

**Total Maximum Daily Load (TMDL)
Lititz Run
Lancaster County**

**Pennsylvania Department of Environmental Protection
Central Office
Office of Water Management**



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Summary of Lititz Run TMDL

1. The impaired stream segment addressed by this Total Maximum Daily Load (TMDL) is predominantly located in Lititz Borough and Warwick Township, Lancaster County. The watershed area also extends into smaller portions of Penn and Manheim townships. The stream segment drains approximately 17 square miles, as part of State Water Plan subbasin 07J. The aquatic life existing use for Lititz Run, including its tributaries, is warm water fishes (25 Pa. Code Chapter 93).
2. Pennsylvania’s 1996 303(d) list identified 1.7 miles of Lititz Run as impaired by turbidity and suspended solids emanating from urban runoff and storm sewers. The miles impaired were then increased on Pennsylvania’s 1998 303(d). The 1996 and 1998 listings were based on data collected prior to 1996 through the Pennsylvania Department of Environmental Protection’s (PADEP’s) Surface Water Monitoring Program. On the 2004 303(d) list, the number of impaired miles was reduced to 5.4, based on more recent assessment data. In order to ensure attainment and maintenance of water quality standards in Lititz Run, mean annual loading for sediment will need to be limited to 6,066,464.43 pounds per year (lbs/yr).

The major components of the Lititz Run TMDL are summarized below:

Components	Sediment (lbs/yr)
TMDL (Total Maximum Daily Load)	6,066,464.43
WLA (Wasteload Allocation)	2,773,697.20
MOS (Margin of Safety)	606,646.44
LA (Load Allocation)	2,686,120.79

3. Mean annual sediment loading is estimated to be 10,571,598.80 lbs/yr. To meet the TMDL, the sediment loading will require a 43 percent reduction.
4. There is one point source included in this TMDL. The Lititz Sewer Authority discharges suspended solids, and is included in the wasteload allocation (WLA). Approximately 58 percent of the watershed falls within an MS4 designated area. Therefore, the WLA portion of the TMDL also includes pollutant loads emanating from an MS4 designated area. Load Allocations (LA) for sediment were made to the following nonpoint sources: hay and pasture lands; croplands; coniferous forest; mixed forest; deciduous forest; developed areas; and streambanks.
5. The adjusted load allocation (ALA) is the actual portion of the LA distributed among nonpoint sources receiving reductions, or sources that are considered controllable. Controllable sources receiving allocations are hay/pasture, cropland, developed lands, and streambanks. The sediment TMDL includes a nonpoint source ALA of 2,681,320.79 lbs/yr. Sediment loading from all other sources, such as forested areas, were maintained at their

existing levels. Allocations of sediment to controllable nonpoint sources, or the ALA, for the Lititz Run TMDL are summarized in the following table.

6.

Adjusted Load Allocations for Sources of Sediment			
Pollutant	Current Loading (lbs/yr)	Adjusted Load Allocation (lbs/yr)	% Reduction
Sediment	10,571,598.80	2,681,320.79	75

7. Ten percent of the Lititz Run sediment TMDL was set-aside as a margin of safety (MOS). The MOS is that portion of the pollutant loading that is reserved to account for any uncertainty in the data and computational methodology used for the analysis. The MOS for the sediment TMDL was set at 606,646.44 lbs/yr.
8. The continuous simulation model used for developing the Lititz Run TMDL considers seasonal variation through a number of mechanisms. Daily time steps are used for weather data and water balance calculations. The model requires specification of the growing season and hours of daylight for each month. The model also considers the months of the year when manure is applied to the land. The combination of these actions accounts for seasonal variability.

I. Introduction

A. Watershed Description

The impaired stream segment addressed by this TMDL is predominantly located in Lititz Borough and Warwick Township, Lancaster County (Figure 1). The watershed area also extends into smaller portions of Penn and Manheim townships. The stream segment drains approximately 17 square miles, as part of State Water Plan subbasin 07J. The aquatic life existing use for Lititz Run, including its tributaries, is warm water fishes (25 Pa. Code Chapter 93).

Traveling north of the City of Lancaster on State Route 501 will bring you to the upper middle portion of the watershed, to the Borough of Lititz. Lititz Run is a third order pastoral limestone stream with its main source of water bubbling out of Lititz Spring in downtown Lititz, Pa. Its major tributary is an intermittent stream, Santo Domingo Creek, which flows through an agricultural dominated landscape. Lititz Run flows directly into the Conestoga River just downstream of the State Route 222 bridge crossing.

B. Topography & Geology

The TMDL watershed is located within the Piedmont Lowland Section, and is typical of watersheds in this section of the Piedmont Province. The highest elevations are located in the northern portion of the watershed area, just north of the Borough of Lititz. However, the remaining terrain is nearly level to undulating, exhibiting karst features. It is not uncommon for the smaller unnamed tributaries to have disappearing stream segments during low-flow conditions.

The majority of the rock type in the watershed is limestone (68 percent), predominantly associated with the Epler and Stonehenge Formations. The remaining rock type is sandstone (32 percent), associated with the Cocalico Formation. As expected, the sandstone rock type represents the hill forming units associated with the higher elevations within the TMDL watershed.

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

C. Land Use

Based on GIS datasets created in 2001, land use values were calculated for the TMDL watershed. Agriculture was the dominant land use at approximately 71 percent. Developed areas are 19 percent of the watershed, covering low-intensity residential, high-intensity/commercial land, and areas currently being developed. Suburban development has substantially increased in the last 20 years, although agriculture is still a very large element of

the watershed. Forested areas account for 9 percent of the watershed. Riparian buffer zones are nearly nonexistent in some of the agricultural lands. Livestock also have unlimited access to streambanks in certain parts of the watershed, resulting in streambank trampling and severe erosion. Little contiguous forested tracts remain in the watershed (Figure 2).

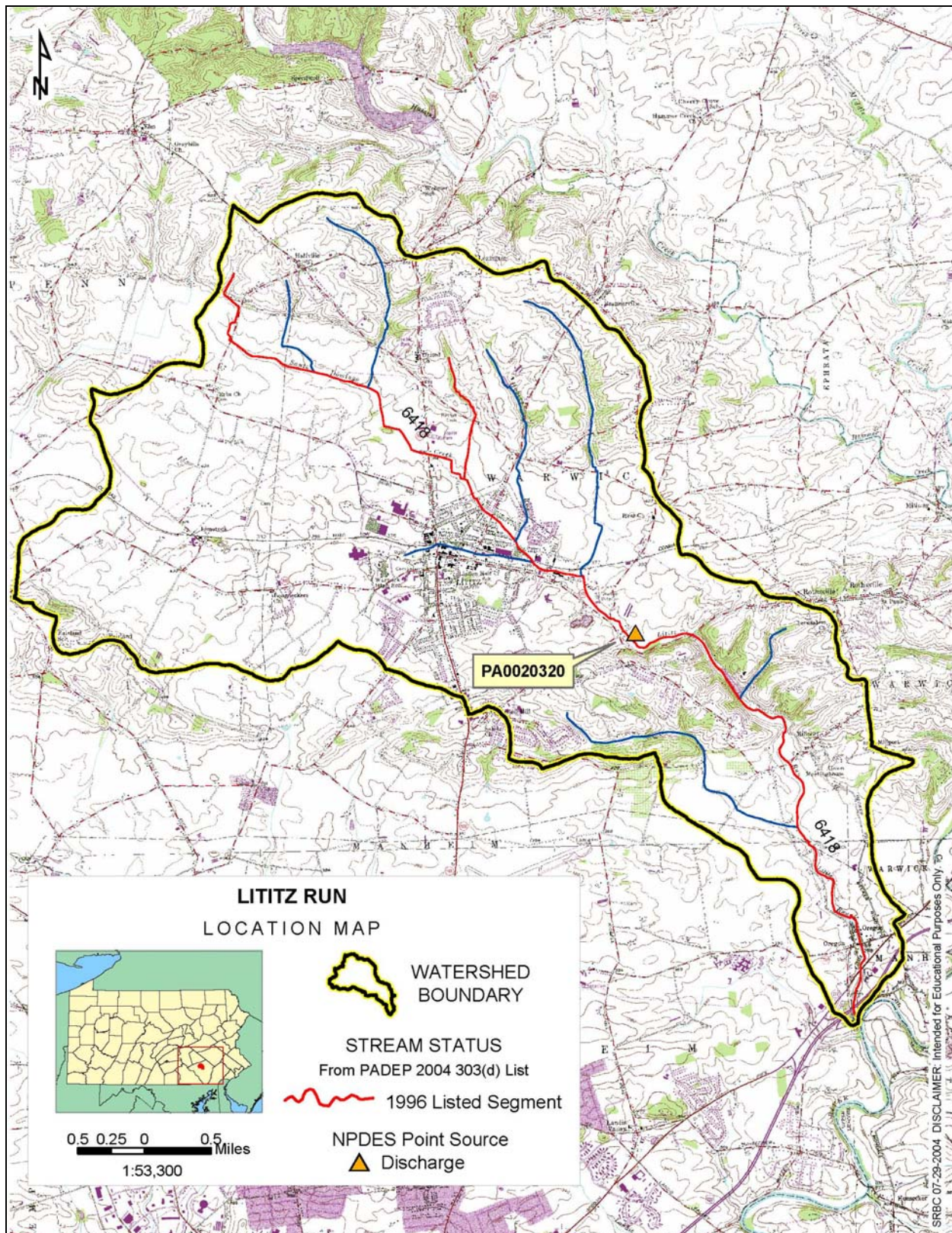


Figure 1. Location Map of Lititz Run Watershed



A



B

Figure 2. Evidence of Streambank Erosion (A) and Lack of Riparian Vegetation (B) in the Lititz Run Watershed

D. Surface Water Quality

Pennsylvania’s 1996 303(d) list identified 1.7 miles of Lititz Run as impaired by turbidity and suspended solids emanating from urban runoff and storm sewers (Table 1). The miles impaired were then increased on Pennsylvania’s 1998 303(d). The 1996 and 1998 listings were based on data collected prior to 1996 through PADEP’s Surface Water Monitoring Program. On the 2004 303(d) list, the number of impaired miles was reduced to 5.4, based on more recent assessment data.

<i>Table 1. 1996, 1998, 2002, and 2004 303(d) Listings Addressed in the Lititz Run TMDL</i>					
1996 303(d) LIST					
STREAM NAME	STREAM CODE	SOURCE	CAUSE	MILES	
Lititz Run	7646	Urban Runoff / Storm Sewers	Turbidity / Suspended Solids	1.7	
1998 303(d) LIST					
SEGMENT ID	WATERSHED	STREAM CODE	SOURCE	CAUSE	MILES
6418	Lititz Run	7646	Urban Runoff / Storm Sewers	Suspended Solids	7.08
2002 303(d) LIST					
SEGMENT ID	WATERSHED	STREAM CODE	SOURCE	CAUSE	MILES
6418	Lititz Run	7646	Urban Runoff / Storm Sewers	Suspended Solids	7.08
2004 303(d) LIST					
SEGMENT ID	WATERSHED	STREAM CODE	SOURCE	CAUSE	MILES
6418	Lititz Run	7646	Urban Runoff / Storm Sewers	Suspended Solids	5.4

In general, soil erosion is a major problem in the Conestoga watershed. Unrestricted access of livestock to streams results in trampled streambanks and excessive stream sedimentation and sparse streamside buffers and riparian vegetation. Soil erosion rates in the subbasin were over 10 tons per acre in 1982, almost double the state average. Large areas of row crops and use of conventional tillage, as well as unrestricted cattle access to streams, combine to leave the soil vulnerable to erosion. Many of the streams in the subbasin are extremely muddy for several days after summer thunderstorms. The resulting high sediment can make water unfit to drink, smother aquatic life and fish eggs, clog fish gills, and block sunlight into the creeks and rivers. Most highways and major roads in the subbasin are overcrowded and are being expanded and

upgraded. Runoff from road construction also can be an additional, although temporary, source of stream sedimentation.

II. Approach to TMDL Development

A. Pollutants & Sources

Suspended solids, or sediment, have been identified as the pollutants causing designated use impairments in the Lititz Run watershed, with the source listed as urban runoff and storm sewers. At present, there is only one point source that contributes to suspended-solid loading in the watershed. The Lititz Sewer Authority discharges approximately 105,393.75 lbs/yr of suspended solids. The remaining sources are nonpoint in nature, and are found throughout the watershed.

A significant portion of the watershed is developed, with 19 percent of the land used for residential/commercial purposes. As expected, this has had some negative influence on water quality conditions. And as documented on Pennsylvania's 303(d) list, urban/residential runoff has contributed to the sediment problem both through direct runoff and increased streambank erosion resulting from increased stream velocities. Agricultural land use in the Lititz Run watershed is 71 percent. This source also has to be considered as a contributor of sediment, and recent assessment data and field observations support such an assumption. Although there has been a lot of restoration activity in the watershed, Best Management Practices (BMPs) are still somewhat limited in the watershed. In some areas, pastures and croplands extend right up to the streambanks with little to no riparian buffer zones present. Livestock still have unlimited access to streambanks in certain areas where grazing occurs in certain areas. Based on visual observations, streambank erosion is severe in some reaches of the stream.

B. TMDL Endpoints

In an effort to address the sediment problem found in the Lititz Run watershed, a TMDL was developed to establish loading limits for sediment. The TMDL is intended to address sediment impairments from developed land uses that were first identified in Pennsylvania's 1996 303(d) list, as well as other nonpoint sources such as agriculture.

C. Reference Watershed Approach

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

The Reference Watershed Approach compares two watersheds, one attaining its uses and one that is impaired based on biological assessments. Both watersheds ideally have similar land use/cover distributions. Other features such as base geologic formation should be matched to the extent possible; however, most variations can be adjusted for in the model. The objective

of the process is to reduce the loading rate of pollutants in the impaired stream segment to a level equivalent to the loading rate in the nonimpaired, reference stream segment. This load reduction will result in conditions favorable to the return of a healthy biological community to the impaired stream segments.

D. Selection of the Reference Watershed

In general, three factors are considered when selecting a suitable reference watershed. The first factor is to use a watershed that the PADEP has assessed and determined to be attaining water quality standards. The second factor is to find a watershed that closely resembles the impaired watershed in physical properties such as land cover/land use, physiographic province, and geology/soils. Finally, the size of the reference watershed should be within 20-30 percent of the impaired watershed area. The search for a reference watershed for the Lititz Run watershed, that would satisfy the above characteristics, was done by means of a desktop screening using several GIS coverages, including the Multi-Resolution Land Characteristics (MRLC), Landsat-derived land cover/use grid, the Pennsylvania's streams database, and geologic rock types.

Catasauqua Creek was selected as the reference watershed for developing the Lititz Run TMDL. Catasauqua Creek is located just north of the Allentown/Bethlehem corridor, in Northampton and Lehigh Counties, Pennsylvania (Figure 3). The watershed is located in State Water Plan subbasin 2C, a tributary to the Lehigh River, and protected uses include aquatic life and recreation. The tributary is currently designated as a Cold Water Fishery (25 Pa. Code Chapter 93). Based on PADEP assessments, Catasauqua Creek is currently attaining its designated uses. The attainment of designated uses is based on sampling done by the PADEP in 1997, as part of its State Surface Water Assessment Program.

Drainage area, location, and other physical characteristics of the Lititz Run watershed were compared to the Catasauqua Creek watershed (Table 2). Agricultural land is the dominant land use category in both Lititz Run (71 percent) and Catasauqua Creek (73 percent). The geology, soils, and precipitation in both are also similar (Table 2).

Table 2. Comparison between Lititz Run and Catasauqua Creek

Attribute	Watershed	
	Lititz Run	Catasauqua Creek
Physiographic Province	Piedmont Lowlands (100%)	Ridge and Valley (100%)
Area (mi²)	17	16
Land Use	Agriculture (71%) Development (19%) Forested (9%)	Agriculture (73%) Development (14%) Forested (12%)
Geology	Carbonate (68%) Sandstone (32%)	Carbonate (64%) Shale (36%)
Soils	Hagerstown – Duffield – Clarksburg (66%) Berks – Weikert – Bedington (34%)	Washington – Urban Land - Clarksburg (39%) Berks – Weikert – Bedington (36%) Ryder – Clarksburg – Berks (24%)
Dominant HSG	C (100%)	C (60%)
K Factor	0.24 – 0.32	0.24 - 0.35
20-Yr. Ave. Rainfall (in)	42.4	46.7
20-Yr. Ave. Runoff (in)	5.0	6.1

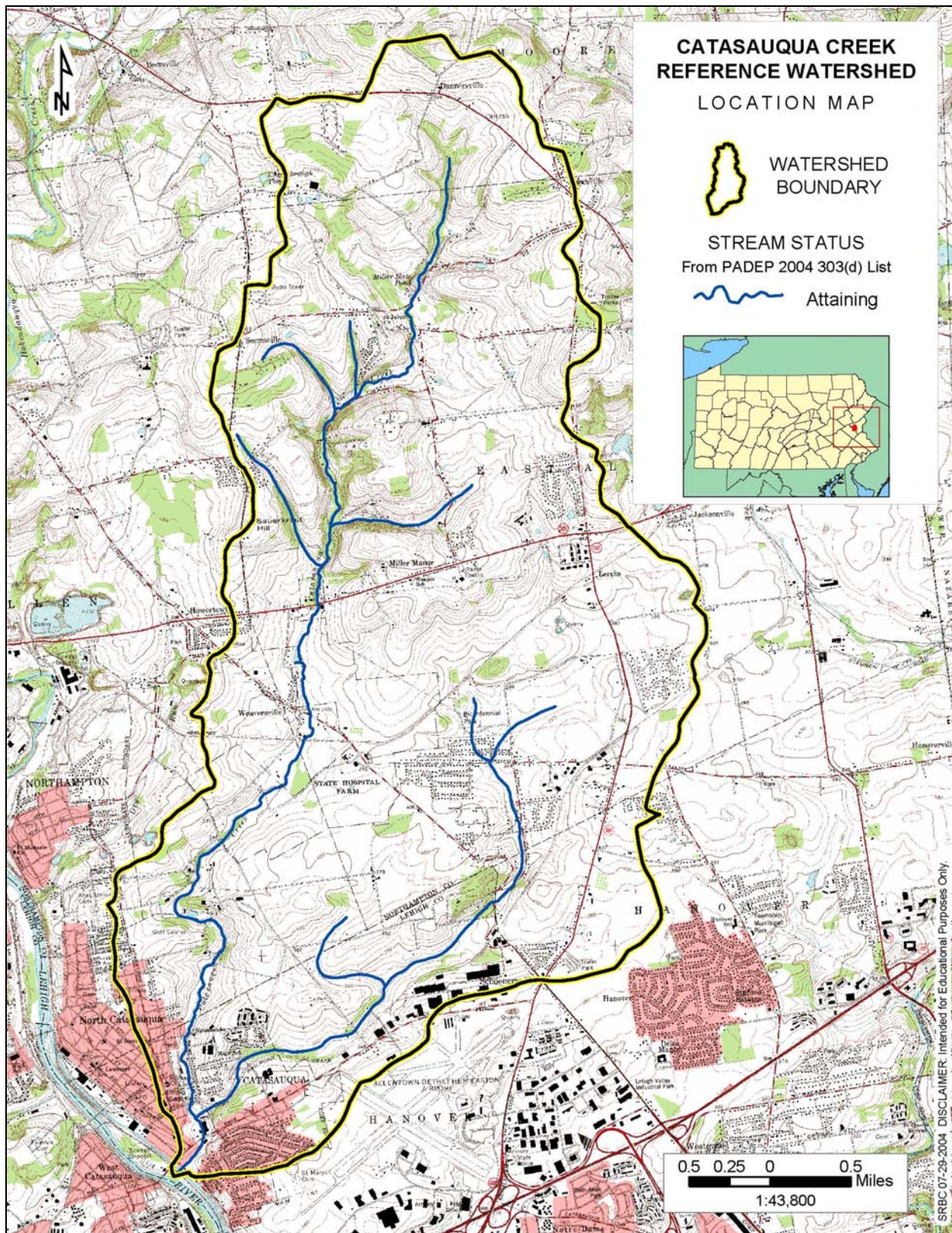


Figure 3. Location Map for Catasaquua Creek.

III. Watershed Assessment and Modeling

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

Lititz Run Watershed

- Local geology dominated by carbonate limestone rock (also sandstone, interbedded sandstone/shale, etc.).
- Significant increases in subdivision development.
- General lack of strip cropping and contour plowing.
- Limited riparian buffer zones in some areas, with residential/commercial and crop/pasture land extending right up to streambanks.

Catasauqua Creek Watershed

- Local geology dominated by carbonate limestone rock (also shale, interbedded sandstone/shale, etc.).
- Forest buffers and streambank fencing along streams.

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

Lititz Run Watershed

- Reset default C factor for cropland (0.42) to 0.50 to reflect the presence of large continuous fields with a general lack of contour plowing and use of cover crops.
- Reset default P factors for cropland and hay/pasture land uses (0.52) to 0.60 to account for:
 - Pastures and cropland generally extending right up to streambanks with unrestricted livestock access to the streams in many places.
 - Lack of quality riparian vegetation resulting in many exposed banks.

Catasauqua Watershed

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

The AVGWLF model produced information on watershed size, land use, and sediment loading. The sediment loads represent an annual average over a 20-year period, from 1978 to 1998 and 1977 to 1997, for the Lititz and Catasauqua watersheds, respectively. This information was then

used to calculate existing unit area loading rates for Lititz Run and Catasauqua Creek reference watersheds. Sediment loading information for both the impaired watershed and the reference watershed are shown in Tables 3 and 4, respectively.

Table 3. Existing Sediment Loads for Lititz Run			
Pollutant Source	Acreage	Sediment	
		Mean Annual Loading (lbs/yr)	Unit Area Loading (lbs/ac/yr)
HAY/PAST	1,967.00	150,800.00	76.66
CROPLAND	5,824.30	7,384,800.00	1,267.93
CONIF_FOR	59.30	400.00	6.75
MIXED_FOR	560.90	2,600.00	4.64
DECID_FOR	459.60	1,800.00	3.92
TRANSITION	51.90	61,400.00	1,183.04
LO_INT_DEV	1,579.00	113,000.00	71.56
HI_INT_DEV	543.60	19,400.00	35.69
Streambank		2,833,933.80	
Groundwater			
Point Source		3,465.00	
Septic Systems			
TOTAL	11,045.60	10,571,598.80	957.09

Table 4. Existing Sediment Loads for Catasauqua Creek			
Pollutant Source	Acreage	Sediment	
		Mean Annual Loading (lbs/yr)	Unit Area Loading (lbs/ac/yr)
HAY/PAST	1,490.00	88,200.00	59.19
CROPLAND	5,883.60	3,137,000.00	533.18
CONIF_FOR	202.60	1,000.00	4.94
MIXED_FOR	74.10	400.00	5.40
DECID_FOR	946.40	4,800.00	5.07
UNPAVED_ROADS	4.90	9,200.00	1,877.55
QUARRY	2.50	1,000.00	400.00
TRANSITION	207.60	769,400.00	3,706.17
LO_INT_DEV	946.40	76,200.00	80.52
HI_INT_DEV	232.30	14,400.00	61.99
Streambank		1,385,324.80	
Groundwater			
Point Source			
Septic Systems			
Total	9,990.40	5,486,924.80	549.22

IV. TMDLs

The targeted TMDL value for the Lititz Run watershed was established based on current loading rates for sediment in the Catasauqua Creek reference watershed. Biological assessments have determined that Catasauqua Creek is currently attaining its designated uses. Reducing the loading rate of sediment in the Lititz Run watershed to levels equivalent to those in the reference watershed will provide conditions favorable for the reversal of current use impairments.

A. Background Pollutant Conditions

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

B. Targeted TMDLs

The targeted TMDL value for sediment was determined by multiplying the total area of Lititz Run watershed (11,045.60 acres) by the appropriate unit-area loading rate for the Catasauqua Creek reference watershed (Table 5). The existing mean annual loading of sediment to Lititz Run (10,571,598.80 lbs/yr) will need to be reduced by 43 percent to meet the targeted TMDL of 6,066,464.43 lbs/yr.

Table 5. Targeted TMDL for the Lititz Run Watershed

Pollutant	Area (ac)	Unit Area Loading Rate Catasauqua Creek Reference Watershed (lbs/ac/yr)	Targeted TMDL for Lititz Run (lbs/yr)
Sediment	11,045.60	549.22	6,066,464.43

Targeted TMDL values were used as the basis for load allocations and reductions in the Lititz Run watershed, using the following two equations:

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

where:

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

C. Waste Load Allocation

The WLA portion of the TMDL equation is the total loading of the pollutant that is assigned to point sources. After reviewing PADEP’s permit files, one point source discharges suspended solids downstream of Lititz Borough. The Lititz Sewer Authority discharges treated sewage effluent into the streams covered within this TMDL, permit number PA0020320. The average suspended solid loading for the facility during 2002-2003 was approximately 105,393.75 lbs/yr of solids, which was included in the AVGWLF modeling runs for determining existing conditions. The maximum allowable loading rate of 351,495 lbs/yr, based on permit requirements, is used in the final TMDL allocation (WLA).

Approximately 58 percent of the watershed falls within an MS4 designated area (Figure 4). The WLA portion of the TMDL must include pollutant loads emanating from an MS4 designated area. To account for that portion of the TMDL, allocations made to land uses within the MS4 area were separated from the non-MS4 loads. These MS4 loads are shown in Table 6.

<i>Table 6. Sediment Waste Load Allocations for MS4 Designated Areas within Lititz Run</i>					
Pollutant Source	Acres	Unit Area Loading Rate (lbs/ac/yr)		Pollutant Loading (lbs/yr)	
		Current	Allowable	Current	Allowable (WLA)
Hay/Pasture	814.00	76.66	59.19	62,401.24	48,180.66
Cropland	2,758.00	1,267.93	533.18	3,496,950.94	1,470,510.44
Developed	2,010.00	89.12	449.51	179,131.20	903,511.10

From Table 6:

$$\begin{aligned} \text{WLA (sediment)} &= 351,495 \text{ lbs/yr (sewer discharge)} + 2,422,202.20 \text{ lbs/yr (MS4)} \\ \text{WLA (sediment)} &= 2,773,697.20 \text{ lbs/yr} \end{aligned}$$

D. Margin of Safety

The MOS is that portion of the pollutant loading that is reserved to account for any uncertainty in the data and computational methodology used for the analysis. For this analysis, the MOS is explicit. Ten percent of the targeted TMDL for sediment was reserved as the MOS. Using 10 percent of the TMDL load is based on professional judgment and will provide an additional level of protection to the designated uses of Lititz Run. The MOS used for the sediment TMDL was 606,646.44 lbs/yr.

$$\text{MOS (sediment)} = 6,066,464.43 \text{ lbs/yr (TMDL)} \times 0.1 = 606,646.44 \text{ lbs/yr}$$

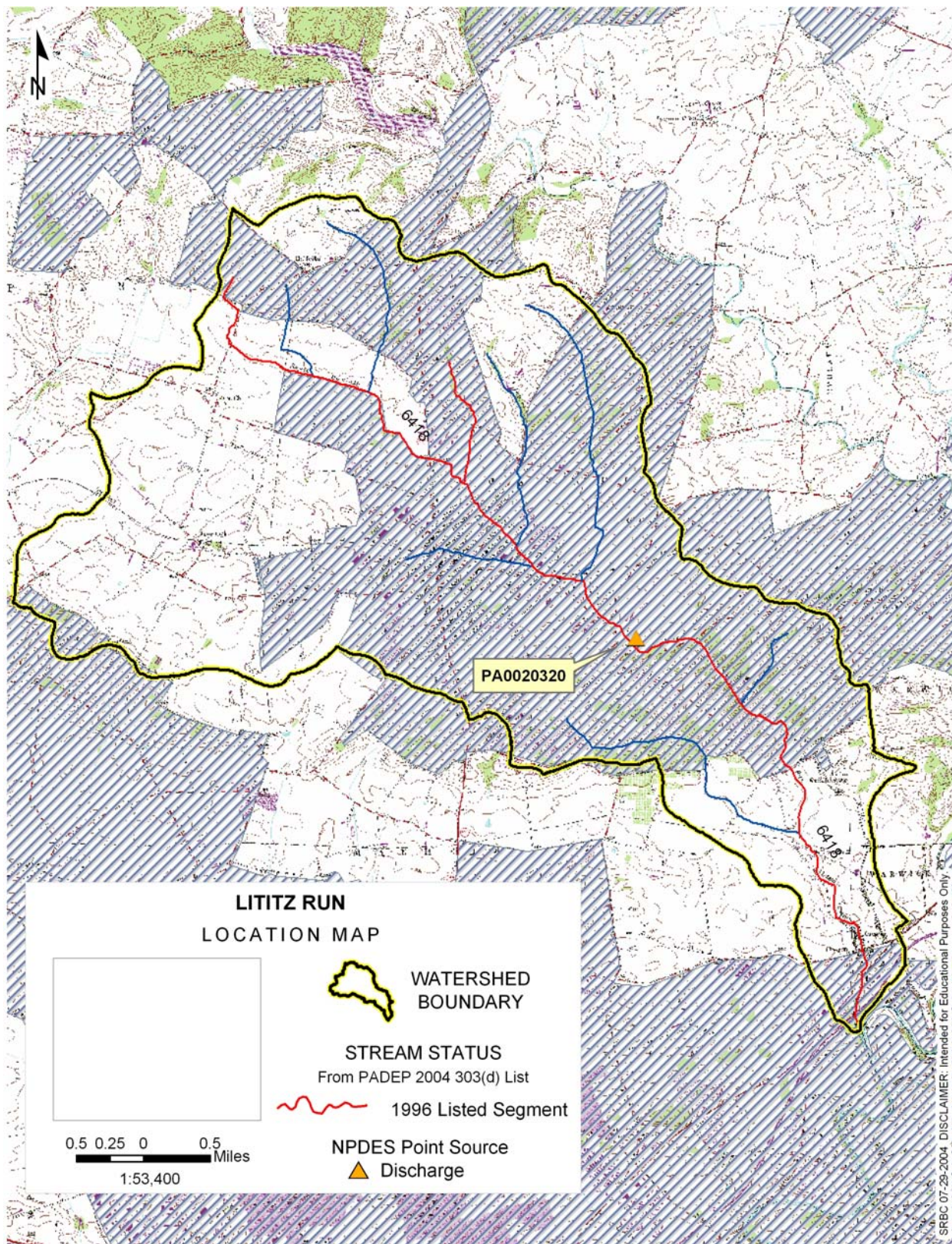


Figure 4. Map showing MS4 Designated Areas (shaded) in the Lititz Run Watershed

E. Load Allocation

The LA is that portion of the TMDL that is assigned to nonpoint sources. The LA was computed by subtracting the WLA and MOS values from the targeted TMDL value. The LA for sediment was 2,686,120.79 lbs/yr.

$$\text{LA (sediment)} = 6,066,464.43 \text{ lbs/yr (TMDL)} - 2,773,697.20 \text{ lbs/yr (WLA)} - 606,646.44 \text{ lbs/yr (MOS)} = 2,686,120.79 \text{ lbs/yr}$$

F. Adjusted Load Allocation

The ALA is the actual portion of the LA distributed among those nonpoint sources receiving reductions. It is computed by subtracting those nonpoint source loads that are not being considered for reductions (loads not reduced or LNR) from the LA. Sediment reductions were made to the hay/pasture, cropland, developed areas (sum of LO_INT_DEV, HI_INT_DEV, UNPAVED ROADS, QUARRY, TRANSITION), and streambanks. Those land uses/sources for which existing loads were not reduced (CONIF_FOR, MIXED_FOR, DECID_FOR) were carried through at their existing loading values (Table 7). The ALA for sediment was 2,681,320.79 lbs/yr.

<i>Table 7. Load Allocations, Loads Not Reduced, and Adjusted Load Allocations for Lititz Run</i>	
	Sediment (lbs/yr)
Load Allocation	2,686,120.79
Loads Not Reduced	4,800
CONIF_FOR	400
MIXED_FOR	2,600
DECID_FOR	1,800
Adjusted Load Allocation	2,681,320.79

G. TMDLs

The sediment TMDL established for the Lititz Run watershed consist of a LA, WLA, and MOS. The individual components of the TMDL are summarized in Table 8.

<i>Table 8. TMDL, WLA, MOS, LA, LNR, and ALA for Lititz Run</i>	
Component	Sediment (lbs/yr)
TMDL (Total Maximum Daily Load)	6,066,464.43
WLA (Wasteload Allocation)	2,773,697.20
MOS (Margin of Safety)	606,646.44
LA (Load Allocation)	2,686,120.79
LNR (Loads Not Reduced)	4,800
ALA (Adjusted Load Allocation)	2,681,320.79

V. Calculation of Sediment Load Reductions

The ALA established in the previous section represents the annual total sediment load that is available for allocation between contributing sources in the Lititz Run watershed. The ALA for sediment was allocated between agriculture, developed areas, and streambanks. LA and reduction procedures were applied to the entire Lititz Run watershed using the Equal Marginal Percent Reduction (EMPR) allocation method (Appendix E). The LA and EMPR procedures were performed using MS Excel and results are presented in Appendix F.

In order to meet the sediment TMDL, the load currently emanating from controllable sources must be reduced to 2,681,320.79 lbs/yr (Table 9). This can be achieved through reductions in current phosphorus loadings of 66 percent from cropland, 54 percent from streambanks, and 51 percent from hay/pasture and developed areas.

<i>Table 9. Sediment Load Allocations & Reductions for Lititz Run</i>						
Pollutant Source	Acres	Unit Area Loading Rate (lbs/ac/yr)		Pollutant Loading (lbs/yr)		% Reduction
		Current	Allowable	Current	Allowable (LA)	
Sediment						
Hay/Pasture	1,153.00	76.67	37.61	88,398.76	43,365.91	51
Cropland	3,066.30	1,267.93	428.98	3,887,849.06	1,315,379.39	66
Developed	164.50	89.17	43.75	14,668.80	7,196.09	51
Streambanks	0.00			2,833,933.80	1,315,379.39	54

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

VII. Consideration of Seasonal Variations

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

VIII. Recommendations for Implementation

TMDLs represent an attempt to quantify the pollutant load that may be present in a waterbody and still ensure attainment and maintenance of water quality standards. The Lititz Run TMDL identifies the necessary overall load reductions for sediment currently causing use impairments and distributes those reduction goals to the appropriate nonpoint sources. Reaching the reduction goals established by this TMDL will only occur through BMPs. BMPs that would be helpful in lowering the amount of sediment reaching Lititz Run include: streambank stabilization and fencing; riparian buffer strips; strip cropping; stormwater retention wetlands; and heavy use area protection, among many others.

Lititz Run is one of the few watersheds in the state that has shown an enormous amount of progress with working towards restoration prior to development of the TMDL. Many of the recommended BMPs mentioned in the previous paragraph have been implemented in various parts of the watershed already, and there are a number of ongoing efforts aimed at expanding BMP coverage. The Lititz Run Watershed Alliance (LRWA), with a membership ranging from local citizens to the local government and business groups, has been a primary proponent of these watershed restoration efforts.

The LRWA has been involved with restoration efforts since 1992. Since that time, projects in the watershed have included education and outreach activities, streambank stabilization and fencing, ordinance development, wetland construction, and many more. In addition, the LRWA has been conducting stream monitoring for the past seven years, in order to track progress and document any trends in water quality. The data indicates there have been improvements in water quality conditions for certain sections of Lititz Run.

The Natural Resources Conservation Service maintains a *National Handbook of Conservation Practices* (NHCP), which provides information on a variety of BMPs. The NHCP is available

online at http://www.ncg.nrcs.usda.gov/nhcp_2.html. Many of the practices described in the handbook could be used in the Lititz Run watershed to help limit sediment impairments. Determining the most appropriate BMPs, where they should be installed, and actually putting them into practice, will require the development and implementation of restoration plans. Development of any restoration plan will involve the gathering of site-specific information regarding current land uses and existing conservation practices. This type of assessment has been ongoing in the Lititz Run watershed, and it is strongly encouraged to continue.

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

IX. Public Participation

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

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

Literature Cited

- Commonwealth of Pennsylvania. 2001. Pennsylvania Code. Title 25 Environmental Protection. Department of Environmental Protection. Chapter 93. Water Quality Standards. Harrisburg, PA.
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- Novotny, V. and H. Olem, 1994. Water Quality: Prevention, Identification, and Management of Diffuse Pollution. Van Nostrand Reinhold, New York.
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Appendix A. Information Sheet for the Lititz Run TMDL

What is being proposed?

Total Maximum Daily Load (TMDL) plans have been developed to improve water quality in the Lititz Run watershed.

Who is proposing the plans? Why?

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

What is a TMDL?

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

What is a water quality standard?

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

What is the purpose of the plans?

Lititz Run is impaired due to sediment emanating from urban runoff, as well as agricultural runoff and other nonpoint sources. The plans include a calculation of the loading for sediment that will correct the problem and meet water quality objectives.

Why was Lititz Run selected for TMDL development?

In 1996, PADEP listed Lititz Run under Section 303(d) of the federal Clean Water Act as impaired due to causes linked to sediment.

What pollutants do these TMDLs address?

The proposed plans provide calculations of the stream's total capacity to accept sediment.

Where do the pollutants come from?

The sediment related impairments in Lititz Run come from nonpoint sources of pollution, primarily overland runoff from developed areas and agricultural lands, as well as from streambank erosion.

How was the TMDL developed?

PADEP used a reference watershed approach to estimate the necessary loading reduction of sediment that would be needed to restore a healthy aquatic community. The reference watershed approach is based on selecting a nonimpaired watershed that has similar land use characteristics and determining the current loading rates for the pollutants of interest. This is done by modeling the loads that enter the stream, using precipitation and land use characteristic data. For this analysis, PADEP used the AVGWLF model (the Environmental Resources Research Institute of the Pennsylvania State University's Arcview based version of the Generalized Watershed Loading Function model developed by Cornell University). This modeling process uses loading rates in the nonimpaired watershed as a target for load reductions in the impaired watershed. The impaired watershed is modeled to determine the current loading rates and determine what reductions are necessary to meet the loading rates of the nonimpaired watershed. The reference stream approach was used to set allowable loading rates in the affected watershed because neither Pennsylvania nor USEPA has instream numerical water quality criteria for sediment.

How much pollution is too much?

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

How will the loading limits be met?

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

How can I get more information on the TMDL?

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

How can I comment on the proposal?

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

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

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

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

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

For execution, the model requires three separate input files containing transport-, nutrient-, and weather-related data. The transport (TRANSPRT.DAT) file defines the necessary parameters for

each source area to be considered (e.g., area size, curve number, etc.), as well as global parameters (e.g., initial storage, sediment delivery ratio, etc.) that apply to all source areas. The nutrient (NUTRIENT.DAT) file specifies the various loading parameters for the different source areas identified (e.g., number of septic systems, urban source area accumulation rates, manure concentrations, etc.). The weather (WEATHER.DAT) file contains daily average temperature and total precipitation values for each year simulated.

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

In using this interface, the user is prompted to identify required GIS files and to provide other information related to “non-spatial” model parameters (e.g., beginning and end of the growing season, the months during which manure is spread on agricultural land, and the names of nearby weather stations). This information is subsequently used to automatically derive values for required model input parameters, which are then written to the TRANSPRT.DAT, NUTRIENT.DAT and WEATHER.DAT input files needed to execute the GWLF model. For use in Pennsylvania, AVGWLF has been linked with statewide GIS data layers such as land use/cover, soils, topography, and physiography; and includes location-specific default information such as background nitrogen and phosphorus concentrations and cropping practices. Complete GWLF-formatted weather files also are included for 80 weather stations around the state.

The following table lists the statewide GIS data sets and provides an explanation of how they were used for development of the input files for the GWLF model.

GIS Data Sets	
DATASET	DESCRIPTION
Censustr	Coverage of Census data including information on individual homes septic systems. The attribute <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. Used to calculate landslope and slope length.
Palumrlc	A satellite image derived land cover grid that is classified into 15 different land cover categories. This dataset provides land cover loading rate for the different categories in the model.
Pasingle	The 1:24,000 scale single line stream coverage of Pennsylvania. Provides a complete network of streams with coded stream segments.
Physprov	A shapefile of physiographic provinces. Attributes <i>rain_cool</i> and <i>rain_warm</i> are used to set recession coefficient.
Pointsrc	Major point source discharges with permitted nitrogen and phosphorus loads.
Refwater	Shapefile of reference watersheds for which nutrient and sediment loads have been calculated.
Soilphos	A grid of soil phosphorous loads, which has been generated from soil sample data. Used to help set phosphorus and sediment values.
Smallsheds	A coverage of watersheds derived at 1:24,000 scale. This coverage is used with the stream network to delineate the desired level watershed.
Statsgo	A shapefile of generalized soil boundaries. The attribute <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>muhs_g_dom</i> is used with land use cover to derive curve numbers.
Strm305	A coverage of stream water quality as reported in Pennsylvania's 305(b) report. Current status of assessed streams.
Surfgeol	A shapefile of the surface geology used to compare watersheds of similar qualities.
T9sheds	Data derived from a PADEP study conducted at PSU with N and P loads.
Zipcode	A coverage of animal densities. Attribute <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.

Appendix C. AVGWLF Model Inputs for the Lititz Run Watershed

Lititz Run Nutrient Input File

Runoff

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

Manure

	Dis N mg/L	Dis P mg/L
	3.66	0.57

Washoff

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

Point source and septic system nitrogen and phosphorus

Month	Pt Src N Kg	Pt Src P Kg	Norm Sys	Pond Sys	Short Circ Sys	Discharge Sys
APR	8639.69	15.125	947	0	26	0
MAY	8639.69	15.125	947	0	26	0
JUN	8639.69	15.125	947	0	26	0
JUL	8639.69	15.125	947	0	26	0
AUG	8639.69	15.125	947	0	26	0
SEP	8639.69	15.125	947	0	26	0
OCT	8639.69	15.125	947	0	26	0
NOV	8639.69	15.125	947	0	26	0
DEC	8639.69	15.125	947	0	26	0
JAN	8639.69	15.125	947	0	26	0
FEB	8639.69	15.125	947	0	26	0
MAR	8639.69	15.125	947	0	26	0

Per capita tank effluent (g/d)

N	P
12	2.5

Growing season (g/d)

N Uptake	P Uptake
1.6	0.4

Sediment (mg/kg)

N	P
3000	812

Groundwater (mg/l)

N	P
4.92368	0.0434125

File path: c:\AVGWLF_5\Lititz\nutredit1.dat

Buttons: Load File, Save File, Close

Lititz Run Transport Input File

Rural LU

Rural LU	Area (ha)	CN	K	LS	C	P
HAY/PAST	796	75	0.29748	0.33767	0.03	0.6
CROPLAND	2357	82	0.29495	0.33801	0.5	0.6
CONIF_FOR	24	73	0.27666	0.49199	0.002	0.45
MIXED_FOR	227	73	0.29145	0.37201	0.002	0.52
DECID_FOR	186	73	0.27828	0.38850	0.002	0.45
TRANSITION	21	87	0.27428	0.15922	0.8	0.8

Urban LU

Urban LU	Area (ha)	CN	K	LS	C	P
LO_INT_DEV	639	83	0.27931	0.37759	0.08	0.2
HI_INT_DEV	220	93	0.31127	0.16869	0.08	0.2

Antecedent Moisture Condition

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

Monthly Erosion Coefficients

Month	Ket	Day Hrs	Season	Eros Coef
APR	0.6344	13	0	0.300
MAY	0.8362	14	1	0.300
JUN	0.9533	15	1	0.300
JUL	1.0212	15	1	0.300
AUG	1.0606	14	1	0.300
SEP	1.0835	12	1	0.120
OCT	0.9034	11	0	0.120
NOV	0.7990	10	0	0.120
DEC	0.7384	9	0	0.120
JAN	0.5500	9	0	0.120
FEB	0.5940	10	0	0.120
MAR	0.6196	12	0	0.120

Initial Unsaturated Storage (cm): 10

Initial Snow (cm): 0

Sediment Delivery Ratio: 0.145

Recess Coef (l/day): 0.10032

Sediment A Factor: 4.493E-04

Seepage Coef (l/day): 0

Unsaturated Avail Wat (cm): 19.2062

File path: c:\Lititz\transedit1.dat

Buttons: Load File, Save File, Close

Appendix D. AVGWLF Model Inputs for the Catsauqua Creek Reference Watershed

Catsauqua Creek Nutrient Input File

Runoff

	Dis N mg/L	Dis P mg/L
HAY/PAST	2.9	0.2
CROPLAND	2.9	0.2
CONIF_FOR	0.19	0.006
MIXED_FOR	0.19	0.006
DECID_FOR	0.19	0.006
UNPAVED_RD	2.9	0.2
QUARRY	0.012	0.0019
TRANSITION	2.9	0.2

Manure

	2.44	0.38
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Washoff

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

Point source and septic system nitrogen and phosphorus

Month	Pt Src N Kg	Pt Src P Kg	Norm Sys	Pond Sys	Short Circ Sys	Discharge Sys
APR	0	0	1174	0	38	0
MAY	0	0	1174	0	38	0
JUN	0	0	1174	0	38	0
JUL	0	0	1174	0	38	0
AUG	0	0	1174	0	38	0
SEP	0	0	1174	0	38	0
OCT	0	0	1174	0	38	0
NOV	0	0	1174	0	38	0
DEC	0	0	1174	0	38	0
JAN	0	0	1174	0	38	0
FEB	0	0	1174	0	38	0
MAR	0	0	1174	0	38	0

Per capita tank effluent (g/d)

N	12
P	2.5

Growing season (g/d)

N Uptake	1.6
P Uptake	0.4

Sediment (mg/kg)

N	3000
P	373

Groundwater (mg/l)

N	3.74669
P	0.0361791

File: nutredit1.dat

Buttons: Load File, Save File, Close

Catsauqua Creek Transport Input File

Rural LU

	Area (ha)	CN	K	LS	C	P
HAY/PAST	603	75	0.28776	0.50599	0.03	0.3
CROPLAND	2381	82	0.29970	0.43765	0.3	0.3
CONIF_FOR	82	73	0.29182	0.33839	0.002	0.52
MIXED_FOR	30	73	0.30166	0.35493	0.002	0.52
DECID_FOR	383	73	0.28485	0.38347	0.002	0.52
UNPAVED_RD	2	87	0.30028	0.17013	0.8	1
QUARRY	1	89	0.24	0.06369	0.8	0.8
TRANSITION	84	87	0.2875	0.44608	0.8	0.8

Urban LU

	Area (ha)	CN	K	LS	C	P
LO_INT_DEV	383	80	0.33120	0.33603	0.08	0.2
HI_INT_DEV	94	90	0.35	0.24465	0.08	0.2

Antecedent Moisture Condition

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

Monthly Erosion Coefficients

Month	Ket	Day Hrs	Season	Eros Coef
APR	0.5299	13	0	0.300
MAY	0.7811	14	1	0.300
JUN	0.9268	15	1	0.300
JUL	1.0113	15	1	0.300
AUG	1.0603	14	1	0.300
SEP	1.0888	12	1	0.120
OCT	0.8612	11	0	0.120
NOV	0.7292	10	0	0.120
DEC	0.6527	9	0	0.120
JAN	0.4595	9	0	0.120
FEB	0.4962	10	0	0.120
MAR	0.5176	12	0	0.120

Initial Conditions

Init Unsat Stor (cm)	10	Initial Snow (cm)	0
Init Sat Stor (cm)	0	Sed Delivery Ratio	0.149
Recess Coef (l/day)	0.10031	Sediment A Factor	2.383E-04
Seepage Coef (l/day)	0	Unsat Avail Wat (cm)	16.9681

File: ltransport1.dat

Buttons: Load File, Save File, Close

Appendix E. Equal Marginal Percent Reduction Method

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

1. Calculation of the TMDL based on impaired watershed size and unit area loading rate of the reference watershed.
2. Calculation of Adjusted Load Allocation based on TMDL, Margin of Safety, and existing loads not reduced.
3. Actual EMPR Process.
 - a. Each land use/source load is compared with the total ALA to determine if any contributor would exceed the ALA by itself. The evaluation is carried out as if each source is the only contributor to the pollutant load of the receiving waterbody. If the contributor exceeds the ALA, that contributor would be reduced to the ALA. If a contributor is less than the ALA, it is set at the existing load. This is the baseline portion of the EMPR.
 - b. After any necessary reductions have been made in the baseline, the multiple analyses are run. The multiple analyses will sum all of the baseline loads and compare them to the ALA. If the ALA is exceeded, an equal percent reduction will be made to all contributors' baseline values. After any necessary reductions in the multiple analyses, the final reduction percentage for each contributor can be computed.
4. Calculation of total loading rate of all sources receiving reductions.
5. Summary of existing loads, final load allocations, and percent reduction for each pollutant source.

Appendix F. Equal Marginal Percent Reduction Calculations for the Lititz Run TMDL

Step 1:	TMDL Total Load				Step 2:	Adjusted LA = (TMDL total load - MOS) - uncontrollable						
	Load = loading rate in ref. * Acres in Impaired					2681320.79	2681321					
	6066464											
	SEDIMENT LOADING											
Step 3:		Non-MS4 Annual Average Load	Load Sum	Check	Initial Adjust	Recheck	% reduction allocation	Load Reduction	Initial LA	Acres	Allowable Loading Rate	% Reduction
	Hay/Past.	88398.76	6824850.42	good	88399	ADJUST	0.02	45032.85	43365.91	1153.00	37.61	51%
	Cropland	3887849.06		bad	2681321	2784388	0.49	1365941.39	1315379.39	3066.30	428.98	66%
	Developed	14668.80		good	14669		0.00	7472.71	7196.09	164.50	43.75	51%
	Streambank	2833933.80		bad	2681321		0.49	1365941.39	1315379.39	0.00		54%
	Total	6824850.42			5465709.138		1.00		2681320.79			
Step 4:	All Ag. Loading Rate	322.03										
Step 5:		Acres	Allowable (Target) Loading Rate	Final LA	Current Loading Rates	Current Load	% Red.					
	Final Hay/Past. LA	1153.00	37.61	43365.91	76.67	88398.76	51%					
	Final Cropland LA	3066.30	428.98	1315379.39	1267.93	3887849.06	66%					
	Developed	164.50	43.75	7196.09	89.17	14668.80	51%					
	Streambank	0.00		1315379.39		2833933.80	54%					
				2681320.79		6824850.42	61%					
	MS4 Loads											
		Acres	Allowable (Target) Loading Rate	Final w/LA	Current Loading Rates	Current Load	% Red.	Total Annual Average Load	Non MS4 Annual Average Load			
	Final Hay/Past. LA	814.00	59.19	48180.66	76.66	62401.24	23%	150800.00	88398.76			
	Final Cropland LA	2758.00	533.18	1470510.44	1267.93	3496950.94	58%	7384800.00	3887849.06			
	Developed	2010.00	449.51	903511.10	89.12	179131.20	0%	193800.00	14668.80			
	Total			2422202.20		3738483.38	35%		3990916.62			
	Lititz Run											

Appendix G. Comment & Response Document for the Lititz Run TMDL