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Total Maximum Daily Load (TMDL)
Unnamed Tributary to Mill Creek
Lancaster County

Pennsylvania Department of Environmental Protection
Central Office
Office of Water Management

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Summary of Unnamed Tributary to Mill Creek TMDL

1. The impaired stream segments addressed by this total maximum daily load (TMDL) are located in Upper Leacock Township, Lancaster County. The three segments drain approximately 3.4 square miles of an unnamed tributary to Mill Creek (UNT Mill Creek), as part of State Water Plan subbasin 07J. The aquatic life existing use for Mill Creek, including its tributaries, is cold water fishes, under §93.9f in Title 25 of the Pa. Code (Commonwealth of Pennsylvania, 2001).

2. The UNT Mill Creek TMDL was developed to address use impairments caused by nutrients and sediment. Pennsylvania's 1996 303(d) list identified 0.2 miles of an UNT to Mill Creek as impaired by nutrients and siltation/suspended solids emanating from agricultural activities in the basin. The miles impaired were then increased on Pennsylvania's 1998 303(d). The 1996 and 1998 listings were based on data collected prior to 1996 through PADEP's Surface Water Monitoring Program. PADEP assessments in 2000 increased the number of miles listed as impaired, and added nutrients as an additional pollutant of concern. In order to ensure attainment and maintenance of water quality standards in the UNT Mill Creek, mean annual loadings of total phosphorus and sediment will need to be limited to 1,289.94 pounds per year (lbs/yr) and 597,865.70 lbs/yr, respectively.

   The major components of the UNT Mill Creek TMDL are summarized below:

Components	**Total Phosphorus (lbs/yr)**	**Sediment (lbs/yr)**
TMDL (Total Maximum Daily Load)	1,289.94	597,865.70
WLA (Wasteload Allocation)	151.07	81,262.99
MOS (Margin of Safety)	128.99	59,786.57
LA (Load Allocation)	1,009.88	456,816.14

3. Mean annual total phosphorus and sediment loadings are estimated to be 1,776.65 lbs/yr and 1,243,807.40 lbs/yr, respectively. To meet the TMDL, the phosphorus and sediment loadings will require a 27 percent and 52 percent reduction, respectively.

4. There are no point sources to address in this TMDL. However, approximately 26 percent of the watershed falls within an MS4 designated area. Therefore, the WLA portion of the TMDL includes pollutant loads emanating from an MS4 designated area. Load Allocations (LA) for phosphorus and sediment were made to the following nonpoint sources: hay and pasture lands, croplands, coniferous forest, mixed forest, deciduous forest, developed areas, streambanks, groundwater and septic systems.

5. The adjusted load allocation (ALA) is the actual portion of the LA distributed among nonpoint sources receiving reductions, or sources that are considered controllable. Controllable sources receiving allocations are hay/pasture, cropland, developed lands, and streambanks. The phosphorus and sediment TMDL includes a nonpoint source ALA of 858.88 lbs/yr and 456,616.14 lbs/yr, respectively. Phosphorus and sediment loadings from all other sources, such as forested areas, were

maintained at their existing levels. Allocations of phosphorus and sediment to controllable nonpoint sources, or the ALA, for the UNT Mill Creek TMDL are summarized below:

Adjusted Load Allocations for Sources of Phosphorus and Sediment			
Pollutant	**Current Loading (lbs/yr)**	**Adjusted Load Allocation (lbs/yr)**	**% Reduction**
Phosphorus	1,776.65	858.88	52
Sediment	1,243,807.40	456,616.14	63

6. Ten percent of the UNT Mill Creek phosphorus and 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 phosphorus and sediment TMDL was set at 128.99 lbs/yr and 59,786.57 lbs/yr, respectively.

7. The continuous simulation model used for developing the UNT Mill Creek TMDL 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 accounts for seasonal variability.

I. Introduction

A. Watershed Description

The impaired stream segments addressed by this TMDL are located in Upper Leacock Township, Lancaster County (Figure 1). The three segments drain approximately 3.4 square miles of an unnamed tributary to Mill Creek, part of State Water Plan subbasin 07J. The aquatic life existing use for Mill Creek, including its tributaries, is cold water fishes, under §93.9f in Title 25 of the Pa. Code (Commonwealth of Pennsylvania, 2001).

Traveling east on state route 23 northeast of the city of Lancaster will bring you to the headwaters area of the three segments, in the vicinity of Leola Borough. The three segments form a fork-like pattern, together flowing southward before joining the mainstem Mill Creek.

B. Topography & Geology

The TMDL watershed is located within the Piedmont Lowland Section, and is typical of watersheds in this section of the Piedmont Province. The highest elevations are located in the northwest portion of the watershed area, in the vicinity of the borough of Leacock. However, the remaining terrain is nearly level to undulating, exhibiting karst features and disappearing stream segments.

The subsurface geologic strata are highly folded and faulted, with numerous faults passing through the area. The majority of the rock type in the watershed is limestone (96 percent), associated with the Ledger Formation. The remaining rock types are a mix of igneous and metamorphic material (4 percent), associated with the Antietam and Harpers Formations. As expected, the igneous/metamorphic rock type comprises the ridge forming unit associated with the highest elevations within the TMDL watershed.

The Hagerstown-Duffield-Clarksburg series is the predominant soil type in the TMDL watershed. Predominantly deep and well drained, these soils have slow to moderate permeability and moderate runoff. The soils are generally fertile and are intensively farmed; most of the forest has been removed. Few wetlands remain; many farm fields have been tiled to drain wet areas.

C. Land Use

Based on GIS datasets created in 2001, land use values were calculated for the TMDL watershed. Agriculture was the dominant land use at approximately 74 percent. Developed areas are 22 percent of the watershed, and are almost evenly split between low-intensity residential and high-intensity/commercial land. Forested areas account for 4 percent of the watershed. Riparian buffer zones are nearly nonexistent in the hay and pasture lands. Livestock have unlimited access to streambanks throughout most of the watershed, resulting in streambank trampling and severe erosion. Little or no contiguous forested tracts remain in the watershed (Figure 2).

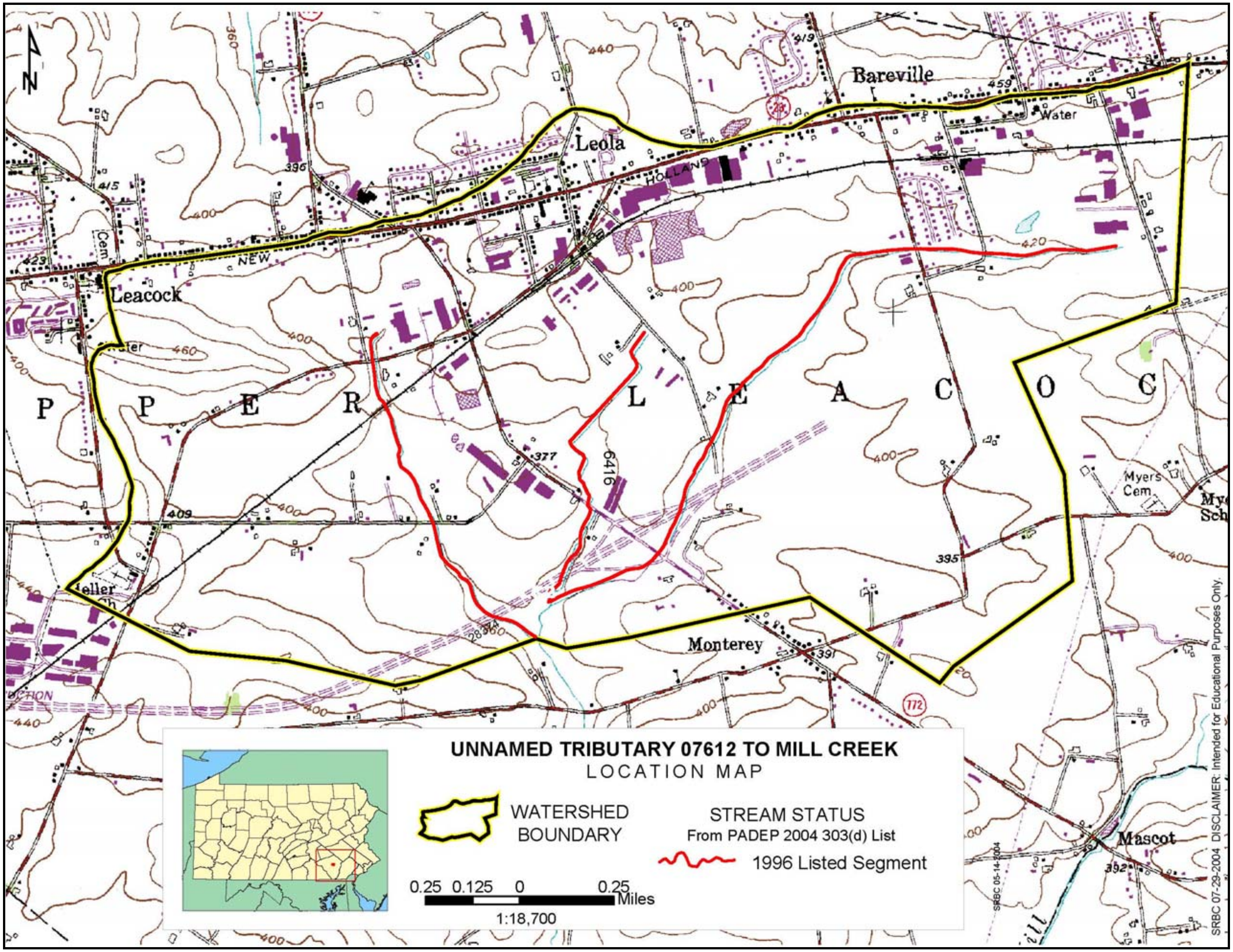

Figure 1. Location Map of UNT Mill Creek Watershed

Figure 2. Lack of Riparian Vegetation in the UNT Mill Creek Watershed

D. Surface Water Quality

Pennsylvania's 1996 303(d) list identified 0.2 miles of an UNT to Mill Creek as impaired by nutrients and siltation/suspended solids emanating from agricultural activities in the basin (Table 1). The miles impaired were then increased on Pennsylvania's 1998 303(d). The 1996 and 1998 listings were based on data collected prior to 1996 through PADEP's Surface Water Monitoring Program.

Table 1. 1996, 1998, 2002, and 2004 303(d) Listings Addressed in the UNT to Mill Creek TMDL					
1996 303(d) LIST					
STREAM NAME	STREAM CODE	SOURCE	CAUSE	MILES	
Mill Creek (UNT)	07612	Agriculture	Suspended Solids	0.2	
1998 303(d) LIST					
SEGMENT ID	WATERSHED	STREAM CODE	SOURCE	CAUSE	MILES
6416	Mill Creek Watershed	07612	Agriculture	Suspended Solids	0.87
2002 303(d) LIST					
SEGMENT ID	WATERSHED	STREAM CODE	SOURCE	CAUSE	MILES
20000522-1510-KEB	Mill Creek (UNT)	07610	Agriculture	Siltation / Nutrients	2.0
20000531-1037-KEB	Mill Creek (UNT)	07611	Crop Related Agriculture / Grazing Related Agriculture	Nutrients / Siltation	1.0
6416	Mill Creek (UNT)	07612	Agriculture	Suspended Solids	0.9
2004 303(d) LIST					
SEGMENT ID	WATERSHED	STREAM CODE	SOURCE	CAUSE	MILES
20000522-1510-KEB	Mill Creek (UNT)	07610	Agriculture	Siltation / Nutrients	2.0
20000531-1037-KEB	Mill Creek (UNT)	07611	Crop Related Agriculture / Grazing Related Agriculture	Nutrients / Siltation	1.0
6416	Mill Creek (UNT)	07612	Agriculture	Suspended Solids	0.9

As part of the PADEP's ongoing State Surface Water Assessment Program (SSWAP), and in anticipation of TMDL development, assessments were conducted in the TMDL watershed in 2000. These assessments resulted in the additional impairment listings on the 2002 and 2004 303(d) lists (Table 1).

The Mill Creek watershed is subjected to a variety of nonpoint source pollutants including organic enrichment and siltation from agriculture, on-lot septic systems, streambank erosion and lack of stabilization, and unrestricted cattle access along streams. The UNT Mill Creek watershed is no exception. The biologist conducting the survey indicated that the more pollutant tolerant macroinvertebrates dominated the biological community. It also was observed that little to no riparian zone existed along the stream corridors assessed in the UNT Mill Creek watershed, along with evidence of severe streambanks erosion. Field observations by SRBC staff during the spring of 2004 supported the assessment results.

II. Approach to TMDL Development

A. Pollutants & Sources

Nutrients and sediment have been identified as the pollutants causing designated use impairments in the UNT Mill Creek watershed, with the source listed as agricultural activities, both crop and grazing related. At present, there are no point source contributions within the area. An industrial site discharged phosphorus and other constituents prior to 2000, but has discontinued its permitted release to the stream.

As stated in previous sections, the landscape is dominantly agriculture. Best Management Practices (BMPs) are very limited in the watershed. Pastures and croplands extend right up to the streambanks with little to no riparian buffer zones present. Livestock have unlimited access to streambanks throughout most of the watershed. Based on visual observations, streambank erosion is severe in most reaches of the stream.

B. TMDL Endpoints

In an effort to address the excessive nutrient and sediment found in the UNT Mill Creek watershed, TMDLs were develop loading limits for phosphorus and sediment. The phosphorus TMDL is intended to address nutrient impairments from agriculture land uses that were first identified in Pennsylvania's 1996 303(d) list. The decision to use phosphorus load reductions to address nutrient enrichment is based on an understanding of the relationship between nitrogen, phosphorus, and organic enrichment in stream systems. Elevated nutrient loads from human activities (nitrogen and phosphorus in particular) can lead to increased productivity of aquatic plants and other organisms, resulting in the degradation of water quality conditions through the depletion of dissolved oxygen in the water column (Novotny and Olem, 1994; Hem, 1983). In aquatic ecosystems the quantities of trace elements are typically plentiful; however, nitrogen and phosphorus may be in short supply. The nutrient that is in the shortest supply is called the limiting nutrient because its relative quantity affects the rate of production (growth) of aquatic biomass. If the limiting nutrient load to a waterbody can be reduced, the available pool of nutrients that can be utilized by plants and other organisms will be reduced and, in general, the total biomass can subsequently be decreased as well (Novotny and Olem, 1994). In most efforts to control the eutrophication processes in waterbodies, emphasis is placed on the limiting nutrient. However, this is not always the case. For example, if nitrogen is the limiting nutrient, it still may be more efficient to control phosphorus loads if the nitrogen originates from difficult to control sources, such as nitrates in groundwater.

In most freshwater systems, phosphorus is the limiting nutrient for aquatic growth. In some cases, however, the determination of which nutrient is the most limiting is difficult. For this reason, the ratio of the amount of nitrogen to the amount of phosphorus is often used to make this determination (Thomann and Mueller, 1987). If the nitrogen/phosphorus (N/P) ratio is less than 10, nitrogen is limiting. If the N/P ratio is greater than 10, phosphorus is the limiting nutrient. For the UNT Mill Creek watershed, the average N/P ratio is approximately 20, which indicates to phosphorus as the limiting nutrient. Controlling the phosphorus loading to the UNT Mill Creek watershed will limit plant growth, thereby helping to eliminate use impairments currently being caused by excess nutrients.

C. Reference Watershed Approach

The TMDL developed for the UNT Mill Creek watershed addresses phosphorus and sediment. Because neither Pennsylvania nor the U.S. Environmental Protection Agency (USEPA) has instream numerical water quality criteria for phosphorus and sediment, a method was developed to implement the applicable narrative criteria. The method for these types of TMDLs is termed the “Reference Watershed Approach.” Meeting the water quality objectives specified for this TMDL will result in the impaired stream segment attaining its designated uses.

The Reference Watershed Approach compares two watersheds, one attaining its uses and one that is impaired based on biological assessments. Both watersheds ideally 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 for 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 the loading rate in the nonimpaired, reference stream 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 PADEP 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/soils. Finally, the size of the reference watershed should be within 20-30 percent of the impaired watershed area. The search for a reference watershed for the UNT Mill Creek watershed, 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 streams database, and geologic rock types.

An unnamed headwater stream of Little Conestoga Creek (UNT7586) was selected as the reference watershed for developing the UNT Mill Creek TMDL. UNT7586 is located north of the city of Lancaster, in Lancaster County, Pennsylvania (Figure 3). The watershed is located in State Water Plan subbasin 7J, and protected uses include aquatic life and recreation. The tributary is currently designated as Trout Stock Fishery under §93.9z in Title 25 of the Pa. Code (Commonwealth of Pennsylvania, 2001). Based on PADEP assessments, UNT7586 is currently attaining its designated uses. The attainment of designated uses is based on sampling done by the PADEP in 1997, as part of its State Surface Water Assessment Program.

Drainage area, location, and other physical characteristics of the UNT Mill Creek were compared to the UNT7586 reference stream (Table 2). Agriculture is the dominant land use category in both UNT7586 (69 percent) and the UNT Mill Creek (74 percent). The geology, soils, and precipitation in both are also similar (Table 2).

Table 2. Comparison Between UNT Mill Creek and UNT7586

Attribute	**Watershed**	
	UNT Mill Creek	**UNT7586**
Physiographic Province	Piedmont Lowlands (100%)	Piedmont Lowlands (100%)
Area (mi^2)	3.39	3.45
Land Use	Agriculture (74%) Development (22%) Forested (4%)	Agriculture (69%) Development (22%) Forested (8%)
Geology	Limestone (96%) Igneous/Metamorphic (4%)	Limestone (92%) Sedimentary (8%)
Soils	Hagerstown – Duffield – Clarksburg (100%)	Hagerstown – Duffield – Clarksburg (100%)
Dominant HSG	A (0%) B (36%) C (60%) D (2%)	A (0%) B (36%) C (60%) D (2%)
K Factor	0.32	0.32
20-Yr. Ave. Rainfall (in)	42.4	42.4
20-Yr. Ave. Runoff (in)	5.74	5.28

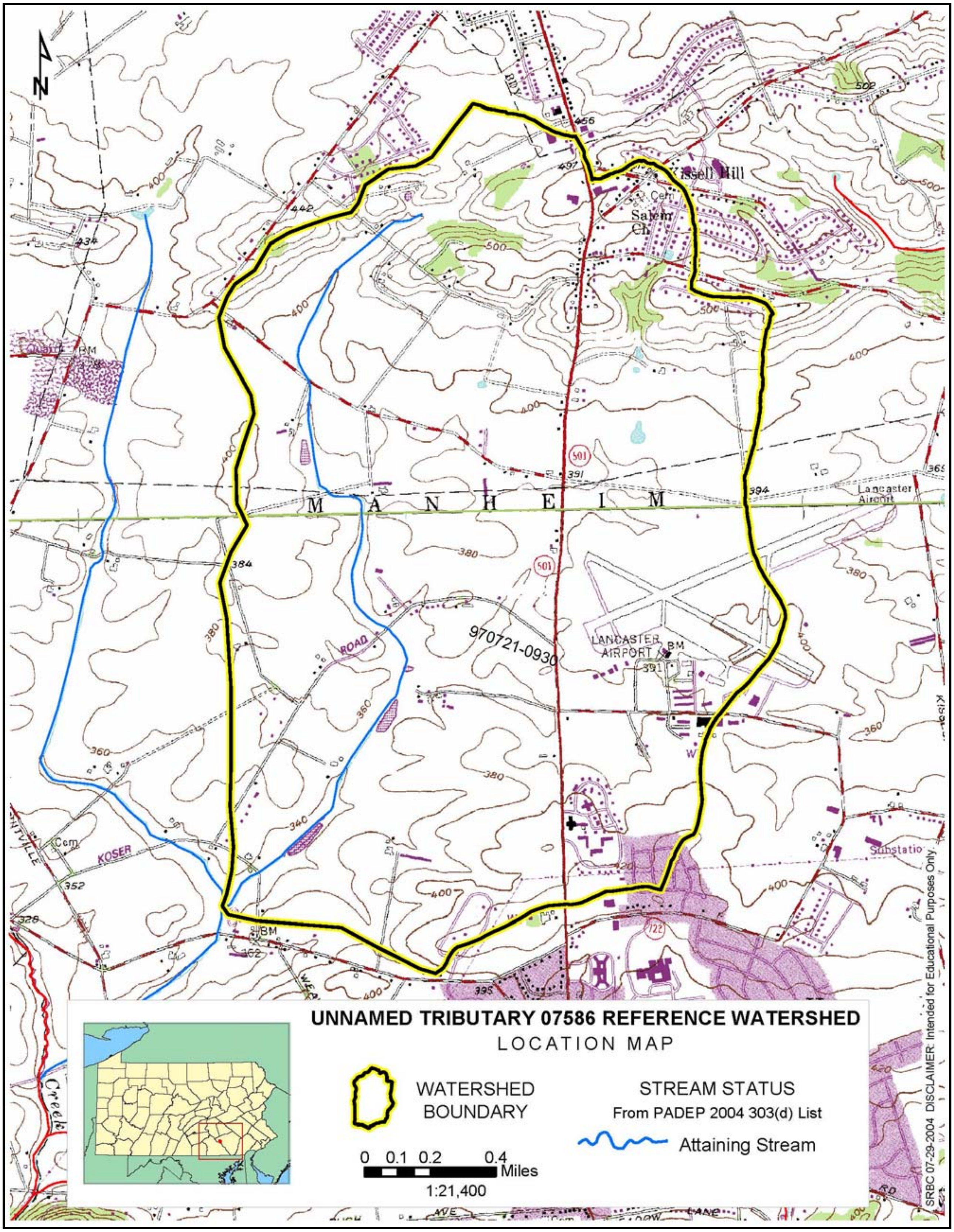

Figure 3. Location Map of the Reference Watershed, UNT7586

III. Watershed Assessment and Modeling

TMDLs for the UNT Mill Creek watershed were developed using the ArcView Generalized Watershed Loading Function model (AVGWLF) as described in Appendix B. The AVGWLF model was used to establish existing loading conditions for the UNT Mill Creek watershed and the reference UNT7586 watershed. All modeling inputs have been attached to this TMDL as Appendices C and D. SRBC staff visited the UNT Mill Creek and UNT7586 watersheds in the spring of 2004. The field visits were conducted to get a better understanding of existing conditions that might influence the AVGWLF model. General observations of the individual watershed characteristics include:

UNT Mill Creek Watershed

- Local geology dominated by karst (limestone) terrain.
- Significant presence of grazing horses and cattle.
- General lack of strip cropping and contour plowing.
- Severely limited riparian buffer zones, with croplands and pastures extending right up to streambanks.

UNT7586 Watershed

- Local geology dominated by karst (limestone) terrain.
- More hay and other cover crops.
- Streambank fencing present.

Adjustments made to specific AVGWLF model parameters, based on existing land use practices in each of the watersheds, included:

UNT Mill Creek Watershed

- Reset default C factor for cropland (0.42) to 0.50 to reflect the presence of large continuous fields with a general lack of contour plowing and use of cover crops. Hay/pasture (0.03) was reset to 0.15 as well to reflect the effects of heavily grazed pastureland.
- Reset default P factors for cropland and hay/pasture land uses (0.52) to 0.65 to account for:
    - Pastures and cropland generally extending right up to streambanks with unrestricted livestock access to the streams.
    - Lack of quality riparian vegetation resulting in many exposed banks.

UNT7586 Watershed

- Reset C factor for cropland (0.42) to 0.30 to account for prevalent use of contour plowing and cover crops.
- Reset P factor for cropland (0.52) and hay/pasture (0.52) land uses to 0.30, respectively, to account for stable streambanks and fencing.

The AVGWLF model produced information on watershed size, land use, and phosphorus loading. The phosphorus and sediment loads represent an annual average over a 20-year period (1978 to 1998). This information was then used to calculate existing unit area loading rates for the UNT Mill Creek and UNT7586 reference watersheds. Phosphorus and sediment loading information for both the impaired watershed and the reference watershed are shown in Tables 3 and 4, respectively.

Table 3. Existing Phosphorus and Sediment Loads for UNT Mill Creek					
		Phosphorus		**Sediment**	
Pollutant Source	**Acreage**	**Mean Annual Loading (lbs/yr)**	**Unit Area Loading (lbs/ac/yr)**	**Mean Annual Loading (lbs/yr)**	**Unit Area Loading (lbs/ac/yr)**
HAY/PAST	427.50	194.80	0.46	83,400.00	195.09
CROPLAND	1,134.20	1,339.30	1.18	859,800.00	758.07
CONIF_FOR	2.50	0.00	0.00	0.00	0.00
MIXED_FOR	61.80	0.30	0.00	200.00	3.24
DECID_FOR	14.80	0.10	0.01	0.00	0.00
TRANSITION	44.50	69.00	1.55	56,200.00	1,262.92
LO_INT_DEV	207.60	0.50	0.00	7,800.00	37.57
HI_INT_DEV	257.00	9.60	0.04	11,600.00	45.14
Streambank		4.95		224,807.40	
Groundwater		150.60			
Point Source		0.00			
Septic Systems		7.50			
TOTAL	2,149.90	1,776.65	0.83	1,243,807.40	578.54

Table 4. Existing Phosphorus and Sediment Loads for UNT7586					
		Phosphorus		**Sediment**	
Pollutant Source	**Acreage**	**Mean Annual Loading (lbs/yr)**	**Unit Area Loading (lbs/ac/yr)**	**Mean Annual Loading (lbs/yr)**	**Unit Area Loading (lbs/ac/yr)**
HAY/PAST	353.40	107.20	0.30	10,000.00	28.30
CROPLAND	1,203.40	923.30	0.77	416,800.00	346.35
CONIF_FOR	7.40	0.00	0.00	0.00	0.00
MIXED_FOR	133.40	0.80	0.01	400.00	3.00
DECID_FOR	37.10	0.40	0.01	400.00	10.78
TRANSITION	2.50	10.60	4.24	11,600.00	4,640.00
LO_INT_DEV	281.70	1.50	0.01	17,600.00	62.48
HI_INT_DEV	165.60	4.80	0.03	9,000.00	54.35
Streambank		3.12		141,681.00	
Groundwater		253.50			
Point Source		0.00			
Septic Systems		7.50			
Total	2,184.50	1,312.72	0.60	607,481.00	278.09

IV. TMDLs

Targeted TMDL values for the UNT Mill Creek watershed were established based on current loading rates for phosphorus and sediment in the UNT7586 reference watershed. Biological assessments have determined that UNT7586 is currently attaining its designated uses. Reducing the loading rate of phosphorus and sediment in the UNT Mill Creek watershed to levels equivalent to those in the 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 TMDLs

Targeted TMDL values for phosphorus and sediment were determined by multiplying the total area of UNT Mill Creek watershed (2,149.90 acres) by the appropriate unit area loading rate for the UNT7586 reference watershed (Table 5). The existing mean annual loading of phosphorus to UNT Mill Creek (1,776.65 lbs/yr) will need to be reduced by 27 percent to meet the targeted TMDL of 1,289.94 lbs/yr. The existing mean annual loading of sediment to UNT Mill Creek (1,243,807.40 lbs/yr) will need to be reduced by 52 percent to meet the targeted TMDL of 597,865.70 lbs/yr.

Table 5. Targeted TMDL for the UNT Mill Creek Watershed

Pollutant	**Area (ac)**	**Unit Area Loading Rate UNT7586 Reference Watershed (lbs/ac/yr)**	**Targeted TMDL for UNT Mill Creek (lbs/yr)**
Phosphorus	2,149.90	0.60	1,289.94
Sediment	2,149.90	278.09	597,865.70

Targeted TMDL values were used as the basis for load allocations and reductions in the UNT Mill 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. Waste Load Allocation

The WLA portion of the TMDL equation is the total loading of a pollutant that is assigned to point sources. Reviewing the PADEP's permitting files identified no point source discharge in the watershed. However, approximately 26 percent of the watershed falls within an MS4 designated area (Figure 4). The WLA portion of the TMDL must include pollutant loads emanating from an MS4 designated area. To account for that portion of the TMDL, allocations made to land uses within the MS4 area were separated from the non-MS4 loads. These MS4 loads are shown in Table 6.

Table 6. Phosphorus and Sediment Waste Load Allocations for MS4 Designated Areas within UNT Mill Creek

Pollutant Source	Acres	Unit Area Loading Rate (lbs/ac/yr)		Pollutant Loading (lbs/yr)	
		Current	Allowable	Current	Allowable (WLA)
Phosphorus					
Hay/Pasture	61.80	0.46	0.30	28.43	18.54
Cropland	158.10	1.18	0.77	186.56	121.74
Developed	291.50	0.17	0.04	49.56	10.79
Sediment					
Hay/Pasture	61.80	195.09	28.30	12,056.56	1,748.94
Cropland	158.10	758.07	346.35	119,850.87	54,757.94
Developed	291.50	148.50	84.93	43,287.75	24,756.11

From Table 6:

WLA (phosphorus) = 151.07 lbs/yr
WLA (sediment) = 81,262.99 lbs/yr

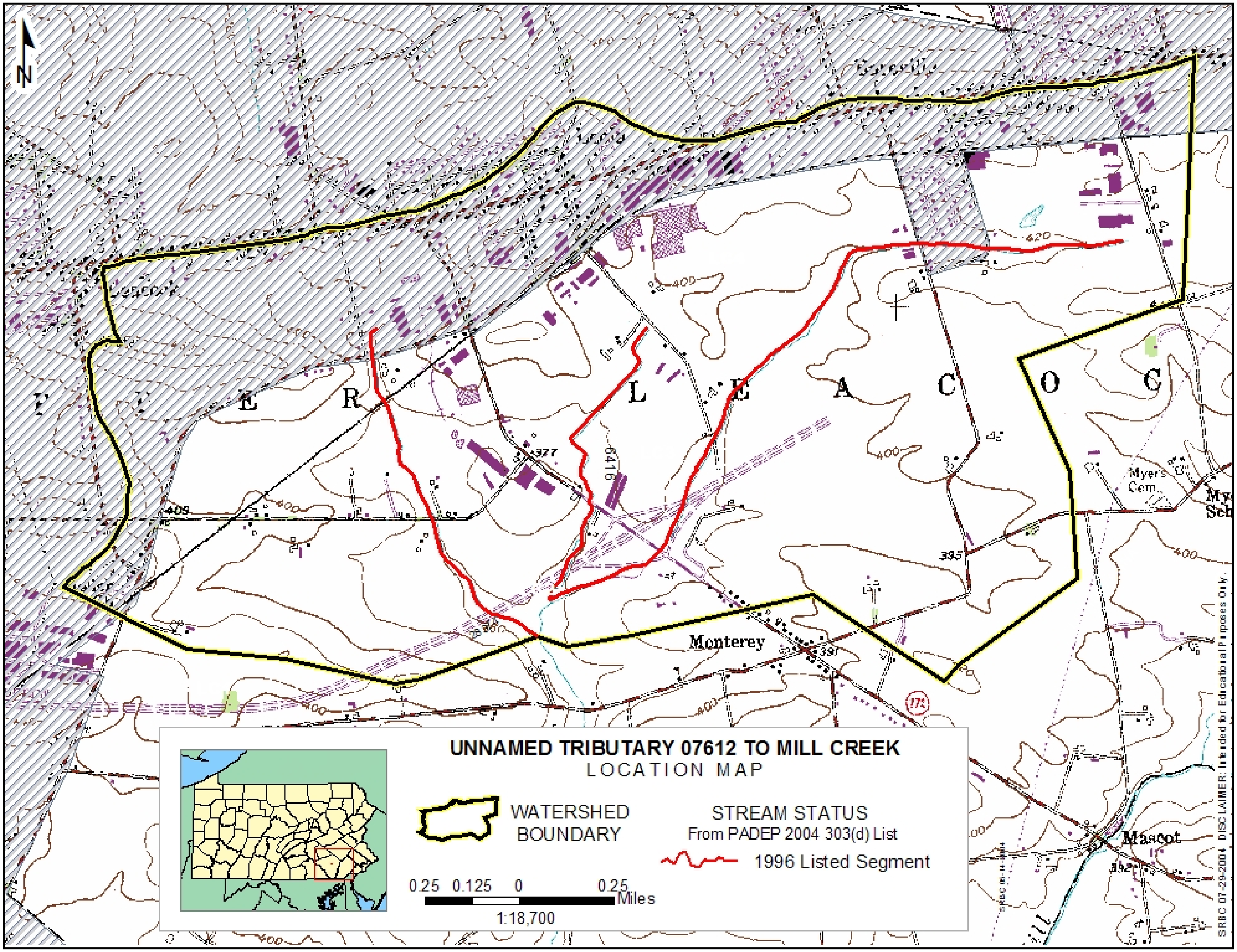

Figure 4 Map Showing MS4 Designated Areas (shaded) for the UNT Mill Creek Watershed

D. Margin of Safety

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. For this analysis, the MOS is explicit. Ten percent of the targeted TMDL for phosphorus and sediment was reserved as the MOS. Using 10 percent of the TMDL load is based on professional judgment and will provide an additional level of protection to the designated uses of UNT Mill Creek. The MOS used for the phosphorus and sediment TMDL was 128.99 lbs/yr and 59,786.57 lbs/yr, respectively.

MOS (phosphorus) = 1,289.94 lbs/yr (TMDL) x 0.1 = 128.99 lbs/yr
MOS (sediment) = 597,865.70 lbs/yr (TMDL) x 0.1 = 59,786.57 lbs/yr

E. Load Allocation

The LA is that portion of the TMDL that is assigned to nonpoint sources. The LA was computed by subtracting the WLA and MOS values from the targeted TMDL values. LAs for phosphorus and sediment were 1,009.88 lbs/yr and 456,816.14 lbs/yr, respectively.

LA (phosphorus) = 1289.94 lbs/yr (TMDL) – 151.07 lbs/yr (WLA) – 128.99 lbs/yr (MOS) = 1,009.88 lbs/yr
LA (sediment) = 597,865.70 lbs/yr (TMDL) – 81,262.99 lbs/yr (WLA) – 59,786.57 lbs/yr (MOS) = 456,816.14 lbs/yr

F. Adjusted Load Allocation

The 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 or LNR) from the LA. Phosphorus and sediment reductions were made to the hay/pasture, cropland, developed areas (sum of LO_INT_DEV, HI_INT_DEV and septic systems), and streambanks. Those land uses/sources for which existing loads were not reduced (CONIF_FOR, MIXED_FOR, DECID_FOR, and groundwater) were carried through at their existing loading values (Table 7). The ALA for phosphorus and sediment were 858.88 lbs/yr and 456,616.14 lbs/yr, respectively.

Table 7. Load Allocations, Loads Not Reduced, and Adjusted Load Allocations for UNT Mill Creek		
	Phosphorus (lbs/yr)	**Sediment (lbs/yr)**
Load Allocation	1,009.88	456,816.14
Loads Not Reduced	151.00	200.00
CONIF_FOR	0.00	0.00
MIXED_FOR	0.30	200.00
DECID_FOR	0.10	0.00
Groundwater	150.60	--
Adjusted Load Allocation	858.88	456,616.14

G. TMDLs

The phosphorus and sediment TMDLs established for the UNT Mill Creek watershed consist of a LA, a WLA, and a MOS. No TMDL was established for nitrogen because the stream is phosphorus limited. The individual components of the TMDL are summarized in Table 8.

Table 8. TMDL, WLA, MOS, LA, LNR, and ALA for UNT Mill Creek		
Component	**Phosphorus (lbs/yr)**	**Sediment (lbs/yr)**
TMDL (Total Maximum Daily Load)	1,289.94	597,865.70
WLA (Wasteload Allocation)	151.07	81,262.99
MOS (Margin of Safety)	128.99	59,786.57
LA (Load Allocation)	1,009.88	456,816.14
LNR (Loads Not Reduced)	151.00	200.00
ALA (Adjusted Load Allocation)	858.88	456,616.14

V. Calculation of Phosphorus and Sediment Load Reductions

ALAs established in the previous section represent the annual total phosphorus and sediment loads that are available for allocation between contributing sources in the UNT Mill Creek watershed. The ALAs for phosphorus and sediment were allocated between agriculture, developed areas, and streambanks. LA and reduction procedures were applied to the entire UNT Mill Creek watershed using the Equal Marginal Percent Reduction (EMPR) allocation method (Appendix E). The LA and EMPR procedures were performed using MS Excel and results are presented in Appendix F.

In order to meet the phosphorus TMDL, the load currently emanating from controllable sources must be reduced to 858.88 lbs/yr. This can be achieved through reductions in current phosphorus loadings of 40 percent from cropland, and 20 percent from hay/pasture, developed, and streambanks (Table 9). The loadings from septic systems were included in the allocation to developed areas.

To meet the sediment TMDL, the current loading from controllable sources will require a reduction to 456,616.14 lbs/yr. This is achievable through sediment load reductions of 64 percent for cropland, 42 percent for hay/pasture, developed lands, and streambanks(Table 9).

Table 9. Phosphorus and Sediment Load Allocations & Reductions for UNT Mill Creek

Pollutant Source	Acres	Unit Area Loading Rate (lbs/ac/yr)		Pollutant Loading (lbs/yr)		% Reduction
		Current	Allowable	Current	Allowable (LA)	
Phosphorus						
Hay/Pasture	365.70	0.45	0.37	166.37	133.89	20
Cropland	976.10	1.18	0.71	1,152.74	691.20	40
Developed	217.60	0.17	0.14	37.05	29.81	20
Streambanks	0.00			4.95	3.98	20
Sediment						
Hay/Pasture	365.70	195.09	113.47	71,343.44	41,494.62	42
Cropland	976.10	758.07	272.08	739,949.13	265,576.12	64
Developed	217.60	148.49	86.37	32,312.25	18,793.38	42
Streambanks	0.00			224,807.40	130,752.01	42

VI. 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 nutrient and sediment loads, based on the daily water balance accumulated to monthly values. Therefore, all flow conditions are taken into account for loading calculations. Because there is generally a significant lag time between the introduction of nutrients to a waterbody and the resulting impact on beneficial uses, establishing these TMDLs using average annual conditions is protective of the waterbody.

VII. Consideration of Seasonal Variations

The continuous simulation model used for these analyses 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.

VIII. 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 UNT Mill Creek TMDL identifies the necessary overall load reductions for pollutants currently causing use impairments and distributes those reduction goals to the appropriate nonpoint sources. Reaching the reduction goals established by this TMDL will only occur through BMPs. BMPs that would be helpful in lowering the amount of nutrients and sediment reaching UNT Mill Creek include streambank fencing, riparian buffer strips, strip cropping, stormwater retention wetlands, and heavy use area protection, among many others.

The Mill Creek Watershed has been the focus of numerous assessment and restoration initiatives. Prior to PADEP's biological assessment of Mill Creek in 2000, the watershed was the focus of an intensive biological survey conducted by the USEPA in the late 1990s. The purpose of the study was to identify the most severely impaired streams for targeting BMP installation, as well as provide baseline data for later use in evaluating their effectiveness. The study indicated that most of the tributaries to Mill Creek were severely impaired in comparison to the mainstem, which was generally found to be in better condition (Green and others, 1999).

The Lancaster County Conservation District and the U.S. Department of Agriculture, as well as other project partners, have been involved in continuing efforts to install the streambank fencing in the watershed, as well as increase the number of manure storage facilities. Most of the efforts have been concentrated in the Muddy Run watershed, identified by the USEPA assessment as a priority for BMP implementation. Although measuring a stream's recovery as a result of BMP installation is generally considered a long-term and complex exercise (~10 years), a study by the U.S. Geological Survey (1999) indicates that total phosphorus levels decreased 31 percent over the study period. Since phosphorus is generally tied to sediment runoff during storm events, it may indicate that fencing efforts have contributed to reducing the runoff by stabilizing streambanks.

Numerous other entities, both public and private, have assisted with similar efforts throughout the county. Specific BMPs implemented in the county include stream fencing, manure storage systems, treatment of runoff from animal confinement areas, and treatment of milk house waste. A number of projects in the Mill Creek watershed are also addressing streambank erosion through the use of natural stream design and stabilization.

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 UNT Mill Creek watershed to help limit nutrient and sediment impairments. Determining the most appropriate BMPs, where they should be installed, and actually putting them into practice, will require the development and implementation of restoration plans. Development of any restoration plan will involve the gathering of site-specific information regarding current land uses and existing conservation practices. This type of assessment would be recommended for the UNT Mill Creek watershed prior to BMP implementation.

By developing TMDLs for the UNT Mill Creek watershed, the PADEP has set the stage for the design and implementation of restoration plans to correct current use impairments. The PADEP welcomes local efforts to support a watershed restoration plan. For more information about this TMDL, interested parties should contact the appropriate watershed manager in PADEP's Southcentral Regional Office (717-705-4700).

IX. Public Participation

A notice of availability for comments on the draft UNT Mill Creek watershed TMDL was published in the PA Bulletin on **<insert publication date>**. The document is on the PADEP's web page, at http://www.dep.state.pa.us/watermanagement_apps/tmdl. In addition, a public meeting was held on **<insert meeting date and location>** to address any outstanding concerns regarding the draft TMDL. A 60-day period (ended on **<insert date>**) was provided for the submittal of comments. Comments and responses are summarized in Appendix G.

Notice of final TMDL approval will be posted on the PADEP's website.

Literature Cited

Commonwealth of Pennsylvania. 2001. Pennsylvania Code. Title 25 Environmental Protection. Department of Environmental Protection. Chapter 93. Water Quality Standards. Harrisburg, PA.

Green, J., and M. Passmore. 1999. The Biological Conditions of Streams in the Pequea and Mill Creek Watersheds in Pennsylvania. U.S. Environmental Protection Agency, Region III, Biology Group, Wheeling, WV.

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Thomann, R.V. and J.A. Mueller, 1987. Principles of Surface Water Quality Modeling and Control. Harper & Row, New York.

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Appendix A. Information Sheet for the UNT Mill Creek TMDL

What is being proposed?

Total Maximum Daily Load (TMDL) plans have been developed to improve water quality in an unnamed tributary to Mill Creek (UNT Mill Creek).

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 (USEPA) for review and approval as required by federal regulation. In 1995, USEPA was sued for not developing TMDLs when Pennsylvania failed to do so. PADEP has entered into an agreement with USEPA to develop TMDLs for certain specified waters over the next several years. This TMDL has been developed in compliance with the state/USEPA 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 the sources of the pollutant on that waterbody. A TMDL plan includes waste load allocations for point sources, load allocations for nonpoint sources, and a margin of safety. The Clean Water Act requires states to submit their TMDLs to USEPA for approval. Also, if a state does not develop the TMDL, the Clean Water Act states that USEPA must do so.

What is a water quality standard?

The Clean Water Act sets a national minimum goal that all waters 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 that make up a water quality standard. If any criteria are being exceeded, then the use is not being met and the water is said to be in violation of water quality standards.

What is the purpose of the plans?

The UNT Mill Creek is impaired due to nutrients and sediment emanating from agricultural runoff. The plans include a calculation of the loading for phosphorus, the limiting nutrient, and sediment that will correct the problem and meet water quality objectives.

Why was the UNT Mill Creek selected for TMDL development?

In 1996, PADEP listed the UNT Mill Creek under Section 303(d) of the federal Clean Water Act as impaired due to causes linked to nutrients and sediment.

What pollutants do these TMDLs address?

The proposed plans provide calculations of the stream’s total capacity to accept phosphorus and sediment.

Where do the pollutants come from?

The nutrient and sediment related impairments in the UNT Mill Creek come from nonpoint sources of pollution, primarily overland runoff from agricultural and developed areas, as well as from streambank erosion.

How was the TMDL developed?

PADEP used a reference watershed approach to estimate the necessary loading reduction of phosphorus and sediment that would be needed to restore a healthy aquatic community. The reference watershed approach is based on selecting a nonimpaired watershed that has similar land use characteristics and determining the current loading rates for the pollutants 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 nonimpaired 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 nonimpaired watershed. The reference stream approach was used to set allowable loading rates in the affected watershed because neither Pennsylvanian nor USEPA has instream numerical water quality criteria for nutrients or sediment.

How much pollution is too much?

The allowable amount of pollution in a waterbody 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 nutrients or 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 nutrients and 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 rates for nutrients and sediment in the impaired watershed to the current loading rates in the reference watershed will result in meeting the water quality objectives.

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 Lee McDonnell at (717) 783-2938 between 8:00 a.m. and 3:00 p.m., Monday through Friday. Mr. McDonnell also can be reached by mail at the Office of Water Management, PADEP, Rachel Carson State Office Building, 400 Market Street, Harrisburg, PA 17105 or by e-mail at lmcdonnell@state.pa.us.

How can I comment on the proposal?

You may provide e-mail or written comments postmarked no later than November 9, 2004, to the above address.

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

The TMDL for the UNT Mill Creek was developed using the Generalized Watershed Loading Function or GWLF model. The GWLF model provides the ability to simulate runoff, sediment, and nutrient (nitrogen and phosphorus) 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 subsurface loading, the model acts as a lumped parameter model using a water balance approach. No distinctly separate areas are considered for subsurface flow contributions. Daily water balances are computed for an unsaturated zone as well as a saturated subsurface 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, transport capacity, and average daily runoff is applied to the calculated erosion for determining sediment yield for each source area. Surface nutrient losses are determined by applying dissolved nitrogen and phosphorus coefficients to surface runoff and a sediment coefficient to the yield portion for each agricultural source area. Point source discharges also can 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. Subsurface losses are calculated using dissolved nitrogen and phosphorus coefficients for shallow groundwater contributions to stream nutrient loads, and the subsurface submodel 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 Manual.

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).

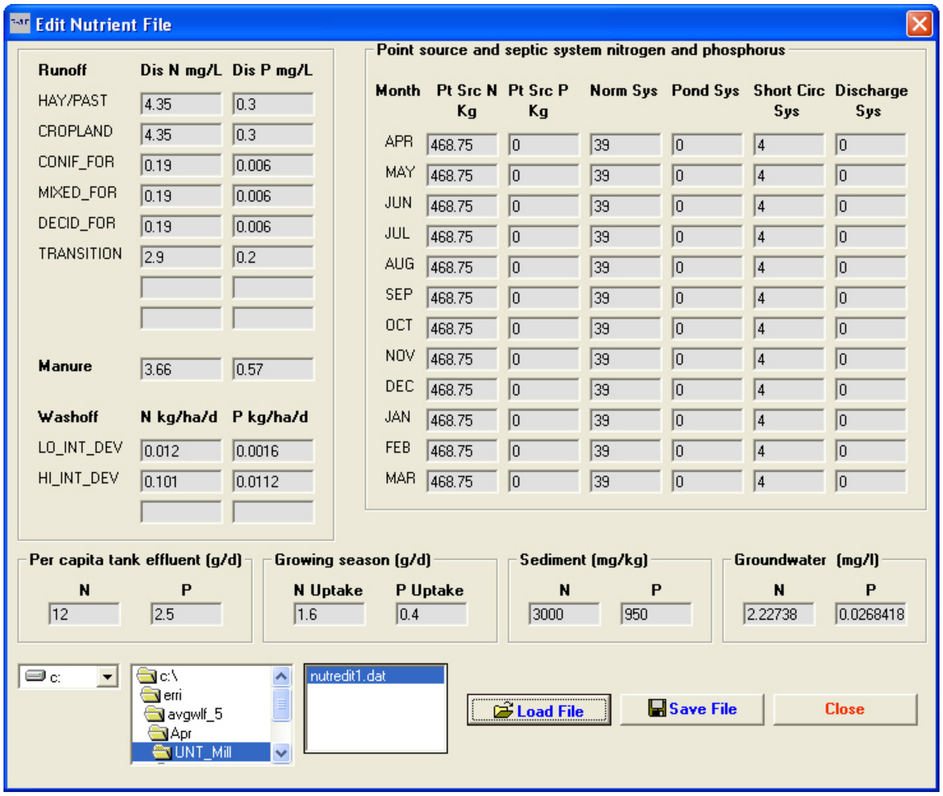
In using this interface, the user is prompted to identify required GIS files and to provide other information related to "non-spatial" model parameters (e.g., beginning and end of the growing season, the months during which manure is spread on agricultural land, and the names of nearby weather stations). 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 nitrogen and phosphorus concentrations and cropping practices. Complete GWLF-formatted weather files also are included for 80 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.

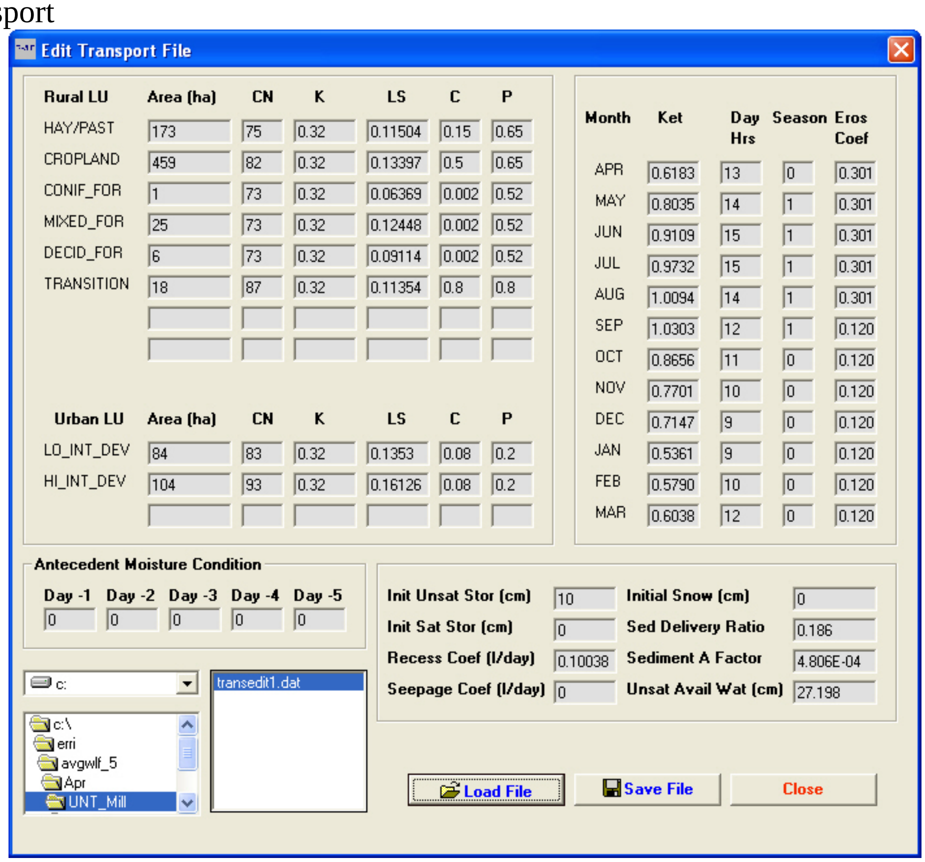
GIS Data Sets	
DATASET	**DESCRIPTION**
Censustr	Coverage of Census data including information on individual homes septic systems. The attribute *usew_sept* includes data on conventional systems, and *sew_other* provides data on short-circuiting and other systems.
County	The County boundaries coverage 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. Used to calculate landslope and slope length.
Palumrlc	A satellite image derived land cover grid that is classified into 15 different land cover categories. This dataset provides land cover 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 nitrogen and phosphorus 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 phosphorus 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 land use 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 PADEP 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 Inputs for the UNT to Mill Creek

UNT Mill Nutrient

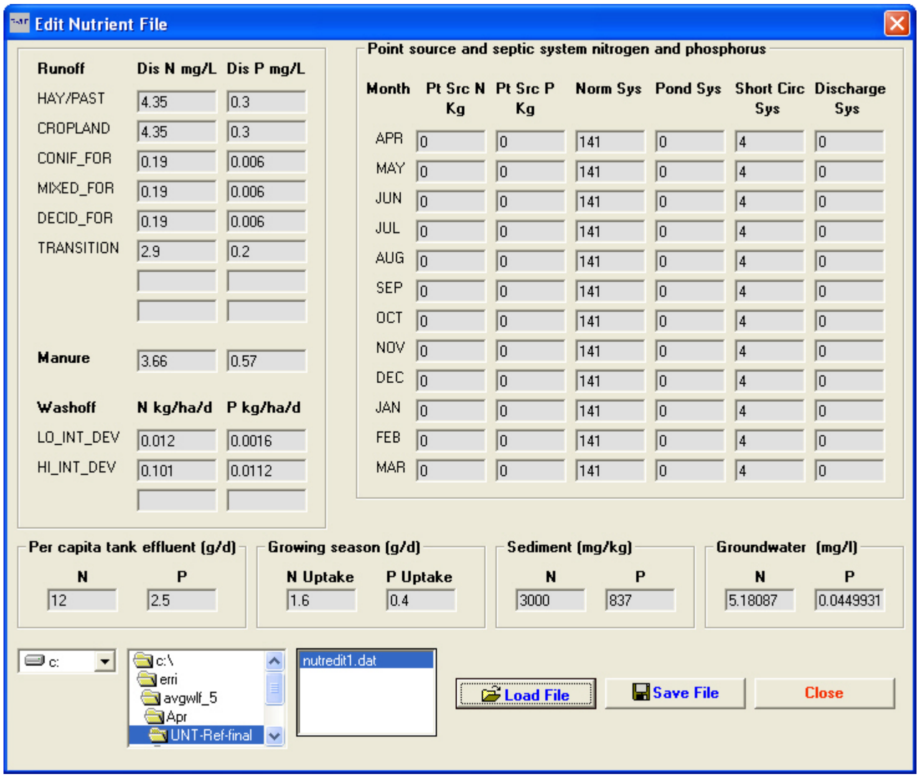


UNT Mill Transport



Appendix D. AVGWLF Model Inputs for the UNT7586 Reference Watershed

UNT Ref Nutrient



Edit Nutrient File

Runoff	Dis N mg/L	Dis P mg/L
HAY/PAST	4.35	0.3
CROPLAND	4.35	0.3
CONIF_FOR	0.19	0.006
MIXED_FOR	0.19	0.006
DECID_FOR	0.19	0.006
TRANSITION	2.9	0.2
Manure	3.66	0.57

Washoff	N kg/ha/d	P kg/ha/d
LO_INT_DEV	0.012	0.0016
HI_INT_DEV	0.101	0.0112

Point source and septic system nitrogen and phosphorus

Month	Pt Src N Kg	Pt Src P Kg	Norm Sys	Pond Sys	Short Circ Sys	Discharge Sys
APR	0	0	141	0	4	0
MAY	0	0	141	0	4	0
JUN	0	0	141	0	4	0
JUL	0	0	141	0	4	0
AUG	0	0	141	0	4	0
SEP	0	0	141	0	4	0
OCT	0	0	141	0	4	0
NOV	0	0	141	0	4	0
DEC	0	0	141	0	4	0
JAN	0	0	141	0	4	0
FEB	0	0	141	0	4	0
MAR	0	0	141	0	4	0

Per capita tank effluent (g/d) N	P	Growing season (g/d) N Uptake	P Uptake	Sediment (mg/kg) N	P	Groundwater (mg/l) N	P
12	2.5	1.6	0.4	3000	837	5.18087	0.0449931

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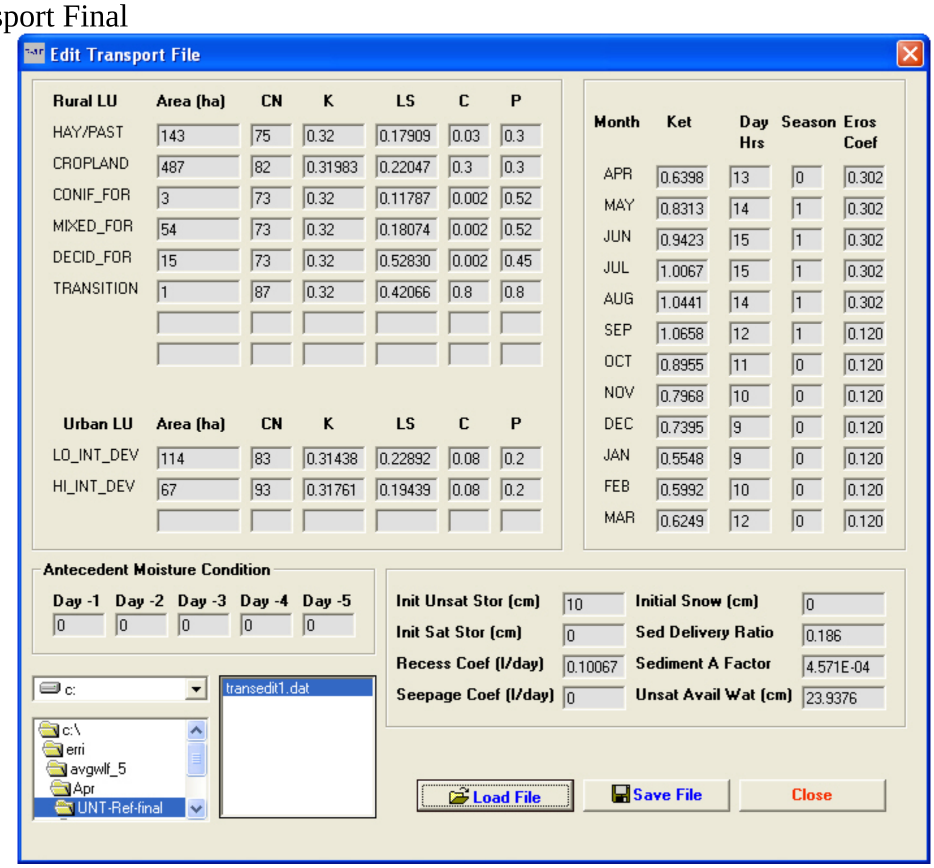
UNT Ref Transport Final



Edit Transport File

Rural LU	Area (ha)	CN	K	LS	C	P
HAY/PAST	143	75	0.32	0.17909	0.03	0.3
CROPLAND	487	82	0.31983	0.22047	0.3	0.3
CONIF_FOR	3	73	0.32	0.11787	0.002	0.52
MIXED_FOR	54	73	0.32	0.18074	0.002	0.52
DECID_FOR	15	73	0.32	0.52830	0.002	0.45
TRANSITION	1	87	0.32	0.42066	0.8	0.8

Urban LU	Area (ha)	CN	K	LS	C	P
LO_INT_DEV	114	83	0.31438	0.22892	0.08	0.2
HI_INT_DEV	67	93	0.31761	0.19439	0.08	0.2

Month	Ket	Day Hrs	Season	Eros Coef
APR	0.6398	13	0	0.302
MAY	0.8313	14	1	0.302
JUN	0.9423	15	1	0.302
JUL	1.0067	15	1	0.302
AUG	1.0441	14	1	0.302
SEP	1.0658	12	1	0.120
OCT	0.8955	11	0	0.120
NOV	0.7968	10	0	0.120
DEC	0.7395	9	0	0.120
JAN	0.5548	9	0	0.120
FEB	0.5992	10	0	0.120
MAR	0.6249	12	0	0.120

Antecedent Moisture Condition

Day -1	Day -2	Day -3	Day -4	Day -5
0	0	0	0	0

Init Unsat Stor (cm)	10	Initial Snow (cm)	0
Init Sat Stor (cm)	0	Sed Delivery Ratio	0.186
Recess Coef (l/day)	0.10067	Sediment A Factor	4.571E-04
Seepage Coef (l/day)	0	Unsat Avail Wat (cm)	23.9376

c: | transedit1.dat | c:\ | erri | avgwlf_5 | Apr | UNT-Ref-final | Load File | Save File | Close

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 the MS Excel and results are presented in Appendix F. The five major steps identified in the spreadsheet are summarized below:

1. Calculation of the TMDL based on impaired watershed size and unit area loading rate of the reference watershed.

2. Calculation of Adjusted Load Allocation based on TMDL, Margin of Safety, and existing loads not reduced.

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 the 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.

4. Calculation of total loading rate of all sources receiving reductions.

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

Appendix F. Equal Marginal Percent Reduction Calculations for the UNT Mill Creek TMDL

Step 1:	TMDL Total Load				Step 2:	Adjusted LA = (TMDL total load - MOS) - uncontrollable						
	Load = loading rate in ref. * Acres in Impaired					858.89	858.89					
	1290											
	PHOSPHORUS LOADING											
Step 3:		Non-MS4 Annual Average Load	Load Sum	Check	Initial Adjust	Recheck	% reduction allocation	Load Reduction	Initial LA	Acres	Allowable Loading Rate	% Reduction
	Hay/Past.	166.37	1361.109	good	166	ADJUST	0.16	32.48	133.89	365.70	0.37	20%
	Cropland	1152.74		bad	859	208	0.80	167.69	691.20	976.10	0.71	40%
	Developed	37.05		good	37		0.03	7.23	29.81	217.60	0.14	20%
	Streambank	4.95		good	5		0.00	0.97	3.98	0.00		20%
	Total	1361.11			1067.253		1.00		858.89			
Step 4:	All Ag. Loading Rate	0.61										
Step 5:		Acres	Allowable (Target) Loading Rate	Final LA	Current Loading Rates	Current Load	% Red.					
	Final Hay/Past. LA	365.70	0.37	133.89	0.45	166.37	20%					
	Final Cropland LA	976.10	0.71	691.20	1.18	1152.74	40%					
	Developed	217.60	0.14	29.81	0.17	37.05	20%					
	Streambank	0.00		3.98		4.95	20%					
				858.89		1361.11	37%					
	MS4 Loads											
		Acres	Allowable (Target) Loading Rate	Final WLA	Current Loading Rates	Current Load	% Red.	Total Annual Average Load	Non MS4 Annual Average Load			
	Final Hay/Past. LA	61.80	0.30	18.54	0.46	28.43	35%	194.80	166.37			
	Final Cropland LA	158.10	0.77	121.74	1.18	186.56	35%	1339.30	1152.74			
	Developed	291.50	0.04	10.79	0.17	49.56	78%	86.60	37.05			
	Total			151.06		264.54	43%		1356.16			
	Unt Mill											

Step 1:	TMDL Total Load				Step 2:	Adjusted LA = (TMDL total load - MOS) - uncontrollable						
	Load = loading rate in ref. * Acres in Impaired					456616.13	456616					
	597866											
	SEDIMENT LOADING											
Step 3:		Non-MS4 Annual Average Load	Load Sum	Check	Initial Adjust	Recheck	% reduction allocation	Load Reduction	Initial LA	Acres	Allowable Loading Rate	% Reduction
	Hay/Past.	71343.44	1068412.221	good	71343	ADJUST	0.09	29848.82	41494.62	365.70	113.47	42%
	Cropland	739949.13		bad	456616	328463	0.58	191040.01	265576.12	976.10	272.08	64%
	Developed	32312.25		good	32312		0.04	13518.87	18793.38	217.60	86.37	42%
	Streambank	224807.40		good	224807		0.29	94055.39	130752.01	0.00		42%
	Total	1068412.22			785079.2199		1.00		456616.13			
Step 4:	All Ag. Loading Rate	228.85										
Step 5:		Acres	Allowable (Target) Loading Rate	Final LA	Current Loading Rates	Current Load	% Red.					
	Final Hay/Past. LA	365.70	113.47	41494.62	195.09	71343.44	42%					
	Final Cropland LA	976.10	272.08	265576.12	758.07	739949.13	64%					
	Developed	217.60	86.37	18793.38	148.49	32312.25	42%					
	Streambank	0.00		130752.01		224807.40	42%					
				456616.13		1068412.22	57%					
	MS4 Loads											
		Acres	Allowable (Target) Loading Rate	Final WLA	Current Loading Rates	Current Load	% Red.	Total Annual Average Load	Non MS4 Annual Average Load			
	Final Hay/Past. LA	61.80	28.30	1748.94	195.09	12056.56	85%	83400.00	71343.44			
	Final Cropland LA	158.10	346.35	54757.94	758.07	119850.87	54%	859800.00	739949.13			
	Developed	291.50	84.93	24756.11	148.50	43287.75	43%	75600.00	32312.25			
				81262.99		175195.18	54%		843604.82			
	UNT Mill											

Appendix G. Comment & Response Document for the UNT Mill Creek TMDL