphorus Load Allocations in the Headwaters of Evitts Creek (Annual Values)						
		Current Loading	Allowable Loading	Current Load	Load Allocation	
Land Use	Acres	(lbs./ac./yr.)	(lbs./ac./yr.)	(lbs./yr.)	(lbs./yr.)	% Reduction
Cropland	692.0	1.37	0.51	947.8	353.4	62.7%
Hay/Pasture	1634.0	0.35	0.13	573.6	213.9	62.7%
Stream Banks				363.8	135.7	62.7%
Farm Animals				894.5	333.5	62.7%

Table 15. Total Phosphorus Load Allocations in the Headwaters of Evitts Creek (Daily Values)						
		Current Loading	Allowable Loading	Current Load	Load Allocation	
Land Use	Acres	(lbs./acre/d.)	(lbs./acre/d.)	(lbs./d.)	(lbs./d.)	% Reduction
Cropland	692.0	0.004	0.001	2.597	0.968	62.7%
Hay/Pasture	1634.0	0.001	0.000	1.572	0.586	62.7%
Stream Banks				0.997	0.372	62.7%
Farm Animals				2.451	0.914	62.7%

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 and nutrient 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 and total phosphorus (nutrients) 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 land uses within the watershed and their respective contributions to the sediment load. The only background sources of sediment and total phosphorus (nutrients) within the watershed would be from forested areas. There are no additional "upstream" these non-point sources to this watershed. The remaining land uses are anthropogenic sources of sediment and total phosphorus (nutrients) to the watershed, thus will not be considered background.

Recommendations

Sediment and total phosphorus (nutrients) reductions in the TMDL are allocated to agricultural activities and stream banks as they have been identified as the sources and causes of the impairments. Implementation of best management practices (BMPs) in these affected areas is called for according to this TMDL document. The implementation of BMPs will achieve the loading reduction goals established by the TMDL.

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 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: manure storage, rotational grazing, livestock exclusion fencing and forested riparian buffers. Some of these BMPs were observed in the impaired watershed; however, they were more extensively used in the unimpaired, reference watershed, with riparian forest buffers commonly used. Since both watersheds have a considerable amount of agricultural activities, it is apparent that the greater use of BMPs, especially riparian forest buffers, in the reference watershed has contributed to its ability to maintain its local attainment status as a High Quality, Cold-Water Fishery (HQ-CWF).

Stream banks contribute to the sediment load in the impaired watershed. Stream bank stabilization projects would be acceptable BMPs for the eroded stream banks in the area. However, the addition of forested riparian buffers is essential to maintaining the biologically rich yet sensitive HQ-CWF habitat. Riparian forest 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 protected under the HQ-CWF use designation.

Important to TMDLs, established riparian forest buffers act as sediment and total phosphorus (nutrients) sinks. This is because the highly active and concentrated biological communities they maintain will assimilate and remove sediment and total phosphorus (nutrients) from the water column instead of allowing them to pass downstream unchecked. Thus, riparian forest buffers work directly toward attaining the goals of the TMDL by reducing pollutant loads. These riparian forest buffers also provide the essential conditions necessary to meet the HQ-CWF designated use of the waterway. Riparian forest buffers also provide critical habitat to rare and sensitive amphibious and terrestrial organisms as well as migratory species. While riparian forest 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 land uses, 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 BMPs required for meeting the sediment reductions outlined in this report. A combined effort involving key personnel from the regional DEP office, the Bedford County Conservation District, 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 TMDL will be published in the Pennsylvania Bulletin on 6/22/2019 to foster public comment. A 30-day period will be provided for the submittal of comments. Any public comments will be placed in the Comments and Response section of the document, Attachment C.

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Attachment A

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.

Table A1. Equal Marginal Percent Reduction calculations for sediment loading in Headwaters of Evitts Creek

1					2	Adjusted LA = TMDL total load - ((MOS) - loads not reduced)						
	TMDL = Sediment loading rate in ref. * Impaired Acres					1357430.2	1357430.2					
	1597711.5											
		Annual				Recheck	% reduction	Load			Allowable	%
3		Avg. Load	Load Sum	Check	Initial Adjust	Adjust	allocation	Reduction	Initial LA	Acres	Loading Rate	Reduction
	CROPLAND	656400.0	2227200.0	good	656400.0		0.3	256338.4	400061.6	692.0	578.1	39.1%
	HAY/PASTURE	256400.0		good	256400.0	869769.8	0.1	100129.8	156270.2	1634.0	95.6	39.1%
	STREAMBANK	1314400.0		good	1314400.0		0.6	513301.7	801098.3			39.1%
					2227200.0		1.0		1357430.2			
4	All Ag. Loading Rate	239.18										
			Allowable		Current	Current						
		Acres	loading rate	Final LA	Loading Rate	Load	% Red.			CURRENT LOAD	FINAL LA	
5	CROPLAND	692.0	578.1	400061.6	948.6	656400.0	39.1%		CROPLAND	656,400.0	400,061.6	
	HAY/PASTURE	1634.0	95.6	156270.2	156.9	256400.0	39.1%		HAY/PASTURE	256,400.0	156,270.2	
	STREAMBANK			801098.3		1314400.0	39.1%		STREAMBANK	1,314,400.0	801,098.3	
				1357430.2		2227200.0	39.1%					

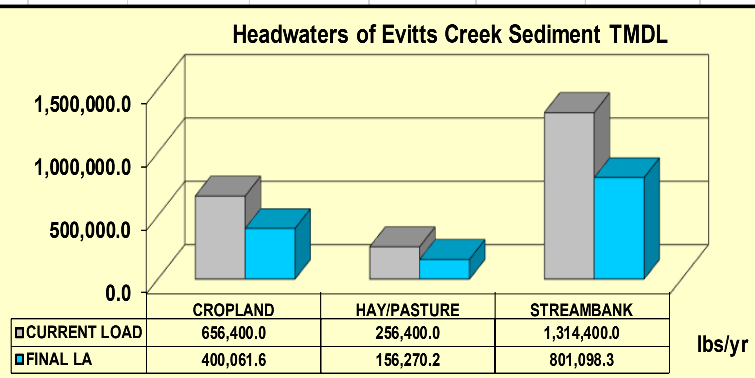
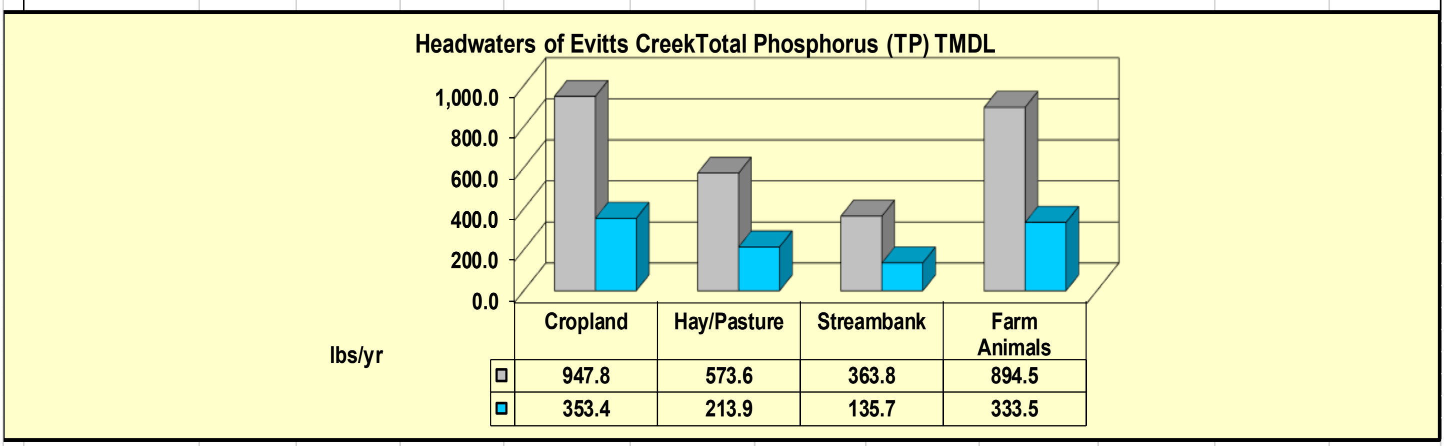


Table A2. Equal Marginal Percent Reduction calculations
for loading of Total Phosphorus in Headwaters of Evitts Creek

1					2	Adjusted LA = TMDL total load - ((MOS) - loads not reduced)						
	TMDL = Sediment loading rate in ref. * Impaired Acres					1036.5	1036.5					
	1538.9											
		Annual				Recheck	% reduction	Load			Allowable	%
3		Avg. Load	Load Sum	Check	Initial Adjust	Adjust	allocation	Reduction	Initial LA	Acres	Loading Rate	Reduction
	CROPLAND	947.8	2779.7	good	947.8		0.3	594.4	353.4	692.0	0.5	62.7%
	HAY/PASTURE	573.6		good	573.6	1743.2	0.2	359.7	213.9	1634.0	0.1	62.7%
	STREAMBANK	363.8		good	363.8		0.1	228.1	135.7			62.7%
	FARM ANIMALS	894.5		good	894.5		0.3	561.0	333.5			62.7%
					2779.7		1.0		1036.5			
4	All Ag. Loading Rate	0.24										
			Allowable		Current	Current						
		Acres	loading rate	Final LA	Loading Rate	Load	% Red.			CURRENT LOAD	FINAL LA	
5	CROPLAND	692.0	0.51	353.4	1.37	947.8	62.7%		Cropland	947.8	353.4	
	HAY/PASTURE	1634.0	0.13	213.9	0.35	573.6	62.7%		Hay/Pasture	573.6	213.9	
	STREAMBANK			135.7		363.8	62.7%		Streambank	363.8	135.7	
	FARM ANIMALS			333.5		894.5	62.7%		Farm Animals	894.5	333.5	
				1036.5		2779.7	62.7%					



Attachment B

MAPSHED Generated Data Tables

Table B1. GWLF model data outputs for the Headwaters of Evitts Creek

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

Source	Area (Acres)	Runoff (in)	Tons		Total Loads (Pounds)			
			Erosion	Sediment	Dissolved N	Total N	Dissolved P	Total P
Hay/Pasture	1634	2.0	924.1	128.2	713.7	1371.4	290.4	573.6
Cropland	692	3.7	2365.1	328.2	1631.6	3314.7	222.9	947.8
Forest	9731	0.9	196.6	27.3	359.6	499.5	18.9	79.2
Wetland	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
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	827	2.6	0.0	4.1	75.9	230.1	10.1	25.4
MD Mixed	11	8.7	0.0	0.3	4.2	12.6	0.5	1.3
HD Mixed	1	12.8	0.0	0.0	0.5	1.5	0.1	0.2
LD Residential	0	2.6	0.0	0.0	0.0	0.0	0.0	0.0
MD Residential	0	4.7	0.0	0.0	0.0	0.0	0.0	0.0
HD Residential	0	6.7	0.0	0.0	0.0	0.0	0.0	0.0
Farm Animals						4141.5		894.5
Tile Drainage				0.0		0.0		0.0
Stream Bank				657.2		842.2		363.8
Groundwater					55732.2	55732.2	913.4	913.4
Point Sources					0.0	0.0	0.0	0.0
Septic Systems					35.5	35.5	0.0	0.0
Totals	12895.4	1.30	3485.7	1145.4	58553.3	66181.1	1456.3	3799.1

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Table B2. GWLF model data outputs for the Headwaters of Town Creek (non-impaired, reference for Headwaters of Evitts Creek)

GWLF Total Loads for file: HDTownCreekWAnimals-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	1689	2.8	974.8	127.6	1050.4	1849.4	371.5	610.9
Cropland	193	4.6	665.2	87.0	567.3	1112.5	69.6	232.9
Forest	12976	2.4	183.4	24.0	1362.3	1512.6	71.7	116.7
Wetland	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
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	69	4.6	56.3	7.4	35.9	82.0	0.7	14.5
Bare Rock	5	4.6	0.0	0.0	1.6	1.7	0.0	0.1
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	764	3.3	0.0	3.5	64.8	196.3	8.7	21.8
MD Mixed	1	8.5	0.0	0.0	0.3	0.9	0.0	0.1
HD Mixed	0	12.0	0.0	0.0	0.0	0.0	0.0	0.0
LD Residential	0	3.3	0.0	0.0	0.0	0.0	0.0	0.0
MD Residential	0	5.3	0.0	0.0	0.0	0.0	0.0	0.0
HD Residential	0	7.2	0.0	0.0	0.0	0.0	0.0	0.0
Farm Animals						1148.3		309.6
Tile Drainage				0.0		0.0		0.0
Stream Bank				722.3		1131.0		339.5
Groundwater					20082.5	20082.5	765.6	765.6
Point Sources					0.0	0.0	0.0	0.0
Septic Systems					3.5	3.5	0.0	0.0
Totals	15698.3	2.60	1879.7	971.9	23168.5	27120.6	1287.9	2411.7

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Attachment C
Comment and Response

Any public comments for the Headwaters of Evitts Creek TMDL will be placed in this section upon completion of the 30-day comment period after 7/22/2019.