

TMDLS

(TOTAL MAXIMUM DAILY LOADS)

NORTH FORK COWANESQUE RIVER WATERSHED

POTTER AND TIOGA COUNTIES, PENNSYLVANIA

WATER MANAGEMENT PROGRAM

NORTHCENTRAL REGIONAL OFFICE

PENNSYLVANIA DEPARTMENT OF ENVIRONMENTAL PROTECTION

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EXECUTIVE SUMMARY

The North Fork Cowanesque River is a tributary to the Cowanesque River in Potter and Tioga Counties of Pennsylvania. The stream and several of its tributaries originate in Steuben County, New York. The stream travels 9.5 miles from its source in New York to its mouth near Westfield, PA. Land use in the 16.25 square mile watershed is dominated by agriculture, including croplands and dairy cattle. The North Fork Cowanesque River watershed is currently designated as a Cold Water Fishery (CWF).

Total Maximum Daily Loads (TMDLs) for sediment and total phosphorus were developed to address impairments noted in Pennsylvania's 1996 and 1998 Section 303(d) lists and the 2000 305(b) Report. The impairments were documented during chemical sampling and biological surveys of the aquatic life present in the watershed. Excessive siltation and nutrient loads resulting from agricultural activities have been identified as causes of impairments in the basin. A sediment TMDL was developed to address impairment caused by siltation. The TMDL developed to address nutrient related impairments focuses on the control of total phosphorus, since it is the limiting nutrient in the watershed.

Pennsylvania does not currently have water quality criteria for sediment and nutrients. TMDL endpoints for sediment and nutrients were identified using a reference watershed approach. Existing sediment and phosphorus loadings in the North Fork Cowanesque River watershed are 13,702,749 and 9,258 pounds per year, respectively. Based on a comparison to a similar, unimpaired watershed (Blockhouse Creek, see Figure 1 on following page), the maximum sediment loading that would still allow water quality objectives to be met in the North Fork Cowanesque River watershed is 6,777,024 pounds per year. Phosphorus loading needs to be limited to 4,891 pounds per year. Reducing sediment and phosphorus loads to the TMDLs identified should allow the North Fork Cowanesque River watershed to support its designated aquatic life uses. Allocations of the sediment and phosphorus TMDLs are summarized below:

Summary of TMDLs for the North Fork Cowanesque River Watershed (lbs./yr.)						
Pollutant	TMDL	WLA	MOS	LA	LNR	ALA
Phosphorus	4,891	0	489	4,402	505	3,897
Sediment	6,777,024	0	677,702	6,099,322	376,010	5,723,312

The North Fork Cowanesque River watershed TMDLs are allocated entirely to nonpoint sources, with 10% of the TMDL reserved as a margin of safety (MOS). The wasteload allocation (WLA) is that portion of the total load assigned to point sources. Since there are no permitted wastewater discharges present in the basin, WLAs were set to zero. The load allocation (LA) is that portion of the total load assigned to nonpoint sources. Loads not reduced (LNR) are the portion of the LA associated with nonpoint sources other than the agricultural and is equal to the sum of existing loadings. The adjusted load allocation (ALA) represents the remaining portion of the LA to be distributed among agricultural land uses receiving load reductions. The TMDLs developed for the North Fork Cowanesque River watershed established a 55% reduction in the current sediment loading of 13,702,749 pounds per year and a 52% reduction in the current phosphorus loading of 9,258 pounds per year.

A more complete discussion of the North Fork Cowanesque River watershed TMDLs and TMDLs in general are contained in the attached Information Sheet (Attachment A).

1 - INTRODUCTION

The North Fork Cowanesque River is located approximately one mile west of Westfield in Tioga County, Pennsylvania. Approximately 56% of the watershed land area lies in PA with the remaining 44% in New York (Figure 1). State Highway 49 parallels the Cowanesque River from west to east through parts of Potter and Tioga Counties.

The North Fork Cowanesque River empties into the Cowanesque River near the intersection of State Highway 49 and SR 4005, approximately one mile west of Westfield. Access to the watershed in Pennsylvania would be from State Highway 49 and SR 4005. The stream originates in Steuben County, New York and flows 9.5 miles to the Cowanesque River. There are a total of 17.2 stream miles in the watershed, including an unnamed tributary, the White Branch and Mink Hollow. The North Fork Cowanesque River drains 16.25 square miles of the Appalachian Plateau physiographic province. Land use in the basin is dominated by agriculture (53%) and deciduous forest (42%). Other land uses are limited, including remaining forest (4%), and unpaved roads (1%). Protected uses of the North Fork Cowanesque River watershed include aquatic life and recreation. The entire basin is currently designated as a Cold Water Fishery in Title 25 PA Code Department of Environmental Protection Chapter 93, Section 93.90 (Commonwealth of Pennsylvania, 1999).

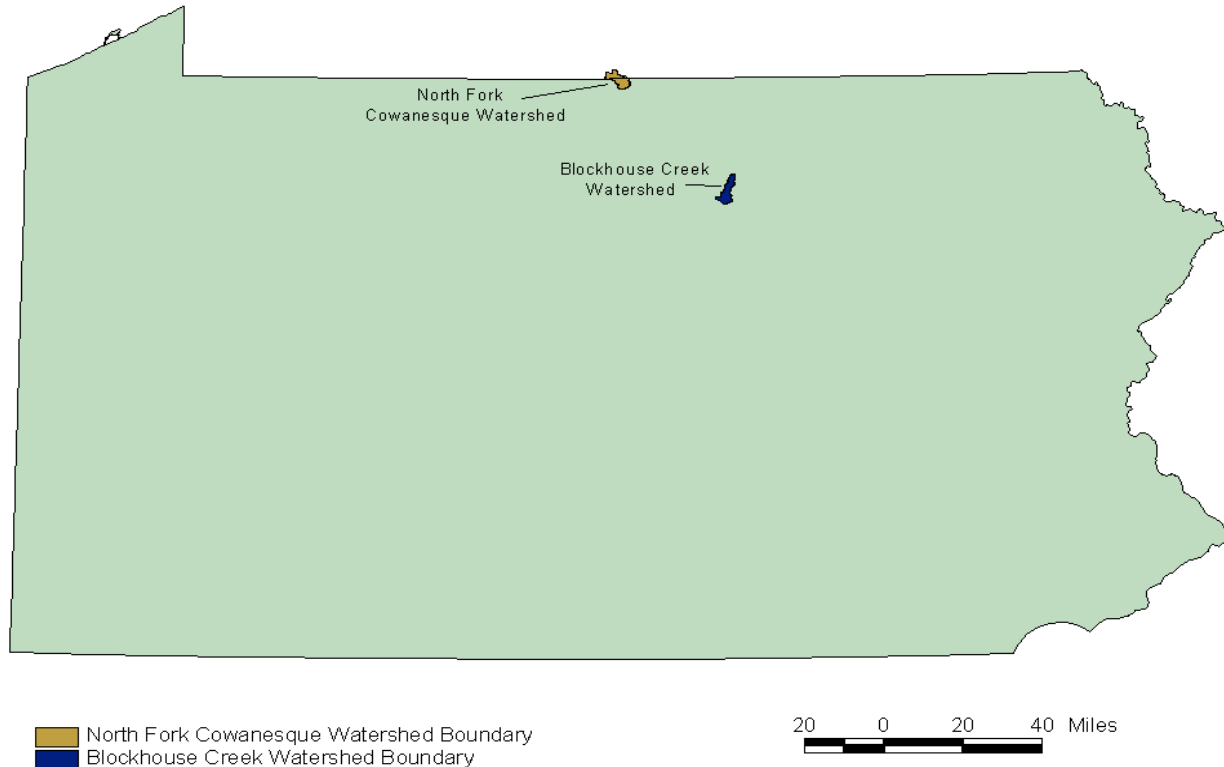


Figure 1: Locations of North Fork Cowanesque River and Blockhouse Creek Watersheds

The Department's 2000 305(b) report database indicates that 6.63 miles of streams in the North Fork Cowanesque River watershed are impaired by agricultural activities and in one case by an upstream impoundment (White Branch). Siltation and organic enrichment are reported as the causes of impairment in the main stem (stream code 31111). Unnamed tributary, stream code 31123, is listed as impaired by siltation. Nutrients and sediment are listed as causing impairments in the White Branch (stream code 31124), while excessive algal growth and siltation are listed as impairments in Mink Hollow (stream code 31116). Surveys conducted by the Department in the North Fork Cowanesque River watershed have clearly identified aquatic life use impairments due to extensive agricultural activities. Lack of riparian vegetation, pastures, and croplands that extend right up to the streambanks, and unrestricted livestock access to streams have allowed excessive levels of sediment and nutrients to reach surface waters. These same conditions were noted in the watershed during a site visit conducted on November 20, 2000 as part of the TMDL development. Streambank erosion is prevalent in the basin, particularly in the many areas where livestock have unrestricted access to the streams. Excess nutrients were causing increased algae growths and sediment deposited in large quantities on the streambank was degrading the habitat of benthic macroinvertebrates.

Originally, the North Fork Cowanesque River was listed as impaired on the 303(d) list based on a 1991 Susquehanna River Basin Commission survey. The impaired reach extended from the New York state line downstream to the Tioga County line (3.3 miles). Causes of impairment were listed as nutrients, turbidity and suspended solids with the source being agriculture.

TMDLs were developed for the North Fork Cowanesque River watershed to address impairments identified in Pennsylvania's 1996 and 1998 303(d) lists and the 2000 305(b) report. The 1996 303(d) list included a 3.8 mile stretch of the North Fork Cowanesque River (stream code 31111) impaired by nutrients and suspended solids. Designated use impairments in the mainstem of the North Fork Cowanesque River were attributed to agricultural activities.

Table 1 identifies stream segments that are addressed by the TMDLs developed for the North Fork Cowanesque River watershed. The TMDLs address agriculture related impairments caused by nutrients and siltation. A TMDL for phosphorus was chosen to address the nutrient impairments.

Table 1: 1996 and 1998 303(d) Listings for Streams in the North Fork Cowanesque River Watershed (2000 305(b) Report Listing are also included)							
303(d) List	Stream Name	Stream Code	Segment ID	Degraded Miles	Cause	Source	Addressed by TMDL
1996 [∇]	North Fork Cowanesque River	31111	N/A [∇]	3.8 4.0	Nutrients Suspended Solids	Agriculture	Yes
1998 [∇]	North Fork Cowanesque River	31111	7066 [∇] (same as above)	3.35	Nutrients Suspended Solids	Agriculture	Yes
2000*	Mink Hollow	31116	990908- 1050-BPG	1.16	Excessive Algal Growth, Siltation	Agriculture	Yes
2000*	North Fork Cowanesque River	31111	990602- 1305-REH	2.2	Organic Enrichment/Low D.O.	Upstream Impound- ment	No
2000*	North Fork Cowanesque River	31111	990602- 1420-REH	2.37	Siltation	Agriculture	Yes
2000*	North Fork Cowanesque River	31123	990602- 1420-REH	1.1	Siltation	Agriculture	Yes

* 2000 Section 305(b) Report

[∇] ID # 7066 is 1998 number assigned to the above, unnumbered segment (list carry-over)

The original 1996 listing in the North Fork Cowanesque Watershed (Stream Code 31111) for nutrients and siltation was approximately 4 miles of stream extending from segment 7066 (see Figure 2 on the following page) and included the segment currently assigned ID 990602-1420-REH (Stream Code 31111). Follow-up surveys performed in 1999 removed the nutrient impairment for segment 990602-1420-REH (Stream Code 31111), but the siltation impairment remains. A phosphorus allocation was given to the entire watershed based on the fact that the 1996 included nutrients as a cause of impairment.

The 2000 305(b) listing for Segment ID 990602-1305-REH is due to an earthen impoundment with a bottom discharge to the receiving stream. This is a physical impairment caused by the stratification in the impoundment and the bottom discharge to the stream. Therefore, this document will not address this listing.

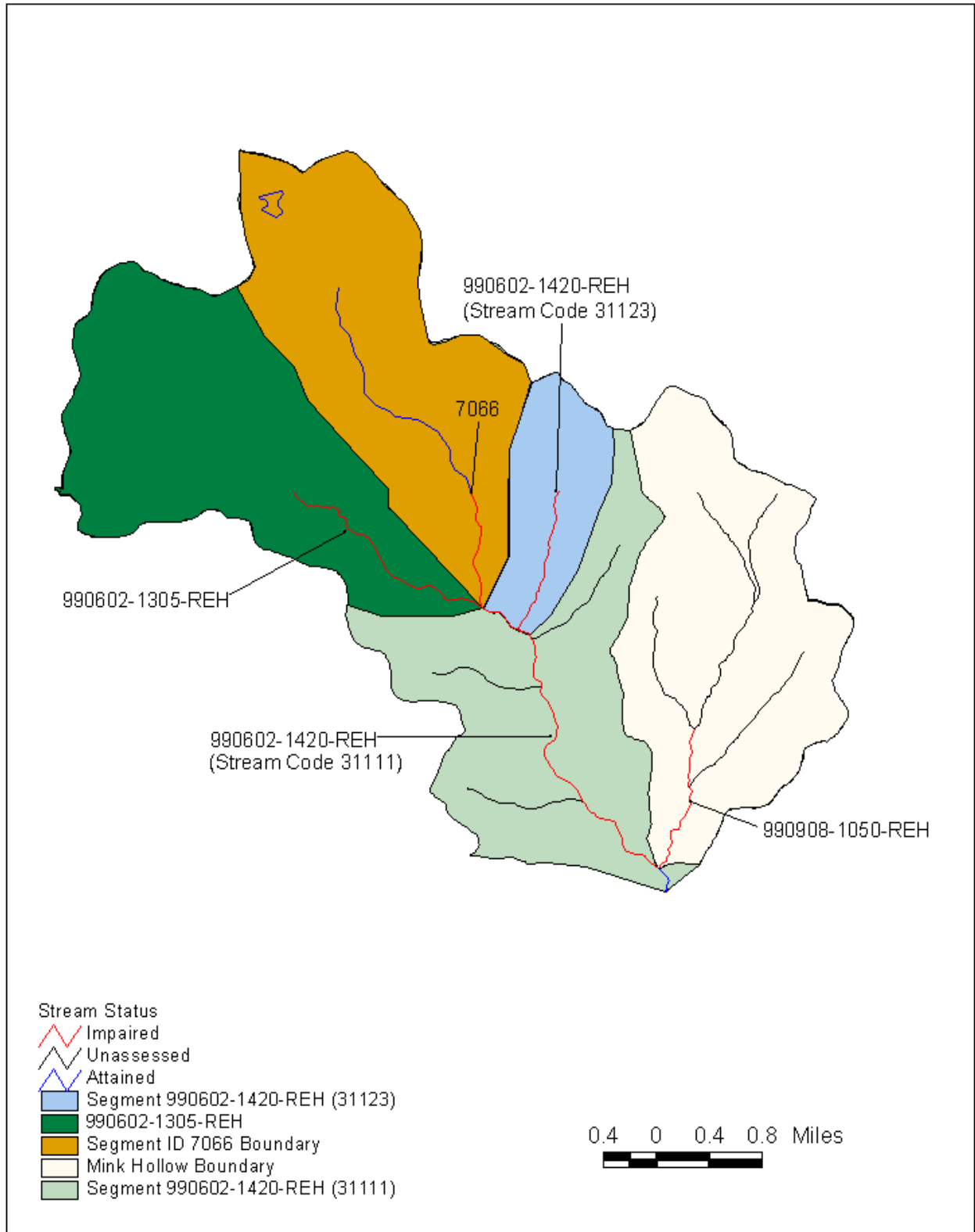


Figure 2. Watershed Boundary Delineations for North Fork Cowanesque TMDLs

2 – TMDL ENDPOINTS

The TMDLs developed for the North Fork Cowanesque River watershed address sediment and phosphorus. Phosphorus was determined to be the nutrient limiting plant growth in the North Fork Cowanesque River watershed. Because neither Pennsylvania nor EPA has water quality criteria for sediments or phosphorus, a method was developed to determine water quality objectives for these parameters that would result in the impaired stream segments attaining their designated uses. The method employed for these TMDLs is termed the "Reference Watershed Approach".

The Reference Watershed Approach compares two watersheds, one attaining its uses and one that is impaired based on biological assessments. Both watersheds have similar land use/cover distributions. Other features such as base geologic formation should be matched to the best extent possible; however, most variations can be adjusted for in the model. The objective of the process is to reduce the loading rate of sediments and nutrients in the impaired stream segment to a level equivalent or slightly lower than the loading rate in the non-impaired, reference stream segment. This load reduction will allow the biological community to return to the impaired stream segment(s). The TMDL endpoints established for this analysis were determined using the Blockhouse Creek basin as the reference watershed.

Impairments in the North Fork Cowanesque River watershed resulting from agricultural activities and caused by siltation will be addressed by reducing the sediment loading. Impairments resulting from agricultural activities and caused by nutrients will be addressed by reducing phosphorus loading. The use of phosphorus load reductions to address nutrient impairments in the North Fork Cowanesque River watershed is based on an understanding of the relationship between nitrogen, phosphorus, and organic enrichment in stream systems. In stream systems, elevated nutrient loads (nitrogen and phosphorus in particular) can lead to increased productivity of plants and other organisms (Novotny and Olem, 1994). Typically in aquatic ecosystems, the quantities of trace elements are 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, or growth, of aquatic biomass. If the 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 the total biomass can be subsequently be decreased as well (Novotny and Olem, 1994). In most efforts to control eutrophication processes in water bodies, emphasis is placed on the limiting nutrient. This is not always the case. If nitrogen is the limiting nutrient, it may still be more efficient to control phosphorus loads if the nitrogen originates from difficult to control sources, such as nitrates in ground water.

2.1 - RELATIONSHIP BETWEEN DISSOLVED OXYGEN LEVELS, NUTRIENT LOADS AND ORGANIC ENRICHMENT IN STREAM SYSTEMS

As indicated earlier, Donegal Creek was listed as being impaired due to problems associated with dissolved oxygen levels, nutrient loads, and organic enrichment. In stream systems, elevated nutrient loads (nitrogen and phosphorus) can lead to increased productivity of plants and other organisms (Novotny and Olem, 1994). Oxygen in water is used by plants (at night) and organisms in the stream. Excessive nutrient input can lead to elevated levels of productivity, which can subsequently lead to depressed dissolved oxygen levels when an abundance of aquatic life is drawing on a limited oxygen supply. Additional problems arise when these organisms die because the microbes that decompose this organic matter also consume large amounts of oxygen. A second effect of nitrogen (specifically ammonia) occurs when bacteria convert ammonia-nitrogen to nitrate-nitrogen. This process, called nitrification, also results in lower dissolved oxygen levels in streams.

Typically in aquatic ecosystems the quantities of trace elements are 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 nutrient load to a water body 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 eutrophication processes in water bodies, emphasis is placed on the limiting nutrient. This is not always the case, however. 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 ground water.

In most freshwater systems, phosphorus is the limiting nutrient for aquatic growth. In some cases the determination of which nutrient is the most limiting is difficult. For this reason, the ratio of the amount of N to the amount of P is often used to make this determination (Thomann and Mueller, 1987). If the N/P ratio is 10 or greater, phosphorus is the limiting nutrient. In the North Fork Cowanesque River watershed, the TN:TP ratio is 10, which indicates that phosphorus is the limiting nutrient. Water quality data, collected for reservoir studies in the nearby Cowanesque River basin, indicate that the N/P ratio in that watershed is greater than 10 and thereby reinforcing that P is the limiting nutrient. Controlling the phosphorus loading to surface waters in the North Fork Cowanesque River watershed will limit plant growth, helping to eliminate use impairments currently caused by excess nutrients.

3 – SELECTION OF THE REFERENCE WATERSHED

The reference watershed approach was used to estimate the appropriate reduction of phosphorus and sediment loading necessary to restore healthy aquatic communities to the North Fork Cowanesque River watershed. This approach is based on selecting a non-impaired watershed (“reference”) and determining its current loading rates for the pollutants of interest. The objective of the process is to reduce loading rates of those pollutants identified as causing impairment to a level equivalent to the loading rates in the reference watershed. Achieving the appropriate load reductions should allow the return of a healthy biological community to affected stream segments.

Three factors should be considered when selecting a suitable reference watershed. The first factor is to use a watershed that the Department has assessed using the Unassessed Waters Protocol and that has been 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 use/land cover, 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 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, Pennsylvania’s 305(b) assessed streams database, and geologic rock types.

Blockhouse Creek was selected as the reference watershed for developing the North Fork Cowanesque River watershed TMDLs. Blockhouse Creek is a tributary to Little Pine Creek located near Liberty in Tioga County, Pennsylvania (Figure 1). Blockhouse Creek is identified in the 2000 305(b) report as attaining its designated uses. The attainment of designated uses is based on sampling done by the Department as part of its ongoing Unassessed Waters program. The watershed is located in the Appalachian Plateau in State Water Plan (SWP) sub-basin 9A. Table 2 compares the two watersheds in terms of size, location, and other physical characteristics.

The analysis of value counts for each pixel of the MRLC grid revealed that land cover/use distributions in both watersheds are similar. Agriculture is the dominant land use category in the North Fork Cowanesque River watershed while forest is the dominant category in the Blockhouse Creek watershed. The agricultural land use, a source of impairment in the North Fork Cowanesque River watershed, accounts for 53% of the total land use as compared to 44% in the Blockhouse Creek watershed. Surface geology in the North Fork Cowanesque River watershed consists of interbedded sedimentary rocks (100%). The Blockhouse Creek watershed consists of interbedded sedimentary (89%) and sandstone (11%). Bedrock geology primarily affects surface runoff and background nutrient loads through its influence on soils, landscape, fracture density, and directional permeability. A look at the attributes in Table 2 indicates that these watersheds are similar.

Table 2: Comparison Between North Fork Cowanesque River and Blockhouse Creek Watersheds

	North Fork Cowanesque River Watershed	Blockhouse Creek Watershed
Physiographic Province	Appalachian Plateau	Appalachian Plateau
Area (square miles)	16.25	16.89
Land Use Distribution – % Agriculture	53.2	44.4
– % Forest	46.1	54.8
Geology – % Interbedded Sedimentary	100	88.7
– % Sandstone	0	11.3

4 – HYDROLOGIC / WATER QUALITY MODELING

4.1 – DATA COMPILATION AND MODEL OVERVIEW

The TMDLs were developed using the Generalized Watershed Loading Function or GWLF model. The GWLF model provides the ability to simulate runoff, sediment and nutrient (N and P) loadings from a 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 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 homogeneous 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 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 the conservation practices factor (P). A sediment delivery ratio, based on watershed size, and transport capacities, based on average daily runoff, are applied to the calculated erosion to determine sediment yield for each source area. Surface nutrient losses are determined by applying dissolved N and P coefficients to surface runoff and a sediment coefficient to the yield portion for each agricultural source area. Point source discharges can also contribute to dissolved losses to the stream and are specified in terms of kilograms per month. Manured areas, as well as septic systems, can also be considered. Urban nutrient inputs are all assumed to be solid-phase, and the model uses an exponential accumulation and wash-off function for these loadings. Sub-surface losses are calculated, using dissolved N and P shallow groundwater coefficients, for 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 depending 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 the GWLF Users Manual, available from the Department's Bureau of Watershed Conservation, Division of Assessment and Standards.

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

4.2 – GIS BASED DERIVATION OF INPUT DATA

The primary sources 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, created by Cornell University. This new version of the software has been named AVGWLF (the 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 growing season, the months when manure is spread on agricultural land and the names of nearby weather stations). This information is subsequently used to automatically derive values for required models 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.

Table 3 lists statewide GIS data sets and provides explanation of how they were used for development of the input files for the GWLF model.

Table 3: GIS Data Sets	
DATASET	DESCRIPTION
Censustr	Coverage of Census data including information on individual homes septic systems. The attribute <i>usew_sept</i> includes data on conventional systems, and <i>sew_other</i> 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 ¹	A satellite image derived land cover grid which 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 <i>rain_cool</i> and <i>rain_warm</i> are used to set recession coefficient
Pointsrc	Major point source discharges with permitted N and P loads.
Refwater	Shapefile of reference watersheds for which nutrient and sediment loads have been calculated.
Soilphos	A grid of soil phosphorous loads which has been generated from soil sample data. Used to help set 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 <i>mu_k</i> sets the k factor in the USLE. The attribute <i>mu_awc</i> is the unsaturated available capacity., and the <i>mu_hsg_dom</i> 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 <i>aeu_acre</i> 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.

1. Multi-Resolution Land Characteristics (MRLC) data were also obtained for the New York portion of the watershed to adjust land use distribution for modeling and allocation purposes.

As described in the Data Compilation and Model Overview section, the GWLF model provides the ability to simulate surface water runoff, as well as sediment and nutrient loads from a watershed based on landscape conditions such as topography, land use/cover, and soil type. In essence, the model is used to estimate surface runoff and nonpoint source loads from different areas within the watershed. If point source discharges are identified, and the corresponding nutrient loads are quantified, these loads are summed to represent the total pollutant loads for the watershed.

In the GWLF model, the nonpoint source load calculated is affected by terrain conditions such as amount of agricultural land, land slope, and inherent soil erodibility. It is also affected by farming practices utilized in the area, as well as by background concentrations of nutrients (i.e., N and P) in soil and groundwater. Various parameters are included in the model to account for these conditions and practices. Some of the more important parameters are summarized below:

Areal extent of different land use/cover categories: This is calculated directly from a GIS layer of land use/cover.

Curve number: This determines the amount of precipitation that infiltrates into the ground or enters surface water as runoff. It is based on specified combinations of land use/cover and hydrologic soil type, and is calculated directly using digital land use/cover and soils layers.

K factor: This factor relates to inherent soil erodibility, and affects the amount of soil erosion taking place on a given unit of land.

LS factor: This factor signifies the steepness and length of slopes in an area and directly affects the amount of soil erosion.

C factor: This factor is related to the amount of vegetative cover in an area. In agricultural areas, the crops grown and the cultivation practices utilized largely control this factor. Values range from 0 to 1.0, with larger values indicating greater potential for erosion.

P factor: This factor is directly related to the conservation practices utilized in agricultural areas. Values range from 0 to 1.0, with larger values indicating greater potential for erosion.

Sediment delivery ratio: This parameter specifies the percentage of eroded sediment that is delivered to surface water and is empirically based on watershed size.

Unsaturated available water-holding capacity: This relates to the amount of water that can be stored in the soil and affects runoff and infiltration. It is calculated using a digital soils layer.

Dissolved nitrogen in runoff: This varies according to land use/cover type, and reasonable values have been established in the literature. This rate, reported in mg/l, can be re-adjusted based on local conditions such as rates of fertilizer application and farm animal populations.

Dissolved phosphorus in runoff: Similar to nitrogen, the value for this parameter varies according to land use/cover type, and reasonable values have been established in the literature. This rate, reported in mg/l, can be re-adjusted based on local conditions such as rates of fertilizer application and farm animal populations.

Nutrient concentrations in runoff over manured areas: These are user-specified concentrations for N and P that are assumed to be representative of surface water runoff leaving areas on which manure has been applied. As with the runoff rates described above, these are based on values obtained from the literature. They also can be adjusted based on local conditions such as rates of manure application or farm animal populations.

Nutrient build-up in non-urban areas: In GWLF, rates of build-up for both N and P have to be specified. In Pennsylvania, this is estimated using historical information on atmospheric deposition.

Background N and P concentrations in groundwater: Subsurface concentrations of nutrients (primarily N) contribute to the nutrient loads in streams. In Pennsylvania, these concentrations are estimated using recently published data from USGS.

Background N and P concentrations in soil: Since soil erosion results in the transport of nutrient-laden sediment to nearby surface water bodies, reasonable estimates of background concentrations in soil must be provided. In Pennsylvania, this information is based on literature values as well as soil test data collected annually at Penn State University. These values can be adjusted locally depending upon manure loading rates and farm animal populations.

Other less important factors that can affect sediment and nutrient loads in a watershed are also included in the model. More detailed information about these parameters and those outlined above can be obtained from the GWLF Users Manual provided in Attachment D of this document. Specific details in this guide that describe equations and typical parameter values used can be found on pages 15 through 41.

4.3 – WATERSHED ASSESSMENT AND MODELING

The AVGWLF model was used to establish existing loading conditions for the North Fork Cowanesque River and the Blockhouse Creek watersheds. All modeling outputs have been attached to this TMDL as Appendices B and C. DEP staff visited the North Fork Cowanesque River and the Blockhouse Creek watersheds on November 20, 2000. These 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:

North Fork Cowanesque River Watershed

- Severely limited riparian buffers, with many exposed and eroding banks
- Free access to the streams by livestock
- Pastures and cropland extending right up to streams and roads
- Noticeable sediment deposition on streambeds

Blockhouse Creek Watershed

- Presence of forested riparian buffers along the streams
- More evidence of overall conservation practices and lower animal densities

Adjustments were made to specific parameters used in the AVGWLF model based on observations made while touring the watersheds. These adjustments are:

North Fork Cowanesque River Watershed

- None were made

Blockhouse Creek Watershed

- Reset Hay/Pasture P-factor to 0.35 to account for better stream buffering on pastureland and less direct access of livestock to stream
- Reset Cropland P-factor to 0.40 to account for less cropland encroaching on streams

The AVGWLF model produced information on watershed size, land use, sediment loading, total nitrogen loading and total phosphorus loading (Tables 4 and 5).

Table 4: Current Loading for North Fork Cowanesque River Watershed

Source	Area (ac)	P Load (lb)	P Loading Rate (lb/ac)	Sed Load (lb)	Sed Loading Rate (lb/ac)
Hay/Pasture	1,727	575	0.33	762,126	441.3
Cropland	3,813	7,904	2.07	12,149,596	3,186.4
Coniferous Forest	200	2.4	0.01	3,158	15.79
Mixed Forest	222	3.5	0.02	4,817	21.70
Deciduous Forest	4,374	239	0.05	368,035	84.14
Unpaved Roads	69	274	3.97	415,017	6,014.7
Groundwater	--	251	--	--	--
Point Sources	--	0	--	--	--
Septic	--	9.5	--	--	--
TOTAL	10,405	9,258.40	0.89	13,702,749	1,317

Table 5: Current Loading for Blockhouse Creek Watershed

Source	Area (ac)	P Load (lb)	P Loading Rate (lb/ac)	Sed Load (lb)	Sed Loading Rate (lb/ac)
Hay/Pasture	1,651	307	0.19	335,766	203.37
Cropland	3,155	4,206	1.33	6,251,393	1,981.42
Coniferous Forest	1,339	15.6	0.01	19,460	14.53
Mixed Forest	704	7.7	0.01	9,354	13.29
Deciduous Forest	3,882	158	0.04	238,072	61.33
Unpaved Roads	47	108	2.30	154,796	3,293.53
Transition	5	11	2.20	15,303	3,060.60
Lo Intensity Urb	22	1.5	0.07	11,644	529.27
Hi Intensity Urb	10	9.5	0.95	8,511	851.10
Groundwater	--	234	--	--	--
Point Sources	--	0	--	--	--
Septic	--	9.5	--	--	--
TOTAL	10,815	5,067.80	0.47	7,044,299	651.3

5 – DEVELOPMENT OF SEDIMENT AND PHOSPHORUS TMDLS

Targeted TMDL values for the North Fork Cowanesque River watershed were established based on current loading rates for phosphorus and sediment in the Blockhouse Creek reference watershed. Blockhouse Creek is currently designated as a Cold Water Fishery (CWF) and recent biological assessments have determined that the portion of the basin used as a reference is attaining its designated uses. Reducing the loading rates of phosphorus and sediment in the North Fork Cowanesque River basin to levels equal to, or less than, the reference watershed will allow for the reversal of current use impairments.

As described in the previous section, phosphorus and sediment loading rates were computed for the Blockhouse Creek watershed using the AVGWLF model. Targeted TMDL values for sediment and phosphorus were determined by multiplying the unit area loading rates for the Blockhouse Creek basin by the total watershed area of the North Fork Cowanesque River watershed (Table 6).

Table 6: TMDL Values for the North Fork Cowanesque River Watershed

Pollutant	North Fork Cowanesque Watershed (ac)	Loading Rate in Reference (lb/ac/yr)	Target TMDL Value (lb/yr)
Sediment	10,405.38	651.3	6,777,024
Phosphorus	10405.38	0.47	4,891

Targeted TMDL values were then used as the basis for load allocations and reductions in the North Fork Cowanesque River 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

5.1 – WASTE LOAD 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 source discharges in the North Fork Cowanesque River basin. The WLAs for sediment and phosphorus were set at zero.

5.2 – MARGIN OF SAFETY

The margin of safety (MOS) is that portion of the pollutant loading that is reserved to account for any uncertainty in the data and computational methodology used for the analysis. For this analysis, the MOS is explicit. Ten percent of the targeted TMDL for sediment and phosphorus 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 the North Fork Cowanesque River. The MOS used for sediment and phosphorus TMDLs were set at 677,702 lbs./yr. and 489 lbs./yr., respectively.

$$\begin{aligned} \text{MOS (Sediment)} &= 6,777,024 \text{ lbs./yr. (TMDL)} * 0.1 = 677,702 \text{ lbs./yr.} \\ \text{MOS (Phosphorus)} &= 4891 \text{ lbs./yr. (TMDL)} * 0.1 = 489 \text{ lbs./yr.} \end{aligned}$$

5.3 – LOAD ALLOCATION

The load allocation (LA) is that portion of the TMDL that is assigned to nonpoint sources. Load Allocations for sediment and phosphorus were computed by subtracting the MOS value from the TMDL value. Load Allocation for sediment and phosphorus were 6,099,322 lbs./yr. and 4,402 lbs./yr., respectively.

$$\begin{aligned} \text{LA (Sediment)} &= 6,777,024 \text{ lbs./yr. (TMDL)} - 677,702 \text{ lbs./yr. (MOS)} = 6,099,322 \text{ lbs./yr.} \\ \text{LA (Phosphorus)} &= 4891 \text{ lbs./yr. (TMDL)} - 489 \text{ lbs./yr. (MOS)} = 4,402 \text{ lbs./yr.} \end{aligned}$$

5.4 – ADJUSTED LOAD ALLOCATION

The adjusted load allocation (ALA) is the actual portion of the LA distributed among those nonpoint sources receiving reductions. It is computed by subtracting those nonpoint source loads that are not being considered for reductions (loads not reduced or LNR) from the LA. Since the North Fork Cowanesque River watershed TMDLs were

developed to address impairments caused by agricultural activities, only these land uses (HAY/PASTURE and CROPLAND) were considered for reductions. Those land uses/source loads not reduced (LNR) were carried through at their existing loading value (Table 7). The ALA for sediment and phosphorus were 5,723,312 lbs./yr. and 3,896.6 lbs./yr., respectively.

Table 7: Load Allocations, Loads Not Reduced and Adjusted Load Allocations		
	Sediment (lbs./yr.)	Phosphorus (lbs./yr.)
Load Allocation	6,099,322	4,402
Loads Not Reduced		
CONIF_FOR	3,158	2.4
MIXED_FOR	4,817	3.5
DECID_FOR	368,035	239
Groundwater	--	251
Septic systems	--	9.5
Adjusted Load Allocation	5,723,312	3,897

5.5 – TMDLs

sediment and phosphorus TMDLs established for North Fork Cowanesque River watershed consist of a Load Allocation (LA) and a Margin of Safety (MOS). No TMDL was established for nitrogen because the North Fork Cowanesque River is phosphorus limited. The individual components of the North Fork Cowanesque River watershed TMDLs are summarized in Table 8.

Table 8: TMDL Components for the North Fork Cowanesque River Watershed		
Component	Sediment (lbs./yr.)	Phosphorus (lbs./yr.)
TMDL	6,777,024	4,891
WLA	0	0
MOS	677,702	489
LA	6,099,322	4,402
LNR	376,010	505
ALA	5,723,321	3,897

6 – CALCULATION OF SEDIMENT AND PHOSPHORUS LOAD REDUCTIONS

The adjusted load allocations established in the previous section represent the sediment and phosphorus loads that are available for allocation between Hay/Pasture and Cropland land uses in the North Fork Cowanesque River watershed. Data needed for load reduction analyses, including land use distribution, were obtained by GIS analysis. The Equal Marginal Percent Reduction (EMPR) allocation method was used to distribute the ALA between Hay/Pasture and Cropland. The process is summarized below:

1. Each land use/source load is compared with the total allocable load to determine if any contributor would exceed the allocable load by itself. The evaluation is carried out as if each source is the only contributor to the pollutant load to the receiving waterbody. If the contributor exceeds the allocable load, that contributor would be reduced to the allocable load. This is the baseline portion of EMPR.
2. After any necessary reductions have been made in the baseline, the multiple analyses are run. The multiple analyses will sum all of the baseline loads and compare them to the total allocable load. If the allocable load is exceeded, an equal percent reduction will be made to all contributors' baseline values.

After any necessary reductions in the multiple analyses, the final reduction percentage for each contributor can be computed.

Table 9 contains the results of the EMPR for Hay/Pasture and Cropland in the North Fork Cowanesque River basin. The load allocation for each land use is shown along with the percent reduction of current loads necessary to reach the targeted LA.

Table 9: Sediment and Phosphorus Load Allocations/Reductions for Land Uses in the North Fork Cowanesque River Watershed						
Land Use	Acres	Current Loading (lbs./acre/yr.)	Allowable Loading (lbs./acre/yr.)	Current Load (lbs./yr.)	Load Allocation (lbs./yr.)	% Reduction
SEDIMENT						
Hay/Pasture	1,727.0	441.3	366.0	762,126.1	632,117.0	17%
Cropland	3,813.0	3,186.4	1245.0	12,149,596.0	4,746,994.0	61%
Unpaved Roads	69.0	6,014.7	4988.7	415,017.0	344,219.0	17%
PHOSPHORUS						
Hay/Pasture	1,727.0	0.33	0.27	575.0	466.0	19%
Cropland	3,813.0	2.07	0.84	7,904.0	3,203.0	59%
Unpaved Roads	69.0	3.97	3.27	274.0	226.0	18%

In order to address the 1996 303(d) listing of the main stem of the North Fork Cowanesque River (stream code 31111) a sub-watershed was developed for segment ID 7066. The load allocation for each sub-watershed land use is presented in Table 10. The percent reductions of the current loads necessary to reach the target LA is also presented in Table 10.

Table 10: Sediment and Phosphorus Load Allocations/Reductions for Land Uses in Segment ID 7066 Sub-Watershed						
Land Use	Acres	Current Loading (lbs./acre/yr.)	Allowable Loading (lbs./acre/yr.)	Current Load (lbs./yr.)	Load Allocation (lbs./yr.)	% Reduction
SEDIMENT						
Hay/Pasture	374.4	441.3	366.0	165,207.6	137,025.3	17%
Cropland	1,007.3	3,186.4	1,245.0	3,209,807.8	1,254,173.3	61%
Unpaved Roads	2.5	6,014.7	4,988.7	15,036.8	12,471.8	17%
PHOSPHORUS						
Hay/Pasture	374.4	0.33	0.27	124.7	101.1	19%
Cropland	1,007.3	2.07	0.84	2,088.3	846.2	59%
Unpaved Roads	2.5	3.97	3.27	9.9	8.1	19%

The following tables (Tables 11, 12, 13 and 14) show load allocations for individual stream segment sub-watersheds within the North Fork Cowanesque River basin.

**Table 11: Sediment and Phosphorus Load Allocations/Reductions for Land Uses
in Mink Hollow Sub-Watershed**

Land Use	Acres	Current Loading (lbs./acre/yr.)	Allowable Loading (lbs./acre/yr.)	Current Load (lbs./yr.)	Load Allocation (lbs./yr.)	% Reduction
SEDIMENT						
Hay/Pasture	470.3	441.3	366.0	207,524.2	172,123.3	17%
Cropland	780.1	3,186.4	1245.0	2,485,637.2	971,169.0	61%
Unpaved Roads	14.3	6,014.7	4988.7	85,738.6	71,112.4	17%
PHOSPHORUS						
Hay/Pasture	470.3	0.33	0.27	156.6	127.0	19%
Cropland	780.1	2.07	0.84	1,617.1	655.3	59%
Unpaved Roads	14.3	3.97	3.27	56.6	46.6	19%

**Table 12: Sediment and Phosphorus Load Allocations/Reductions for Land Uses
in the White Branch Sub-Watershed**

Land Use	Acres	Current Loading (lbs./acre/yr.)	Allowable Loading (lbs./acre/yr.)	Current Load (lbs./yr.)	Load Allocation (lbs./yr.)	% Reduction
SEDIMENT						
Hay/Pasture	117.0	441.3	366	51,632.1	42,822.0	17%
Cropland	130.6	3,186.4	1245	416,143.8	162,597.0	61%
Unpaved Roads	11.4	6,014.7	4988.7	68,567.6	56,871.2	17%
PHOSPHORUS						
Hay/Pasture	117.0	0.33	0.27	38.6	31.6	18%
Cropland	130.6	2.07	0.84	270.3	109.7	59%
Unpaved Roads	11.4	3.97	3.27	45.3	37.3	18%

**Table 13 - Sediment and Phosphorus Load Allocations/Reductions for Land Uses
in the Unnamed Tributary (Stream Code 31123) Sub-Watershed**

Land Use	Acres	Current Loading (lbs./acre/yr.)	Allowable Loading (lbs./acre/yr.)	Current Load (lbs./yr.)	Load Allocation (lbs./yr.)	% Reduction
SEDIMENT						
Hay/Pasture	103	441.3	366	45,453.9	37,698.0	17%
Cropland	109.4	3,186.4	1245	348,592.2	136,203.0	61%
Unpaved Roads	5.6	6,014.7	4988.7	33,682.3	27,936.7	17%
PHOSPHORUS						
Hay/Pasture	103	0.33	0.27	33.9	27.8	18%
Cropland	109.4	2.07	0.84	226.5	91.9	59%
Unpaved Roads	5.6	3.97	3.27	22.2	18.3	18%

Table 14 - Sediment and Phosphorus Load Allocations/Reductions for Land Uses in the Segment ID 990602-1420-REH (Stream Code 31111) Sub-Watershed						
Land Use	Acres	Current Loading (lbs./acre/yr.)	Allowable Loading (lbs./acre/yr.)	Current Load (lbs./yr.)	Load Allocation (lbs./yr.)	% Reduction
SEDIMENT						
Hay/Pasture	662.3	441.3	366	292,308.3	242,448.4	17%
Cropland	1785.6	3,186.4	1245	5689415.0	2,222,851.7	61%
Unpaved Roads	35.2	6,014.7	4988.7	211991.4	175,826.9	17%
PHOSPHORUS						
Hay/Pasture	662.3	0.33	0.27	221.2	178.5	19%
Cropland	1785.6	2.07	0.84	3701.8	1,499.9	59%
Unpaved Roads	35.2	3.97	3.27	140.0	115.7	18%

7- CONSIDERATION OF CRITICAL CONDITIONS

The AVGWLF model is a continuous simulation model, which uses daily time steps for weather data and water balance calculations. Monthly calculations are made for sediment and nutrient loads, based on daily water balance accumulated in monthly values. Therefore, all flow conditions are taken into account for loading calculations. Because there is generally a significant lag time between the introduction of sediment and nutrients to a waterbody and the resulting impact on beneficial uses, establishing these TMDLs using average annual conditions is protective of the waterbody.

8 - CONSIDERATION OF SEASONAL VARIATIONS

The continuous simulation model used for this analysis considers seasonal variation through a number of mechanisms. Daily time steps are used for weather data and water balance calculations. The model requires specification of the growing season and hours of daylight for each month. The model also considers the months of the year when manure is applied to the land. The combination of these actions by the model accounts for seasonal variability.

9 - RECOMMENDATIONS

Sediment and phosphorus reductions in the TMDLs are allocated entirely to agricultural activities in the watershed. Implementation of best management practices (BMPs) in the affected areas should achieve the loading reduction goals established in the TMDLs. Substantial reductions in the amount of sediment reaching the streams can be made through the planting of riparian buffer zones, contour strips, and cover crops. These BMPs range in efficiency from 20% to 70% for sediment reduction. Implementation of BMPs aimed at sediment reduction will also assist in the reduction of phosphorus. Additional phosphorus reductions can be achieved through the installation of more effective animal waste management systems and stone ford cattle crossings. Other possibilities for attaining the desired reductions in phosphorus and sediment include stabilization of streambanks and streambank fencing. Since phosphorus is the limiting nutrient in the watershed, these implementations will also serve to reduce nitrogen. Further "ground truthing" will be performed in order to assess both the extent of existing BMPs, and to determine the most cost effective and environmentally protective combination of BMPs required for meeting the sediment and nutrient reductions outlined in this report.

10 – PUBLIC PARTICIPATION

The Department published this TMDL in the Pennsylvania Bulletin on December 16, 2000 (Volume 30, Number 51, Page 6482), in the Potter Leader Enterprise on December 20, 2000, in the Wellsboro Gazette on December 20, 2000 and on the Department's Website to foster comment on the calculated allowable loads. The official comment period was from December 16, 2000 to February 13, 2001. A public meeting was scheduled for January 29, 2001 and advertised/noticed in the above mentioned publications. No public comments were received during the comment period or at the meeting. Notice of the final TMDL approval will also be published in the Pennsylvania Bulletin. See Attachment H – Comment & Response Document.

On January 26, 2001, Water Management program staff from the NCRO presented the draft TMDL for the North Fork Cowanesque River Watershed to the Tioga County Conservation. The discussion included stream assessment, the reference watershed approach, the AVGWLF model and Growing Greener Grants.

The state of New York had no involvement in the development of this TMDL although they were notified of it at the onset of the project. Several agencies were contacted, both in Pennsylvania and New York regarding the possibility of future implementation. All are aware of the TMDLs, via the Department's TMDL website. Agencies contacted include Tioga County Conservation District (Wellsboro, PA), The Upper Susquehanna Coalition (Owego, NY), NY Department of Environmental Conservation – Region 8 Office (Avon, NY), Susquehanna River Basin Commission (Harrisburg, PA) and the Steuben County Soil and Water Conservation District (Bath, NY). New York doesn't have streams within the North Fork Cowanesque River Watershed listed on their 303(d) list and no TMDLs are currently under development in the (NY) Upper Susquehanna River Watershed. Sources have indicated that New York's basins are assessed on a cyclical basis and that New York plans to assess the region encompassed in this report and develop TMDLs in the next two to five years. Subsequent to New York's assessment and listing of impaired streams in this watershed, the New York agencies contacted expressed interest in participating in a collaborative watershed restoration effort.

11 – LITERATURE CITED

Commonwealth of Pennsylvania. 1999. Pennsylvania Code. Title 25 – Environmental Protection. Chapter 93 – Water Quality Standards. Department of Environmental Protection. Harrisburg, PA.

Novotny, V. and H. Olem. 1994. Water Quality: Prevention, Identification and Management of Diffuse Pollution. Van Nostrand Reinhold. New York.

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

Attachment E

AVGWLF MODEL OUTPUTS FOR NORTH FORK COWANESQUE
RIVER WATERSHED

North Fork Cowanesque Input Files

Transport.dat file

Edit Transport File

Rural LU	Area (ha)	CN	K	LS	C	P
HAY/PAST	699	75	0.24	5.23680	0.03	0.45
CROPLAND	1543	82	0.24	5.40255	0.21	0.45
CONF_FOR	81	73	0.24	2.42994	0.002	0.52
MIXED_FOR	90	73	0.24	3.33946	0.002	0.52
DECID_FOR	1770	73	0.24	12.9561	0.002	0.52
UNPAVED_RD	28	87	0.24	1.20132	0.8	1

Month	ET	Day Hrs	Season	Eros Coef
APR	0.4099	13	0	0.265
MAY	0.8395	14	1	0.265
JUN	1.1080	15	1	0.265
JUL	1.2798	15	1	0.265
AUG	1.3807	14	1	0.265
SEP	1.4463	12	1	0.081
OCT	1.0742	11	0	0.081
NOV	0.8417	10	0	0.081
DEC	0.6954	9	0	0.081
JAN	0.2725	9	0	0.081
FEB	0.3407	10	0	0.081
MAR	0.3832	12	0	0.081

Urban LU

Area (ha)	CN	K	LS	C	P

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 Del Ratio** 0.168
Recess Coef (1/day) 0.10205 **Unsat Avail Wat (cm)** 3.17707
Seepage Coef (1/day) 0

File Explorer: D:\n_for2

Buttons: Load Transport File, Save Changes, Close

Nutrient.dat file

Edit Nutrient File

Rural LU

Rural LU	Dis N mg/L	Dis P mg/L
HAY/PAST	1.9	0.1
CROPLAND	1.9	0.1
CONF_FOR	0.19	0.006
MIXED_FOR	0.19	0.006
DECID_FOR	0.19	0.006
UNPAVED_RD	2.9	0.2

Manure

N kg/ha/d	P kg/ha/d
81	0.2

Washoff

N kg/ha/d	P kg/ha/d

Point source and septic system nitrogen and phosphorus

Month	Pt Src N Kg	Pt Src P Kg	Nonm Sys	Point Sys	Sheet Crc Sys	Discharge Sys
APR	0	0	89	0	5	0
MAY	0	0	89	0	5	0
JUN	0	0	89	0	5	0
JUL	0	0	89	0	5	0
AUG	0	0	89	0	5	0
SEP	0	0	89	0	5	0
OCT	0	0	89	0	5	0
NOV	0	0	89	0	5	0
DEC	0	0	89	0	5	0
JAN	0	0	89	0	5	0
FEB	0	0	89	0	5	0
MAR	0	0	89	0	5	0

Per capita tank effluent (g/d)

N	P
12	2.5

Growing season (g/d)

N Uptake	P Uptake
1.5	0.4

Sediment (mg/kg)

N	P
3000	675

Groundwater (mg/l)

N	P
1.09013	0.0076308

File Explorer: n_for2

Buttons: Load Nutrient File, Save Changes, Close

Attachment F

AVGWLF MODEL OUTPUTS FOR BLOCKHOUSE CREEK
WATERSHED

Blockhouse Creek Input Files

Transport.dat file

Edit Transport File

Rural LU	Area (ha)	CN	K	LS	C	P
HAY/PAST	668	.75	0.24670	3.08309	0.03	0.35
CROPLAND	1277	.82	0.24695	3.74965	0.21	0.4
CONF_FOR	542	.73	0.24821	2.94908	0.002	0.45
MIXED_FOR	285	.73	0.24807	2.33099	0.002	0.45
DECID_FOR	1571	.73	0.24513	9.44595	0.002	0.52
UNPAVED_RD	19	.87	0.24651	0.69642	0.8	1
TRANSITION	2	.87	0.25	0.75988	0.8	0.8

Urban LU	Area (ha)	CN	K	LS	C	P
LO_INT_DEV	9	.83	0.25	0.40001	0.2	0.2
HI_INT_DEV	4	.93	0.25	0.18491	0.2	0.2

Month	ET	Day Hrs	Season	Eros Coef
APR	0.5224	13	0	0.209
MAY	0.8896	14	1	0.289
JUN	1.1192	15	1	0.289
JUL	1.2626	15	1	0.289
AUG	1.3523	14	1	0.289
SEP	1.4083	12	1	0.109
OCT	1.0673	11	0	0.109
NOV	0.9029	10	0	0.109
DEC	0.7814	9	0	0.109
JAN	0.3473	9	0	0.109
FEB	0.4342	10	0	0.109
MAR	0.4885	12	0	0.109

Antecedent Moisture Condition

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

Init Unsat Stor (cm) Initial Snow (cm)

Init Sat Stor (cm) Sed Del Ratio

Recess Coef (l/day) Unsat Avail Wat (cm)

Seepage Coef (l/day)

Nutrient.dat file

Edit Nutrient File

Runoff	Dis N mg/L	Dis P mg/L
HAY/PAST	1.9	0.1
CROPLAND	1.9	0.1
CONF_FOR	0.19	0.006
MIXED_FOR	0.19	0.006
DECID_FOR	0.19	0.006
UNPAVED_RD	2.9	0.2
TRANSITION	2.9	0.2

Manure

Washoff	N kg/ha/d	P kg/ha/d
LO_INT_DEV	0.012	0.016
HI_INT_DEV	0.101	0.0112

Point source and septic system nitrogen and phosphorus

Month	Pt Src N Kg	Pt Src P Kg	Nonn Sys	Pond Sys	Sheet Cnc Sys	Discharge Sys
APR	0	0	103	0	5	0
MAY	0	0	103	0	5	0
JUN	0	0	103	0	5	0
JUL	0	0	103	0	5	0
AUG	0	0	103	0	5	0
SEP	0	0	103	0	5	0
OCT	0	0	103	0	5	0
NOV	0	0	103	0	5	0
DEC	0	0	103	0	5	0
JAN	0	0	103	0	5	0
FEB	0	0	103	0	5	0
MAR	0	0	103	0	5	0

Per capita tank effluent (g/d)		Growing season (g/d)		Sediment (mg/kg)		Groundwater (mg/l)	
N	P	N Uptake	P Uptake	N	P	N	P
12	25	1.6	0.4	3000	622	0.244483	0.007

Attachment H

Comment and Response Document

COMMENT AND RESPONSE DOCUMENT

NORTH FORK COWANESQUE RIVER WATERSHED TMDLS

COMMENT – A load allocation must be assigned to each listed segment for which TMDLs are being developed. The TMDL report includes load allocations for North Fork Cowanesque River segment ID# 7066 and the Mink Hollow Creek. Figure 2 denotes 3 sub-watersheds. As set forth in CFR §130.7, individual load allocations must be assigned to each water quality limited segment as identified on a states section 303(d) list of impaired waters. Table 1 describes the 1996, 1998 and proposed 2000 303(d) listings for the North Fork Cowanesque. The narrative explains the changes in the stream segment's listing description and segment numbers. Please further clarify which listings are original to the year described and which are the same segment carried through the listing cycles.

RESPONSE – Tables 12, 13, and 14 (on pages 16 and 17) have been added to show load allocations for the remaining water quality limited segment sub-watersheds. Table 1 (page 3) has been modified to indicate the 2 listings that represent the same segment. A reference has been added to the table, as well as a footnote (✓) below the table.

COMMENT – Please clarify how the North Fork Cowanesque River segment #7067 is addressed in the TMDL. The 1998 303(d) list includes two segments for the North Fork Cowanesque River, #7066 and #7067, both described as originally listed in 1996. Segment #7066 is presented in Table 1 and addressed in the TMDL. Segment #7067 is not presented in Table 1, and it is unclear how or whether it is addressed in the TMDL.

RESPONSE – Segment #7067 was re-surveyed, through the Unassessed Waters Program, on September 24, 1999 and was found to be attaining its designated uses. The segment does not appear on the 2000 305(b) report and therefore will not be addressed in this TMDL. Follow-up surveys that meet de-listing requirements will be performed in the near future. Segment #7067 is outside of the watershed boundary used in this TMDL.

COMMENT – Please include the list defining the AVGWLF model parameters ('c' factor, 'p' factor etc.) as found in similar PA TMDLs.

RESPONSE – A list defining the AVGWLF model parameters has been added and can be found on pages 9, 10 and 11.

COMMENT – The discussion of the limiting nutrient is slightly different than that used in other PA developed TMDLs. Please reference this new literature source. The TMDL states that when the nitrogen/phosphorus ratio is less than 7, then nitrogen is limiting, between 7-10 the is co-nutrient limitation and greater than 10 phosphorus is limiting. Other PA TMDLs quote Thomann and Mueller, 1987 and state that when the N/P is less than 10 that nitrogen is the limiting nutrient, a ration above 10 indicates phosphorus is limiting and at 10 neither nutrient controls. Either literature source can be used, the emphasis should be made that controlling phosphorus is the most practical; the most easily implemented and will achieve the desired results.

RESPONSE – The revised discussion can be found on page 6 in the section titled 4.1 – Data Compilation and Model Overview.

COMMENT – Please include the full discussion on the relationship between dissolved oxygen, nutrient loads and organic enrichment in streams. As is found in similar PA TMDLs for streams with low DO/organic enrichment listing, such as the Donegal Creek TMDL. It needs to be established that addressing nutrients will improve those streams listed for and impaired by low DO/organic enrichment and excessive algal growth

RESPONSE – The revised discussion can be found on page 5 in the section titled 2.1 – Relationship between Dissolved Oxygen Levels, Nutrient Loads and Organic Enrichment in Stream Systems.

COMMENT – We request that more information be included in the TMDL regarding the New York portion of the watershed. There is no indication in the TMDL of New York involvement in developing or implementing the TMDL. To ensure that there is the reasonable assurance that the TMDL can be implemented, The New York state environmental agencies, local watershed conservation district, and local stakeholders should be aware of the TMDL and encouraged to participate. Please explain how NY has had the opportunity to be involved and what their role in this TMDL is or could be. Please state whether NY has assessed the NY portion of the watershed and whether it is listed on New York's 303(d) list of impaired waters. Please explain whether organizations or agencies such as the Susquehanna River Basin Commission will have a role to act as an intermediary between the states and to coordinate implementation.

RESPONSE – The revised discussion can be found on page 18 in the section titled 10 – Public Participation.