# LITTLE CHIQUES CREEK WATERSHED TMDL

## Lancaster and Lebanon Counties

Prepared for:

Pennsylvania Department of Environmental Protection

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## TABLE OF CONTENTS



## FIGURES



## TABLES

## ATTACHMENTS

## TMDL SUMMARIES

1. The impaired stream segments addressed by this Total Maximum Daily Load (TMDL) are located in Penn, Mount Joy, East Donegal, and South Londonderry Townships in Lancaster and Lebanon Counties, Pennsylvania. The stream segments drain approximately 44.5 square miles as part of State Water Plan subbasin 7G. The aquatic life existing uses for Little Chiques Creek, including its tributaries, are trout stocking fishery and migratory fishes (25 Pa. Code Chapter 93).

2. Pennsylvania's 2012 303(d) list identified 22.16 miles within the Little Chiques Creek Watershed as impaired by nutrients and sediment from agricultural land use. The listings were based on data collected in 1997 through the Pennsylvania Department of Environmental Protection's (PADEP's) Surface Water Monitoring Program. In order to ensure attainment and maintenance of water quality standards in the Little Chiques Creek Watershed, mean annual loadings for sediment and phosphorus will need to be limited 23,230.6498 pounds per day (lbs/day) and 17.0709 lbs/day, respectively.

   The major components of the Little Chiques Creek Watershed TMDL are summarized below.

| **Little Chiques Creek Watershed Components** | **Sediment (lbs/day)** | **Phosphorus (lbs/day)** |
|---|---|---|
| TMDL (Total Maximum Daily Load) | 23,230.6498 | 17.0709 |
| MOS (Margin of Safety) | 2,323.0650 | 1.7071 |
| WLA (Waste Load Allocation) | 679.8321 | 11.3184 |
| LA (Load Allocation) | 20,227.7527 | 4.0454 |

3. Mean annual sediment and phosphorus loadings are estimated at 29,519.5803 lbs/day and 32.1627 lbs/day, respectively. To meet the TMDL, the sediment and phosphorus loadings will require reductions of 21 percent and 47 percent, respectively.

4. Permit PA0042781 (Mount Joy Wire Corp.) has a sediment and phosphorus waste load allocation (WLA) of 61.3107 lbs/day and 0.6220 lbs/day. Permit PA0021067 (Mount Joy Boro Sewer Authority) has a sediment and phosphorus WLA of 383.0355 lbs/day and 10.2079 lbs/day. Permit PA0088498 (Eagle Land Management) has a sediment and phosphorus WLA of 3.1794 lbs/day and 0.3178 lbs/day. Bulk reserves of 232.3065 lbs/day for sediment and 0.1707 lbs/day for phosphorus have been inserted into the TMDL to reflect dynamic permit activity.

5. The adjusted load allocation (ALA) is the actual portion of the load allocation (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 and phosphorus TMDL includes a nonpoint source ALA of 20,178.0540 lbs/day and 3.7747 lbs/day, respectively. Sediment and phosphorus loadings from all other sources, such as forested, wetlands, and septic systems were maintained at their existing levels. Allocations of sediment and phosphorus to controllable nonpoint sources, or the ALA, for the Little Chiques Creek Watershed TMDL are summarized below.

| Little Chiques Creek: Adjusted Load Allocations for Sources of Sediment and Phosphorus | | | |
|---|---|---|---|
| **Pollutant** | **Current Loading (lbs/day)** | **Adjusted Load Allocation (lbs/day)** | **% Reduction** |
| **Sediment** | 29,519.5803 | 20,178.0540 | 32 |
| **Phosphorus** | 32.1627 | 3.7747 | 88 |

6. Ten percent of the Little Chiques Creek Watershed 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 and phosphorus TMDL is 2,323.0650 lbs/day and 1.7071 lbs/day, respectively.

7. The continuous simulation model used for developing the Little Chiques Creek Watershed 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.

## WATERSHED BACKGROUND

The Little Chiques Creek Watershed is approximately 44.5 square miles in area. The headwaters of Little Chiques Creek are located inside the southeastern portion of Lebanon County, a few miles northeast of Mount Joy, Pa. The watershed is located on the U.S. Geological Survey (USGS) 7.5 minute quadrangles of Elizabethtown, Manheim, Columbia East, and Columbia West, Pa. The stream flows south to its confluence with Chiques Creek. The major tributaries to Little Chiques Creek include Brubaker Run and Back Run, as well as several unnamed tributaries (UNTs). Interstate 76 provides access to the headwaters of Little Chiques Creek while State Highways 283 and 230 provide access to the southern portion of the watershed and its numerous tributaries.

The TMDL watershed is located within both the Gettysburg-Newark-Lowland Section and Piedmont Lowland Section of the Piedmont physiographic province. The highest elevations are located in the northeastern portion of the watershed near Mount Joy. The total change in elevation in the watershed is approximately 450 feet from the headwaters to the mouth.

The majority of the rock type in the upland portions of the watershed is sandstone (60 percent), predominantly associated with the Cocalico Formation and the New Oxford Formation (Figure 1). The remaining rock types found in the watershed are interbedded sedimentary and carbonate (33 percent combined), predominantly associated with the Hammer Creek Formation and the Epler Formation.

The Berks-Weikert-Bedington series is the predominant soil type in the TMDL watershed. This soil is listed as a channery silt loam soil and is mostly associated with nearly level to sloping

uplands within the watershed (Figure 2). Other dominant soils in the watershed consist of Ungers-Penn-Klinesville and Hagerstown-Duffield-Clarksburg.

Based on GIS datasets created in 2001, land use values were calculated for the TMDL watershed. Agricultural land was the dominant land use at approximately 68 percent (Figure 3). Forested land accounts for approximately 19 percent of the watershed. Developed areas are 13 percent of the watershed, covering low-intensity residential and transitional. Riparian buffer zones are existent but in need of improvement (Figure 4) in some of the agricultural lands. Livestock also have limited access to streambanks in most parts of the watershed, helping reduce streambank trampling and severe erosion. Some contiguous forested tracts remain in the watershed.

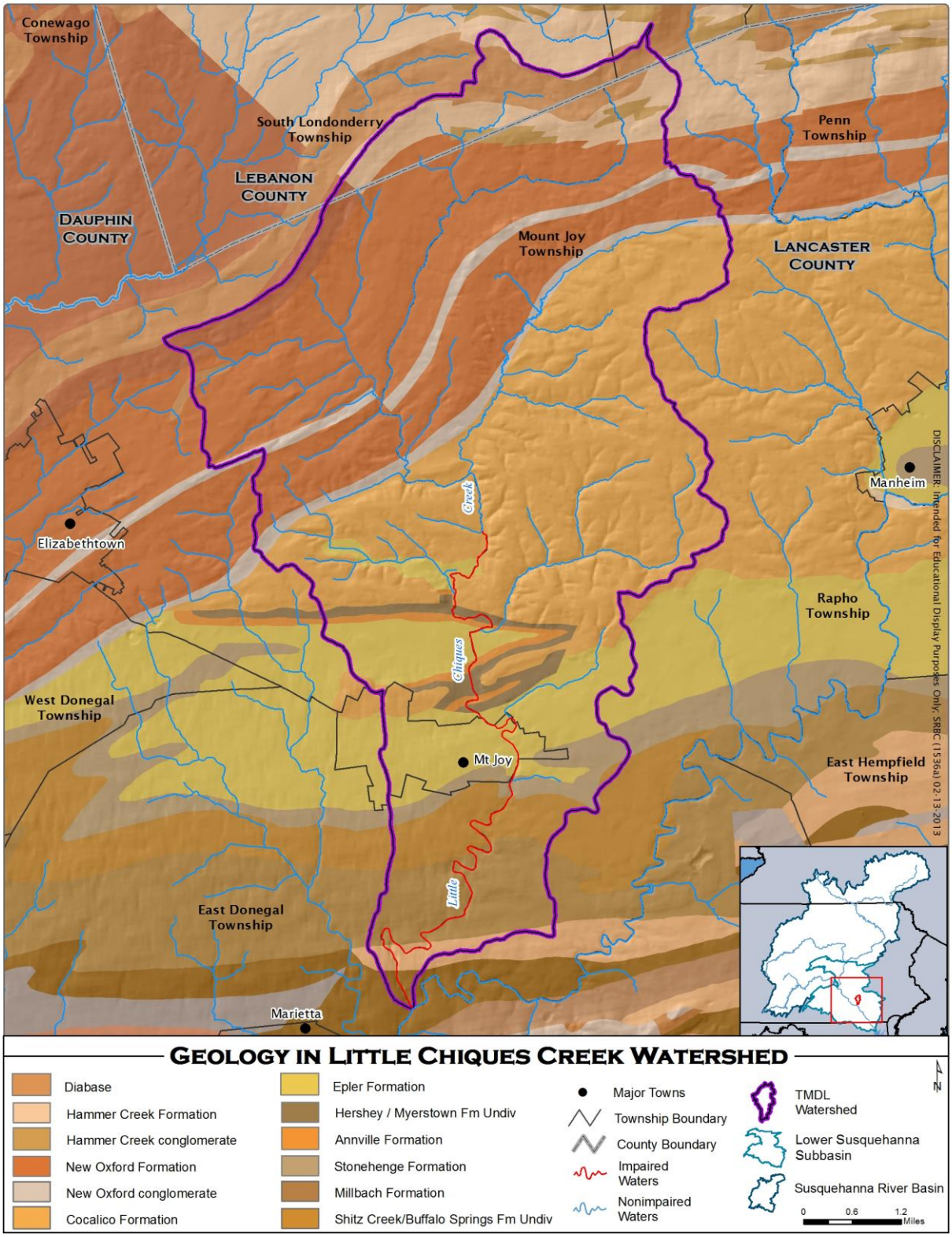



***Figure 1. Geology Map of Little Chiques Creek Watershed***

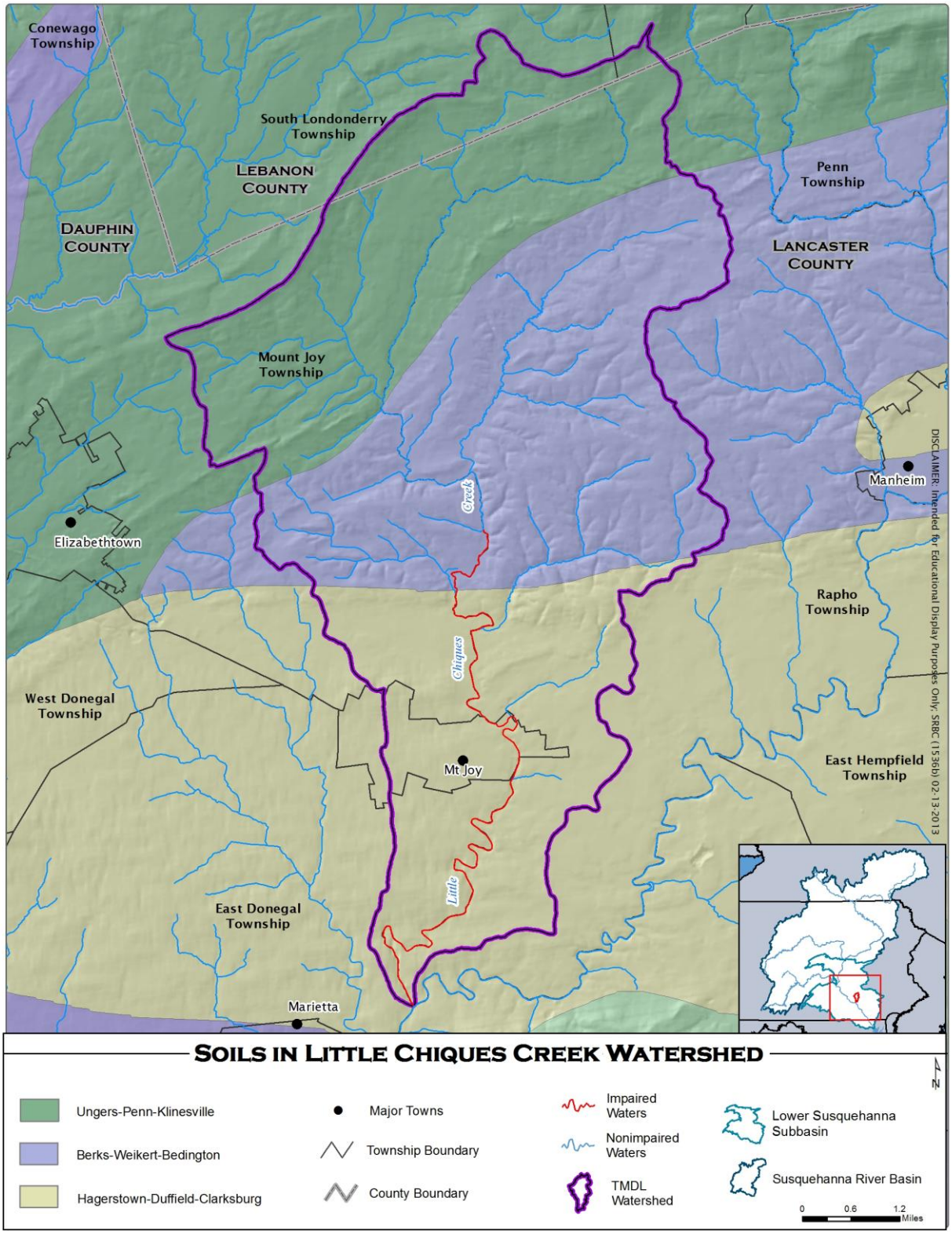



***Figure 2. Soils Map of Little Chiques Creek Watershed***

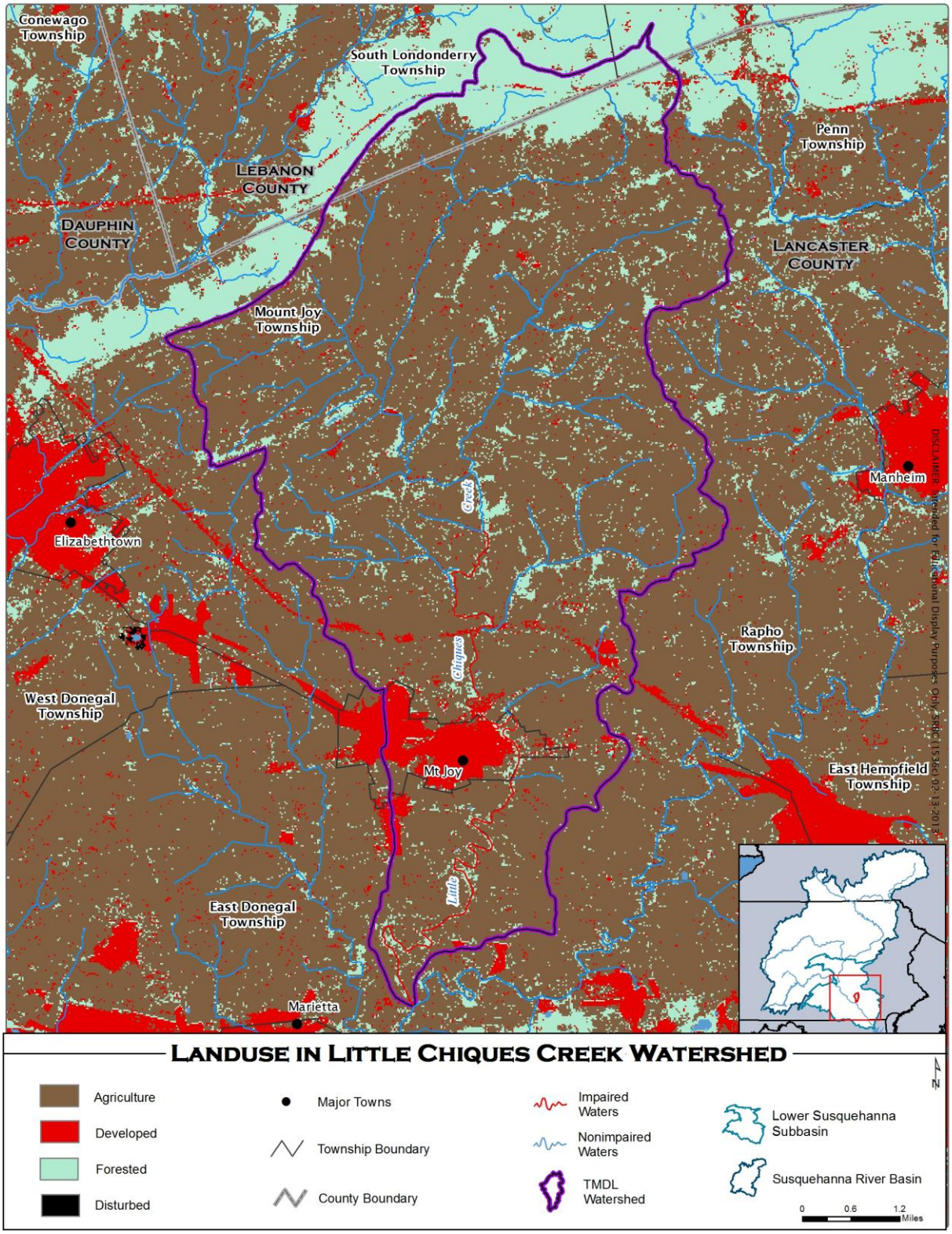



***Figure 3. Land Use Map of Little Chiques Creek Watershed***

***Figure 4. Photo of Little Chiques Creek***

### Surface Water Quality

Pennsylvania's 2012 edition of the 303(d) list identified 22.16 miles of the Little Chiques Creek Watershed as impaired by nutrients and siltation emanating from agricultural practices (Table 1).

***Table 1. Integrated Water Quality Monitoring and Assessment Report Listed Segments***

| State Water Plan (SWP) Subbasin: 7G | | | | |
|---|---|---|---|---|
| HUC: 02050306 – Lower Susquehanna | | | | |
| Watershed – Little Chiques Creek | | | | |
| **Source** | **EPA 305(b) Cause Code** | **Miles** | **Designated Use** | **Use Designation** |
| Agriculture* | Siltation | 11.08 | TSF, MF | Aquatic Life |
| Agriculture | Nutrients | 11.08 | TSF, MF | Aquatic Life |

* Please see Attachment H for more details.

## APPROACH TO TMDL DEVELOPMENT

### Pollutants & Sources

Nutrients and sediment have been identified as the pollutants causing designated use impairments in the Little Chiques Creek Watershed, with the source(s) listed as agricultural. At present, there are no point source contributions within the segments addressed in this TMDL.

As stated in previous sections, the land use is dominantly agriculture. Pasture and croplands extend right up to the streambanks with little to no riparian buffer zones present. Livestock have unlimited access to streambanks throughout most of the watershed. Based on visual observations, streambank erosion is severe in most reaches of the streams.

### TMDL Endpoints

In an effort to address the sediment and nutrients problem found in the Little Chiques Creek Watershed, a TMDL was developed to establish loading limits for sediment and nutrients. The TMDL is intended to address sediment and nutrient impairments from developed land uses that were first identified in Pennsylvania's 1998 303(d) list, as well as other nonpoint sources such as agriculture. The decision to use phosphorus load reductions to address nutrient enrichment is based on an understanding of the relationship between nitrogen, phosphorus, and organic enrichment in stream systems. Elevated nutrient loads from human activities (nitrogen and phosphorus in particular) can lead to increased productivity of aquatic plants and other organisms, resulting in the degradation of water quality conditions through the depletion of dissolved oxygen in the water column (Novotny and Olem, 1994; Hem, 1983). In aquatic ecosystems, the quantities of trace elements are typically plentiful; however, nitrogen and phosphorus may be in short supply. The nutrient that is in the shortest supply is called the limiting nutrient because its relative quantity affects the rate of production (growth) of aquatic

biomass. If the limiting nutrient load to a waterbody can be reduced, the available pool of nutrients that can be utilized by plants and other organisms will be reduced and, in general, the total biomass can subsequently be decreased as well (Novotny and Olem, 1994). In most efforts to control the eutrophication processes in waterbodies, emphasis is placed on the limiting nutrient. However, this is not always the case. For example, if nitrogen is the limiting nutrient, it still may be more efficient to control phosphorus loads if the nitrogen originates from difficult to control sources, such as nitrates in groundwater.

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

### Reference Watershed Approach

The TMDL developed for the Little Chiques Creek Watershed addresses sediment and nutrients. Because neither Pennsylvania nor the U.S. Environmental Protection Agency (USEPA) has instream numerical water quality criteria for sediment and phosphorus, 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.

### 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 20-35 percent of the impaired watershed area. The search for a reference watershed for the Little Chiques Creek Watershed to 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 streams database, and geologic rock types.

Clover Creek was selected as the reference watershed for developing the Little Chiques Creek Watershed TMDL. Clover Creek is located just east of Williamsburg, in Blair County, Pa. (Figure 5). The watershed is located in State Water Plan subbasin 11A, a tributary to Frankstown Branch Juniata River, and protected uses include aquatic life and recreation. The tributary is currently designated as a High Quality Cold Water Fishery (25 Pa. Code Chapter 93). Based on PADEP assessments, Clover Creek is currently attaining its designated uses. The attainment of designated uses is based on sampling done by PADEP as part of its State Surface Water Assessment Program.

Drainage area, location, and other physical characteristics of the impaired segments of the Little Chiques Creek Watershed were compared to the Clover Creek Watershed (Table 2). Agricultural land is a dominant land use category in the Little Chiques Creek Watershed (68 percent) and Clover Creek (40 percent). The geology, soils, and precipitation in both are also similar (Table 2).

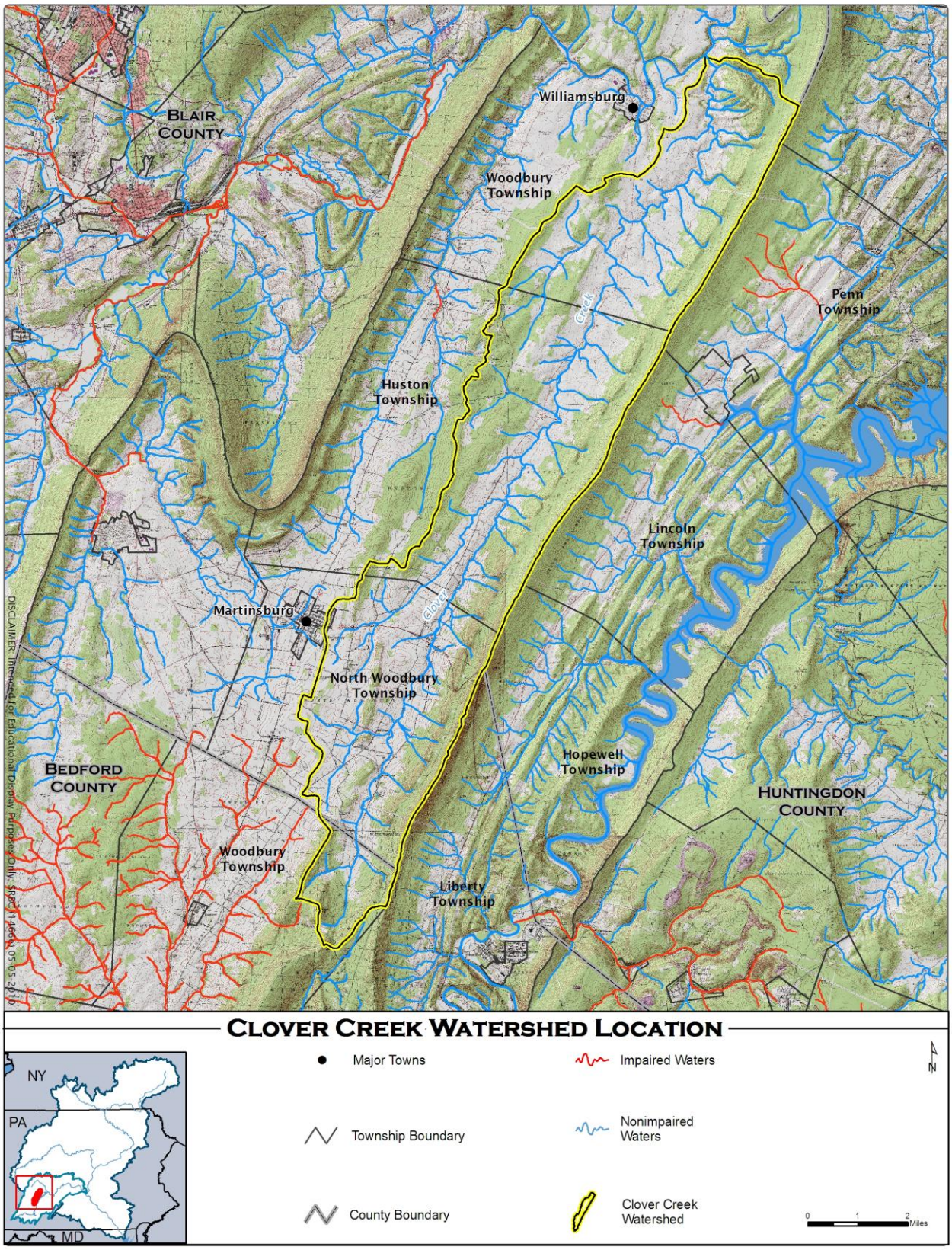



***Figure 5. Location Map for Reference Watershed Clover Creek***

***Table 2. Comparison Between Little Chiques Creek Watershed and Clover Creek Watershed***

| | Little Chiques Creek Watershed | Clover Creek Watershed |
|---|---|---|
| Physiographic Province | Piedmont Lowland Section – Piedmont Province (60%) Gettysburg-Newark Lowland Section – Piedmont Province (40%) | Appalachian Mountain Section – Ridge & Valley Province (100%) |
| Area (acres) | 28,451.5 | 32,052.0 |
| Land Use Distribution<br>% Agriculture<br>% Forested<br>% Other | <br>67.99<br>18.88<br>13.13 | <br>39.49<br>57.57<br>2.94 |
| Soils<br>Dominant Group C % | 70.0 | 85.0 |
| Surface Geology<br>Carbonate % | 31.0 | 48.0 |
| Average Rainfall (in) | 42.11, 24 years | 40.50, 24 years |
| Average Runoff (in) | 0.29, 24 years | 0.19, 24 years |

## Watershed Assessment and Modeling

The TMDL for the impaired segments of the Little Chiques Creek Watershed was developed using the ArcView Generalized Watershed Loading Function model (AVGWLF) as described in Attachment C. The AVGWLF model was used to establish existing loading conditions for the impaired segments of the Little Chiques Creek Watershed and the Clover Creek reference watershed. All modeling inputs have been attached to this TMDL as Attachments D and E. SRBC staff visited the watershed in winter 2012 and spring 2013. 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:

**Little Chiques Creek Watershed**

- Reset P factor for cropland (0.52) and hay/pasture (0.52) land uses to 0.36 and 0.36, respectively, while forested (0.45) and wetlands (0.10) remained unchanged. These changes were made to account for the erosion reducing management practices.
- Reset C factor for cropland (0.42) and hay/pasture (0.03) land uses to 0.29 and 0.02, respectively, while forested (0.002) and wetlands (0.01) remained unchanged. These changes were made to reflect general vegetative management practices in the watershed.

The AVGWLF model produced information on watershed size, land use, nutrients, and sediment loading. The sediment and nutrient loadings represent an annual average over a 24-year period, from 1975 to 1998, and for the Little Chiques Creek Watershed and Clover Creek Watershed, respectively. This information was then used to calculate existing unit area loading rates for the two watersheds. Acreage and sediment loading information for both the impaired watershed and the reference watershed are shown in Tables 3 and 4, respectively.

*Table 3. Existing Sediment and Phosphorus Loads for Little Chiques Creek Watershed*

| Pollutant Source | Acreage | Phosphorus | | Sediment | |
|---|---|---|---|---|---|
| | | Mean Annual Loading (lbs/day) | Unit Area Loading (lbs/ac/day) | Mean Annual Loading (lbs/day) | Unit Area Loading (lbs/ac/day) |
| HAY/PAST | 8,250.8 | 4.0790 | 0.0005 | 523.6712 | 0.0635 |
| CROPLAND | 11,092.5 | 17.8395 | 0.0016 | 14,016.1644 | 1.2636 |
| FOREST | 5,297.9 | 0.0487 | 0.0000 | 49.4795 | 0.0093 |
| WETLAND | 74.1 | 0.0021 | 0.0000 | 0.2192 | 0.0030 |
| TURF_GRASS | 202.6 | 0.1024 | 0.0005 | 75.4521 | 0.3724 |
| TRANSITION | 160.6 | 0.2194 | 0.0014 | 120.3836 | 0.7496 |
| LO_INT_DEV | 3,338.4 | 0.5558 | 0.0002 | 566.3562 | 0.1692 |
| HI_INT_DEV | 34.6 | 0.0654 | 0.0019 | 2.1370 | 0.0618 |
| Streambank | - | 0.3117 | - | 14,165.7173 | - |
| Groundwater | - | 8.7187 | - | - | - |
| Septic System | - | 0.2199 | - | - | - |
| **TOTAL** | 28,451.5 | 32.1627 | 0.0011 | 29,519.5803 | 1.0375 |

*Table 4. Existing Sediment and Phosphorus Loads for Clover Creek Watershed*

| Pollutant Source | Acreage | Phosphorus | | Sediment | |
|---|---|---|---|---|---|
| | | Mean Annual Loading (lbs/day) | Unit Area Loading (lbs/ac/day) | Mean Annual Loading (lbs/day) | Unit Area Loading (lbs/ac/day) |
| HAY/PAST | 10,247.4 | 5.7632 | 0.0006 | 2,894.0274 | 0.2824 |
| CROPLAND | 2,411.7 | 5.0141 | 0.0021 | 6,548.2740 | 2.7152 |
| FOREST | 18,414.3 | 1.5927 | 0.0001 | 2,966.6849 | 0.1611 |
| WETLAND | 37.1 | 0.0010 | 0.0000 | 0.1644 | 0.0044 |
| UNPAVED_RD | 9.9 | 0.0228 | 0.0023 | 30.5753 | 3.0884 |
| LO_INT_DEV | 931.6 | 0.1467 | 0.0002 | 184.3288 | 0.1979 |
| Streambank | - | 0.2980 | - | 13,546.0167 | - |
| Groundwater | - | 6.9755 | - | - | - |
| Septic System | - | 0.1050 | - | - | - |
| **TOTAL** | 32,052.0 | 19.9189 | 0.0006 | 26,170.0715 | 0.8165 |

## TMDLS

The targeted TMDL value for the Little Chiques Creek Watershed was established based on current loading rates for sediment and phosphorus in the Clover Creek reference watershed. Biological assessments have determined that Clover Creek is currently attaining its designated uses.

Reducing the loading rate of sediment and phosphorus in the Little Chiques Creek Watershed to levels equivalent to those in the reference watershed will provide conditions favorable for the reversal of current use impairments.

### 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.

## Targeted TMDLs

The targeted TMDL value for sediment and phosphorus was determined by multiplying the total area of the Little Chiques Creek Watershed (28,451.5 acres) by the appropriate unit-area loading rate for the Clover Creek reference watershed (Table 4). The existing mean annual loading of sediment and phosphorus to Little Chiques Creek Watershed (29,519.5803 lbs/day and 32.1627 lbs/day, respectively) will need to be reduced by 21 and 47 percent, respectively, to meet the targeted TMDL of 23,230.6498 lbs/day and 17.0709 lbs/day, respectively.

***Table 5. Targeted TMDL for Little Chiques Creek Watershed***

| Pollutant | Area (ac) | Unit Area Loading Rate Clover Creek Reference Watershed (lbs/ac/day) | Targeted TMDL for Little Chiques Creek (lbs/day) |
|---|---|---|---|
| **Sediment** | 28,451.5 | 0.8165 | 23,230.6498 |
| **Phosphorus** | 28,451.5 | 0.0006 | 17.0709 |

Targeted TMDL values were used as the basis for load allocations and reductions in the Little Chiques Creek Watershed, using the following two equations:

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

where:

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

## 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 and phosphorus were 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 Little Chiques Creek Watershed. The MOS used for the sediment and phosphorus TMDL is shown below.

Little Chiques Creek Watershed:

MOS (sediment) = 23,230.6498 lbs/day (TMDL) x 0.1 = 2,323.0650 lbs/day

MOS (phosphorus) = 17.0709 lbs/day (TMDL) x 0.1 = 1.7071 lbs/day

### Waste Load Allocation

The WLA portion of the TMDL equation is the total loading of a pollutant that is assigned to point sources. Reviewing the PADEP's permitting files identified three point source discharges for sediment and phosphorus in the watershed.

The Mount Joy Wire Corp. discharges into the streams covered by this TMDL, permit number PA0042781. The monthly average for suspended solids is 31.0 mg/L and ~0.3145 mg/L for phosphorus, which was included in the AVGWLF modeling runs for determining existing conditions. The design flow for the Mount Joy Wire Corp. is 0.237 million gallons per day (mgd). Based on the monthly average for this facility, the potential for sediment and phosphorus loads if the Mount Joy Wire Corp. capacities were fully utilized is 61.3107 lbs/day and 0.6220 lbs/day, respectively. This loading rate based on the design capacities of the plant is used in the final TMDL allocations (WLA).

The Mount Joy Boro Sewer Authority discharges treated sewage effluent into the streams covered by this TMDL, permit number PA0021067. The monthly average for suspended solids is 30.0 mg/L and ~0.7995 mg/L for phosphorus, which was included in the AVGWLF modeling runs for determining existing conditions. The design flow for the Mount Joy Boro Sewer Authority is 1.53 mgd. Based on the monthly average for this facility, the potential for sediment and phosphorus loads if the Mount Joy Boro Sewer Authority capacities were fully utilized is 383.0355 lbs/day and 10.2079 lbs/day, respectively. This loading rate based on the design capacities of the plant is used in the final TMDL allocations (WLA).

The Eagle Land Management discharges into the streams covered by this TMDL, permit number PA0088498. The monthly average for suspended solids is 30.0 mg/L and ~2.9987 mg/L for phosphorus, which was included in the AVGWLF modeling runs for determining existing conditions. The design flow for the Eagle Land Management is 0.0127 mgd. Based on the monthly average for this facility, the potential for sediment and phosphorus loads if the Eagle Land Management capacities were fully utilized is 3.1794 lbs/day and 0.3178 lbs/day, respectively. This loading rate based on the design capacities of the plant is used in the final TMDL allocations (WLA).

The bulk reserve is explicit and is calculated as one percent of the targeted TMDL. This bulk reserve enables the TMDL to account for the dynamic nature of permit activity (Table 6).

*Table 6. Waste Load Allocations for the Warrior Run Watershed*

| Name | NPDES Permit # | Phosphorus WLA (lb/yr) | Phosphorus WLA (lb/day) | Sediment WLA (lb/yr) | Sediment WLA(lb/day) |
|---|---|---|---|---|---|
| Mount Joy Wire Corp. | PA0042781 | 227.0 | 0.6220 | 22,378.4 | 61.3107 |
| Mount Joy Boro Sewer Authority | PA0021067 | 3,726.0 | 10.2079 | 139,808.0 | 383.0355 |
| Eagle Land Management | PA0088498 | 116.0 | 0.3178 | 1,160.5 | 3.1794 |
| Bulk Reserve | - | 62.3 | 0.1707 | 84,791.9 | 232.3065 |
| **Total** | **-** | **4,131.3** | **11.3184** | **248,138.8** | **679.8321** |

## 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 and phosphorus reductions were made to the hay/pasture, cropland, developed areas (sum of LO_INT_DEV and TRANSITION), and streambanks. Those land uses/sources for which existing loads were not reduced (FOREST, WETLANDS, and Septic Systems,) were carried through at their existing loading values (Table 7).

***Table 7. Load Allocations, Loads not Reduced, and Adjusted Load Allocation for Little Chiques Creek***

| Component | Sediment (lbs/day) | Phosphorus (lbs/day) |
|---|---|---|
| **Load Allocation** | 20,227.7527 | 4.0454 |
| **Loads not Reduced** | 49.6987 | 0.2707 |
| **FOREST** | 49.4795 | 0.0487 |
| **WETLANDS** | 0.2192 | 0.0021 |
| **Septic Systems** | - | 0.2199 |
| **Adjusted Load Allocation** | 20,178.0540 | 3.7747 |

## TMDLs

The sediment and phosphorus TMDL established for the Little Chiques Creek Watershed consists of a LA, ALA, and MOS. The individual components of the TMDL are summarized in Table 8.

***Table 8. Load Allocations, Loads not Reduced, and Adjusted Load Allocation for Little Chiques Creek***

| Component | Sediment (lbs/day) | Phosphorus (lbs/day) |
|---|---|---|
| **TMDL (Total Maximum Daily Load)** | 23,230.6498 | 17.0709 |
| **MOS (Margin of Safety)** | 2,323.0650 | 1.7071 |
| **WLA (Waste Load Allocation)** | 679.8321 | 11.3184 |
| **LA (Load Allocation)** | 20,227.7527 | 4.0454 |
| **LNR (Loads not Reduced)** | 49.6987 | 0.2707 |
| **ALA (Adjusted Load Allocation)** | 20,178.0540 | 3.7747 |

## CALCULATION OF SEDIMENT LOAD REDUCTIONS

The ALA established in the previous section represents the annual total sediment and phosphorus loads that are available for allocation between contributing sources in the Little Chiques Creek Watershed. The ALA for sediment and phosphorus was allocated between agriculture, developed areas, and streambanks. LA and reduction procedures were applied to the entire Little Chiques Creek Watershed using the Equal Marginal Percent Reduction (EMPR) allocation method (Attachment F). The LA and EMPR procedures were performed using MS Excel, and results are presented in Attachment G.

In order to meet the sediment and phosphorus TMDL, the load currently emanating from controllable sources must be reduced (Table 8). This can be achieved through reductions in current sediment and phosphorus loadings from cropland, from hay/pasture, developed areas, and streambanks (Table 9).

***Table 9. Sediment and Phosphorus Load Allocations and Reductions for Little Chiques Creek Watershed***

| Pollutant Source | Acres | Unit Area Loading Rate (lbs/ac/day) | | Pollutant Loading (lbs/day) | | % Reduction |
|---|---|---|---|---|---|---|
| | | Current | Allowable | Current | Allowable (LA) | |
| **Sediment** | | | | | | |
| Hay/Pasture | 5,379.50 | 0.0635 | 0.0435 | 523.6713 | 358.5582 | 32 |
| Cropland | 3,784.60 | 1.2636 | 0.8652 | 14,016.1644 | 9,596.8801 | 32 |
| Developed | 4,156.30 | 0.2046 | 0.1401 | 764.3289 | 523.3367 | 32 |
| Streambanks | - | - | - | 14,165.7173 | 9,699.2791 | 32 |
| Total | | | | 29,469.8819 | 20,178.0540 | 32 |
| **Phosphorus** | | | | | | |
| Hay/Pasture | 5,379.50 | 0.0005 | 0.0001 | 4.0790 | 0.9663 | 76 |
| Cropland | 3,784.60 | 0.0016 | 0.0001 | 17.8395 | 1.2991 | 93 |
| Developed | 4,156.30 | 0.0003 | 0.0001 | 0.9430 | 0.2830 | 70 |
| Groundwater | - | - | - | 8.7187 | 1.1327 | 87 |
| Streambanks | - | - | - | 0.3117 | 0.0935 | 70 |
| Total | | | | 31.8919 | 3.7747 | 88 |

## 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.

## 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.

## 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 Little Chiques Creek Watershed TMDL identifies the necessary overall load reductions for sediment and phosphorus 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 Best Management Practices (BMPs). BMPs that would be helpful in lowering the amounts of sediment and phosphorus reaching Little Chiques Creek include the following: streambank stabilization and fencing; riparian buffer strips; strip cropping; conservation tillage; stormwater retention wetlands; and heavy use area protection, among many others.

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 Little Chiques Creek Watershed to help limit sediment and phosphorus 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 Little Chiques Creek Watershed, and it is strongly encouraged to continue.

The Chesapeake Bay TMDL, established by USEPA in 2010, requires reductions of nitrogen, phosphorus, and sediment loads throughout the Bay watershed to meet water quality standards that protect the designated uses in the Bay and its tidal tributaries. Pennsylvania's Phase I and Phase II WIPs, together with the State's schedule of two-year milestones, provide implementation strategies and a time line for achieving sediment reductions across Pennsylvania's Chesapeake Bay watershed to meet Chesapeake Bay interim target loads by 2017, equivalent to 60% of the final target goals set for 2025 to fully implement the Chesapeake Bay TMDL in Pennsylvania. A Phase III Plan will be developed in 2018 to address the additional reductions needed from 2018 through 2025 to meet the final targets.

The sediment reductions for the Bay TMDL are independent of those needed to implement any TMDLs developed to address sediment-related impairments in Pennsylvania's non-tidal waterbodies, although their reduction goals and strategies do overlap. For example, the implementation planning framework, developed by the Bay watershed jurisdictions in partnership with USEPA, provides a staged approach to achieving Bay TMDL sediment

reduction goals that is also applicable to implementation of sediment TMDLs in local non-tidal watersheds. In short, sediment reductions required to meet the Chesapeake Bay TMDL will also support the restoration and protection of local water quality and vice versa. Links to Chesapeake Bay TMDL related documents are provided below.

PADEP Chesapeake Bay Program website:
http://www.portal.state.pa.us/portal/server.pt/community/chesapeake_bay_program/10513

Pennsylvania's Phase I WIP:
http://files.dep.state.pa.us/Water/Chesapeake%20Bay%20Program/ChesapeakePortalFiles/WIPs/REVISED%20FINAL%20Chesapeake%20Bay%20WIP%20-%20sent%20to%20EPA%2012-23-10.pdf

Pennsylvania's Phase II WIP:
http://files.dep.state.pa.us/Water/Chesapeake%20Bay%20Program/ChesapeakePortalFiles/4-2-2012/Clean%20FINAL%20Phase%202%20WIP%203-30-2012%20(2).pdf

Pennsylvania's Phase II WIP Wastewater Supplement:
http://files.dep.state.pa.us/Water/Wastewater%20Management/EDMRPortalFiles/Phase_2_WIP_Supplement.pdf

Pennsylvania's Milestones for 2012-2013:
http://files.dep.state.pa.us/Water/Chesapeake%20Bay%20Program/ChesapeakePortalFiles/7-9-2012/PA%20FINAL%202012-2013%20Milestones.pdf

By developing a sediment and phosphorus TMDL for the Little Chiques Creek Watershed, PADEP continues to support design and implementation of restoration plans to correct current use impairments. 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).

## PUBLIC PARTICIPATION

A notice of availability for comments on the draft Little Chiques Creek Watershed TMDL was published in the Pa. Bulletin on June 8th, 2013, and *newspaper* on date, to foster public comment on the allowable loads calculated. A public meeting was held on June 19, 2013, at the Mount Joy Borough Municipal office building to discuss the proposed TMDL. The public participation process (which ended on July 8th, 2013) was provided for the submittal of comments. Comments and responses are summarized in Attachment I. There were no public comments received for this TMDL.

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

## REFERENCES

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

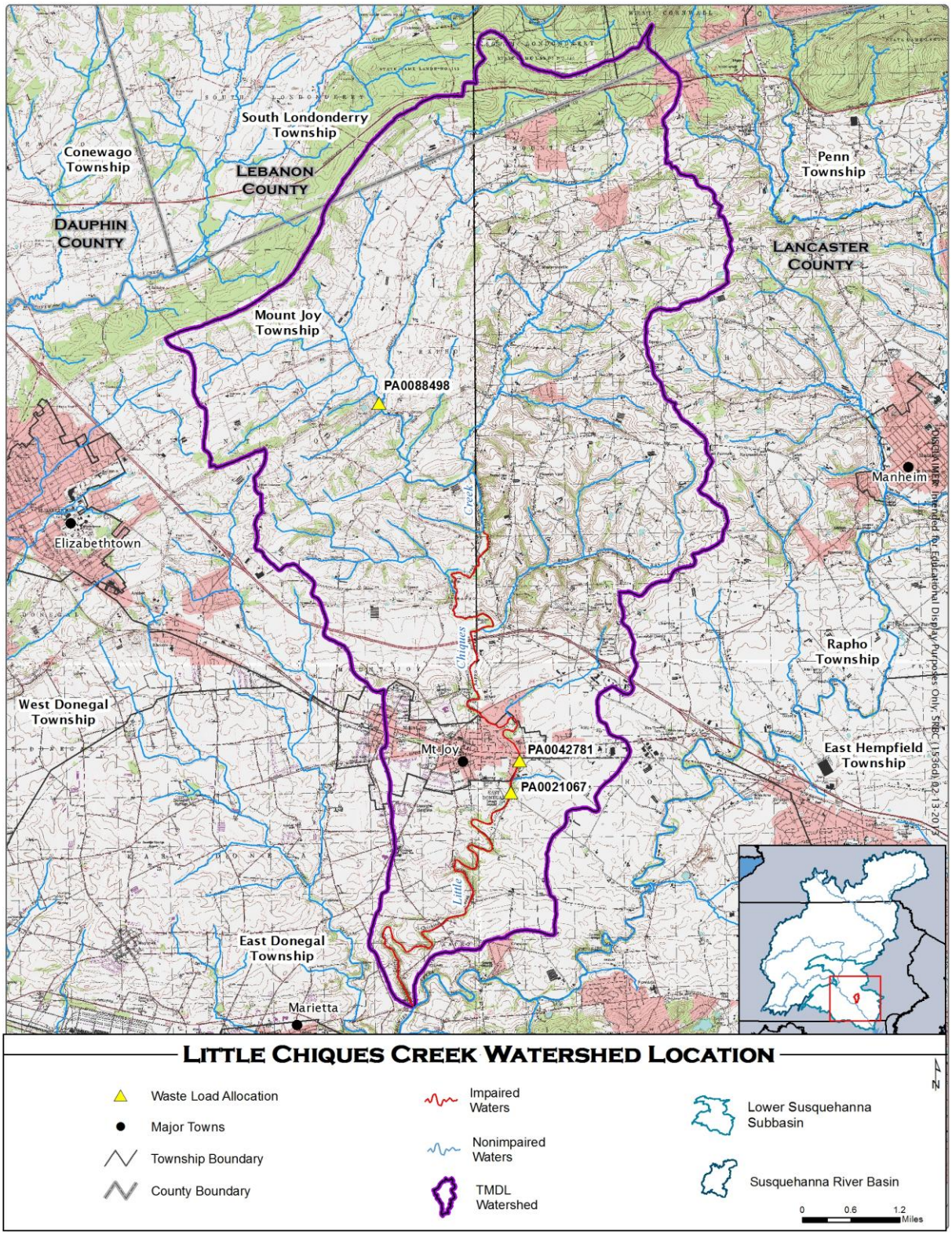
Hem, J.D. 1983. Study and Interpretation of the Chemical Characteristics of Natural Water. U.S. Geological Survey Water Supply Paper 1473.

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

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

# Attachment A

## Little Chiques Creek Watershed Impaired Waters


South Londonderry Township
Conewago Township
LEBANON COUNTY
DAUPHIN COUNTY
Penn Township
LANCASTER COUNTY
Mount Joy Township
PA0088498
Manheim
Elizabethtown
Little Chiques Creek
Rapho Township
West Donegal Township
Mt Joy
PA0042781
PA0021067
East Hempfield Township
East Donegal Township
Marietta
DISCLAIMER: Intended for Educational Display Purposes Only. SRBC (1596dh) 02-13-2015
LITTLE CHIQUES CREEK WATERSHED LOCATION
Waste Load Allocation
Major Towns
Township Boundary
County Boundary
Impaired Waters
Nonimpaired Waters
TMDL Watershed
Lower Susquehanna Subbasin
Susquehanna River Basin
0 0.6 1.2 Miles
N

# Attachment B

## Information Sheet for the Little Chiques Creek Watershed TMDL

***What is being proposed?***
Total Maximum Daily Load (TMDL) plans have been developed to improve water quality in the Little Chiques Creek Watershed.

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

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

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

***What is the purpose of the plans?***
The Little Chiques Creek Watershed is impaired due to sediment and phosphorus emanating from agricultural runoff. The plans include a calculation of the loading for sediment that will correct the problem and meet water quality objectives.

***Why was the Little Chiques Creek Watershed selected for TMDL development?***
In 2010, PADEP listed segments of the Little Chiques Creek Watershed under Section 303(d) of the federal Clean Water Act as impaired due to causes linked to sediment and phosphorus.

***What pollutants do these TMDLs address?***
The proposed plans provide calculations of the stream's total capacity to accept sediment and phosphorus.

***Where do the pollutants come from?***
The sediment and phosphorus related impairments in the Little Chiques Creek Watershed 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 streamflow 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 and phosphorus 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 William Brown at (717) 783-2938 between 8:00 a.m. and 3:00 p.m., Monday through Friday. Mr. Brown 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 wbrown@state.pa.us.

***How can I comment on the proposal?***
You may provide e-mail or written comments postmarked no later than May 30, 2011 to the above address.

# Attachment C

## AVGWLF Model Overview & GIS-Based Derivation of Input Data

The TMDL for the Little Chiques Creek Watershed 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 the watershed given variable-size source areas (e.g., agricultural, forested, and developed land). It also has algorithms for calculating septic system loads, and allows for the inclusion of point source discharge data. It is a continuous simulation model, which uses daily time steps for weather data and water balance calculations. Monthly calculations are made for sediment and nutrient loads, based on the daily water balance accumulated to monthly values.

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

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

For execution, the model requires three separate input files containing transport-, nutrient-, and weather-related data. The transport (TRANSPRT.DAT) file defines the necessary parameters for each source area to be considered (e.g., area size, curve number, etc.), as well as global parameters (e.g., initial storage, sediment delivery ratio, etc.) that apply to all source areas. The

nutrient (NUTRIENT.DAT) file specifies the various loading parameters for the different source areas identified (e.g., number of septic systems, urban source area accumulation rates, manure concentrations, etc.). The weather (WEATHER.DAT) file contains daily average temperature and total precipitation values for each year simulated.

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

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

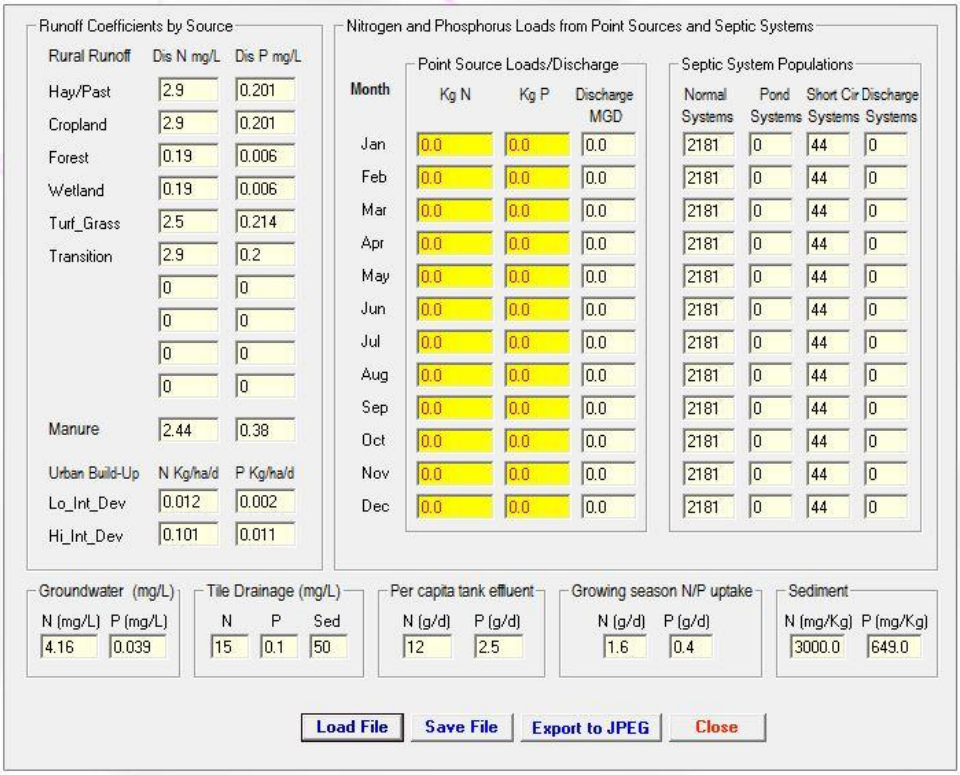
The following table lists the statewide GIS data sets and provides an explanation of how they were used for development of the input files for the GWLF model.

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

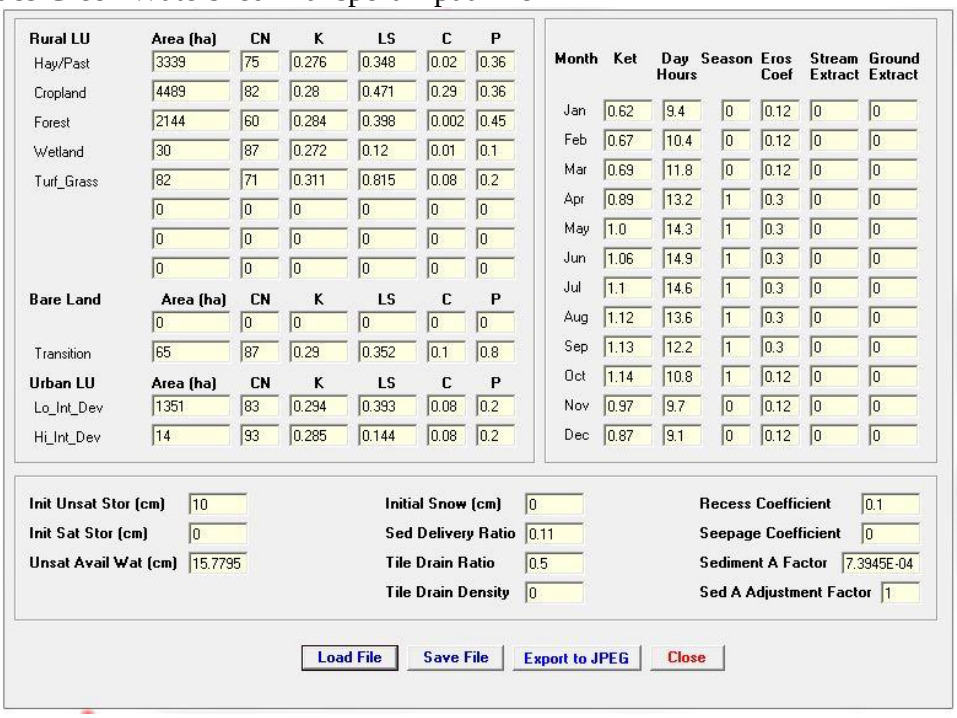
# Attachment D

## AVGWLF Model Inputs for the Little Chiques Creek Watershed

Little Chiques Creek Watershed Nutrient Input File



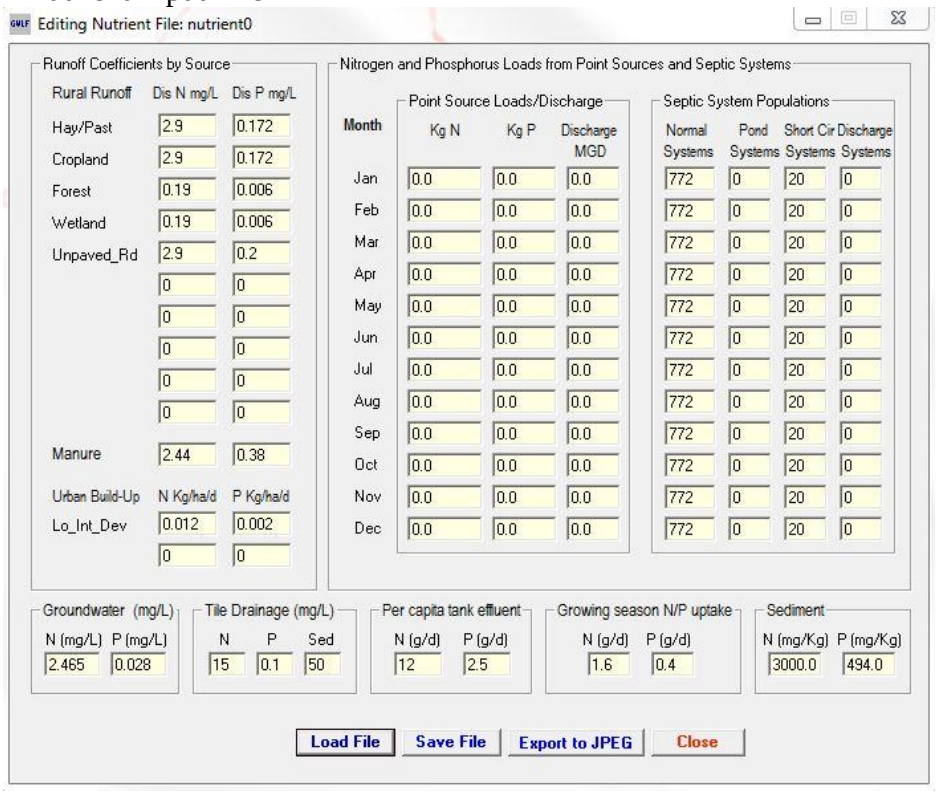

Little Chiques Creek Watershed Transport Input File



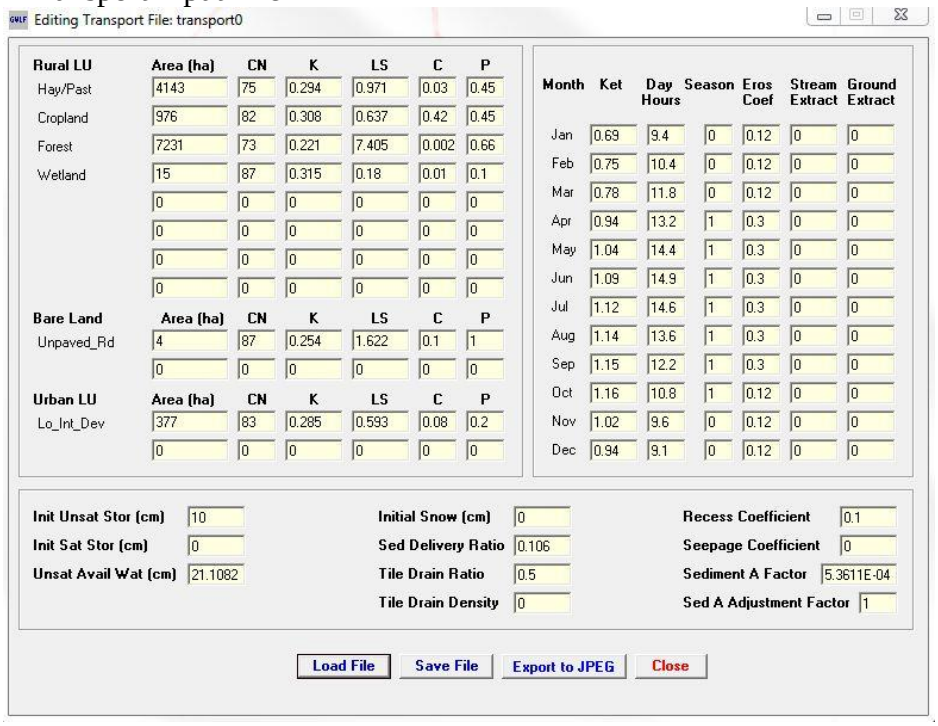
# Attachment E

## AVGWLF Model Inputs for the Clover Creek Reference Watershed

Clover Creek Nutrient Input File




Clover Creek Transport Input File



# Attachment F

## 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 Attachment G. 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.

# Attachment G

## Equal Marginal Percent Reduction Calculations for the Little Chiques Creek Watershed TMDL

Step 1: TMDL Total Load

Load = loading rate in ref. * Acres in Impaired

17.0709

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

3.7747 4

PHOSPHORUS LOADING

| Step 3: | Non-MS4 Daily Average Load | Load Sum | Check | Initial Adjust | Recheck | % reduction allocation | Load Reductior | Initial LA | Acres | Allowable Loading Rate | % Reduction |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Hay/Past. | 4.0790 | 31.8919 | bad | 4 | ADJUST | 0.30 | 2.642 | 1.133 | 8250.80 | 0.000 | 72% |
| Cropland | 17.8395 | | bad | 4 | 9 | 0.30 | 2.642 | 1.133 | 11092.50 | 0.000 | 94% |
| Developed | 0.943 | | good | 1 | | 0.07 | 0.660 | 0.283 | 3736.20 | 0.000 | 70% |
| Groundwater | 8.7187 | | bad | 4 | | 0.30 | 2.642 | 1.133 | | | 87% |
| Streambank | 0.3117 | | good | 0 | | 0.02 | 0.218 | 0.094 | | | 70% |
| Total | 31.8919 | | | 12.57883 | | 1.00 | | 3.775 | | | |

Step 4 All Ag. Loading Rat 0.00

| Step 5: | Acres | Allowable (Target) Loading Rate | Final LA | Current Loading Rates | Current Load | % Red. |
|---|---|---|---|---|---|---|
| Final Hay/Past. LA | 8250.80 | 0.0001 | 0.9663 | 0.0005 | 4.0790 | 76% |
| Final Cropland LA | 11092.50 | 0.0001 | 1.2931 | 0.0016 | 17.8395 | 93% |
| Developed | 3736.20 | 0.0001 | 0.2830 | 0.0003 | 0.9430 | 70% |
| Groundwater | | | 1.1327 | | 8.7187 | 87% |
| Streambank | | | 0.0935 | | 0.3117 | 70% |
| Total | | | 3.7747 | | 31.8919 | 88% |

**Little Chiques Creek**

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Step 1: | TMDL Total Load | | | | Step 2: | Adjusted LA = (TMDL total load - MOS) - uncontrollable | | | | | | | |
| | Load = loading rate in ref. * Acres in Impaired | | | | | 20178.0540 | 20178 | | | | | | |
| | 23230.6498 | | | | | | | | | | | | |
| | SEDIMENT LOADING | | | | | | | | | | | | |
| Step 3: | | Non-MS4 Daily Average Load | Load Sum | Check | Initial Adjust | Recheck | % reduction allocation | Load Reductior | Initial LA | Acres | Allowable Loading Rate | % Reduction | |
| | Hay/Past. | 523.6713 | 29469.882 | good | 524 | ADJUST | 0.02 | 165.113 | 358.558 | 8250.80 | 0.043 | 32% | |
| | Cropland | 14016.1644 | | good | 14016 | 9292 | 0.48 | 4419.284 | 9596.880 | 11092.50 | 0.865 | 32% | |
| | Developed | 764.3289 | | good | 764 | | 0.03 | 240.992 | 523.337 | 3736.20 | 0.140 | 32% | |
| | Streambank | 14165.7173 | | good | 14166 | | 0.48 | 4466.438 | 9699.279 | | | 32% | |
| | Total | 29469.8819 | | | 29469.882 | | 1.00 | | 20178.054 | | | | |
| Step 4 | All Ag. Loading Rat | 0.51 | | | | | | | | | | | |
| Step 5: | | Acres | Allowable (Target) Loading Rate | Final LA | Current Loading Rates | Current Load | % Red. | | | | | | |
| | Final Hay/Past. LA | 8250.80 | 0.0435 | 358.5582 | 0.0635 | 523.6713 | 32% | | | | | | |
| | Final Cropland LA | 11092.50 | 0.8652 | 9596.8801 | 1.2636 | 14016.1644 | 32% | | | | | | |
| | Developed | 3736.20 | 0.1401 | 523.3367 | 0.2046 | 764.3289 | 32% | | | | | | |
| | Streambank | | | 9699.2791 | | 14165.7173 | 32% | | | | | | |
| | Total | | | 20178.0540 | | 29469.8819 | 32% | | | | | | |
| | **Little Chiques Creek** | | | | | | | | | | | | |

# Attachment H

## Little Chiques Creek Watershed Impaired Segment Listings

| **Stream Name** / **Use Designation (Assessment ID)** / **Source** | **Cause** | **Date Listed** | **TMDL Date** |
|---|---|---|---|
| Ass | | | |

## Hydrologic Unit Code: 02050306 - Lower Susquehanna

**Little Chiques Creek**
HUC: 02050306

| | | | |
|---|---|---|---|
| Aquatic Life (8406) - 11.08 miles; 17 Segment(s)* | | | |
| Agriculture | Nutrients | 1998 | 2011 |
| Agriculture | Siltation | 1998 | 2011 |

## Report Summary

### Watershed Summary

| | Stream Miles | Assessment Units | Segments (COMIDs) |
|---|---|---|---|
| Watershed Characteristics | 70.73 | 1 | 118 |

### Impairment Summary

| Source | Cause | Miles | Assessment Units | Segments (COMIDs) |
|---|---|---|---|---|
| Agriculture | Nutrients | 11.08 | 1 | 17 |
| Agriculture | Siltation | 11.08 | 1 | 17 |
| | | | **1**** | **17**** |

**Totals reflect actual miles of impaired stream. Each stream segment may have multiple impairments (different sources or causes contributing to the impairment), so the sum of individual impairment numbers may not add up to the totals shown.

### Use Designation Summary

# Attachment I

## Comment & Response Document for the Little Chiques Creek Watershed TMDL

There were no public comments received for this TMDL.