Whiteley Creek Sediment TMDL
Monongahela River

Greene County

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

February 2018

Whiteley Creek Sediment TMDL
Greene County, Pennsylvania

Executive Summary

A Total Maximum Daily Load (TMDL) was developed to address agricultural impairments in Whiteley Creek as noted in the 2016 Pennsylvania Integrated Water Quality Monitoring and Assessment Report (Integrated List), initially listed in 2006 (see Table 2.). Whiteley Creek is a tributary of the Monongahela River and located in southeastern Greene County, near Kirby, primarily within Whiteley Township. The impairments were noted during bioassessments in the watershed (2005) and excessive siltation due to agriculture was identified as causing impairment to Whiteley Creek's designated aquatic life use of Trout Stocked Fishery (TSF) (headwaters to S.R. 2011 bridge) and Warm Water Fishery (WWF) (from the bridge to the Monongahela) (Figure 1.).

Because PA does not currently have water quality criteria for sediment, a TMDL endpoint was identified using a reference watershed approach. Based on a comparison to the similar, non-impaired headwaters of Dunning Creek, Bedford County (Figure 2.), an **53.3%** reduction in sediment loading will allow water quality objectives to be met in the impaired segments of Whiteley Creek (Table 1.)

Table 1. Summary of TMDL for Whiteley Creek in Sediment, lbs./yr. and lbs./day

TMDL – Total Maximum Daily Load, WLA – Waste Load Allocation, MOS – Margin of Safety LA – Load Allocation, LNR – Loads Not Reduced, ALA – Adjusted Load Allocation

TMDL	WASTE LOAD	MOS	LA	LNR	ALA
5,521,338.5	1,249,319.6	552,133.8	3,719,885.0	227,600.0	3,492,285.1
55,213.4	3,422.8	1,512.7	10,191.5	623.6	9567.9

Load allocations were distributed to nonpoint 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. A search of the Pennsylvania Department of Environmental Protection's (Department) efacts permit database identified **17** known point source discharges within Whiteley Creek. To take in account future permit activity, 1% of the TMDL was incorporated into the WLA as a bulk reserve.

The load allocation (LA) is that portion of the total load assigned to nonpoint sources, specifically all land use sources other than NPDES permitted point sources. Loads not reduced (LNR) are the portion of the LA associated with nonpoint sources other than agricultural (croplands, hay/pasture), and associated transitional and stream banks. It is equal to the sum of modeled loading on forested land use, a quarry, and low development. The adjusted load allocation (ALA) represents the remaining portion of the LA distributed among agricultural land and associated stream banks

Introduction

Whiteley Creek is currently designated as a Trout Stocked and Warm Water Fishery (TSF, WWF), (PA Code 25 § 93.3), classified as Trout Stocked Fisheries (TSF). The Aquatic Life Definition is: "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." This watershed is located in southeastern Greene County, near Kirby, and lies primarily within Whiteley Township. From its headwaters, Whiteley Creek flows east for about 10 miles with a total drainage area of 21,824 acres. Major tributaries include water Patterson Run, Dyers Fork, Dutch Run, Frosty Run, and numerous unnamed tributaries. The current land use estimated for Whitely Creek watershed is as follows: Forest – 68%, Agriculture – 24%, Develop. – 8%.

Figure 1. Whiteley Creek is a Trout Stocked (TSF-brown), Warm Water Fishery (WWF-green)

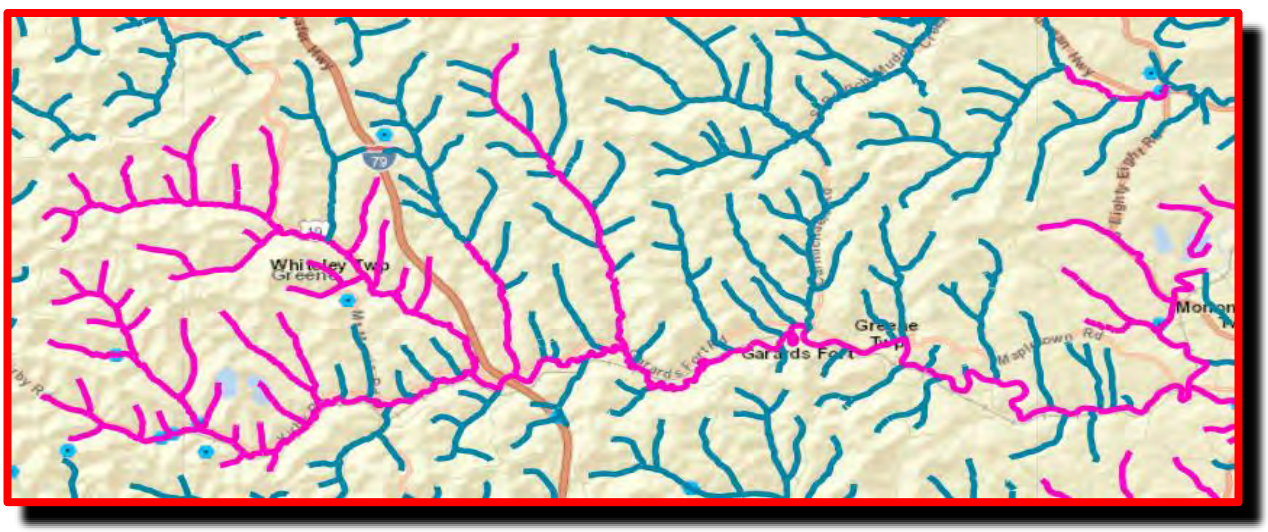

Figure 2. Not impaired segments (purple) and impaired segments of Whiteley Creek (green)

The watershed of Whiteley Creek lies within the Pittsburgh Low Plateau Section of the Appalachian Plateau Province. This section consists of a smooth undulating upland surface cut by numerous, narrow, relatively shallow valleys. Elevation ranges from 302 to 427 m above sea level. Rocks within the watershed are entirely interbedded sedimentary, and the underlying bedrock groups are the Greene Formation and the Washington Formation. The Pittsburgh Coal seam is the primary mineral extraction in the area. The dominant hydrologic soil group is C; this soil group is characterized as having a slow infiltration rate when thoroughly wetted.

The TMDL was completed to address the agricultural impairments noted on the *2016 Pennsylvania Integrated Water Quality Monitoring and Assessment Report, Streams, Category 5, Waterbodies, Pollutants Requiring A TMDL* required under the Clean Water Act, and cover the listed segments shown in Table 2 (following 5 pages). Excessive siltation, from agriculture-related activities has been listed a source of impairment. The TMDL addresses these impairments from croplands, hay/pasture land uses, and associated stream banks.

Table 2. Summary of TMDL for Whiteley Creek in Sediment, lbs./yr. and lbs./day

2016 Pennsylvania Integrated Water Quality Monitoring and Assessment Report - Streams, Category 4a, 4c, and 5 Waterbodies

Stream Nam / HUC / Use Assessed (Assessment ID) - Miles / Source	Cause	Date Listed	TMDL Date
Hydrologic Unit Code: 05020005-Lower Monongahela			
Dyers Fork HUC: 05020005 Aquatic Life (6939) - 6.68 miles Agriculture	Siltation	2006	2019
Dyers Fork Unnamed Of (ID:99417274) HUC: 05020005 Aquatic Life (6939) - 0.34 miles Agriculture	Siltation	2006	2019
Dyers Fork Unnamed Of (ID:99417710) HUC: 05020005 Aquatic Life (6939) - 0.54 miles Agriculture	Siltation	2006	2019
Dyers Fork Unnamed Of (ID:99417786) HUC: 05020005 Aquatic Life (6939) - 0.3 miles Agriculture	Siltation	2006	2019
Dyers Fork Unnamed Of (ID:99425116) HUC: 05020005 Aquatic Life (6939) - 0.28 miles Agriculture	Siltation	2006	2019
Dyers Fork Unnamed To (ID:99417438) HUC: 05020005 Aquatic Life (6939) - 1.18 miles Agriculture	Siltation	2006	2019
Dyers Fork Unnamed To (ID:99417454) HUC: 05020005 Aquatic Life (6939) - 0.36 miles Agriculture	Siltation	2006	2019
Dyers Fork Unnamed To (ID:99417476) HUC: 05020005 Aquatic Life (6939) - 1.27 miles Agriculture	Siltation	2006	2019
Dyers Fork Unnamed To (ID:99417498) HUC: 05020005 Aquatic Life (6939) - 0.68 miles Agriculture	Siltation	2006	2019
Dyers Fork Unnamed To (ID:99417508) HUC: 05020005 Aquatic Life (6939) - 0.48 miles Agriculture	Siltation	2006	2019

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Stream Nam HUC Use Assessed (Assessment ID) - Miles Source	Cause	Date Listed	TMDL Date
Dyers Fork Unnamed To (ID:99417574) HUC: 05020005			
Aquatic Life (6939) - 1.09 miles			
Agriculture	Siltation	2006	2019
Dyers Fork Unnamed To (ID:99417590) HUC: 05020005			
Aquatic Life (6939) - 1.96 miles			
Agriculture	Siltation	2006	2019
Dyers Fork Unnamed To (ID:99417668) HUC: 05020005			
Aquatic Life (6939) - 0.39 miles			
Agriculture	Siltation	2006	2019
Dyers Fork Unnamed To (ID:99417690) HUC: 05020005			
Aquatic Life (6939) - 0.91 miles			
Agriculture	Siltation	2006	2019
Dyers Fork Unnamed To (ID:99417708) HUC: 05020005			
Aquatic Life (6939) - 0.95 miles			
Agriculture	Siltation	2006	2019
Dyers Fork Unnamed To (ID:99417724) HUC: 05020005			
Aquatic Life (6939) - 0.36 miles			
Agriculture	Siltation	2006	2019
Dyers Fork Unnamed To (ID:99417788) HUC: 05020005			
Aquatic Life (6939) - 0.78 miles			
Agriculture	Siltation	2006	2019
Dyers Fork Unnamed To (ID:99425106) HUC: 05020005			
Aquatic Life (6939) - 0.58 miles			
Agriculture	Siltation	2006	2019
Patterson Run HUC: 05020005			
Aquatic Life (7014) - 2.17 miles			
Agriculture	Siltation	2006	2019
Aquatic Life (13135) - 0.54 miles			
Agriculture	Siltation	2006	2019
Patterson Run Unnamed Of (ID:99417934) HUC: 05020005			
Aquatic Life (7014) - 0.42 miles			
Agriculture	Siltation	2006	2019

Stream Nam HUC Use Assessed (Assessment ID) - Miles Source	Cause	Date Listed	TMDL Date
Patterson Run Unnamed To (ID:99417938) HUC: 05020005			
Aquatic Life (7014) - 0.57 miles			
Agriculture	Siltation	2006	2019
Patterson Run Unnamed To (ID:99417980) HUC: 05020005			
Aquatic Life (7014) - 0.32 miles			
Agriculture	Siltation	2006	2019
Patterson Run Unnamed To (ID:99418066) HUC: 05020005			
Aquatic Life (7014) - 0.41 miles			
Agriculture	Siltation	2006	2019
Patterson Run Unnamed To (ID:99418072) HUC: 05020005			
Aquatic Life (7014) - 0.38 miles			
Agriculture	Siltation	2006	2019
Patterson Run Unnamed To (ID:99418190) HUC: 05020005			
Aquatic Life (7014) - 1.04 miles			
Agriculture	Siltation	2006	2019
Patterson Run Unnamed To (ID:99418304) HUC: 05020005			
Aquatic Life (13135) - 1.08 miles			
Agriculture	Siltation	2006	2019
Whiteley Creek HUC: 05020005			
Aquatic Life (7013) - 2.57 miles			
Agriculture	Siltation	2006	2019
Subsurface Mining		2006	2019
Aquatic Life (16383) - 8.84 miles			
Agriculture	Siltation	2006	2019
Subsurface Mining		2006	2019
Whiteley Creek Unnamed Of (ID:99418208) HUC: 05020005			
Aquatic Life (7140) - 1.13 miles			
Agriculture	Siltation	2006	2019
Subsurface Mining		2006	2019
Whiteley Creek Unnamed To (ID:99418262) HUC: 05020005			
Aquatic Life (7140) - 1.7 miles			
Agriculture	Siltation	2006	2019
Subsurface Mining		2006	2019

Stream Nam
HUC
Use Assessed (Assessment ID) - Miles

Source	Cause	Date Listed	TMDL Date

Whiteley Creek Unnamed To (ID:99418342)
HUC: 05020005

Aquatic Life (7140) - 0.77 miles

Source	Cause	Date Listed	TMDL Date
Agriculture	Siltation	2006	2019
Subsurface Mining		2006	2019

Whiteley Creek Unnamed To (ID:99418362)
HUC: 05020005

Aquatic Life (7013) - 0.3 miles

Source	Cause	Date Listed	TMDL Date
Agriculture	Siltation	2006	2019
Subsurface Mining		2006	2019

Whiteley Creek Unnamed To (ID:99418392)
HUC: 05020005

Aquatic Life (7013) - 0.67 miles

Source	Cause	Date Listed	TMDL Date
Agriculture	Siltation	2006	2019
Subsurface Mining		2006	2019

Whiteley Creek Unnamed To (ID:99418396)
HUC: 05020005

Aquatic Life (7013) - 0.51 miles

Source	Cause	Date Listed	TMDL Date
Agriculture	Siltation	2006	2019
Subsurface Mining		2006	2019

Whiteley Creek Unnamed To (ID:99418404)
HUC: 05020005

Aquatic Life (7013) - 0.31 miles

Source	Cause	Date Listed	TMDL Date
Agriculture	Siltation	2006	2019
Subsurface Mining		2006	2019

Whiteley Creek Unnamed To (ID:99418436)
HUC: 05020005

Aquatic Life (7013) - 0.35 miles

Source	Cause	Date Listed	TMDL Date
Agriculture	Siltation	2006	2019
Subsurface Mining		2006	2019

Whiteley Creek Unnamed To (ID:99418456)
HUC: 05020005

Aquatic Life (7013) - 0.4 miles

Source	Cause	Date Listed	TMDL Date
Agriculture	Siltation	2006	2019
Subsurface Mining		2006	2019

Whiteley Creek Unnamed To (ID:99418504)
HUC: 05020005

Aquatic Life (7013) - 0.43 miles

Source	Cause	Date Listed	TMDL Date
Agriculture	Siltation	2006	2019
Subsurface Mining		2006	2019

Stream Nam / HUC / Use Assessed (Assessment ID) - Miles / Source	Cause	Date Listed	TMDL Date
Whiteley Creek Unnamed To (ID:99418510)			
HUC: 05020005			
Aquatic Life (7013) - 0.29 miles			
Agriculture	Siltation	2006	2019
Subsurface Mining		2006	2019
Whiteley Creek Unnamed To (ID:99418512)			
HUC: 05020005			
Aquatic Life (7013) - 0.33 miles			
Agriculture	Siltation	2006	2019
Subsurface Mining		2006	2019
Whiteley Creek Unnamed To (ID:99425184)			
HUC: 05020005			
Aquatic Life (7013) - 0.24 miles			
Agriculture	Siltation	2006	2019
Subsurface Mining		2006	2019
Whiteley Creek Unnamed To (ID:99425186)			
HUC: 05020005			
Aquatic Life (7013) - 0.46 miles			
Agriculture	Siltation	2006	2019
Subsurface Mining		2006	2019

Clean Water Act Requirements

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

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

- States to develop lists of impaired waters for which current pollution controls are not stringent enough to meet water quality standards (the list is used to determine which streams need TMDLs);
- States to establish priority rankings for waters on the lists based on severity of pollution and the designated use of the waterbody; states must also identify those waters for which TMDLs will be developed and a schedule for development;
- States to submit the list of waters to EPA every two years (April 1 of the even numbered years);
- States to develop TMDLs, specifying a pollutant budget that meets state water quality standards and allocate pollutant loads among pollution sources in a watershed, e.g., point and nonpoint sources; and
- EPA to approve or disapprove state lists and TMDLs within 30 days of final submission.

Despite these requirements, states, territories, authorized tribes, and EPA have not developed many TMDLs since 1972. Beginning in 1986, organizations in many states filed lawsuits against EPA for failing to meet the TMDL requirements contained in the federal Clean Water Act and its implementing regulations. While EPA has entered into consent agreements with the plaintiffs in several states, many lawsuits still are pending across the country. In the cases that have been settled to date, the consent agreements require EPA to backstop TMDL development, track TMDL development, review state monitoring programs, and fund studies on issues of concern (e.g., Abandoned Mine Drainage (AMD), implementation of nonpoint source Best Management Practices (BMPs), etc.).

Pennsylvania Clean Streams Law Requirements and Agricultural Operations

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

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

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

With guidance from EPA, the states have developed methods for assessing the waters within their respective jurisdictions. From 1996-2006, the primary method adopted by the Pennsylvania Department of Environmental Protection for evaluating waters found on the 303(d) lists (1998-2002) or in the Integrated Water Quality Monitoring and Assessment Report (2004-2006) was the Statewide Surface Waters Assessment Protocol (SSWAP). SSWAP was a modification of the EPA Rapid Bioassessment Protocol II (RPB-II) and provided a more consistent approach to assessing Pennsylvania's streams.

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

The listings found in the Integrated Water Quality Monitoring and Assessment Reports from 2008 to present were derived based on the Instream Comprehensive Evaluation protocol (ICE). Like the SSWAP protocol that preceded the ICE protocol, the method requires selecting representative segments based on factors such as surrounding land uses, stream characteristics, surface geology, and point source discharge locations. The biologist selects as many sites as necessary to establish an accurate assessment for a stream segment; the length of the stream segment could vary between sites. All the biological surveys include D-frame 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 (WASTE LOAD) 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 WLA, 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

- Changes among individual WLAs but not the total sum of the WLAs with no other changes in the TMDL; 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 specific numeric criteria for sediment loading requirements. Therefore, to establish endpoints such that the designated uses of the Whiteley Creek watershed are attained and maintained, 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)).*

In an effort to address excess agricultural-related siltation in the Whiteley Creek watershed, a Total Maximum Daily Loads (TMDLs) were developed. Based on a reference watershed approach, a total load capacity (or endpoint) of **5,521,338.5 lbs./yr.** of sediment loading was determined sufficient in order to be protective of all TSF and WWF, aquatic life uses, as the reference watershed.

TMDL Approach

Sedimentation is an essential component of aquatic ecosystems, as it often contains minerals used by many aquatic organisms, and also provides habitat. Sedimentation is a natural process that is caused by the weathering of landscape, whereby wind and water erode the surfaces of rocks and soils creating small particles. When these particles enter streams, they may flow with the current (suspended solids), or be deposited on the streambed. Typically, natural inputs of sediment to streams do not cause problems; however, when landscape is modified, excessive amounts of sediment can enter streams or erode from streams and cause undesirable effects (Bryan and Rutherford 1995). Agricultural practices such as row cropping involve the tilling of landscapes to make the soil porous and fertile, which consequently loosens soil directly, as well as indirectly by removing plants whose roots once held soil in place. During 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 streambanks 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).

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

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

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

As a result, the headwaters of Dunning Creek (Figure 3.) was selected as the reference for developing the Whiteley Creek Sediment TMDL. It is designated as a Warm Water Fishery and is identified as attaining this aquatic life use. The headwaters of Dunning Creek flows within West and East St. Clair Township, Bedford County. Figure 4. And Table 4. compares the respective impaired and reference headwaters in terms of size, location, and other physical characteristics.

Figure 3. - Comparison of land use in Whiteley Creek (impaired) in Greene County and land use in the headwaters of Dunning Creek (reference) in Bedford County

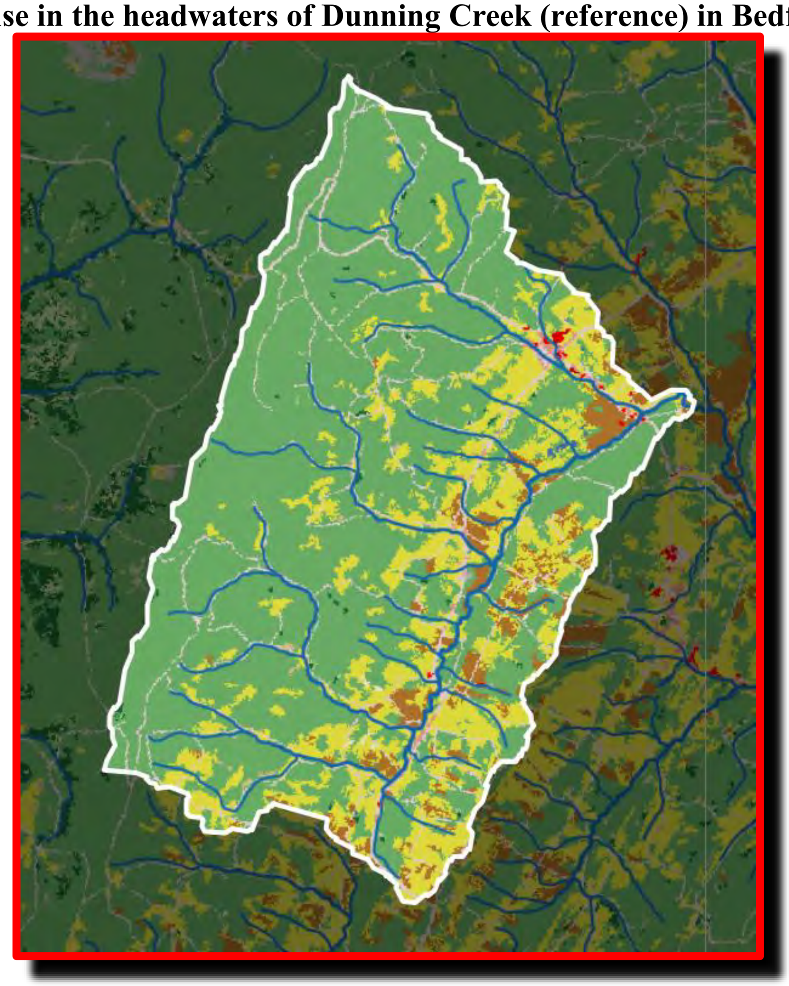


Figure 4. Land cover in Whiteley Creek (left) and the the headwaters of Dunning C. (right)

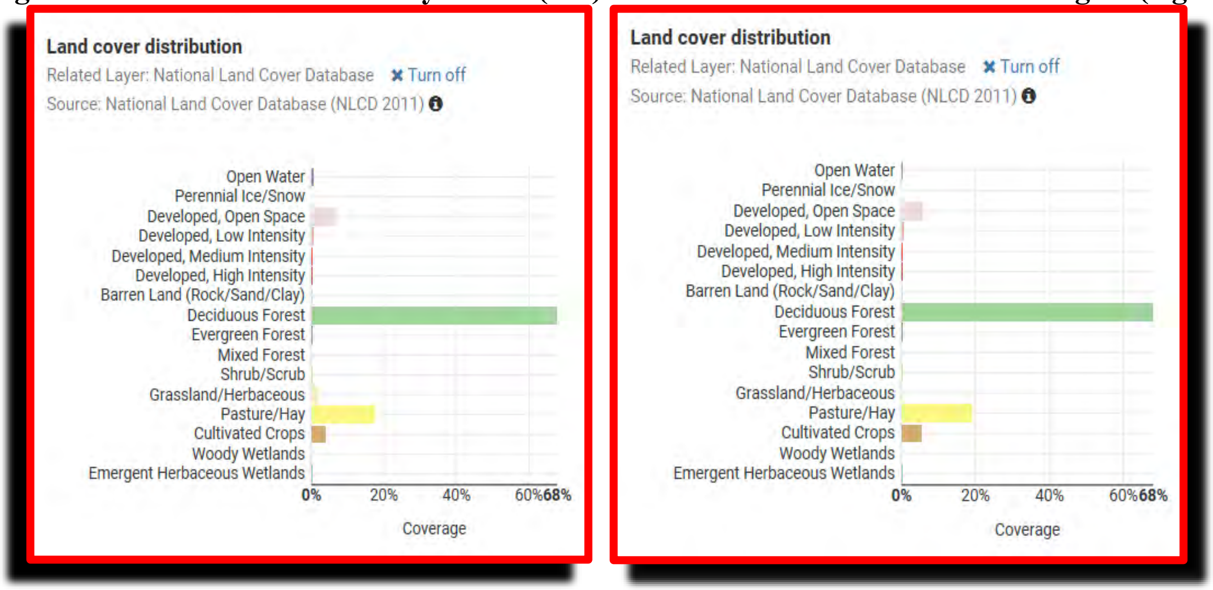


Table 4. Comparison of Whiteley Creek (impaired) and Headwaters of Dunning Creek (reference)

	Whitely Creek	Headwaters of Dunning Creek
Physiographic Province	Appalachian Plateau Province (Waynesburg Hill Section)	Appalachian Plateau Province (Appalachian Mtn. Section)
Area (acres)	34,648.0	27,915.0
Land Use Distribution **% Agriculture** **% Forest** **% Development**	 21 68 8	 25 68 7
<u>Surface Geology:</u> **% Interbedded Sed.** **<u>% Dominant Soils:</u>**	100	100
Average Rainfall (in.)	38.09, 30 years	38.09 30 years

Type	Area (km²)	Coverage (%)
A - High Infiltration	3.15	2.2
A/D - High/Very Slow Infiltration	0.00	0.0
B - Moderate Infiltration	7.74	5.5
B/D - Medium/Very Slow Infiltration	8.89	6.3
C - Slow Infiltration	3.22	2.3
C/D - Medium/Very Slow Infiltration	7.95	5.7
D - Very Slow Infiltration	109.44	78.0

Type	Area (km²)	Coverage (%)
A - High Infiltration	30.28	26.9
A/D - High/Very Slow Infiltration	0.00	0.0
B - Moderate Infiltration	24.39	21.6
B/D - Medium/Very Slow Infiltration	5.44	4.8
C - Slow Infiltration	18.29	16.2
C/D - Medium/Very Slow Infiltration	12.75	11.3
D - Very Slow Infiltration	21.58	19.1

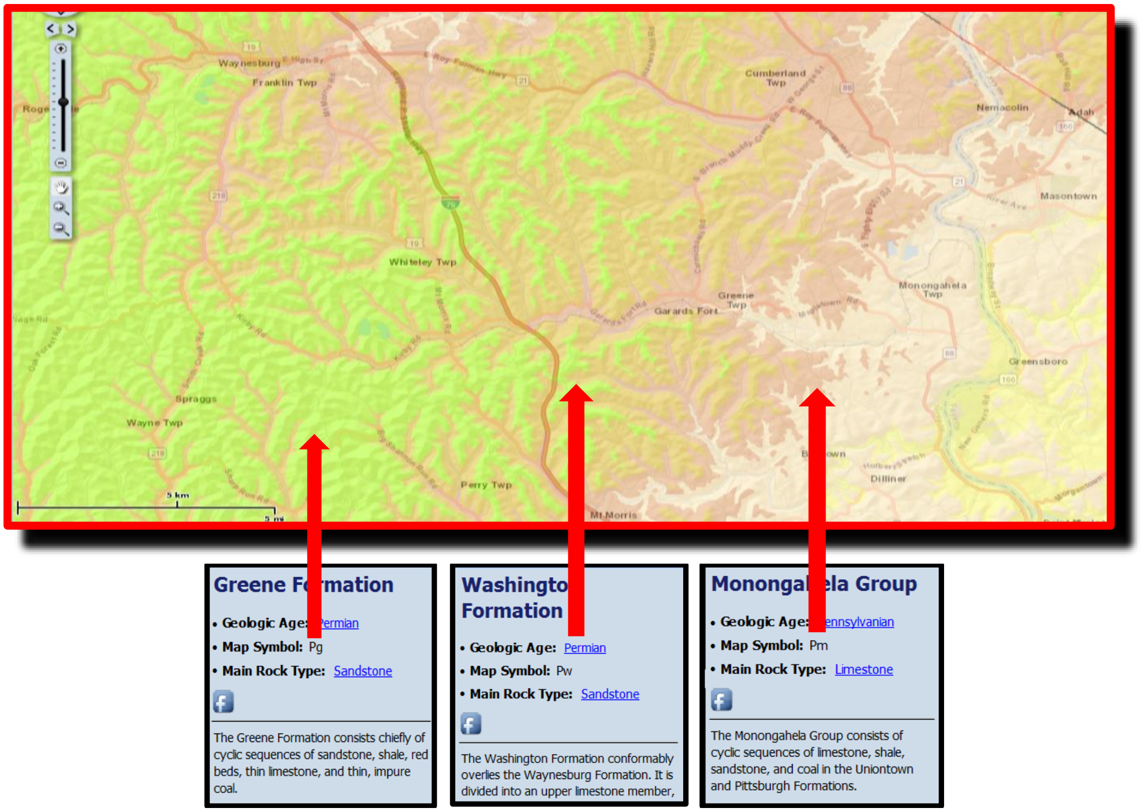
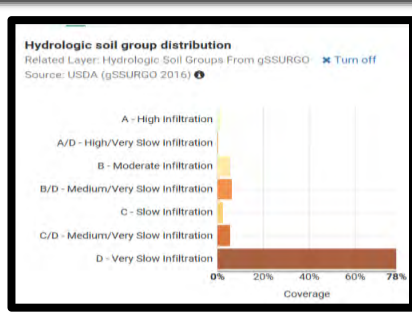


Figure 5. Geology and, Figure 6., Hydric Soils of Whiteley Creek



Hydrologic / Water Quality Modeling

Part 1. Model Overview & Data Compilation

The TMDL for this watershed was calculated using the Mapshed. The remaining paragraphs in this section are excerpts from the Mapshed 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 now MapWindow, and tested extensively in the U.S. and elsewhere.

The Mapshed model provides the ability to simulate runoff and corresponding sediment 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 loading based on the daily water balance accumulated to monthly values.

Mapshed 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, Mapshed 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 Mapshed 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 Mapshed 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 GIS software 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 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 the Whitely Creek sediment 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 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.

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 impaired (siltation) Whiteley Creek and the corresponding non-impaired, reference of the headwaters of Dunning Creek. All Mapshed data and outputs have been attached to this TMDL as Attachment A. Department staff visited the listed watersheds to get a better understanding of existing conditions that might influence the MAPSHED model. The following are general observations (as detailed with photos and descriptions) of the individual watersheds of Whiteley Creek and the headwaters of Dunning Creek.

Figures 6. Overview aerial map of on the ground land use in the headwaters of Dunning Creek, Bedford County (not impaired, cold water reference for Whiteley Creek)

Figures 7. And 8. – The headwaters, as well as its first major tributary, Rocklick Hollow form out of Shaffer Mountain and forested hills and fields surrounding New Paris

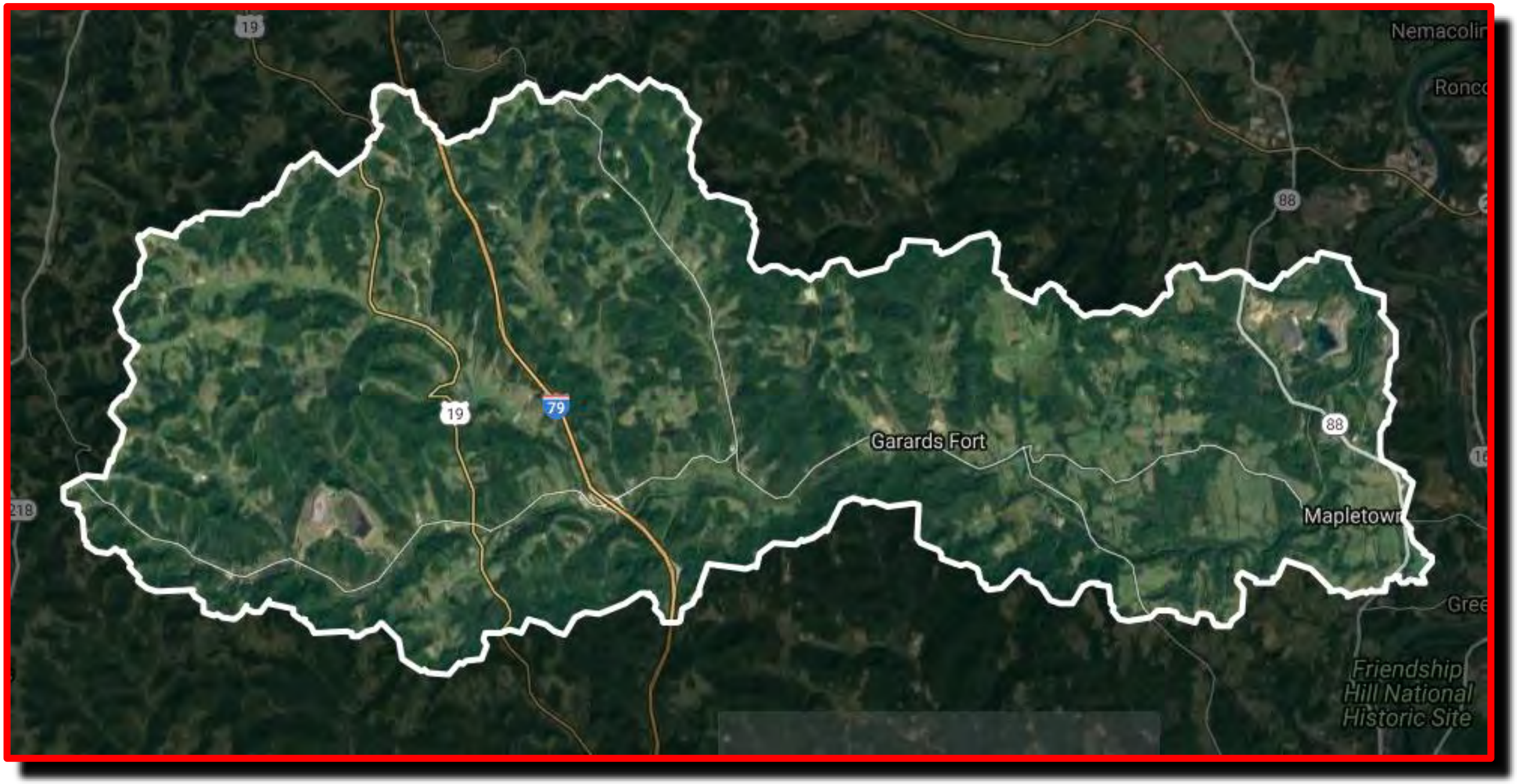
Figures 9. and 10. – Following SR 96 north to the town of Ryot, another tributary, Ryot Run, enters with stable banks, fluvial thorough thru, and a variety of stable habitats

Figures 11. and 12. – Following SR 96 north to the town of Ryot, another tributary, Ryot Run, enters Dunning Creek with stable banks, fluvial thorough thru, and a variety of stable habitats perpetuating the main stem downstream even among pool prevalence

Figures 13. – Aesthetics, as well as, land management are demonstrated at various farms, forested stream banks, covered bridges and field cover

Figures 14. and 15. – Dunning Creek travels northeast to Pleasantville, then another major tributary, Georges Creek; here, vegetative strips and contour cropping contribute to ideal stream characteristics

Figures 16 and 17. – The end of the reference section is around Reynoldsville; as Dunning Creek travels through low gradient, ag. influence, the watershed becomes more susceptible to silt loading



Figures 18. – Overview aerial map of on the ground land use in Whiteley Creek

Figures 19. The headwaters of Whiteley Creek flow for over a mile and half and is surrounded by mostly forest, intermingled with fields or low development.

Figures 20. The main stem of Whiteley Creek intercepts a coal operation until the confluence with its tributary, Patterson Run

Figure 21. Streambanks in the headwaters of Patterson Run have been over-grazed and trampled, and loosened sediment is entering the stream. The remaining portion of the watershed is greatly affected by steep hillsides that adjoin the stream

Figure 22. Some of these hillsides are forested, some have been overgrazed, or modified whereby little vegetative buffer exists to slow surface runoff and banks become incised

Figure 23. and 24. The substrate of the Patterson Run shortly upstream from its confluence with Whitely Creek consists of a muddy ditch for large stretches

Figure 25 and 26. The substrate of the Patterson Run shortly upstream from its confluence with Whitely Creek consists of a muddy ditch for large stretches.

Figure 27. and 28. After joining Patterson Creek, Whiteley Creek flows east, adjacent To SR 2018 (Kirby Road) for over mile and half until Shiver Road. Heavy instream pastureland creates large areas of wasted land use

The upper portion of the Dyers Fork watershed (Figure 3 for location) is also largely affected by steep, over-grazed hillsides (**Figures 29. and 30**.). Some of the cropland in this region appears to be separated from the stream by adequate vegetative buffer. Another cattle farm exists along Dyers Fork shortly upstream from the confluence of Mt. Phoebe Run.

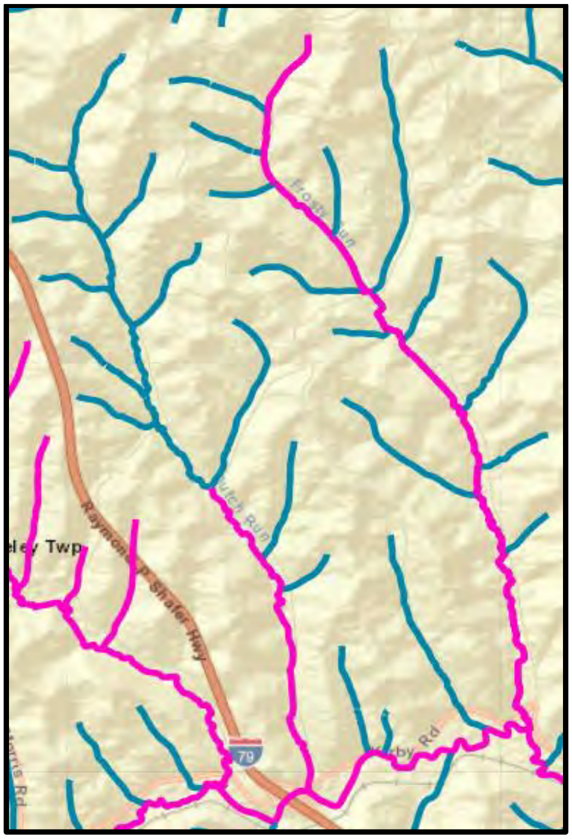
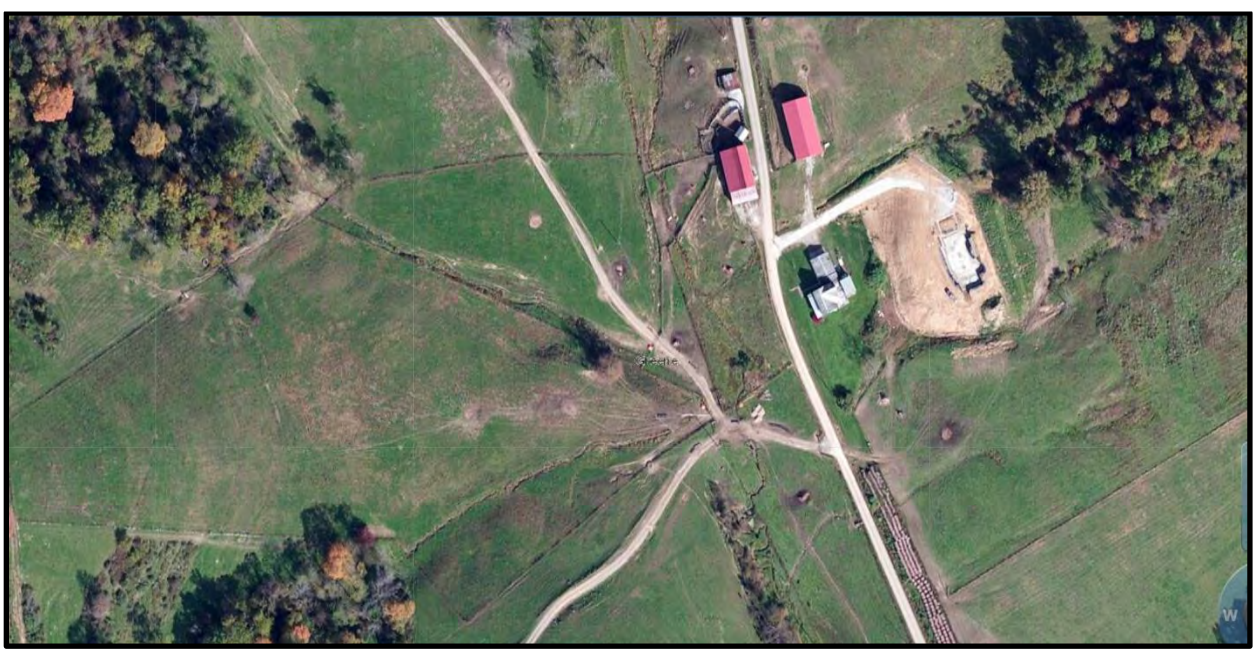


Figure 31. and 32. The lower part of Dutch and Frosty Run are tributaries where the valleys are susceptible to storm water flushing and several farms, it is another large source of excess siltation



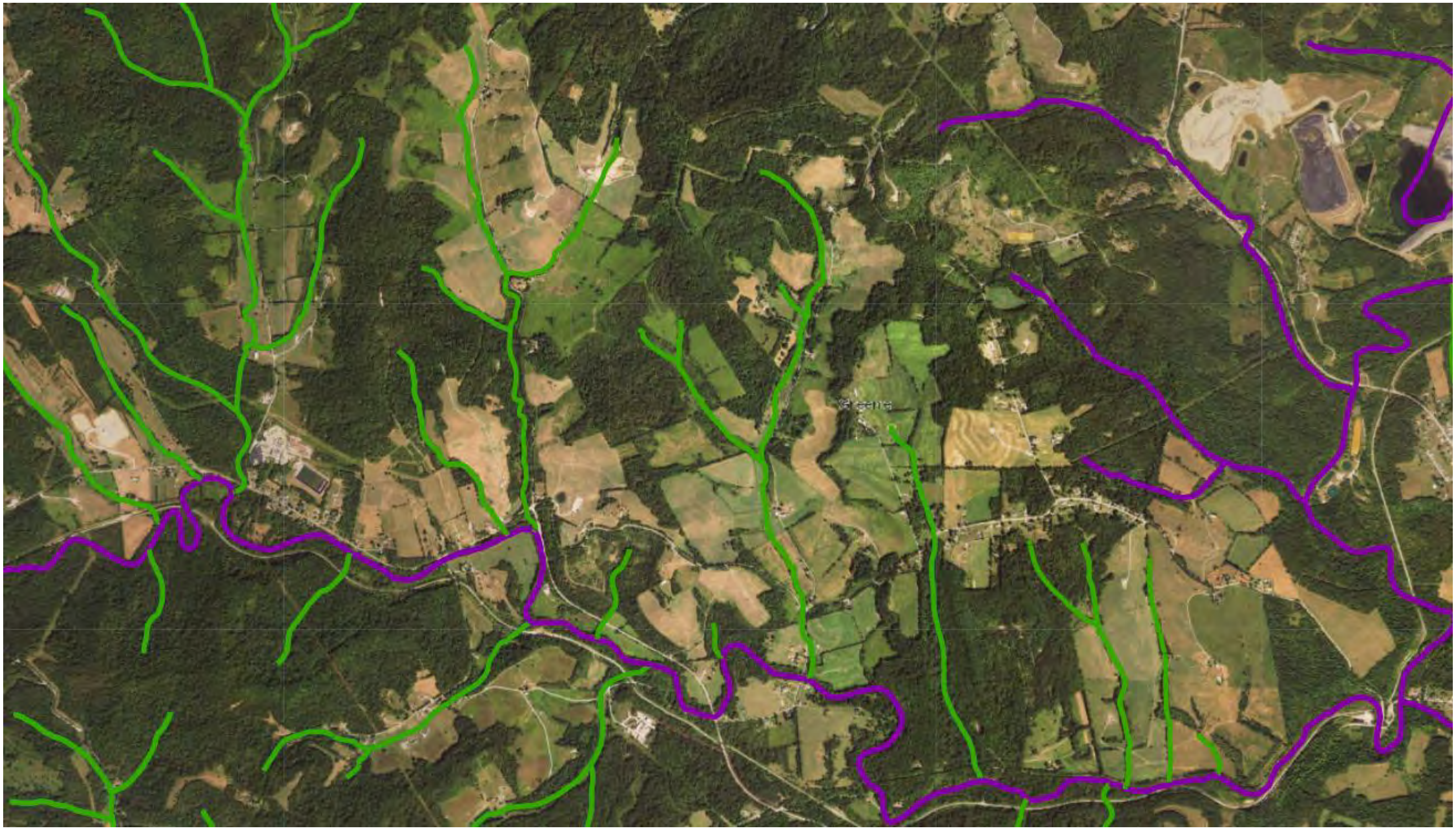


Figure 33. Downstream Geralds Fort to Mapletown, Whiteley Creek flows east with generally some form of forest or rooted vegetative strips; however upstream erosion and downstream low gradients produces wetlands and silty bottoms. Most tributaries exhibit non-impairment due to a minimization of sediment loading

Figure 34. Whiteley travels north, parallel to Route 88, for approximately five miles, opening up to grassy fields and slopes, to its confluence with Monogahela River (west of Masontown); **Figure 35**. On the other hand, an unnamed tributary, south of Mapletown, contributes silt from numerous low cropped banks

Development of Sediment TMDL

The target TMDL value for the biologically impaired Whiteley Creek was established based on current loading rates for sediment in the reference of the headwaters of Dunning Creek. As described in the previous section, agricultural-related sediment 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 the biologically impaired one (Table 6).

Table 6. Target TMDL Using Reference Loading Rate with Total Area of Impaired

Pollutant	Loading Rate in Reference (lbs./ac-yr.)	Total Area Impaired Watershed (ac)	Target TMDL Value (lbs./yr.)	Target TMDL Value (lbs./day)
Sediment	**159.4**	**34,648.0**	**5,521,338.5**	**15,127.0**

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

TMDL = MOS + (AWLA+BR) + (ALA + LNR)

1. TMDL = WLA + LA + MOS
2. LA = ALA + LNR,
3. WLA = AWLA + BR where:

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

Bulk Reserve of TMDL

The waste load allocation (WLA) portion of the sediment TMDL equation is 1% of the Sediment TMDL (**5,521,338.5** lbs./yr.) was incorporated as a bulk reserve (**55,213.4** lbs./yr.) for the dynamic nature of future permit activity.

BR = 5,521,338.5 lbs./yr. (TMDL) x 0.01 (1% Bulk Reserve)

BR = 55,213.4 lbs./yr. or 151.3 lbs./day (1% Bulk Reserve)

Point Source Waste Load

A search of the Pennsylvania Department of Environmental Protection's (Department) efacts permit database identified **17** known point source discharges within the Whiteley Creek (Figure 36 and 37).

Ten NPDES discharges are associated with Cumberland Mine, permit #: PA0013511. Three NPDES discharges are associated with Cumberland Mine, Coal Refuse Disposal Facility, permit #: PA0033511. Three NPDES discharge is associated with Cumberland Mine No. 2 Coal Refuse Disposal Facility, permit #: PA0235440, two NPDES discharges associated with Warwick Mine No. 2 Preparation Plant, permit #: PA0215562. One NPDES discharge associated with Cumberland Coal Resources, permit #: PA0216666, and one NPDES discharge associated with PA Department of Transportation, Bureau of Project Delivery, permit #: PA0098434.

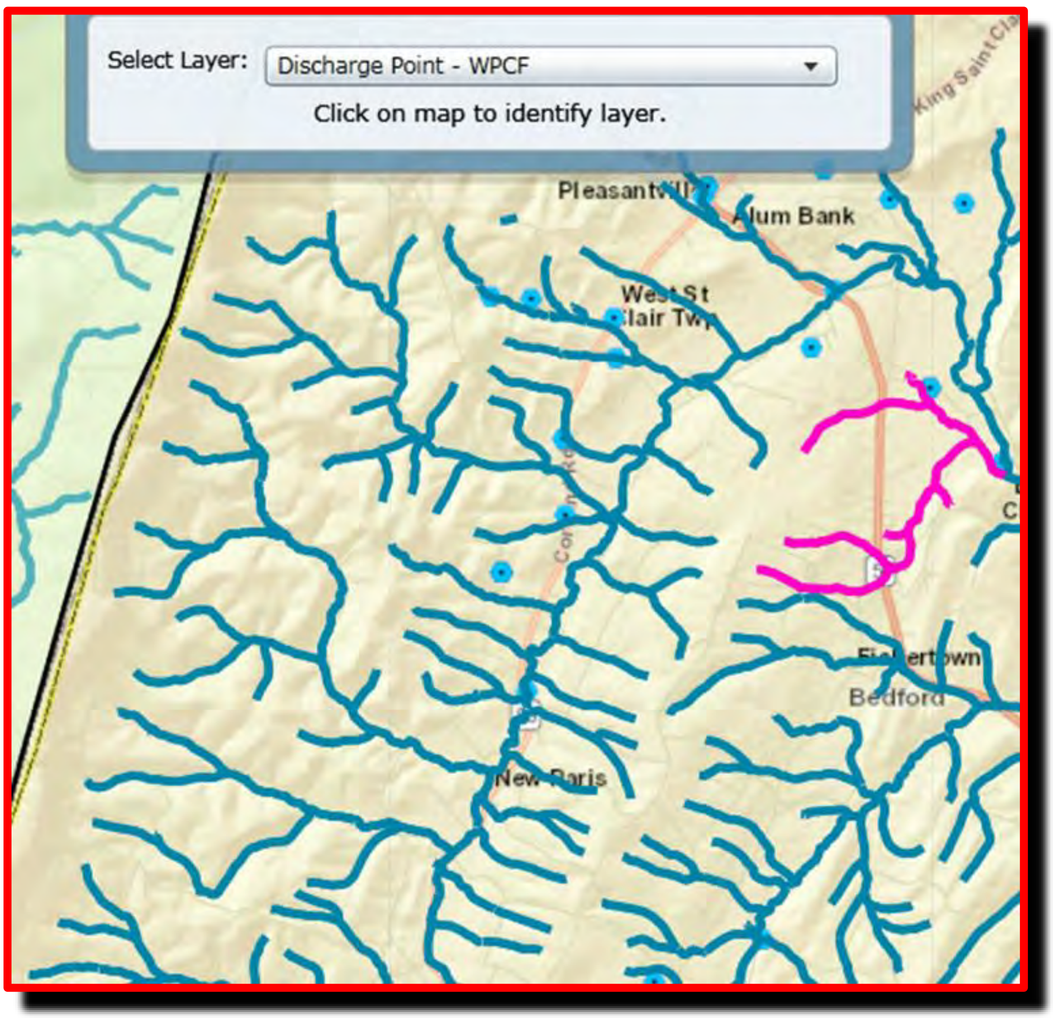
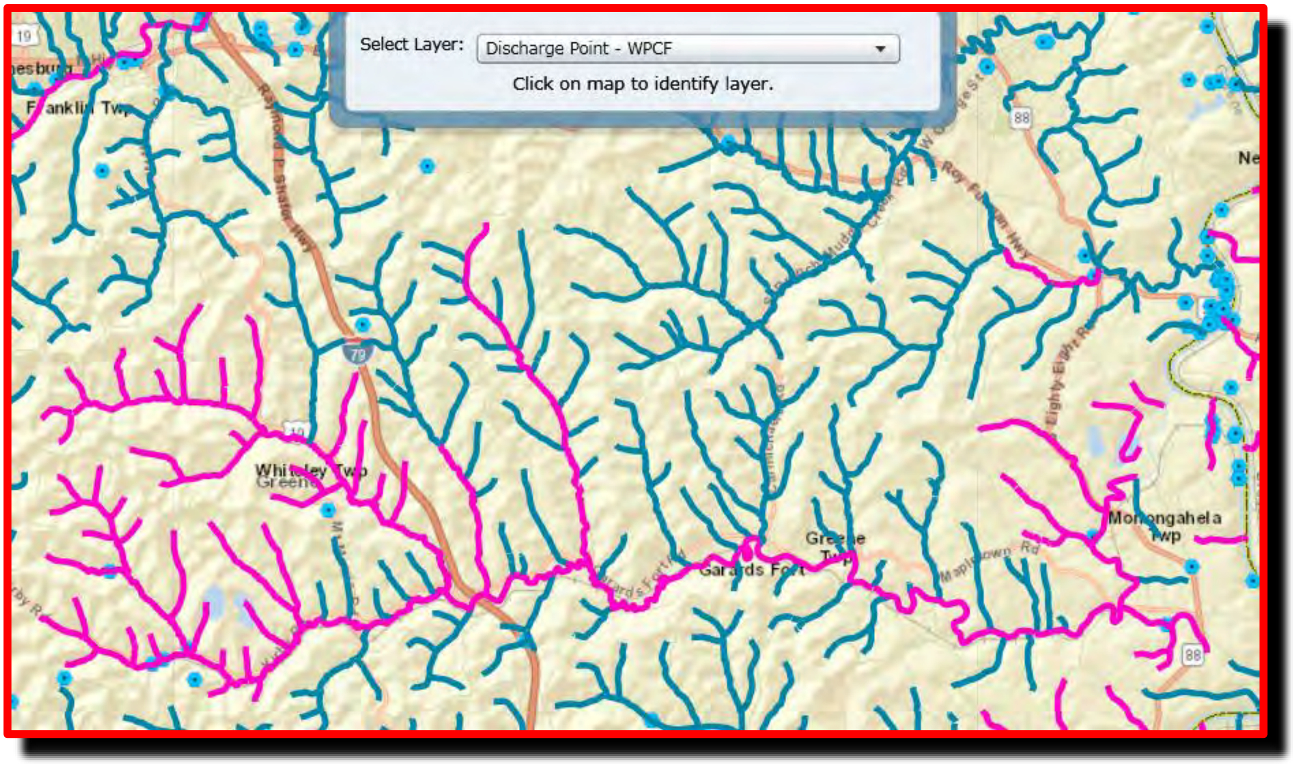


Figure 36. Map of known point source discharges (blue dots) on Dunning Creek (ref.)
Figure 37. Map of known point source discharges (blue dots) on Whiteley Creek (impaired)



<u>Cumberland Mine – PA0013511 - Discharge 006, 015, 021, 025, 026, 027, 028, 030, 031, 033</u>

WASTE LOAD = 2.00 MGD Flow * 35.00 mg/L monthly average concentration* 8.345* 365

WASTE LOAD = 213,214.75 lbs./yr. or 584.15 lbs./day (WASTE LOAD for the NPDES permit)

WASTE LOAD = 213,214.75 lbs./yr. (WASTE LOAD for NPDES permits) X 10 discharges

WASTE LOAD = 2,132,147.5 lbs./yr. or 5,841.5 lbs./day (WASTE LOAD for NPDES permits)

<u>Cumberland Mine Coal Refuse DP – PA0033511 - Discharge 001, 014, 015</u>

WASTE LOAD = 2.00 MGD Flow * 35.00 mg/L monthly average concentration* 8.345* 365

WASTE LOAD = 213,214.75 lbs./yr. or 584.15 lbs./day (WASTE LOAD for the NPDES permit)

WASTE LOAD = 213,214.75 lbs./yr. (WASTE LOAD for NPDES permits) X 3 discharges

WASTE LOAD = 639,644.25 lbs./yr. or 1,752.45 lbs./day (WASTE LOAD for NPDES permits)

Warwick Mine No. 2 Preparation Plant – PA0215562 - Discharge 002 and 007 Combined

WASTE LOAD = 2.64 MGD Flow * 35.00 mg/L monthly average concentration* 8.345* 365

WASTE LOAD = 281,274.84 lbs./yr. or 770.62 lbs./day (WASTE LOAD for the NPDES permit)

Cumberland Coal Resources – PA0216666 – Discharge 001

WASTE LOAD = 0.02 MGD Flow * 30.00 mg/L monthly average concentration* 8.345* 365

WASTE LOAD = 1,826.46 lbs./yr. or 5.00 lbs./day (WASTE LOAD for the NPDES permit)

PA D.O.T Bureau of Project Delivery – PA0098434 – Discharge 001

WASTE LOAD = 0.0095 MGD Flow * 10.00 mg/L monthly average concentration* 8.345* 365

WASTE LOAD = 289.19 lbs./yr. or 0.79 lbs./day (WASTE LOAD for the NPDES permit)

TOTAL WASTE LOAD = 2,132,147.5 lbs./yr. + 639,644.25 lbs./yr. + 281,274.84 lbs./yr. + 1,826.46 lbs./yr. + 289.19 lbs./yr.

TOTAL WASTE LOAD = 3,055,182.2 lbs./yr. (WASTE LOAD-NPDES permits)
ADJUSTED WLA (reduction by model) = 1,194,106.2 lbs./yr.
WASTE LOAD ALLOCATION = (BR + AWLA) = (55,213.4+1,194,106.2)
= 1,249,319.6 lbs./yr. or 3,422.8 lbs./day

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 Whiteley Creek. The MOS used for the Sediment TMDL was set at**: 552,133.8 lbs./yr.**

MOS = 5,521,338.5 lbs./yr. (TMDL) * 0.1 = 552,133.8 lbs./yr. or 1,512.7 lbs./day

Load Allocation

The load allocation (LA) is that portion of the TMDL that is assigned to nonpoint sources. The LA for the Sediment TMDL was computed by subtracting the MOS value and the WLA from the TMDL value. The LA for the Sediment TMDL was set at **3,719,885.1** lbs./yr.

LA = 5,521,338.5 lbs./yr. (TMDL) – 552,133.8 lbs./yr. (MOS) – 1,249,319.6 lbs./yr. (WLA)

LA = 3,719,885.1 lbs./yr. or 10,191.5 lbs./day

Adjusted Load Allocation

The adjusted load allocation (ALA) is the actual portion of the LA distributed among those nonpoint sources receiving reductions. It is computed by subtracting those nonpoint source loads that are not being considered for reductions (loads not reduced (LNR)) from the LA. The Whiteley Creek agricultural TMDL was developed to address impairments caused by agricultural activities, including hay/pastureland and cropland, including associated stream banks. Land uses/source loads not reduced (LNR) were carried through at their existing loading values. The ALA for the Sediment TMDL was set at **3,492,285.1** lbs./yr. (Table 7.)

ALA (adjusted load allocation) = **LA – LNRs**

Table 7. Loads of pollutant sources that will not be reduced (LNRs).

	Sediment (lbs./yr.)
Loads Allocation (LA)	**3,719,885.1**
Loads Not Reduced (LNR)	**227,600.0**
Forest	112,200.0
Wetland	0.0
Barren Land	1,200.0
Open Space	89,200.0
Low Development	20,600.0
Moderate Development	3,400.0
High Development	1,000.0
Adjusted Load Allocation (ALA)	**3,492,285.1 (9,567.9 lbs./day)**

The sediment TMDL established for Whiteley Creek is summarized in Table 8:

Parameter	Sediment (lbs./yr.)	Sediment (lbs./day)
TMDL (Total Max Daily Load)	5,521,338.5	15,127.0
WLA (Waste load Allocation)	1,249,319.6	3,422.8
MOS (Margin of Safety)	552,133.8	1,512.7
LA (Load Allocation)	3,719,885.1	10,191.5
LNRs (Loads not reduced)	227,600.0	623.6
ALA (Adjusted Load Allocation)	3,492,285.1	9,567.9

Calculation of Sediment Load Reductions

The adjusted load allocation established in the previous section represents the sediment load that is available for allocation between agricultural activities (cropland and hay/pastureland), associated stream banks, and existing point sources in the Whiteley 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 the two land use types and stream banks. 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.
2. After any necessary reductions, have been made in the baseline, the multiple analyses are run. The multiple analyses will sum all of the baseline loads and compare them to the total allocable load. If the allocable load is exceeded, an equal percent reduction will be made to all contributors' baseline values. After any necessary reductions in the multiple analyses, the final reduction percentage for each contributor can be computed. For this evaluation, the allocable load was exceeded. The equal percent reduction, i.e., the ALA divided by the summation of the baselines, worked out to a **53.3%** reduction in current sediment loading for agricultural activities (cropland and hay/pastureland), and associated stream banks.

Tables 9. (Annual Values) contains the results of the EMPR in sediment loading. The load allocations for each land use are shown along with the percent reduction of current loads necessary to reach the targeted LA.

Table 9. Sediment Load Allocations/Reductions for Land Uses and Stream Banks in the Whiteley Creek (Annual Values)

Pollutant Source	Current Loading Rate (lbs./yr./acre)	Allowable Loading Rate (lbs./yr./acre)	Current Load (lbs./yr.)	Allowable Load (lbs./yr.)	Percent Load Reduction
Cropland	1,606.9	628.0	2,203,000.0	861,034.1	60.9%
Hay/Pasture	336.3	131.4	2,045,800.0	799,593.0	60.9%
Stream bank	-	-	5,776,000.0	1,831,657.9	68.3%
Point Sources	-	-	3,055,182.2	1,194,106.2	60.9%*

*: 60.9% reduction for each point source waste load

Table 10. Sediment Load Allocations/Reductions for Land Uses and Stream Banks in the Whiteley Creek (Daily Values)

Pollutant Source	Current Loading Rate (lbs./day/acre)	Allowable Loading Rate (lbs./day/acre)	Current Load (lbs./day)	Allowable Load (lbs./day)	Percent Load Reduction
Cropland	4.4	1.7	6,035.6	2,359.0	60.9%
Hay/Pasture	0.9	0.4	5604.9	2,190.7	60.9%
Stream bank	-	-	15,824.7	5,018.2	68.3%
Point Sources	-	-	8,370.4	3,271.5	60.9%

Recommendations

Sediment loading reductions in the TMDL are allocated to nonpoint sources in the watershed including: agricultural activities, disturbed land (NCUFs), associated stream banks and existing point sources. Implementation of best management practices (BMPs) in these affected areas are called for according to this TMDL document. The proper implementation of these BMPs should achieve the loading reduction goals established in 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 biologically impaired Whiteley Creek; however, they were more extensively used in the unimpaired, reference the headwaters of Dunning Creek with forested riparian buffers being the predominant BMP in use. Since both watersheds have a considerable amount of agricultural activities, it is apparent that the greater use of BMPs, especially forested riparian buffers, in the reference watershed has contributed to its ability to maintain its attainment status as a TSF and WWF.

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

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

Funding Sources

The Federal Nonpoint Source Management Program (§ 319 of the Clean Water Act) is one funding source for nonpoint source pollution reduction BMPs, such as those described above. This grant program provides funding to assist in implementing Pennsylvania's Nonpoint Source Management Program. This includes funding for abandoned mine drainage, agricultural and urban run-off, and natural channel design/stream bank stabilization projects.

Information on Pennsylvania's Nonpoint Source Management Program can be found at: http://www.portal.state.pa.us/portal/server.pt/community/nonpoint_source_management/10615
As mentioned before, a second funding source is Pennsylvania's Growing Greener Watershed Grants, which provides nearly $547 million in funding to clean up non-point sources of pollution throughout Pennsylvania. The grants were established by the Environmental Stewardship & Watershed Protection Act. Information on Pennsylvania's Growing Greener Watershed Grants http://www.depweb.state.pa.us/portal/server.pt/community/growing_greener/13958
Information on these and other programs and additional funding sources can be found at: http://www.depreportingservices.state.pa.us/ReportServer/Pages/ReportViewer.aspx?/Grants

Stream Restoration Efforts

A watershed mitigation plan for Whiteley Creek (Foundation for California University, 1999) was implemented in 1999 to mitigate impacts incurred by RAG Emerald Resources Corporation during coal mining operations. Mitigation measures included planting 110 acres of warm seasons grasses, construct 23 border edge cuts, and restore 7.2 miles of stream bank (7.2 miles of fencing, 5 acres of wetland restoration, construction of 7 cattle crossings, 5 ramps, 1 watering trough, 2 H-braces, 26 spring gates, and 4 wire gates) along Whiteley Creek. Implementation measures and monitoring is ongoing.

In addition, the Greene County Conservation District has implemented best management practices (BMP) in the watershed. Some highlights include improved animal access, underground downspout, water trough installation. Another project included mature storage.

Manure storage facility prior to construction

Manure storage facility after final construction

Animal access area prior to construction
Animal access area after construction
Underground downspout outlet
A watering trough installation
Before
Underground downspout outlet

VII. Public Participation

Public notice of the TMDL was published in the Pennsylvania Bulletin on **2/10/2018** to foster public comment on the allowable loads calculated. A 30-day period was provided for the submittal of comments and notice. Any comments received during this period will be placed in Attachment B, Comments and Response, Pages 56 and 57.

VI. References

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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) among the appropriate contributing non-point sources. The load allocation and EMPR procedures were performed using MS Excel and results are presented in Appendix E. 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.

1. a. Each land use/source load is compared with the total ALA to determine if any contributor would exceed the ALA by itself. The evaluation is carried out as if each source is the only contributor to the pollutant load of the receiving water-body. If the contributor exceeds the ALA, that contributor would be reduced to the ALA. If a contributor is less than the ALA, it is set at the existing load. This is the baseline portion of EMPR.
2. 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.

FIGURE A1. Mapshed Output for Whiteley Creek

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

Source	Area (Acres)	Runoff (in)	Tons		Total Loads (Pounds)			
			Erosion	Sediment	Dissolved N	Total N	Dissolved P	Total P
Hay/Pasture	6083	2.0	9909.2	1022.9	2366.1	6457.8	756.3	2153.0
Cropland	1371	3.2	10670.6	1101.5	2882.9	7289.0	279.1	1783.1
Forest	23687	1.1	543.5	56.1	1145.6	1370.0	60.3	136.9
Wetland	3	1.7	0.0	0.0	0.2	0.2	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	615	5.4	432.5	44.6	373.0	551.5	7.5	68.4
Bare Rock	151	4.1	5.9	0.6	42.7	45.2	1.4	2.2
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	2661	1.5	0.0	10.3	200.6	607.7	26.1	65.4
MD Mixed	60	6.6	0.0	1.7	24.1	73.1	3.0	7.5
HD Mixed	17	10.1	0.0	0.5	7.0	21.2	0.9	2.2
LD Residential	0	1.5	0.0	0.0	0.0	0.0	0.0	0.0
MD Residential	0	3.2	0.0	0.0	0.0	0.0	0.0	0.0
HD Residential	0	4.7	0.0	0.0	0.0	0.0	0.0	0.0
Farm Animals						5036.9		1571.0
Tile Drainage				0.0		0.0		0.0
Stream Bank				2888.0		2888.0		985.8
Groundwater					26945.0	26945.0	1093.6	1093.6
Point Sources					0.0	0.0	0.0	0.0
Septic Systems					188.1	188.1	0.0	0.0
Totals	34648.3	3.4	21561.6	5126.4	34175.3	51473.8	2228.2	7869.3

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FIGURE A2. Mapshed Output for the Headwaters of Dunning Creek

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

Source	Area (Acres)	Runoff (in)	Tons		Total Loads (Pounds)			
			Erosion	Sediment	Dissolved N	Total N	Dissolved P	Total P
Hay/Pasture	5686	0.9	2110.9	232.7	1070.1	2000.8	334.6	648.4
Cropland	1289	0.9	2398.7	264.4	781.4	1839.0	75.8	432.4
Forest	19070	0.5	187.9	20.7	416.6	499.4	21.9	49.8
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	32	2.2	12.3	1.4	8.0	13.5	0.2	2.0
Bare Rock	10	4.1	0.1	0.0	2.8	2.8	0.1	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	1783	1.5	0.0	6.9	134.4	407.3	17.5	43.8
MD Mixed	37	6.6	0.0	1.1	14.5	44.0	1.8	4.5
HD Mixed	8	10.1	0.0	0.2	3.3	10.1	0.4	1.0
LD Residential	0	1.5	0.0	0.0	0.0	0.0	0.0	0.0
MD Residential	0	3.2	0.0	0.0	0.0	0.0	0.0	0.0
HD Residential	0	4.7	0.0	0.0	0.0	0.0	0.0	0.0
Farm Animals						15231.3		3550.5
Tile Drainage				0.0		0.0		0.0
Stream Bank				1696.8		1696.8		572.1
Groundwater					96546.4	96546.4	1611.0	1611.0
Point Sources					0.0	0.0	0.0	0.0
Septic Systems					113.6	113.6	0.0	0.0
Totals	27913.7	1.6	4709.8	2224.2	99091.1	118404.9	2063.4	6915.6

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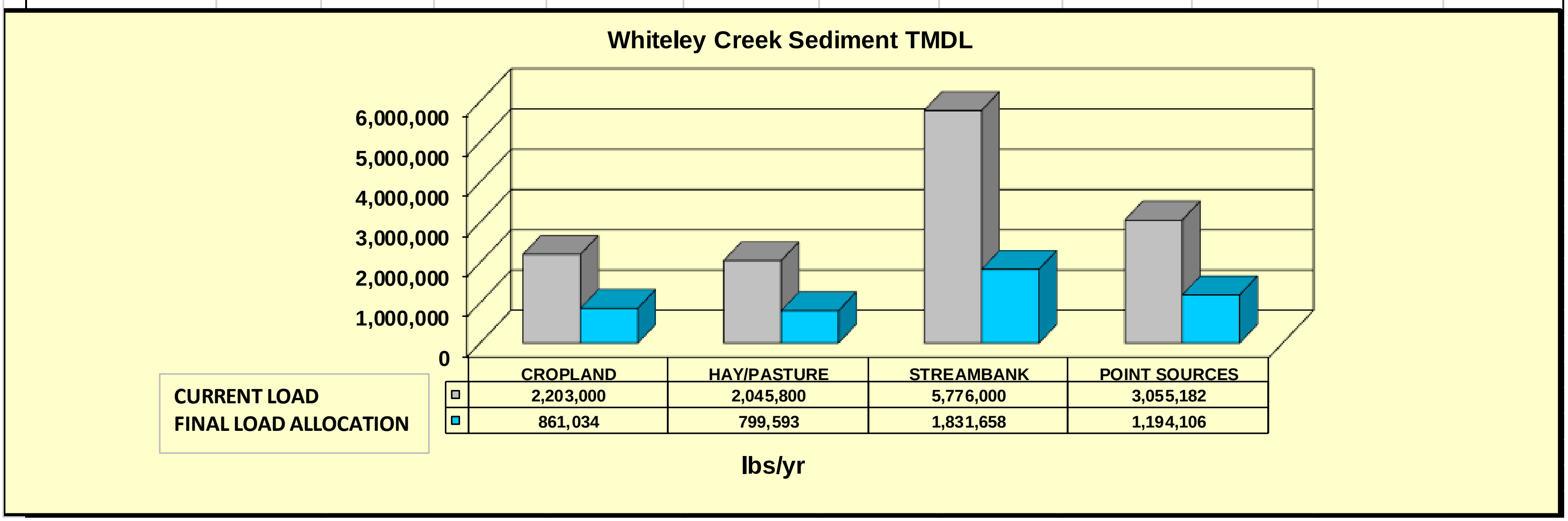
FIGURE A3. Equal Marginal Percent Reduction Calculations for Whiteley Creek

1	TMDL				2	Adjusted LA = TMDL total load - ((MOS) - loads not reduced)						
	TMDL = Sediment loading rate in ref. * Impaired Acres					4686391.2	4686391.2					
	5521338.5											
		Annual				Recheck	% reduction	Load			Allowable	%
3		Avg. Load	Load Sum	Check	Initial Adjust	Adjust	allocation	Reduction	Initial LA	Acres	Loading Rate	Reduction
	CROPLAND	2203000.0	13079982.2	good	2203000.0		0.2	1341965.9	861034.1	1371.0	628.0	60.9%
	HAY/PASTURE	2045800.0		good	2045800.0	7303982.2	0.2	1246207.0	799593.0	6083.0	131.4	60.9%
	STREAMBANK	5776000.0		bad	4686391.2		0.4	2854733.3	1831657.9			68.3%
	POINT SOURCES	3055182.2		good	3055182.2		0.3	1861076.0	1194106.2			60.9%
					11990373.4		1.0		4686391.2			
4	All Ag. Loading Rate	222.78										
			Allowable		Current	Current						
		Acres	loading rate	Final LA	Loading Rate	Load	% Red.			CURRENT LOAD	FINAL LA	
5	CROPLAND	1371.0	628.0	861034.1	1606.9	2203000.0	60.9%		CROPLAND	2,203,000	861,034	
	HAY/PASTURE	6083.0	131.4	799593.0	336.3	2045800.0	60.9%		HAY/PASTURE	2,045,800	799,593	
	STREAMBANK			1831657.9		5776000.0	68.3%		STREAMBANK	5,776,000	1,831,658	
	POINT SOURCES			1194106.2		3055182.2	60.9%		POINT SOURCES	3,055,182	1,194,106	
				4686391.2		10024800.0	53.3%					



Attachment B.

Comment and Response

Public comments for the Whiteley Creek Sediment TMDL are available for submittal within the 30-day window starting 2/10/2018.