Draft1
10/20/2004

Sediment
Total Maximum Daily Load (TMDL)

Wyomissing Creek (stream code 01833)
Berks County

Pennsylvania Department of Environmental Protection
Southcentral Regional Office, Water Management Program

October 20, 2004

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I. Summary of the Wyomissing Creek TMDLs

1. This TMDL was developed for Wyomissing Creek, in SWP subbasin 03C (Tulpehocken Creek), located in Berks County, Pennsylvania. Access to the watershed is available by traveling west from Reading on either Route 422 or 222. Wyomissing Creek originates in Brecknock Township, and flows in a northeasterly direction for approximately 8.4 miles before its confluence with the Schuylkill River in Reading. The 15.7 square mile watershed contains a total of 20.8 miles of streams.. The entire basin is currently designated as Cold Water Fishes (CWF) under §93.9f in Title 25 of the Pa. Code (Commonwealth of Pennsylvania, 2003).

2. A sediment TMDL for the Wyomissing Creek watershed was developed to address use impairments caused by siltation. Wyomissing Creek first appeared on Pennsylvania's 303(d) list in 1996, when 0.1 miles were listed as impaired by unknown causes related to urban runoff/storm sewers. Approximately 6 miles of streams in the Wyomissing Creek watershed are currently identified in the Department's 305b database as impaired due to siltation related to urban runoff/storm sewers and small residential runoff. In order to ensure attainment and maintenance of water quality standards in the Wyomissing Creek watershed, mean annual loading of sediment will need to be limited to 6,329,495 lbs./yr.

   The major components of the Wyomissing Creek watershed sediment TMDL are summarized below:

Component	Sediment (lbs./yr.)
TMDL (Total Maximum Daily Load)	6,329,495.48
MOS (Margin of Safety)	632,949.55
WLA (Wasteload Allocation)	3,747,238.13
LA (Load Allocation)	1,949,307.80

3. The current mean annual sediment loading to the Wyomissing Creek is estimated to be 10,553,976 lbs./yr. and will require a 40% overall reduction to meet the TMDL.

4. Approximately 42% of the Wyomissing Creek watershed area falls in a designated municipal separate storm sewer system (MS4) area. EPA guidelines and policy require a portion of the sediment load specified by the TMDL be classified as a wasteload allocation (WLA) for the MS4 area. Therefore, a WLA covering the MS4 portion of the watershed was set at 3,747,238.13 lbs./yr.

5. The sediment TMDL includes a nonpoint source LA of 1,949,308 lbs./yr. Allocations to sources within non-MS4 areas receiving reductions (hay/pasture, cropland, transition, low_int-dev, hi_int_dev, and stream bank erosion) add up to 1,880,598 lbs./yr. Sediment loadings from all other nonpoint sources were maintained at 68,710 lbs./yr. Allocations of sediment to all nonpoint sources in the non-MS4 portions of Wyomissing Creek watershed are summarized below:

Load Allocations for Sources of Sediment			
Source	**Current Loading (lbs./yr.)**	**Load Allocation (lbs./y.)**	**% Reduction**
HAY/PASTURE	79,236.29	35,073.52	56%
CROPLAND	2,183,057.05	832,436.44	62%
TRANSITION	713,435.31	315,798.79	56%
LO_INT_DEV	67,887.51	30,050.04	56%
HI_INT_DEV	18,341.32	8,118.69	56%
Stream Bank	1,489,051.19	659,120.54	56%
Total	**4,551,008.67**	**1,880,597.55**	**59%**

6. Ten percent of the Wyomissing Creek sediment TMDL was set-aside as a margin of safety (MOS). The 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. The MOS for the sediment was set at 632,950 lbs./yr.

7. The continuous simulation model used for developing the Wyomissing Creek TMDL considered 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 accounts for seasonal variability.

II. Introduction

A. Watershed Description

Wyomissing Creek is part of State Water Plan subbasin 03C (Tulpehocken Creek, located in Berks County, Pennsylvania (Figure 1). Access to the watershed is available by traveling west from Reading on either Route 422 or 222. Wyomissing Creek originates in Brecknock Township, just north of Knauers and flows in a northeasterly direction for approximately 8.4 miles before its confluence with the Schuylkill River in Reading. The 15.7 square mile watershed contains a total of 20.8 miles of streams.

B. Topography & Geology

The Wyomissing Creek watershed drains land located in the Great Valley Section of the Ridge and Valley physiographic province and the Gettysburg-Newark-Lowland Section of the Piedmont Province. The Great Valley Section consists of a very broad lowland area lying south of Blue Mountain in southeastern Pennsylvania. The lowland is characterized by gently undulating hills eroded into shales and siltstones on the north side of the valley and a lower elevation, flatter landscape developed on limestones and dolomites on the south side. The Wyomissing Creek watershed is located on the southern edge of the Great Valley. Elevations in this portion of the basin ranges from 860 feet in Spring Township to 220 feet at the mouth.

The Gettysburg-Newark Lowland Section consists mainly of rolling low hills and valleys developed on red sedimentary rock. There are also isolated higher hills developed on diabase, baked sedimentary rock (hornfels), and conglomerates. Elevations in this portion of the basin ranges from 880 feet in the headwaters to roughly 330 feet

C. Land Use

Land use in the Wyomissing Creek watershed covered by this TMDL report is dominated by development (40%), forest (34%) and agriculture (24%). Approximately 4.4 miles of streams in the watershed flow through agricultural land use. Other land uses, including wetlands, waterbodies and transitional lands account for less than 3% of the watershed area.

D. Surface Water Quality

Protected uses of the Wyomissing Creek watershed include aquatic life, water supply, and recreation. The entire basin is currently designated as Cold Water Fishes in Title 25 Pa. Code Department of Environmental Protection Chapter 93, Section 93.9f (Commonwealth of Pennsylvania, 2003). A total of 0.1 miles of Wyomissing Creek appeared on the Department's 1996-303d list (Table 1). The cause of the impairment was listed as unknown on the 1996 303d list and the source was identified as urban runoff. The entire Wyomissing Creek watershed was surveyed in 2002 under the Department's Statewide Surface Water Assessment program, which resulted in 6.1 miles of streams appearing in the 2004 Integrated List of all Waters as impaired. The major cause of these impairments is identified as siltation emanating from urban runoff, storm sewers and small residential runoff in the watershed.

Table 1 - 1996 303(d) and 2004 Integrated Water Quality Monitoring and Assessment Report Listings for Streams in the Wyomissing Creek Watershed

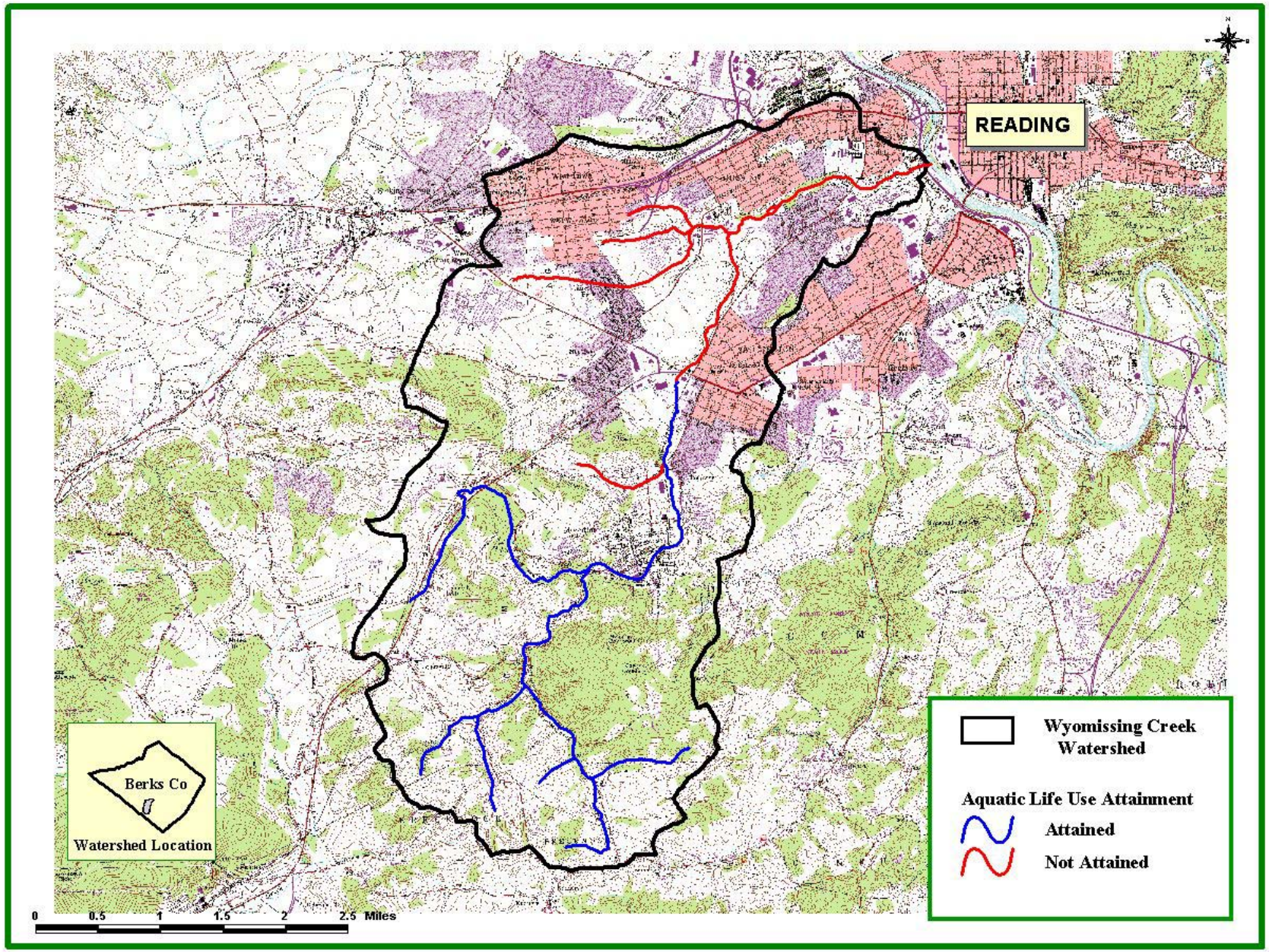
1996 303(d) LIST - Wyomissing Creek

STREAM CODE	SOURCE	CAUSE	MILES
01833	Urban Runoff	Cause Unknown	0.1

2004 Integrated Water Quality Monitoring and Assessment Report - Wyomissing Creek Watershed

STREAM CODE	GIS KEY	MILES	SOURCE	CAUSE
01833	6382	0.7	Urban Runoff/Storm Sewers	Cause Unknown
	20020429-1000-KHM	1.9	Urban Runoff/Storm Sewers	Siltation
01834	20020429-1000-KHM	0.1	Urban Runoff/Storm Sewers	Siltation
01835	20020429-1200-KHM	2	Small Residential Runoff	Siltation
01836	20020429-1200-KHM	0.6	Small Residential Runoff	Siltation
01837	20020429-1200-KHM	0.8	Small Residential Runoff	Siltation

Figure 1 - Wyomissing Creek Watershed
Berks County



III. Approach to TMDL Development

A. Pollutants & Sources

Siltation has been identified as the pollutant causing designated use impairments in the Wyomissing Creek watershed. Based on information contained in the Department's 305(b) report database and visual observations made during field visits, runoff from urban and residential areas and storm sewers are the primary source of the sediment causing impairment. Additional sediment sources in the basin include development activities, streambank erosion and agricultural land uses.

B. TMDL Endpoints

In an effort to address impairments in the Wyomissing Creek watershed caused by siltation, a Total Maximum Daily Load (TMDL) was developed for sediment.

C. Reference Watershed Approach

The TMDL developed for the Wyomissing Creek watershed addresses sediment. Because neither Pennsylvania nor EPA has instream numerical water quality criteria for this pollutant, a method was developed to implement the applicable narrative criteria. The method employed for the TMDL development is termed the "Reference Watershed Approach." Meeting the water quality objectives specified by this TMDL will result in the impaired stream segments attaining designated uses.

The Reference Watershed Approach compares two watersheds, one attaining its uses and one that is impaired based on biological assessments. Both watersheds must have similar land use/cover distributions. Other features such as base geologic formation should be matched to the extent possible; however, most variations can be adjusted in the model. The objective of the process is to reduce the loading rate of pollutants in the impaired stream segment to a level equivalent to, or slightly lower than, the loading rate in the non-impaired, reference segment. This load reduction will result in conditions favorable to the return of a healthy biological community to the impaired stream segments.

D. Selection of the Reference Watershed

In general, three factors are considered when selecting a suitable reference watershed. The first factor is to use a watershed that the Department has assessed and determined to be attaining water quality standards. The second factor is to find a watershed that closely resembles the impaired watershed in physical properties such as land cover/land use, physiographic province, and geology. Finally, the size of the reference watershed should be within 40% of the impaired watershed area. The search for a reference watershed for Wyomissing Creek that would satisfy the above characteristics was done by means of a desktop screening using several GIS coverages, including the Multi-Resolution Land Characteristics (MRLC), Landsat-derived land cover/use grid, the Pennsylvania's 305(b) assessed streams database, and geologic rock types

Big Hollow (stream code 23015) was selected as the reference watershed for developing the Wyomissing Creek sediment TMDL. Big Hollow is a tributary of Spring Creek, located in Center County, PA (Figure 2). The watershed is part of State Water Plan subbasin 09C. Approximately 84% of the watershed falls within a designated municipal separate storm sewer system (MS4) area. Big Hollow is identified in the 2004 Integrated List of all Waters as attaining its designated uses, based on sampling done by the Department in 2002 (segment ID 20020529-1111-REH and 20020529-1112-REH), as part of its ongoing Statewide Surface Water Assessment program.

Drainage area, land use, and other physical characteristics of the Wyomissing Creek watershed were compared to the Big Hollow watershed (Table 2). An analysis of value counts for each pixel of the MRLC grid revealed that while land cover/use distributions are not an exact match, both watersheds are similar. Agriculture, development and forested lands are the dominant land use in both watersheds. Surficial geology in the Wyomissing Creek and Big Hollow watersheds was also compared. Carbonate rocks underlie the entire Big Hollow watershed and 39% of the Wyomissing Creek watershed. The remainder of the Wyomissing Creek watershed consists of conglomerate (28%), interbedded sedimentary (19%), and metamorphic/igneous (14%) rocks. Bedrock geology primarily affects surface runoff and background sediment loads

through its influences on soils, landscape, fracture density, and directional permeability. The Wyomissing Creek and Big Hollow watersheds are fairly similar in terms of soil types, soil K factor, precipitation, and average runoff (Table 2).

Figure 2 - Big Hollow Reference Watershed
Centre County

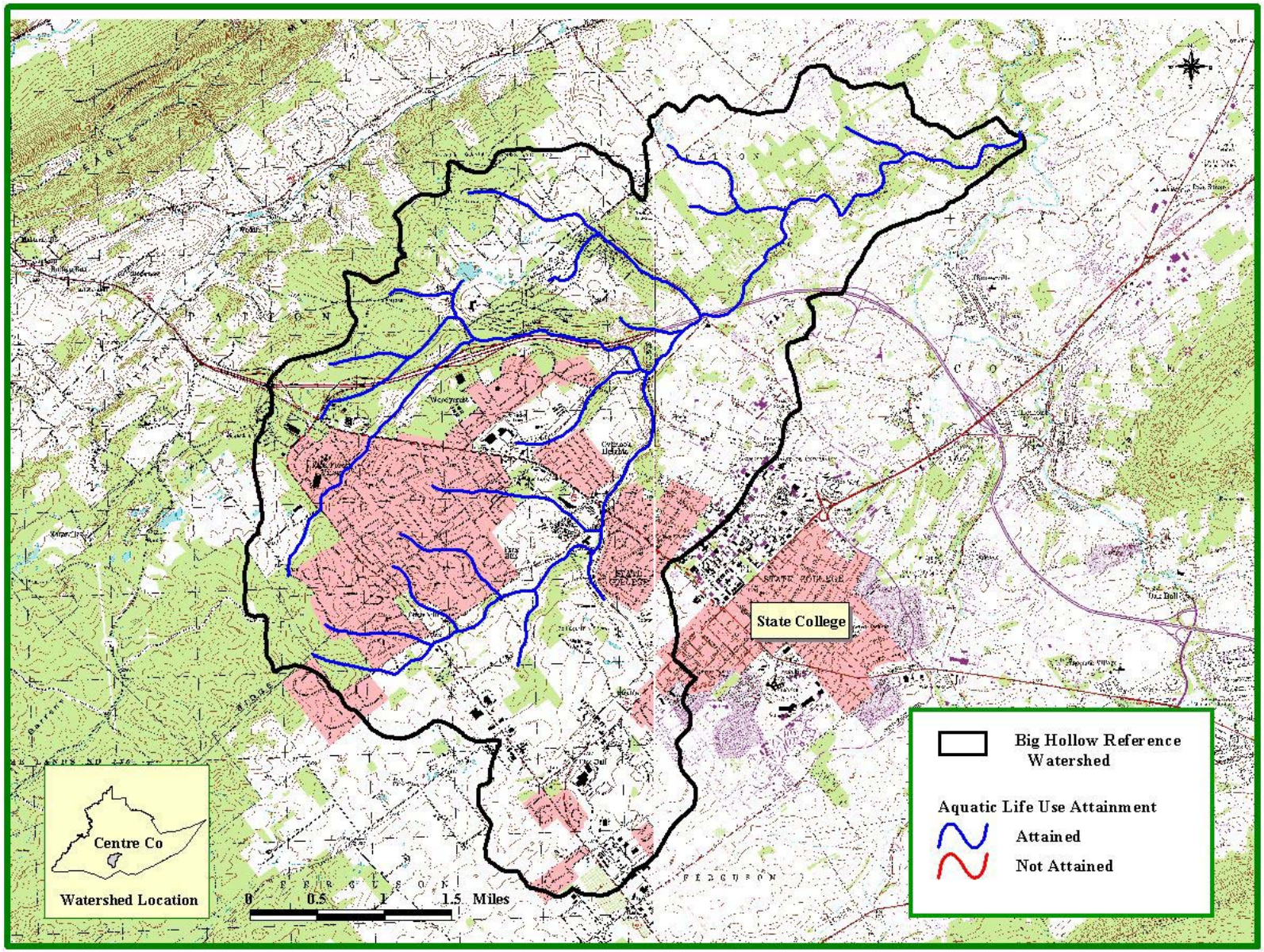


Table 2 - Comparison Between Wyomissing Creek and Big Hollow Watersheds		
ATTRIBUTE	**WATERSHED**	
	Wyomissing Creek	**Big Hollow Reference**
Physiographic Province	Piedmont (53%) Ridge and Valley (47%)	Ridge and Valley (100%)
Area (mi^2)	15.7	17.1
Land Use	Development (40%) Forest (34%) Agriculture (24)%	Agriculture (41%) Forest (33%) Development (23%)
MS4 Area	6,791 ac (67%)	9,254 ac (84%)
Geology	Carbonate (39%) Conglomerate (28%) Interbedded Sedimentary (19%) Metamorphic/Igneous (14%)	Carbonate (100%)
Soils	Hagerstown-Duffield-Clarksburg - PA058 (33%) Ungers-Penn-Klinesville - PA063 (25%) Chester-Glenelg-Manor - PA061 (22%) Neshaminy-Lehigh-Glenelg - PA062 (20%)	Hagerstown-Duffield-Clarksburg - PA058 (81%) Morrison-Hazleton-Clymer - PA078 (19%)
Dominant HSG	B (50%) C (38%) D (11%) A (1%)	C (52%) B (46%) D (2%) A (1%)
K Factor	0.31	0.30
5-Yr Ave Rainfall (in)	45.1	41.2
5-Year Ave Runoff (in)	4.1	3.4

IV.Watershed Assessment and Modeling

The sediment TMDL for the Wyomissing Creek watershed was developed using the ArcView Generalized Watershed Loading Function (AVGWLF) model as described in Appendix B. The AVGWLF model was used to establish existing loading conditions for the Wyomissing Creek watershed and the Big Hollow reference watershed. All modeling outputs have been attached to this TMDL as Appendices C and D. DEP staff conducted a field visit to both watersheds to get a better understanding of existing conditions that might influence the AVGWLF model. No adjustments were made to specific default parameters used in the AVGWLF model based on observations made while touring the watersheds.

The AVGWLF model produced information on watershed size, land use, and sediment loading (Tables 3). The sediment loads represent an annual average over the 5 years simulated by the model (1989 to 1994). This information was then used to calculate existing unit area loading rates for the Wyomissing Creek and the Big Hollow reference watersheds.

Unit area loading rates for sediment were estimated for each watershed by dividing the mean annual loadings (lbs./yr.) by the total area (acres). Unit area load estimates for sediment in the Wyomissing Creek and Big Hollow watersheds are 1,057 lbs./acre/yr. and 634 lbs./acre/yr., respectively (Table 3).

Table 3 - Existing Sediment Loads for the Wyomissing Creek and Reference Watersheds

Pollutant Source	Wyomissing Creek			Big Hollow Reference		
	Area (ac)	Mean Annual Loading (lbs./yr.)	Unit Area Loading (lbs./ac./yr.)	Area (ac)	Mean Annual Loading (lbs./yr.)	Unit Area Loading (lbs./ac./yr.)
HAY/PAST	751.2	163,200.0	217.25	1,722.3	101,200.0	58.76
CROPLAND	1,700.1	4,095,400.0	2,408.92	2,775.0	2,242,800.0	808.22
CONIF_FOR	464.6	16,600.0	35.73	121.1	400.0	3.30
MIXED_FOR	395.4	15,000.0	37.94	817.9	3,400.0	4.16
UNPAVED_RD				2,572.4	9,400.0	3.65
DECID_FOR	2,604.5	82,600.0	31.71	4.9	-	-
TRANSITION	133.4	1,523,000.0	11,416.79	388.0	1,026,600.0	2,645.88
LO_INT_DEV	2,985.0	306,600.0	102.71	2,018.8	123,800.0	61.32
HI_INT_DEV	953.8	108,800.0	114.07	464.6	25,000.0	53.81
Stream Bank		4,242,776.0	203,979.62		3,466,479.8	
Total	**9,988.0**	**10,553,976.0**	**1,056.67**	**10,885.0**	**6,897,879.8**	**633.71**

V. TMDL

The sediment TMDL for the Wyomissing Creek watershed was established based on the estimated loading rate for sediment in the Big Hollow reference watershed. Big Hollow is currently designated as a Cold Water Fishery (CWF) and the latest Statewide Surface Water Assessment Program activity has determined that the basin is attaining its designated uses. Reducing the loading rate of sediment in the Wyomissing Creek basin to a level equal to, or less than, that of the Big Hollow reference watershed, will provide conditions favorable for the reversal of current use impairments.

A. Background Pollutant Conditions

There are two separate considerations of background pollutants within the context of this TMDL. First, there is the inherent assumption of the reference watershed approach that because of the similarities between the reference and impaired watershed, the background pollutant contributions will be similar. Therefore, the background pollutant contributions will be considered when determining the loads for the impaired watershed that are consistent with the loads from the reference watershed. Second, the AVGWLF model implicitly considers background pollutant contributions through the soil and the groundwater component of the model process.

B. Targeted TMDL

The targeted TMDL value for sediment (6,329,495.48 lbs/yr) was determined by multiplying the total area of the Wyomissing Creek watershed (9,988 acres) by the appropriate unit area loading rate for the Big Hollow reference watershed (633.71 lbs/ac/yr).

Targeted TMDL = 9,988 acres x 633.71 lbs/ac/yr = 6,329,495.48 lbs/yr

This targeted TMDL value was then used as the basis for load allocations and reductions in the Wyomissing Creek watershed, using the following two equations:

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

where:

TMDL = Total Maximum Daily Load
WLA = Waste Load Allocation (point sources)
LA = Load Allocation (nonpoint sources)
ALA = Adjusted Load Allocation
LNR = Loads not Reduced

C. 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 Wyomissing Creek. The MOS for the sediment TMDL was set at 632,949.55 lbs./yr.

MOS = 6,329,495.48 lbs./yr. (TMDL) x 0.1 = 632,949.55 lbs./yr.

D. Wasteload Allocation

The waste load allocation (WLA) portion of the TMDL equation is the total loading of a pollutant that is assigned to point sources. Approximately 42% of the Wyomissing Creek watershed area falls in a designated municipal separate storm sewer system (MS4) area (Figure 3), including parts of Cumru and Spring Townships, the boroughs of Mohnton, Shillington, West Lawn, West Reading, Wyomissing, and Wyomissing Hills, and the City of Reading. Therefore, EPA guidelines and policy require a portion of the sediment load specified by the TMDL to be classified as a wasteload allocation (WLA). The WLA portion of the TMDL was calculated based on the difference between the total allowable load for the entire Wyomissing Creek watershed and the allowable load from the watershed area not classified as an MS4 area, minus the MOS. The allowable loading from the watershed area not classified as an MS4 (1,949,307.80 lbs./yr.) was estimated based on the unit area loading rates of the Big Hollow reference watershed (Table 4). The WLA for the sediment TMDL was set at 3,747,238.13 lbs./yr.

WLA = 6,329,495.48 lbs./yr. (TMDL) - 632,949.55 lbs./yr. (MOS) – 1,949,307.80 lbs./yr. (Loading from non-MS4 areas) = 3,747,238.13 lbs./yr.

Figure 3 - MS4 Areas in the Wyomissing Creek Watershed

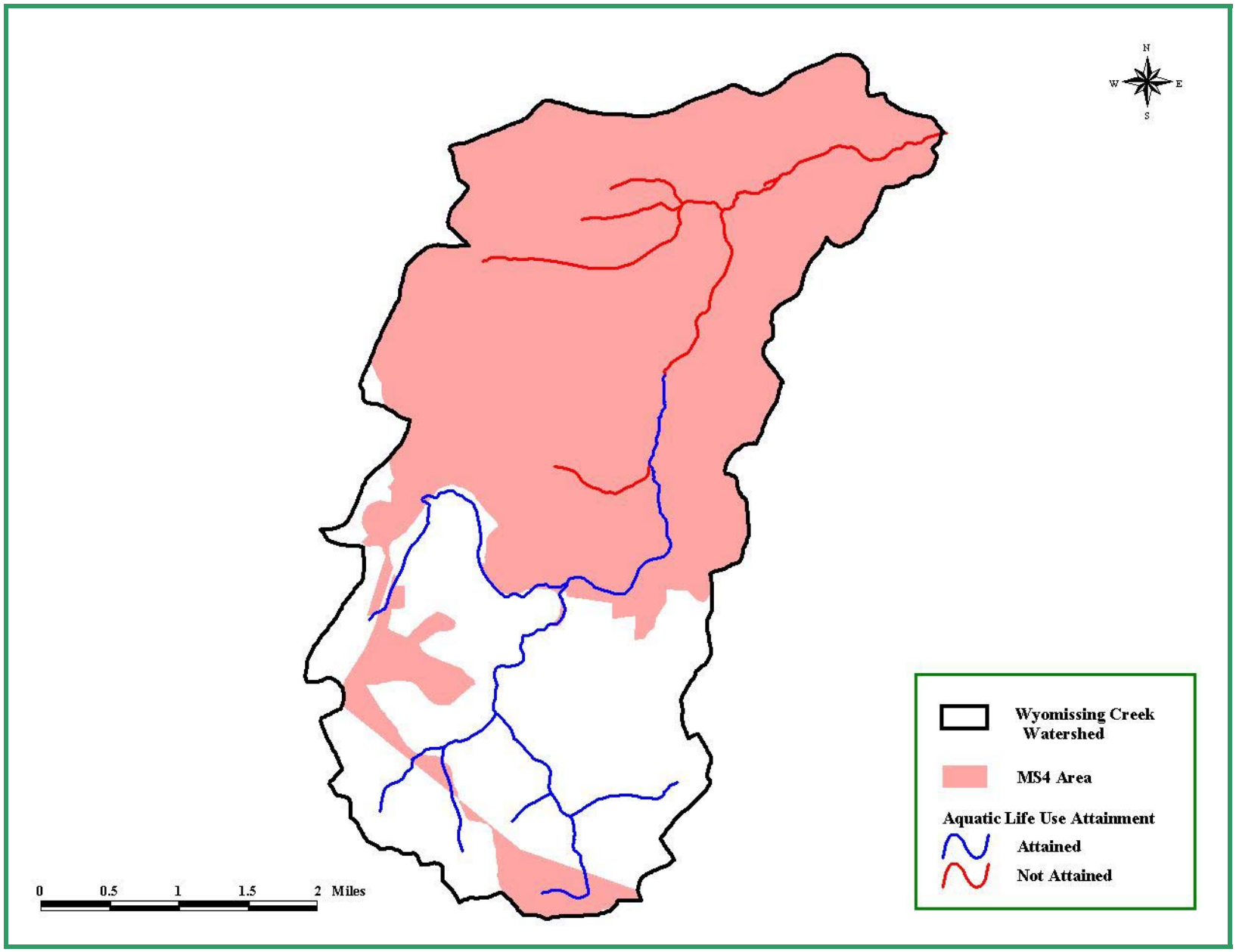


Table 4 - Reference Watershed Based Loading From Non-MS4 Areas in the Wyomissing Creek Watershed			
LANDUSE	**Non MS4 Areas (Acres or Miles)**	**Ref Loading Rate (lbs./ac. or mile/yr.)**	**Annual Load (lbs/yr)**
HAY/PAST	364.72	58.76	21,430.95
CROPLAND	906.24	808.22	732,441.29
CONIF_FOR	280.66	3.30	926.18
MIXED_FOR	229.28	4.16	953.80
DECID_FOR	1576.08	3.65	5,752.69
TRANSITION	62.49	2,645.88	165,341.04
LO_INT_DEV	660.94	61.32	40,528.84
HI_INT_DEV	160.79	53.81	8,652.11
Stream Bank	7.30	133,326.15	973,280.90
Total			**1,949,307.80**

E. Load Allocation

The load allocation (LA) is that portion of the TMDL that is assigned to nonpoint sources in the non-MS4 areas of the Wyomissing Creek watershed. A LA of 1,949,307.80 lbs./yr. was computed by subtracting the MOS and WLA values from the targeted TMDL value.

LA = 6,329,495.48 lbs./yr. (TMDL) – 632,949.55 lbs./yr. (MOS) – 3,747,238.13 lbs./yr. (WLA) = 1,949,307.80 lbs./yr.

F. Adjusted Load Allocation

The adjusted load allocation (ALA) is the actual portion of the LA distributed among those nonpoint sources in the non-MS4 areas of the watershed receiving reductions. It is computed by subtracting those non-point source loads that are not being considered for reductions (loads not reduced or LNR) from the LA. Sediment reductions were applied to HAY/PASTURE, CROPLAND, TRANSITION, LO_INT_DEV, HI_INT_DEV and Stream Bank erosion sources. Those land uses/sources for which existing loads were not reduced (CONIF_FOR, MIXED_FOR, and DECID_FOR) were carried through at their existing loading values (Table 5). The ALA for sediment was 1,880597.55 lbs./yr.

Table 5 - Load Allocation, Loads Not Reduced, and Adjusted Load Allocation for Wyomissing Creek Sediment TMDL	
NPS Allocation	**Sediment (lbs./yr.)**
Load Allocation	**1,949,307.80**
Loads Not Reduced	**68,710.25**
CONIF_FOR	10,027.89
MIXED_FOR	8,698.03
DECID_FOR	49,984.33
Adjusted Load Allocation	**1,880,597.55**

G. TMDLs

The sediment TMDL established for the Wyomissing Creek watershed consists of a Margin of Safety (MOS), a Waste Load Allocation (WLA), and a Load Allocation (LA). The individual components of the TMDL are summarized in Table 6.

Table 6 - TMDL, WLA, MOS, LA, LNR, and ALA for Wyomissing Creek Watershed

Component	Sediment (lbs./yr.)
TMDL (Total Maximum Daily Load)	6,329,495.48
MOS (Margin of Safety)	632,949.55
WLA (Wasteload Allocation)	3,747,238.13
LA (Load Allocation)	1,949,307.80
LNR (Loads Not Reduced)	68,710.25
ALA (Adjusted Load Allocation)	1,880,597.55

VI.Calculation of Sediment Load Reductions

The adjusted load allocation established in the previous section represents the sediment load that is available for allocation between contributing sources in the non-MS4 areas of the Wyomissing Creek watershed. Data needed for load reduction analyses, including land use distribution, were obtained by GIS analysis. The Equal Marginal Percent Reduction (EMPR) allocation method (Appendix E) was used to distribute the ALA between the appropriate contributing land uses.

The load allocation and EMPR procedures were performed using MS Excel and results are presented in Appendix F. Table 7 contains the results of the EMPR for sediment for the appropriate contributing land uses in the non-MS4 areas of the Wyomissing Creek watershed. The load allocation for each land use is shown, along with the percent reduction of current loads necessary to reach the targeted LA.

Table 7 - Sediment Load Allocations & Reductions for the Non-MS4 Areas of the Wyomissing Creek Watershed

Pollutant Source	Acres	Unit Area Loading Rate (lbs./ac./yr.)		Pollutant Loading (lbs./yr.)		% REDUCTION
		Current	Allowable	Current	Allowable (LA)	
HAY/PASTURE	364.72	217.25	96.17	79,236.29	35,073.52	56%
CROPLAND	906.24	2,408.92	918.56	2,183,057.05	832,436.44	62%
TRANSITION	62.49	11,416.79	5,053.58	713,435.31	315,798.79	56%
LO_INT_DEV	660.94	102.71	45.47	67,887.51	30,050.04	56%
HI_INT_DEV	160.79	114.07	50.49	18,341.32	8,118.69	56%
Stream Bank				1,489,051.19	659,120.54	56%
Total				4,551,008.67	1,880,597.55	59%

VII. Consideration of Critical Conditions

The AVGWLF model is a continuous simulation model, which uses daily time steps for weather data and water balance calculations. Monthly calculations are made for sediment loads, based on the daily water balance accumulated to monthly values. Therefore, all flow conditions are taken into account for loading calculations.

VIII. 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.

IX.Recommendations for Implementation

TMDLs represent an attempt to quantify the pollutant load that may be present in a waterbody and still ensure attainment and maintenance of water quality standards. The Wyomissing Creek TMDL identifies the necessary overall load reduction for the pollutant currently causing use impairments and distributes that reduction goal to the appropriate MS4 and nonpoint sources. Reaching the reduction goal established by this TMDL will only occur through changes in current land use practices, including the incorporation of more "best management practices" (BMPs).

The Natural Resources Conservation Service maintains a National Handbook of Conservation Practices (NHCP), which provides information on a variety of BMPs. The NHCP is available online at http://www.ncg.nrcs.usda.gov/nhcp_2.html. Many of the practices described in the handbook could be used in the Wyomissing Creek watershed to help limit sediment loading to the creek. Determining the most appropriate BMPs, where they should be installed, and actually putting them into practice, will require the development and implementation of a comprehensive watershed restoration plan. Development of any restoration plan will involve the gathering of site-specific information regarding current land uses and existing conservation practices. The required level of detail is outside the scope of this TMDL document and is an activity best accomplished at the local level. Successful implementation of the activities necessary to address current use impairments to Wyomissing Creek will require local citizens taking an active interest in the watershed and the enthusiastic cooperation of local landowners.

By developing the sediment TMDL for the Wyomissing Creek watershed, the Department has set the stage for local citizens to design and implement restoration plans to correct current use impairments. The Department will support local efforts to develop and implement watershed restoration plans based on the reduction goals specified in this TMDL. Interested parties should contact the appropriate Watershed Manager in the Department's Southcentral Regional Office (717-705-4700) for information regarding technical and financial assistance currently available. Individuals and/or local watershed groups interested in "fixing" the identified problems in the Wyomissing Creek watershed are strongly encouraged to avail themselves of funding sources available through DEP and other state and federal agencies (e.g., Growing Greener or 319 Program).

X. Public Participation

A notice of availability for comments on the draft Wyomissing Creek watershed TMDLs was published in the PA Bulletin on October 23, 2004 and on the Department's web page shortly thereafter. In addition, a public meeting was held on October 25th at 7 pm in the Shillington Municipal Building to address any outstanding concerns regarding the draft TMDL. A notice on the public meeting was published in the Reading Eagle on October 12, 2004. A 30-day period (ending on November 23, 2004) was provided for the submittal of comments.

COMMENTS RECEIVED

Notice of final TMDL approval will be posted on the Department's website and published in the PA Bulletin.

Appendix A - Information Sheet for Wyomissing Creek Watershed Sediment TMDL

What is being proposed?

A Total Maximum Daily Load (TMDL) has been developed to improve water quality in the Wyomissing Creek watershed.

Who is proposing the plans? Why?

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

What is a TMDL?

A TMDL sets a ceiling on the pollutant loads that can enter a waterbody so that it will meet water quality standards. The Clean Water Act requires states to list all waters that do not meet their water quality standards even after pollution controls required by law are in place. For these waters, the state must calculate how much of a substance can be put in the water without violating the standard, and then distribute that quantity to all sources of the pollutant on that water body. A TMDL plan includes waste load allocations for point sources and MS4s, load allocations for nonpoint sources, and a margin of safety. The Clean Water Act requires states to submit their TMDLs to U.S. EPA for approval. Also, if a state does not develop the TMDL, the Clean Water Act states that U.S. EPA must do so.

What is a water quality standard?

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

What is the purpose of the TMDL?

Siltation has been documented to be impairing Wyomissing Creek. This TMDL includes a calculation of the sediment loadings that will meet water quality objectives.

Why was Wyomissing Creek watershed selected for TMDL development?

In 1996, Pa. DEP listed a portion of the Wyomissing Creek watershed under Section 303(d) of the federal Clean Water Act as impaired due to unknown causes related to urban runoff and storm sewers. Surveys conducted by the Department since then have identified the cause as siltation emanating from urban runoff/storm sewers and small residential runoff.

What pollutants does this TMDL address?

The proposed TMDL provides a calculation of the stream's total capacity to accept sediment.

Where do the pollutants come from?

The sediment related impairments in the Wyomissing Creek watershed come from areas within municipal separate storm sewer system (MS4) area, as well as other nonpoint sources (NPS) of pollution, primarily overland runoff from developed lands, agricultural land uses and stream bank erosion.

How was the TMDL developed?

PADEP used a reference watershed approach to estimate the necessary sediment loading that would be needed to restore a healthy aquatic community. The reference watershed approach is based on selecting a non-impaired watershed that has similar land use characteristics and determining the current loading rates for the pollutant of interest. This is done by modeling the loads that enter the stream, using precipitation and land use characteristic data. For this analysis, PADEP used the AVGWLF model (the Environmental Resources Research Institute of the Pennsylvania State University's ArcView based version of the Generalized Watershed Loading Function model developed by Cornell University). This modeling process uses loading rates in the non-impaired watershed as a target for load reductions in the impaired watershed. The impaired watershed is modeled to determine the current loading rates and determine what reductions are necessary to meet the loading

rates of the non-impaired watershed. The reference stream approach was used to set allowable loading rates in the affected watershed because neither Pennsylvanian nor U.S. EPA has water quality criteria for sediment.

How much pollution is too much?

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

What are the major components of this TMDL?

The major components of the Wyomissing Creek watershed sediment TMDL are summarized below:

Component	Sediment (lbs./yr.)
TMDL (Total Maximum Daily Load)	6,329,495.48
MOS (Margin of Safety)	632,949.55
WLA (Wasteload Allocation)	3,747,238.13
LA (Load Allocation)	1,949,307.80

How will the loading limits be met?

Best Management Practices (BMPs) will be encouraged throughout the watershed to achieve the necessary load reductions.

How can I get more information on the TMDL?

To request a copy of the full report, contact Joseph P. Hepp at 717-705-4788 during the business hours of 8:00 a.m. to 3:00 p.m., Monday through Friday. One may also contact Mr. Hepp by mail at the Water Management Program, SCRO PADEP, 909 Elmerton Avenue Harrisburg, PA 17110 or by e-mail at jhepp@.state.pa.us.

How can I comment on the proposal?

You may provide e-mail or written comments postmarked no later than November 23, 2004 to the above addresses.

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

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

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

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

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

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

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

GIS Data Sets	
DATASET	DESCRIPTION
Censustr	Coverage of Census data including information on individual homes septic systems. The attribute *usew_sept* includes data on conventional systems, and *sew_other* provides data on short-circuiting and other systems.
County	The County boundaries coverage lists data on conservation practices, which provides C and P values in the Universal Soil Loss Equation (USLE).
Gwnback	A grid of background concentrations of N in groundwater derived from water well sampling.
Landuse5	Grid of the MRLC that has been reclassified into five categories. This is used primarily as a background.
Majored	Coverage of major roads. Used for reconnaissance of a watershed.
MCD	Minor civil divisions (boroughs, townships and cities).
Npdespts	A coverage of permitted point discharges. Provides background information and cross check for the point source coverage.
Padem	100-meter digital elevation model. This used to calculate landslope and slope length.
Palumrlc	A satellite image derived land cover grid that is classified into 15 different landcover categories. This dataset provides landcover loading rate for the different categories in the model.
Pasingle	The 1:24,000 scale single line stream coverage of Pennsylvania. Provides a complete network of streams with coded stream segments.
Physprov	A shapefile of physiographic provinces. Attributes *rain_cool* and *rain_warm* are used to set recession coefficient
Pointsrc	Major point source discharges with permitted N and P loads.
Refwater	Shapefile of reference watersheds for which nutrient and sediment loads have been calculated.
Soilphos	A grid of soil phosphorous loads, which has been generated from soil sample data. Used to help set sediment and sediment values.
Smallsheds	A coverage of watersheds derived at 1:24,000 scale. This coverage is used with the stream network to delineate the desired level watershed.
Statsgo	A shapefile of generalized soil boundaries. The attribute *mu_k* sets the k factor in the USLE. The attribute *mu_awc* is the unsaturated available capacity., and the *muhsg_dom* is used with landuse cover to derive curve numbers.
Strm305	A coverage of stream water quality as reported in the Pennsylvania's 305(b) report. Current status of assessed streams.
Surfgeol	A shapefile of the surface geology used to compare watersheds of similar qualities.
T9sheds	Data derived from a DEP study conducted at PSU with N and P loads.
Zipcode	A coverage of animal densities. Attribute *aeu_acre* helps estimate N & P concentrations in runoff in agricultural lands and over manured areas.
Weather Files	Historical weather files for stations around Pennsylvania to simulate flow.

Appendix C - AVGWLF Model Outputs for the Wyomissing Creek Watershed

GWLF Transport Summary for Wyomissing_5yrs

Period of analysis: 5 years, from Apr 1989 to Mar 1994

	Units in Inches				
Month	Precip	Evapotrans	Gr. Wat. Flow	Runoff	Streamflow
APR	4.13	1.08	2.62	0.58	3.20
MAY	5.42	2.60	1.99	0.50	2.49
JUN	3.24	4.36	0.95	0.03	0.98
JUL	4.30	5.60	0.23	0.09	0.32
AUG	3.40	4.74	0.04	0.10	0.14
SEP	4.27	2.68	0.00	0.13	0.13
OCT	3.73	1.34	0.21	0.31	0.52
NOV	3.17	0.62	0.92	0.48	1.40
DEC	3.46	0.22	1.84	0.41	2.25
JAN	3.20	0.13	1.75	0.44	2.19
FEB	2.21	0.18	1.78	0.33	2.11
MAR	4.57	0.53	3.31	0.71	4.02
Total	45.10	24.09	15.63	4.11	19.74

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GWLF Nutrient Summary for Wyomissing_5yrs

Period of analysis: 5 years, from Apr 1989 to Mar 1994

	Tons		Nutrient Loads (Pounds)			
Month	Erosion	Sediment	Dis. Nitr.	Tot. Nitr.	Dis. Phos.	Tot. Phos
APR	3339.92	102.51	12276.44	13879.59	213.77	409.28
MAY	5100.06	366.32	9953.28	13339.33	211.42	602.25
JUN	1733.17	2.47	5797.46	5942.70	81.39	103.29
JUL	2888.91	47.84	3410.18	4016.33	51.69	121.85
AUG	2353.06	55.52	2770.77	3437.74	41.28	118.25
SEP	1263.87	83.17	2639.21	3320.51	38.56	115.07
OCT	1137.20	344.64	3614.40	5921.30	67.34	322.82
NOV	1212.21	442.17	6376.91	9390.91	126.48	462.85
DEC	969.82	372.37	9124.31	11648.90	183.81	469.34
JAN	277.45	462.73	8924.68	11787.27	182.30	501.62
FEB	162.57	183.08	8989.38	10113.85	174.25	303.77
MAR	740.73	692.85	14754.43	19090.73	250.85	734.59
Total	21178.98	3155.67	88631.45	111889.15	1623.15	4264.98

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GWLF Total Loads for Wyomissing_5yrs

Period of analysis: 5 years, from Apr 1989 to Mar 1994

Source	(Acres) Area	(in) Runoff	(Tons) Erosion	(Tons) Sediment	Total Loads (Pounds) Dis. Nitr.	Tot. Nitr.	Dis. Phos.	Tot. Phos.
HAY/PAST	751.2	1.25	547.97	81.65	574.61	1064.50	60.17	113.41
CROPLAND	1700.1	3.18	13742.77	2047.67	3307.43	15593.47	342.65	1677.73
CONIF_FOR	464.6	0.97	55.94	8.33	19.39	69.40	0.61	6.05
MIXED_FOR	395.4	0.97	50.64	7.54	16.50	61.77	0.52	5.44
DECID_FOR	2604.5	0.97	277.05	41.28	108.72	356.40	3.43	30.35
TRANSITION	133.4	5.36	5110.93	761.53	470.03	5039.19	32.42	528.93
LO_INT_DEV	2985.0	5.79	1028.77	153.29	0.00	1562.17	0.00	208.29
HI_INT_DEV	953.8	13.98	364.92	54.37	0.00	2549.39	0.00	282.70
Stream Bank				2121.39		212.14		93.34
Groundwater					47707.68	47707.68	758.65	758.65
Point Sources					30835.40	30835.40	385.27	385.27
Septic Syst.					5591.69	5591.69	39.44	39.44
Totals	9988.0	4.10	21179.0	5277.1	88631.45	110643.20	1623.15	4129.60

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	Entire Watershed			Non MS4 Areas		MS4 Areas	
Source	Area (Ac)	Sed (lbs/yr)	Loading Rate (lbs/ac/yr)	Area (Ac)	Sed (lbs/yr)	Area (Ac)	Sed (lbs/yr)
HAY/PAST	751.20	163,200.00	217.25	364.72	79,236.29	386.48	83,963.71
CROPLAND	1,700.10	4,095,400.00	2,408.92	906.24	2,183,057.05	793.86	1,912,342.95
CONIF_FOR	464.60	16,600.00	35.73	280.66	10,027.89	183.94	6,572.11
MIXED_FOR	395.40	15,000.00	37.94	229.28	8,698.03	166.12	6,301.97
DECID_FOR	2,604.50	82,600.00	31.71	1,576.08	49,984.34	1,028.42	32,615.66
TRANSITION	133.40	1,523,000.00	11,416.79	62.49	713,435.31	70.91	809,564.69
LO_INT_DEV	2,985.00	306,600.00	102.71	660.94	67,887.51	2,324.06	238,712.49
HI_INT_DEV	953.80	108,800.00	114.07	160.79	18,341.32	793.01	90,458.68
Stream Bank	20.80	4,242,776.00	203,979.62	7.30	1,489,051.19	13.50	2,753,724.81
Total	9,988.00	10,553,976.00	1,056.67		4,619,718.92		5,934,257.08
				Reducable	4,551,008.67	Reducable	5,888,767.33
				LNR	68,710.25	LNR	45,489.75
				Total	4,619,718.92	Total	5,934,257.08

Appendix D - AVGWLF Model Outputs for the Big Hollow Reference Watershed

GWLF Transport Summary for BigHollow_Ref_5yr

Period of analysis: 5 years, from Apr 1989 to Mar 1994

	Units in Inches				
Month	Precip	Evapotrans	Gr. Wat. Flow	Runoff	Streamflow
APR	3.81	0.98	2.50	0.52	3.02
MAY	3.75	2.39	1.31	0.06	1.37
JUN	3.75	3.92	0.75	0.30	1.05
JUL	4.72	5.03	0.49	0.13	0.63
AUG	3.15	4.26	0.17	0.05	0.22
SEP	4.05	2.46	0.31	0.06	0.37
OCT	2.86	1.22	0.73	0.22	0.96
NOV	3.10	0.51	1.10	0.11	1.21
DEC	3.01	0.14	1.41	0.36	1.77
JAN	2.76	0.08	1.48	0.28	1.77
FEB	2.14	0.14	1.59	0.51	2.10
MAR	4.07	0.44	3.13	0.82	3.95
Total	41.17	21.57	14.97	3.42	18.40

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GWLF Total Loads for BigHollow_Ref_5yrs

Period of analysis: 5 years, from Apr 1989 to Mar 1994

			(Tons)		Total Loads (Pounds)			
Source	(Acres) Area	(in) Runoff	Erosion	Sediment	Dis. Nitr.	Tot. Nitr.	Dis. Phos.	Tot. Phos.
HAY/PAST	1722.3	2.12	346.31	50.56	2208.63	2512.00	239.46	290.83
CROPLAND	2775.0	3.91	7680.58	1121.36	6601.53	13329.72	702.47	1841.77
CONIF_FOR	121.1	1.78	1.36	0.20	9.25	10.45	0.29	0.49
MIXED_FOR	817.9	1.78	11.55	1.69	62.51	72.63	1.97	3.69
DECID_FOR	2572.4	1.78	32.53	4.75	196.61	225.10	6.21	11.03
UNPAVED_RD	4.9	6.19	0.00	0.00	20.11	20.11	1.39	1.39
TRANSITION	388.0	6.19	3515.93	513.33	1578.97	4658.93	108.89	630.43
LO_INT_DEV	2018.8	4.28	423.83	61.88	0.00	305.93	0.00	40.79
HI_INT_DEV	464.6	11.72	85.93	12.55	0.00	260.25	0.00	28.86
Stream Bank				1733.24		173.32		76.26
Groundwater					81606.23	81606.23	987.36	987.36
Point Sources					0.00	0.00	0.00	0.00
Septic Syst.					2380.80	2380.80	1.88	1.88
Totals	10885.0	3.40	12098.0	3499.5	94664.66	105555.48	2049.92	3914.79

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GWLF Total Loads for BigHollow_Ref_5yrs

Period of analysis: 5 years, from Apr 1989 to Mar 1994

Source	(Acres) Area	(in) Runoff	(Tons) Erosion	(Tons) Sediment	Total Loads (Pounds) Dis. Nitr.	Tot. Nitr.	Dis. Phos.	Tot. Phos.
HAY/PAST	1722.3	2.12	346.31	50.56	2208.63	2512.00	239.46	290.83
CROPLAND	2775.0	3.91	7680.58	1121.36	6601.53	13329.72	702.47	1841.77
CONIF_FOR	121.1	1.78	1.36	0.20	9.25	10.45	0.29	0.49
MIXED_FOR	817.9	1.78	11.55	1.69	62.51	72.63	1.97	3.69
DECID_FOR	2572.4	1.78	32.53	4.75	196.61	225.10	6.21	11.03
UNPAVED_RD	4.9	6.19	0.00	0.00	20.11	20.11	1.39	1.39
TRANSITION	388.0	6.19	3515.93	513.33	1578.97	4658.93	108.89	630.43
LO_INT_DEV	2018.8	4.28	423.83	61.88	0.00	305.93	0.00	40.79
HI_INT_DEV	464.6	11.72	85.93	12.55	0.00	260.25	0.00	28.86
Stream Bank				1733.24		173.32		76.26
Groundwater					81606.23	81606.23	987.36	987.36
Point Sources					0.00	0.00	0.00	0.00
Septic Syst.					2380.80	2380.80	1.88	1.88
Totals	10885.0	3.40	12098.0	3499.5	94664.66	105555.48	2049.92	3914.79

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Source	Area (Ac)	Runoff (in)	Erosion (in)	Sed (tons)	Sed (lbs/yr)	Sed (lbs/ac/yr)
HAY/PAST	1,722.30	2.12	346.31	50.60	101,200.00	58.76
CROPLAND	2,775.00	3.91	7,680.58	1,121.40	2,242,800.00	808.22
CONIF_FOR	121.10	1.78	1.36	0.20	400.00	3.30
MIXED_FOR	817.90	1.78	11.55	1.70	3,400.00	4.16
DECID_FOR	2,572.40	1.78	32.53	4.70	9,400.00	3.65
UNPAVED_RD	4.90	6.19	-	-	-	-
TRANSITION	388.00	6.19	3,515.93	513.30	1,026,600.00	2,645.88
LO_INT_DEV	2,018.80	4.28	423.83	61.90	123,800.00	61.32
HI_INT_DEV	464.60	11.72	85.93	12.50	25,000.00	53.81
Stream Bank				1,733.24	3,466,479.80	
Groundwater					-	
Point Source					-	
Septic Systems					-	
Total	10,885.00	39.75	12,098.02	3,499.54	6,897,879.80	633.71

Appendix E - Equal Marginal Percent Reduction Method

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

Appendix F - Equal Marginal Percent Reduction Calculations for Wyomissing Creek

Sediment

Step 1: TMDL Total Load

Load = Sed loading rate in ref. * Acres

6,329,495.48

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

1,880,597.55 1,880,597.55

WLA =	3,747,238.13
MOS =	632,949.55
LA =	1,949,307.80
ALA =	1,880,597.55

Step 3:		Annual Average Load	Load Sum	Check	Initial Adjust	Recheck	% reduction allocation	Load Reduction	Initial LA	Acres	Allowable Loading Rate	% Red.
	HAY/PAST	79,236.29	4,551,008.67	good	79,236.29	ADJUST	0.02	44,162.77	35,073.52	364.72	96.17	56%
	CROPLAND	2,183,057.05		bad	1,880,597.55	2,367,951.62	0.44	1,048,161.11	832,436.44	906.24	918.56	62%
	TRANSITION	713,435.31		good	713,435.31		0.17	397,636.99	315,798.32	62.49	5,053.58	56%
	LO_INT_DEV	67,887.51		good	67,887.51		0.02	37,837.46	30,050.04	660.94	45.47	56%
	HI_INT_DEV	18,341.32		good	18,341.32		0.00	10,222.63	8,118.69	160.79	50.49	56%
	Stream Bank	1,489,051.19		good	1,489,051.19		0.35	829,930.65	659,120.54			56%
		4,551,008.67			4,248,549.17		1.00		1,880,597.55	2,155.18		

Step 4:	All NPS Loading Rate	682.56

Step 5:		Acres	Allowable (Target) Loading Rate	Final LA	Current Loading Rates	Current Load	% Red.
	HAY/PAST	364.72	96.17	35,073.52	217.25	79,236.29	56%
	CROPLAND	906.24	918.56	832,436.44	2,408.92	2,183,057.05	62%
	TRANSITION	62.49	5,053.58	315,798.32	11,416.79	713,435.31	56%
	LO_INT_DEV	660.94	45.47	30,050.04	102.71	67,887.51	56%
	HI_INT_DEV	160.79	50.49	8,118.69	114.07	18,341.32	56%
	Stream Bank	-	-	659,120.54	-	1,489,051.19	56%
	Total	2,155.18	-	1,880,597.55	-	4,551,008.67	59%