Total Maximum Daily Loads (TMDLs)

UNT Connoquenessing Watershed
Butler County

Pennsylvania Department of Environmental Protection

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Table of Contents

List of Tables

List of Figures

Summary of the UNT Connoquenessing TMDLs

1. These TMDLs were developed for UNT Connoquenessing, a tributary to Connoquenessing Creek in SWP 20C, located in Butler County, Pennsylvania. Access to the watershed is available by traveling Route 38 through Boydstown. Protected stream uses in the watershed include aquatic life, water supply, and recreation. The entire basin is currently designated as High Quality Warm Water Fishes (HQ WWF) under §93.9w in Title 25 of the Pa. Code.

2. TMDLs for the UNT Connoquenessing Watershed were developed to address use impairments caused by suspended solids. UNT Connoquenessing first appeared on Pennsylvania's 303(d) list in 1996, when the mainstem was listed as impaired by suspended solids emanating from upstream mining activities. Suspended solids TMDLs were developed to address suspended solids impairments identified in the Department's current Integrated Water Quality Report. In order to ensure attainment and maintenance of water quality standards in the UNT Connoquenessing Watershed, mean annual loading of suspended solids will need to be limited to 52 tons/yr.

   The major components of the UNT Connoquenessing Watershed TMDLs are summarized below:

Component	Suspended solids (tons/yr.)
TMDL (Total Maximum Daily Load)	52
WLA (Wasteload Allocation)	0
MOS (Margin of Safety)	5
LA (Load Allocation)	47

3. The current mean annual suspended solids loading to UNT Connoquenessing is estimated to be 187 tons/yr., requiring a 72% reduction to meet the TMDL.

4. There are no known point sources of suspended solids located in the UNT Connoquenessing Watershed; therefore the TMDLs do not include Waste Load Allocations (WLA). Load Allocations (LA) for suspended solids was made to the following nonpoint sources: croplands, pasture and mined/transition land.

5. Since there are no industrial or municipal point sources, or other point source discharges subjected to general permits in the UNT Connoquenessing Watershed, the TMDLs do not include WLAs.

6. The suspended solids TMDL includes a nonpoint source load allocation (LA) of 47 tons/yr. Allocations to sources receiving reductions (cropland, mined/transitional land, and pasture) total 37 tons/yr. Suspended solids loadings from the remaining nonpoint sources (loads not reduced) were maintained at 10 tons/yr. Allocations of suspended solids to all nonpoint sources in the UNT Connoquenessing Watershed are summarized below:

Load Allocations for Sources of Suspended solids			
Source	**Current Loading (tons/yr)**	**Load Allocation (tons/yr)**	**% Reduction**
Cropland	30	15	50%
Pasture	7	4	43%
Mined Land	141	19	86.5%
NPS Loads Not Reduced	10	9	-
Total	**187**	**47**	**74%**

7. Ten percent of the UNT Connoquenessing suspended solids TMDLs 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 suspended solids TMDL was set at 5 tons/yr.

8. The continuous simulation model used for developing the UNT Connoquenessing TMDLs 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 combination of these actions accounts for seasonal variability.

I. Introduction

A. Watershed Description

UNT Connoquenessing is part of State Water Plan subbasin 20C and is located north of Boydstown in Butler County, Pennsylvania (Figure 1). Access to the watershed is available by traveling northeast on Route 38 past Lake Oneida. Protected stream uses in the watershed include aquatic life, water supply, and recreation. The entire basin is currently designated as High Quality Warm Water Fishes (HQ CWF) under §93.9w in Title 25 of the Pa. Code. UNT Connoquenessing lies entirely in the Appalachian Plateau physiographic province. Land use in the UNT Connoquenessing basin is a mix of forest (~41%) and agriculture (~37%). Other land uses include coalmines/transitional land (16%), and development (4%) with wetlands and roads making up the rest of the area. .

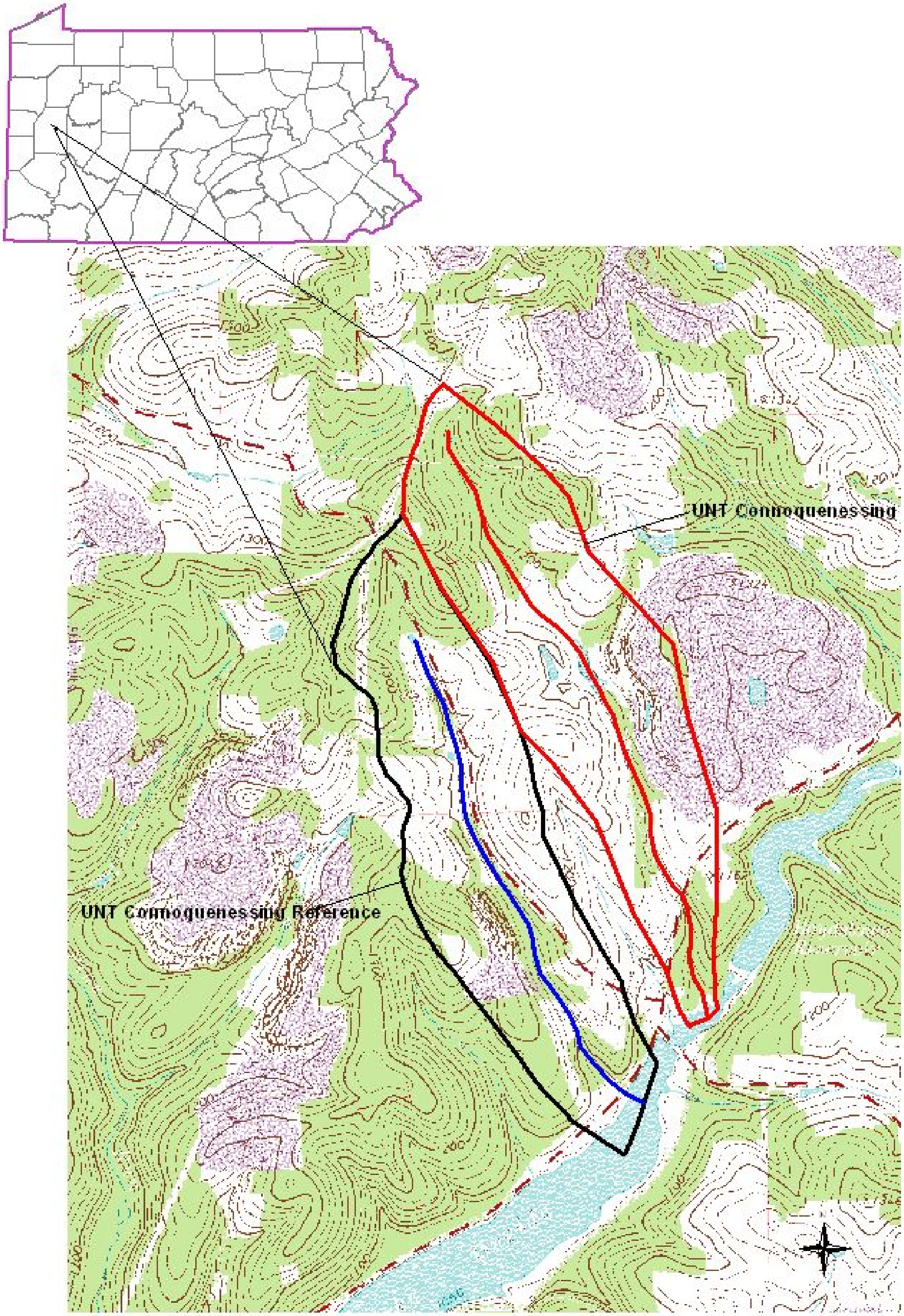
B. Surface Water Quality

Pennsylvania's 1996 303(d) list identified 1.5 miles of UNT Connoquenessing as impaired by suspended solids emanating from abandoned mining activities in the basin (Table 1). The original listing of UNT Connoquenessing resulted from a nonpoint source survey conducted by the Department's Southwest Regional Office in 1982. Based on data collected, the investigator concluded that 1.5 miles of UNT 35314 to Connoquenessing was impaired (Table 1)(Figure 2).

Table 1 - Impaired Waters Listings for UNT Connoquenessing Watershed

1996 303(d) LIST					
STREAM NAME	**STREAM CODE**	**SOURCE**	**CAUSE**	**MILES**	
UNT Connoquenessing	35314	Resource Extraction	Suspended Solids	1.5	
1998 303(d) LIST					
SEGMENT ID	**WATERSHED**	**STREAM CODE**	**SOURCE**	**CAUSE**	**MILES**
Not in GIS	UNT Connoquenessing	35314	AMD	Suspended Solids	1.5
2002 303(d) LIST – not included on list					
2004 Integrated Water Quality Report					
SEGMENT ID	**WATERSHED**	**STREAM CODE**	**SOURCE**	**CAUSE**	**MILES**
4598	UNT Connoquenessing	35314	AMD	Suspended Solids	1.58
2006 Integrated Water Quality Report					
ASSESSMENT ID	**WATERSHED**	**STREAM CODE**	**SOURCE**	**CAUSE**	**MILES**
758005030105	UNT Connoquenessing	35314	AMD	Suspended Solids	1.58

Figure 1 - UNT Connoquenessing Watershed (Impaired) and UNT Connoquenessing Watershed (Reference), Butler County



II. Approach to TMDL Development

A. Pollutants & Sources

Suspended solids have been identified as the pollutants causing designated use impairments in the UNT Connoquenessing Watershed. Based on information contained in the Department's 305(b) report database, abandoned mining activities appear to be the primary source of pollutants. There are no known point source discharges present in the watershed.

B. TMDL Endpoints

In an effort to address suspended solids impairments found in the UNT Connoquenessing Watershed, Total Maximum Daily Loads (TMDLs) were developed for suspended solids. The suspended solids TMDL was developed to address suspended solids impairments from mining activities.

C. Reference Watershed Approach

The TMDLs developed for the UNT Connoquenessing Watershed address suspended solids. Because neither Pennsylvania nor EPA has instream numerical water quality criteria for suspended solids, a method was developed to implement the applicable narrative criteria. The method employed for these TMDLs is termed the "Reference Watershed Approach." Meeting the water quality objectives specified by these TMDLs will result in the impaired stream segments attaining their 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 20-30% of the impaired watershed area. The search for a reference watershed for UNT Connoquenessing 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

The unnamed tributary to Connoquenessing Creek (Reference) (35311) Watershed located upstream of UNT Connoquenessing was selected as the reference watershed for developing the UNT Connoquenessing TMDLs (Figure 4). The watershed is located in State Water Plan subbasin 18D and protected uses include aquatic life, water supply, and recreation. The reference watershed of the unnamed tributary to Connoquenessing Creek (Reference) (35311) is currently designated as Cold Water Fishes (CWF) under §93.9t in Title 25 of the Pa. Code. Based on the Department's 305(b) report database, the unnamed tributary to Connoquenessing Creek (Reference) is currently attaining its designated uses. The attainment of designated uses is based on sampling done by the Department in 2002, using the Statewide Surface Water Assessment Program (SSWAP) protocol.

Drainage area, location, and other physical characteristics of the UNT Connoquenessing Watershed were compared to the unnamed tributary to Connoquenessing Creek (Reference) Watershed (Table 3). 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. Forest and agriculture are the dominant land use categories in both watersheds. Surficial geology was also compared. Rock types in the UNT Connoquenessing Watershed include interbedded sedimentary (69%) and sandstone (31%). The unnamed tributary to Connoquenessing Creek (Reference) Watershed also contains interbedded sedimentary (43%), and sandstone (57%) rocks. Bedrock geology primarily affects surface runoff and background nutrient loads through its influences on soils, landscape, fracture density, and directional permeability. UNT Connoquenessing and the unnamed tributary to Connoquenessing Creek (Reference) Watershed are very similar in terms of soil types, soil K factor, precipitation, and average runoff, (Table 2).

Table 2 - Comparison Between UNT Connoquenessing and unnamed tributary to Connoquenessing Creek (Reference) Reference Watershed

ATTRIBUTE	WATERSHED	
	UNT Connoquenessing (Impaired)	**UNT Connoquenessing (Reference)**
Physiographic Province	Appalachian Plateau (100%)	Appalachian Plateau (!00%)
Area (mi²)	0.45	0.45
Land Use	Agriculture (37%) Forested (41%) Mined (17%) Other (5%)	Agriculture (36%) Forested (43%) Mined (11%) Other (10%)
Geology	Interbedded Sedimentary (100%)	Interbedded Sedimentary (100%)
Soils	Ernest-Glipin (78%) Hazleton-Cookport-Ernest (22%)	Ernest-Glipin (57%) Hazleton-Cookport-Ernest (43%)
Dominant HSG	C (22%) D (78%)	C (43%) D (57%)
K Factor	0.25	0.25
20-Year Average Rainfall (in)	41.9	41.9
20-Year Average Runoff (in)	3.0	3.8

III. Watershed Assessment and Modeling

TMDLs for the UNT Connoquenessing Watershed were 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 UNT Connoquenessing Watershed and the Reference UNT to Connoquenessing Watershed. All modeling outputs have been attached to this TMDL as Appendices C and D.

The AVGWLF model produced information on watershed size, land use, and suspended solids loading (Tables 3 and 4). The suspended solids loads represent an annual average over the 20 years simulated by the model. This information was used to calculate existing unit area loading rates for the UNT Connoquenessing and the unnamed tributary to Connoquenessing Creek (Reference) Watersheds.

Unit area loading rates for suspended solids were estimated for each watershed by dividing the mean annual loadings (lbs./yr.) by the total area (acres). Unit area load estimates for suspended solids in the UNT Connoquenessing Watershed are 987 lbs./acre/yr. (Table 3). Unit area load estimates for suspended solids in the unnamed tributary to Connoquenessing Creek (Reference) Watershed are 480 lbs./acre/yr. (Table 4).

Table 3. Existing Loading Values for UNT Connoquenessing (impaired)			
Source	Area (ac)	Suspended solids (tons)	Unit Area Load (tons/ac/yr)
HAY/PAST	86.5	7.6	.088
CROPLAND	22.2	29.7	1.34
FOREST	118.6	0.3	0.003
MINED LAND	49.4	140.9	2.85
WETLAND	2.5	0.0	0.00
LO_INT_DEV	9.9	0.2	0.02
UNPAVED ROAD	2.5	1.6	0.64
Stream Bank		7.0	
Total	291.6	187.3	0.64

Table 4. Existing Loading Values for UNT Connoquenessing (reference)			
Source	Area (ac)	Suspended solids (TONS)	Unit Area Load (lb/ac/yr)
HAY/PAST	81.5	2.6	0.032
CROPLAND	19.8	5.8	0.29
FOREST	121.1	0.3	0.002
MINED LAND	29.7	34.5	1.16
WETLAND	2.5	0.0	0
LO_INT_DEV	27.2	0.7	0.026
Stream Bank		5.9	
Total	281.7	49.8	0.18

IV. TMDLs

Targeted TMDL values for the UNT Connoquenessing Watershed were established based on current loading rates for suspended solids in the Reference UNT Connoquenessing Watershed. The entire length of the Reference UNT Connoquenessing is currently designated as High Quality Warm Water Fishes (HQ WWF) and recent Unassessed Waters program assessments have determined that the portion of the basin used as a reference is attaining its designated uses. Reducing the loading rates of suspended solids in the UNT Connoquenessing basin to levels equal to, or less than, the unnamed tributary to Reference UNT Connoquenessing 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 these TMDLs. 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 TMDL target suspended solids load for UNT Connoquenessing is the product of the unit area suspended solids-loading rate in the reference watershed (Tributary 35311 UNT Connoquenessing Watershed) and the total area of the impaired watershed (UNT Connoquenessing). These numbers and the resulting TMDL target load are shown in Table 5.

Table 5. TMDL Total Load Computation			
Pollutant	Unit Area Loading Rate in UNT 35311 Connoquenessing Creek Watershed (tons/acre/yr)	Total Watershed Area in UNT Connoquenessing (acres)	TMDL Total Load (tons/year)
Suspended solids	0.18	291	52

Targeted TMDL values were used as the basis for load allocations and reductions in the UNT Connoquenessing Watershed, using the following equation

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

Where:

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

C. 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. Reviewing the Department's permitting files identified no point sources of suspended solids in the UNT Connoquenessing Watershed; therefore WLAs were set at zero.

1. TMDLs and NPDES Permitting Coordination

NPDES permitting is unavoidably linked to TMDLs through waste load allocations and their translation, through the permitting program, to effluent limits. Primary responsibility for NPDES permitting rests with the District Mining Offices (for mining NPDES permits) and the Regional Offices (for industrial NPDES permits). Therefore, the DMOs and Regions will maintain tracking mechanisms of available waste load allocations, etc. in their respective offices. The TMDL program will assist in this effort. However, the primary role of the TMDL program is TMDL development and revision/amendment (the necessity for which is as defined in the Future Modifications section) at the request of the respective office. All efforts will be made to coordinate public notice periods for TMDL revisions and permit renewals/reissuances.

a) Load Tracking Mechanisms

The Department has developed tracking mechanisms that will allow for accounting of pollution loads in TMDL watersheds. This will allow permit writers to have information on how allocations have been distributed throughout the watershed in the watershed of interest while making permitting decisions. These tracking mechanisms will allow the Department to make minor changes in WLAs without the need for EPA to review and approve a revised TMDL. Tracking will also allow for the evaluation of loads at downstream points throughout a watershed to ensure no downstream impairments will result from the addition, modification or movement of a permit.

2. Options for Permittees in TMDL Watersheds

The Department is working to develop options for permits in watersheds with approved TMDLs.

a) Options identified

1. Build excess WLA into the TMDL for anticipated future discharges. This could then be used for a new permit. The permittee must show that there has been actual load reduction in the amount of the proposed permit or must include a schedule to guarantee the reductions using current data referenced to the TMDL prior to permit issuance.
2. Use WLA that is freed up from another permit in the watershed when that discharge ceases. If no permits have been recently terminated, it may be necessary to delay permit issuance until additional WLA becomes available.
3. Re-allocate the WLA(s) of existing permits. WLAs could be reallocated based on actual flows (as opposed to design flows). The "freed-up" WLA could be applied to the new permit. This option would require the simultaneous amendment of the permits involved in the reallocation.
4. Non-discharge alternative.

b) Other possible options

The following two options have also been identified for use in TMDL watersheds. However, before recommendation for use as viable implementation options, a thorough regulatory (both state and federal) review must be completed. These options should not be implemented until the completion of the regulatory review and development of any applicable administrative mechanisms.

1. Issue the permit with in-stream water quality criteria values as the effluent limits. The in-stream criteria value would represent the monthly average, with the other limits adjusted accordingly (e.g., for Fe, the limits would be 1.5 mg/L monthly average, 3.0 mg/L daily average and 4.0 instantaneous max mg/L).
2. The applicant would agree to treat an existing source (point or non-point) where there is no responsible party and receive a WLA based on a proportion of the load reduction to be achieved. The result of using these types of offsets in permitting is a net improvement in long-term water quality through the reduction of the total pollutant load delivered to the waterbody. Offsets should not be confused with trading, in which credits are generated for market sale. Trading necessitates meeting the TMDL goals fully before marketing credits, while offsets allow for an alternate approach to meeting the WLA portion of the TMDL while making net progress toward meeting the TDML goals.

D. 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 TMDLs for suspended solids were 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 UNT Connoquenessing. The MOS for the suspended solids TMDL is 5 tons/yr.

MOS (Suspended solids) 52 tons/yr. (TMDL) x 0.1 = 5 tons/yr.

E. Load Allocation

The load allocation (LA) is that portion of the TMDL that is assigned to nonpoint sources. Since there are no point sources present in the UNT Connoquenessing Watershed, load allocations for suspended solids were computed by subtracting the MOS value from the targeted TMDL value. Load Allocations for suspended solids were 655,942 lbs./yr.

LA (Suspended solids) = 52 tons/yr. (TMDL) – 5 tons/yr. (MOS) = 47 tons/yr.

F. Adjusted Load Allocation

The adjusted load allocation (ALA) is the actual portion of the LA distributed among those nonpoint sources receiving reductions. It is computed by subtracting those non-point source loads that are not being considered for reductions (loads not reduced or LNR) from the LA. Since the UNT Connoquenessing Watershed TMDLs were developed to address impairments resulting from mining activities, mining related sources were considered for reductions before other sources of suspended solids. Reductions were applied to CROPLAND, TRANSITIONAL, and QUARRY sources for both suspended solids and total phosphorus. Those land uses/sources for which existing loads were not reduced (HAY/PAST, FOREST, LO_INT_DEV, Streambank) were carried through at their existing loading values (Table 6). The ALA for suspended solids is 527,554 lbs./yr.

Table 6. Load Allocation, Loads Not Reduced and Adjusted Load Allocations for the UNT Connoquenessing Suspended solids TMDL	
	Suspended solids (tons/yr)
Load Allocation	47
Loads Not Reduced	9
Hay/Past	4
Cropland	15
Mined Land	19
Adjusted load allocation	47

G. TMDLs

The suspended solids TMDLs established for the UNT Connoquenessing Watershed consists of a Load Allocation (LA) and a Margin of Safety (MOS). The individual components of the TMDLs are summarized in Table 7.

Table 7. TMDL, WLA, MOS, LA, LNR and ALA for UNT Connoquenessing Suspended solids TMDL	
Component	Suspended solids (tons/yr)
TMDL (Total Maximum Daily Load)	52
WLA (Waste Load Allocation)	0
MOS (Margin of Safety)	5
LA (Load Allocation)	47
LNR (Loads Not Reduced)	10
ALA (Adjusted Load Allocation)	37

V. Calculation of Suspended Solids Load Reductions

Adjusted load allocations established in the previous section represent the suspended solids loads that are available for allocation between contributing sources in the UNT Connoquenessing 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 8 contains the results of the EMPR for suspended solids for the appropriate contributing land uses in UNT Connoquenessing 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 8. Suspended solids Load Allocations & Reductions for the UNT Connoquenessing Watershed						
Pollutant Source	Acres	Unit Area Loading Rate (tons/ac/yr)		Pollutant Loading (lbs/yr)		Percent Reduction
		Current	Allowable	Current	Allowable	
CROPLAND	22	1.34	0.67	30	14.85	50%
HAY/PASTURE	87	0.09	0.04	8	3.80	50%
MINED LAND	49	2.85	0.38	141	18.65	87%
TOTAL				178	37.30	79%

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 suspended solids 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 suspended solids and 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 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 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 Connoquenessing TMDLs identify the necessary overall load reductions for those pollutants currently causing use impairments and distribute those reduction goals to the appropriate nonpoint sources.

Various methods to eliminate or treat pollutant sources and to provide a reasonable assurance that the proposed TMDLs can be met exist in Pennsylvania. These methods include PADEP's primary efforts to improve water quality through reclamation of abandoned mine lands (for abandoned mining) and through the National Pollution Discharge Elimination System (NPDES) permit program (for active mining). Funding sources available that are currently being used for projects designed to achieve TMDL reductions include the Environmental Protection Agency (EPA) 319 grant program and Pennsylvania's Growing Greener Program. Federal funding is through the Department the Interior, Office of Surface Mining (OSM), for reclamation and mine drainage treatment through the Appalachian Clean Streams Initiative and through Watershed Cooperative Agreements.

OSM reports that nationally, of the $8.5 billion of high priority (defined as priority 1&2 features or those that threaten public health and safety) coal related AML problems in the AML inventory, $6.6 billion (78%) have yet to be reclaimed; $3.6 billion of this total is attributable to Pennsylvania watershed costs. Almost 83 percent of the $2.3 billion of coal related environmental problems (priority 3) in the AML inventory are not reclaimed.

The Bureau of Abandoned Mine Reclamation, Pennsylvania's primary bureau in dealing with abandoned mine reclamation (AMR) issues, has established a comprehensive plan for abandoned mine reclamation throughout the Commonwealth to prioritize and guide reclamation efforts for throughout the state to make the best use of valuable funds (www.dep.state.pa.us/dep/deputate/minres/bamr/complan1.htm). In developing and implementing a comprehensive plan for abandoned mine reclamation, the resources (both human and financial) of the participants must be coordinated to insure cost-effective results. The following set of principles is intended to guide this decision making process:

- Partnerships between the DEP, watershed associations, local governments, environmental groups, other state agencies, federal agencies and other groups organized to reclaim abandoned mine lands are essential to achieving reclamation and abating acid mine drainage in an efficient and effective manner.

- Partnerships between AML interests and active mine operators are important and essential in reclaiming abandoned mine lands.

- Preferential consideration for the development of AML reclamation or AMD abatement projects will be given to watersheds or areas for which there is an approved rehabilitation plan. (guidance is given in Appendix B to the Comprehensive Plan).

- Preferential consideration for the use of designated reclamation moneys will be given to projects that have obtained other sources or means to partially fund the project or to projects that need the funds to match other sources of funds.

- Preferential consideration for the use of available moneys from federal and other sources will be given to projects where there are institutional arrangements for any necessary long-term operation and maintenance costs.

- Preferential consideration for the use of available moneys from federal and other sources will be given to projects that have the greatest worth.

- Preferential consideration for the development of AML projects will be given to AML problems that impact people over those that impact property.

- No plan is an absolute; occasional deviations are to be expected.

A detailed decision framework is included in the plan that outlines the basis for judging projects for funding, giving high priority to those projects whose cost/benefit ratios are most favorable and those in which stakeholder and landowner involvement is high and secure.

In addition to the abandoned mine reclamation program, regulatory programs also are assisting in the reclamation and restoration of Pennsylvania's land and water. PADEP has been effective in implementing the NPDES program for mining operations throughout the Commonwealth. This reclamation was done through the use of remining permits that have the potential for reclaiming abandoned mine lands, at no cost to the Commonwealth or the federal government. Long-term treatment agreements were initialized for facilities/operators who need to assure treatment of post-mining discharges or discharges they degraded which will provide for long-term treatment of discharges. According to OSM, "PADEP is conducting a program where active mining sites are, with very few exceptions, in compliance with the approved regulatory program".

The Commonwealth is exploring all options to address its abandoned mine problem. During 2000-2006, many new approaches to mine reclamation and mine drainage remediation have been explored and projects funded to address problems in innovative ways. These include:

- Project XL - The Pennsylvania Department of Environmental Protection ("PADEP"), has proposed this XL Project to explore a new approach to encourage the remining and reclamation of abandoned coal mine sites. The approach would be based on compliance with in-stream pollutant concentration limits and implementation of best management practices ("BMPs"), instead of National Pollutant Discharge Elimination System ("NPDES") numeric effluent limitations measured at individual discharge points. This XL project would provide for a test of this approach in up to eight watersheds with significant acid mine drainage ("AMD") pollution. The project will collect data to compare in-stream pollutant concentrations versus the loading from individual discharge points and provide for the evaluation of the performance of BMPs and this alternate strategy in PADEP's efforts to address AMD.
- Awards of grants for 1) proposals with economic development or industrial application as their primary goal and which rely on recycled mine water and/or a site that has been made suitable for the location of a facility through the elimination of existing Priority 1 or 2 hazards, and 2) new and innovative mine drainage treatment technologies that will provide waters of higher purity that may be needed by a particular industry at costs below conventional treatment costs as in common use today or reduce the costs of water treatment below those of conventional lime treatment plants. Eight contracts totaling $4.075 M were awarded in 2006 under this program.
- Projects using water from mine pools in an innovative fashion, such as the Shannopin Deep Mine Pool (in southwestern Pennsylvania), the Barnes & Tucker Deep Mine Pool (the Susquehanna River Basin Commission into the Upper West Branch Susquehanna River), and the Wadesville Deep Mine Pool (Excelon Generation in Schuylkill County).

There currently isn't a watershed organization interested in the UNT Connoquenessing Watershed. It is recommended that agencies work with local interests to form a watershed group that will be dedicated to the remediation and preservation of these watersheds through public education, monitoring and assessment, and improvement projects. Information on formation of a watershed group is available through websites for the PADEP (www.dep.state.pa.us), the AMR Clearinghouse (www.amrclearinghouse.com), the EPA (www.epa.gov), the Susquehanna River Basin Commission (www.srbc.net) and others. In addition, each DEP Regional Office (6) and each District Mining Office (5) have watershed managers to assist stakeholder groups interested in restoration in their watershed. Most Pennsylvania county conservation districts have a watershed specialist who can also provide assistance to stakeholders (www.pacd.org). Potential funding sources for AMR projects can be found at www.dep.state.pa.us/dep/subject/pubs/water/wc/FS2205.pdf.

IX. Public Participation

A notice of availability for comments on the draft UNT Connoquenessing Watershed TMDLs was published in the PA Bulletin on 9/27/08. A 60-day period ending on date November 20, 2008 was provided for the submittal of comments. No comments were received.

Notice of final TMDL approvals will be posted on the Department's website.

X. Future TMDL Modifications

In the future, the Department may adjust the load and/or wasteload allocations in this TMDL to account for new information or circumstances that are developed or discovered during the implementation of the TMDL when a review of the new information or circumstances indicate that such adjustments are appropriate. Adjustment between the load and wasteload allocation will only be made following an opportunity for public participation. A wasteload allocation adjustment will be made consistent and simultaneous with associated permit(s) revision(s)/reissuances (i.e., permits for revision/reissuance in association with a TMDL revision will be made available for public comment concurrent with the related TMDLs availability for public comment). New information generated during TMDL implementation may include, among other things, monitoring data, BMP effectiveness information, and land use information. All changes in the TMDL will be tallied and once the total changes exceed 1% of the total original TMDL allowable load, the TMDL will be revised. The adjusted TMDL, including its LAs and WLAs, will be set at a level necessary to implement the applicable WQS and any adjustment increasing a WLA will be supported by reasonable assurance demonstration that load allocations will be met. The Department will notify EPA of any adjustments to the TMDL within 30 days of its adoption and will maintain current tracking mechanisms that contain accurate loading information for TMDL waters.

A. Changes in TMDLs Requiring EPA Approval

- Increase in total load capacity.
- Transfer of load between point (WLA) and nonpoint (LA) sources.
- Modification of the margin of safety (MOS).
- Change in water quality standards (WQS).
- Non-attainment of WQS with implementation of the TMDL.
- Allocations in trading programs.

B. Changes in TMDLs Not Requiring EPA Approval

- Total loading shift less than or equal to 1% of the total load.
- Increase of WLA results in greater LA reductions provided reasonable assurance of implementation is demonstrated (a compliance/implementation plan and schedule).
- Changes among WLAs with no other changes; TMDL public notice concurrent with permit public notice.
- Removal of a pollutant source that will not be reallocated.
- Reallocation between LAs.
- Changes in land use.

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

TMDLs for the UNT Connoquenessing Watershed were developed using the Generalized Watershed Loading Function or GWLF model. The GWLF model provides the ability to simulate runoff, suspended solids, 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 suspended solids 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 suspended solids 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 suspended solids delivery ratio based on watershed size and transport capacities based on average daily runoff are applied to the calculated erosion to determine suspended solids yield for each source area. Surface nutrient losses are determined by applying dissolved N and P coefficients to surface runoff and a suspended solids 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 Management, Division of Watershed Protection.

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, suspended solids 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 suspended solids 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 suspended solids 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 B - AVGWLF Model Outputs for the UNT Connoquenessing Watershed

Editing Transport File: transport6706

Rural LU	Area (ha)	CN	K	LS	C	P
Hay/Past	35	81	0.25	1.426	0.03	0.45
Cropland	9	85	0.25	1.555	0.42	0.45
Forest	48	80	0.25	0.534	0.002	0.45
Mined Land	20	89	0.25	0.982	0.8	0.8
Wetland	1	87	0.25	0.051	0.01	0.1
	0	0	0	0	0	0
	0	0	0	0	0	0
	0	0	0	0	0	0
Bare Land	**Area (ha)**	**CN**	**K**	**LS**	**C**	**P**
Unpaved_Rd	1	89	0.25	0.182	0.8	1
	0	0	0	0	0	0
Urban LU	**Area (ha)**	**CN**	**K**	**LS**	**C**	**P**
Lo_Int_Dev	4	83	0.25	0.309	0.08	0.2
	0	0	0	0	0	0

Month	Ket	Day Hours	Season	Eros Coef	Stream Extract	Ground Extract
Jan	0.68	9.3	0	0.08	0	0
Feb	0.73	10.3	0	0.08	0	0
Mar	0.76	11.8	0	0.08	0	0
Apr	0.9	13.2	1	0.26	0	0
May	0.98	14.4	1	0.26	0	0
Jun	1.03	15	1	0.26	0	0
Jul	1.05	14.7	1	0.26	0	0
Aug	1.07	13.7	1	0.26	0	0
Sep	1.08	12.3	1	0.26	0	0
Oct	1.08	10.8	1	0.08	0	0
Nov	0.97	9.6	0	0.08	0	0
Dec	0.9	9	0	0.08	0	0

Init Unsat Stor (cm)	10	Initial Snow (cm)	0	Recess Coefficient	0.1
Init Sat Stor (cm)	0	Sed Delivery Ratio	0.196	Seepage Coefficient	0
Unsat Avail Wat (cm)	12.3851	Tile Drain Ratio	0.5	Sediment A Factor	1.1549E-03
		Tile Drain Density	0		

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GWLF-E Average Loads by Source

GWLF Total Loads for file: Unt_Conn1-6706

Period of analysis: 24 years from 1975 to 1998

Source	Area (Ha)	Runoff (cm)	Kg X 1000 Erosion	Kg X 1000 Sediment	Total Loads (Kg) Dis N	Total Loads (Kg) Total N	Total Loads (Kg) Dis P	Total Loads (Kg) Total P
Hay/Past	35	7.9	35.0	6.9	72.6	93.1	7.0	8.8
Cropland	9	11.5	137.3	26.9	27.3	108.0	2.6	9.9
Forest	48	7.2	1.2	0.2	6.5	7.2	0.2	0.3
Mined Land	20	17.2	652.4	127.9	6.5	390.1	0.2	35.1
Wetland	1	13.9	0.0	0.0	4.0	4.1	0.3	0.3
Unpaved_Rd	1	17.2	7.6	1.5	5.0	9.4	0.3	0.8
Lo_Int_Dev	4	9.5	1.0	0.2	0.0	1.9	0.0	0.3
Farm Animals						0.0		0.0
Tile Drainage				0.0		0.0		0.0
Stream Bank				6.4		0.3		0.1
Groundwater					328.4	328.4	7.9	7.9
Point Sources					0	0	0	0
Septic Systems					1.4	1.4	0.0	0.0
Totals	118	9.6	834.4	169.9	451.7	944.0	18.5	63.5

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

Appendix C - AVGWLF Model Outputs for the UNT Connoquenessing Watershed (Reference) Watershed

Editing Transport File: transport0

Rural LU	Area (ha)	CN	K	LS	C	P
Hay/Past	33	81	0.25	0.515	0.03	0.45
Cropland	8	85	0.25	0.294	0.42	0.52
Forest	49	73	0.25	0.558	0.002	0.45
Mined Land	12	89	0.25	0.401	0.8	0.8
Wetland	1	0	0.0	0.045	0.01	0.1
	0	0	0	0	0	0
	0	0	0	0	0	0
	0	0	0	0	0	0
Bare Land	**Area (ha)**	**CN**	**K**	**LS**	**C**	**P**
	0	0	0	0	0	0
	0	0	0	0	0	0
Urban LU	**Area (ha)**	**CN**	**K**	**LS**	**C**	**P**
Lo_Int_Dev	11	84	0.25	0.372	0.08	0.2
	0	0	0	0	0	0

Month	Ket	Day Hours	Season	Eros Coef	Stream Extract	Ground Extract
Jan	0.71	9.3	0	0.08	0	0
Feb	0.77	10.3	0	0.08	0	0
Mar	0.8	11.8	0	0.08	0	0
Apr	0.94	13.2	1	0.26	0	0
May	1.01	14.4	1	0.26	0	0
Jun	1.06	15	1	0.26	0	0
Jul	1.09	14.7	1	0.26	0	0
Aug	1.1	13.7	1	0.26	0	0
Sep	1.11	12.3	1	0.26	0	0
Oct	1.12	10.8	1	0.08	0	0
Nov	1.0	9.6	0	0.08	0	0
Dec	0.94	9	0	0.08	0	0

Init Unsat Stor (cm)	10	Initial Snow (cm)	0	Recess Coefficient	0.1
Init Sat Stor (cm)	0	Sed Delivery Ratio	0.196	Seepage Coefficient	0
Unsat Avail Wat (cm)	12.9767	Tile Drain Ratio	0.5	Sediment A Factor	1.1114E-03
		Tile Drain Density	0		

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GWLF-E Average Loads by Source

GWLF Total Loads for file: Unt_Con_Ref-0

Period of analysis: 24 years from 1975 to 1998

Source	Area (Ha)	Runoff (cm)	Erosion (Kg X 1000)	Sediment (Kg X 1000)	Dis N (Total Loads (Kg))	Total N	Dis P	Total P
Hay/Past	33	7.9	11.9	2.3	68.4	75.4	6.6	7.2
Cropland	8	11.5	26.7	5.2	24.2	39.9	2.3	3.7
Forest	49	3.8	1.3	0.3	3.5	4.2	0.1	0.2
Mined Land	12	17.2	159.8	31.3	3.9	97.9	0.1	8.7
Wetland	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lo_Int_Dev	11	10.4	3.4	0.7	0.0	5.6	0.0	0.8
Farm Animals						0.0		0.0
Tile Drainage				0.0		0.0		0.0
Stream Bank				5.3		0.3		0.1
Groundwater					148.5	148.5	6.4	6.4
Point Sources					0	0	0	0
Septic Systems					1.5	1.5	0.0	0.0
Totals	114	7.5	203.1	45.1	250.1	373.4	15.5	27.1

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

Appendix D - 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 E - Equal Marginal Percent Reduction Calculations in tons for UNT Connoquenessing

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Step 1:	TMDL Total Load				Step 2:	Adjusted LA = (TMDL total load - MOS) - uncontrollable						
2		Load = TP loading rate in ref. * Acres in Impaired					37	37					
3		52											
7	Step 3:		Annual Average Load	Load Sum	Check	Initial Adjust	Recheck	% reduction allocation	Load Reduction	Initial LA	Acres	Allowable Loading Rate	% Reduction
8		Cropland	29.7	178.2	good	30	ADJUST	0.40	15	15	22	0.6689	50.0%
9		Hay/Pasture	8		good	8	37	0.10	4	4	87	0.0439	50.0%
10		Mined Land	141		bad	37	0	0.50	19	19	49	0.3775	86.8%
13						75		1		37			
16	Step 4:	All Ag. Loading Rate	0.17										
19	Step 5:		Acres	Allowable (Target) Loading Rate	Final LA	Current Loading Rates	Current Load	% Red.					
20		Cropland	22	0.67	14.85	1.34	30	50%					
21		Hay/Pasture	87	0.04	3.80	0.09	8	50%					
22		Mined Land	49	0.38	18.65	2.85	141	87%					
23					37.30		178						