Salisbury Township Pollutant Reduction Plan

Gap, PA
DRAFT – July 1, 2020

Prepared for:
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Introduction

This pollutant reduction plan (PRP) was developed for Salisbury Township as a requirement of their municipal separate storm sewer system (MS4) permit. Salisbury Township has previously had MS4 permit waiver instead of an MS4 permit due to the Township's small Urban Area (UA) and population. In November 2019, Salisbury Township's MS4 Waiver Renewal was denied by the Pennsylvania Department of Environmental Protection (DEP) because the increased population within the UA moved the Township above the threshold needed to obtain an MS4 permit waiver. Salisbury Township is operating under permit number PAI133548 and is expected to receive an approval of coverage under the individual MS4 permit upon DEP's approval of this PRP.

The PRP outlines the actions that the Township will take to address pollutant loads to the waterbodies within the MS4 that drain to the Chesapeake Bay/impaired waters. These actions include public participation, mapping of outfalls and other discharges, pollutant load calculations, best management practices (BMPs) selection, identification of potential funding sources and partners, and operations and maintenance (O&M) activities.

A. Public Participation – to be completed following Public Comment Period

Public participation is an essential part of the PRP because it enhances buy-in from landowners that may have an impact on pollutant discharges, can uncover missing elements or errors in calculations, and builds cooperative partnerships among the municipality and other entities.

A copy of the draft PRP was released via public notice on MONTH, DAY, YEAR to the following media outlets: _____. The notice ran for # days. A copy of the public notice is included as Item A-1. The public was given 30 days to provide commentary on the contents of the PRP. A copy of all written public comments is included as Item A-2. Salisbury Township held a public meeting on MONTH, DAY, YEAR to receive verbal commentary on the contents of the PRP. A copy of the comments and the record of consideration is included as Item A-3. Salisbury Township used the public comments to update the draft PRP in the following ways: _____.

B. Map

Ninety-three percent of Salisbury Township is located within the Chesapeake Bay Basin. The Upper West Branch Brandywine Creek HUC-12 subwatershed, part of the Delaware River Basin, covers about 7 percent (1,845 acres) in Salisbury Township's northwest tier; however, there is no UA located within this watershed. Therefore, the Upper West Branch Brandywine Creek HUC-12 subwatershed is not addressed further in this PRP.

Within the Chesapeake Bay Basin, the Headwaters Pequea Creek HUC-12 subwatershed comprises approximately 90 percent of the Township (24,052 acres) and approximately 90 percent of the municipality's Planning Area. The Eshelman Run-Pequea Creek HUC-12 subwatershed accounts for less than 2 percent (536 acres) of the Township. The Pine Creek watershed accounts for approximately 1.2 percent (319 acres) of Salisbury Township and the Valley-Creek East Branch Octoraro Creek watershed accounts for 0.3% of Salisbury Township (87 acres). Figure 1 identifies the subwatershed basins within Salisbury Township, as well as the non-attaining (impaired) and attaining streams (not impaired) from the DEP 2014 Integrated List, and the location of the 2010 Census urban area. Additional maps are provided in Appendix B.

Map B1 in Appendix B identifies the 2011 Land Use types throughout the Township, the MS4 outfall locations, and the storm sewershed boundaries grouped into the Pequea Creek Planning Area. Less than 5 percent of Salisbury Township (1,286 acres) is within the UA based on the 2010 U.S. Census data. The total impervious cover within the UA is only approximately 5 percent based on 2011 National Land Cover Database (NLCD) data used in the WikiWatershed Model My Watershed modeling application. A significant portion of the UA is in forested and agricultural land use types. The 2011 NLCD impervious surface cover by land use type includes the following ranges:

- Low Density Developed Use: 15% impervious
- Medium Density Developed Use: 52% Impervious
- High Density Developed Use: 87% Impervious

Map B2 in Appendix B, provides an overview of the three planning areas in Salisbury Township: the Pequea Creek Planning Area, Pine Creek Planning Area, and Valley Creek East Branch (Octoraro) Planning Area. Due to small size of the planning areas and their dispersed nature, Map B3 focuses on the planning areas within the southern portion of the Township and Map B4 focuses on the planning areas in the east.

These maps include justification notation for UA locations that were parsed out of these planning areas. Map B5 provides the proposed location(s) of structural BMPs that will be implemented to achieve the required pollutant load reductions per watershed during the current permit cycle.

B.1 Mapping of Planning Areas

In accordance with DEP's guidelines, Salisbury Township used the following process to parse areas and establish their MS4 planning area for the PRP. Prior to beginning PRP development, Salisbury went through a desktop and field verification exercise to establish inlets, outlets, pipes, swales and outfalls ("system") within the Township.

As part of the PRP development, Salisbury's system mapping was added to a base map with National Hydrology Dataset (NHD) streams, topography, and watershed boundaries in order to aid in the field drainage boundary assessment to establish MS4 planning areas for the PRP. Mapping also included areas that could be parsed out such as state-owned road right of ways and areas without MS4 infrastructure.

The field review then continued to field verify outfalls on NHD streams with matching observed general drainage flow to the map; or to determine that the regulated system (inlets, curb and gutter, etc.) tied to the end point adequately collects stormwater run-off from the drainage areas reviewed. This process involves a visual tracing against the system map. The field review is supported by a condensed desktop reconfirmation analysis, where a topographic map with an aerial image, as well as the "system" map, are reviewed to determine the areas draining to outfalls and how these areas could be combined into a planning area that could be mapped in GIS and analyzed for pollutant loading rates.

Planning areas were then drawn to capture the drainage areas that are collected into the MS4 infrastructure and discharge via the outfall or group of outfalls within a watershed.

Within the Eshelman Run–Pequea Creek subwatershed, only 0.42 acres draining to MS4 infrastructure existed within the UA. Therefore, this small area was added into the Pequea Creek Planning Area. Within the Pequea Creek Planning Area, PENNDOT roads and areas without any MS4 infrastructure were excluded. Forty acres of non-UA land that is located upgradient from the UA, but drains into the Township's MS4 infrastructure were added into the Pequea Creek Planning Area.

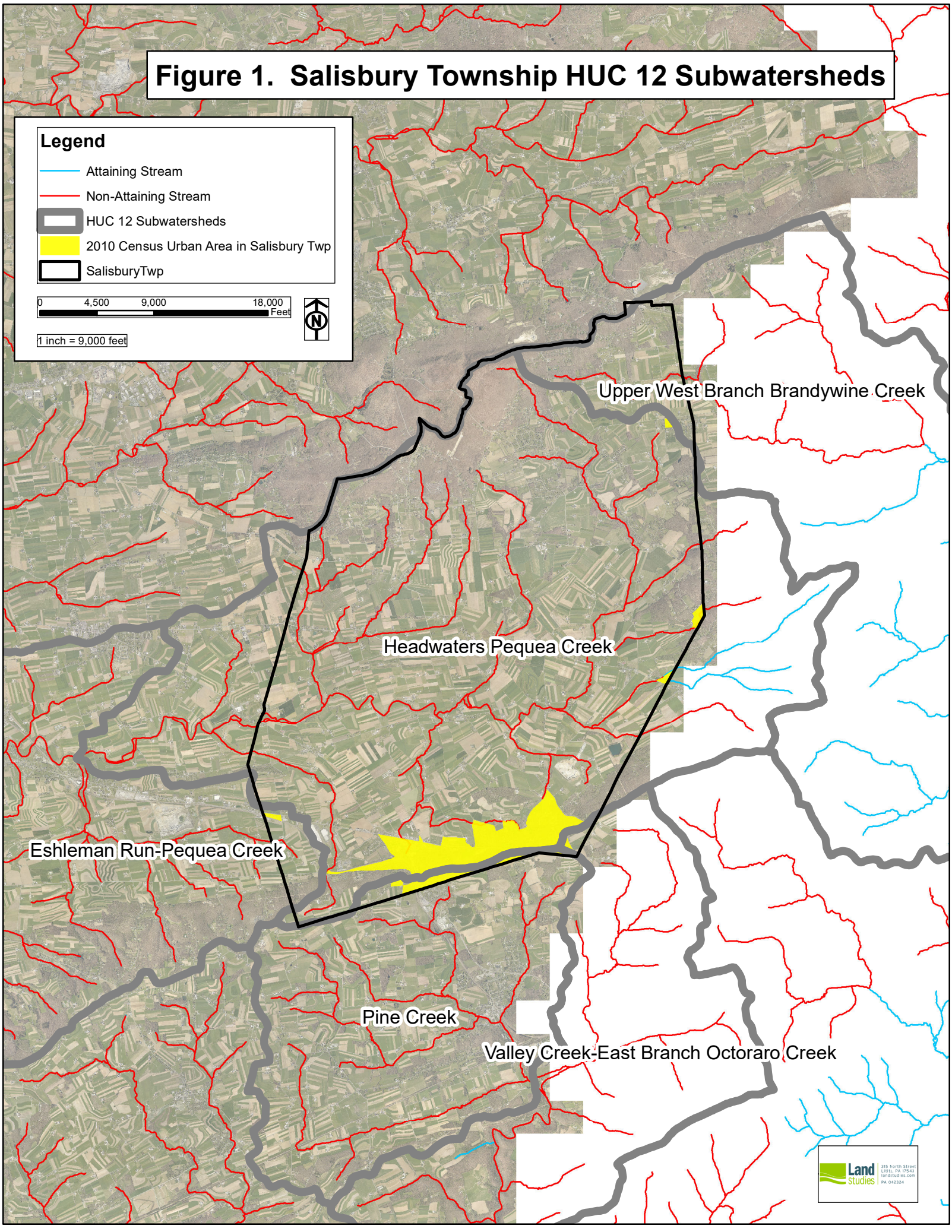
Within the Pine Creek Planning Area, there were several tracts of forested and agricultural land that did not contain any MS4 infrastructure and drained to undeveloped land outside of Salisbury Township's border. A small 7.6-acre area outside of the UA drained into a development in the Pine Creek Planning Area and was, therefore, added to the planning area.

Aside from a small 3.2-acre area with no MS4 infrastructure that drained to undeveloped land outside of the Township, the Valley Creek East Branch Planning Area did not have any excluded areas.

In total, 235 acres of UA within Salisbury Township were excluded from the planning areas based on the aforementioned rational. The total planning area acreage is approximately 1,095 acres for the Pequea Creek, Pine Creek, and Valley Creek Planning Areas.

Maps of these planning areas and excluded areas were reviewed and discussed with DEP's Southcentral Regional Office staff in January 2020.

Figure 1. Salisbury Township HUC 12 Subwatersheds



C. Pollutants of Concern

Since the Pequea Creek, Pine Creek, and Valley Creek East Branch watersheds ultimately drain to the Chesapeake Bay, the following are pollutants concern: sediment, total nitrogen (TN), and total phosphorus (TP). Because of this drainage to the Chesapeake Bay, the Township must prepare a CBPRP in accordance with Appendix D in the PAG-13 General Permit. Salisbury Township also discharges stormwater to local impaired waters, including the Pequea Creek and its tributaries. Therefore, it must reduce pollutant loads associated with those impairments and prepare an impaired waters PRP in accordance with Appendix E in the PAG-13 General Permit. Note: there are no surface waters of the Pine Creek or Valley Creek East Branch watersheds within the Township.

Table 1 shows the affected subwatersheds within Salisbury Township and the pollutant(s) that are of concern to the municipality as shown on the DEP MS4 requirements table revised 11/18/2019. Other impairments listed in Table 1 that are not addressed in this upcoming permit cycle will be considered in future permit cycles.

Table 1. Salisbury Township MS4 Requirements Table

MS4 Planning Area / Watershed	Pollutant(s) of Concern
Pequea Creek	Appendix E – Nutrients, Organic Enrichment / Low DO[1], Suspended Solids (4a)
Chesapeake Bay Nutrients / Sediment	Appendix D – Nutrients, Siltation (4a)

NOTE1: The MS4 Requirements Table identifies "Organic Enrichment / Low D.O." as Appendix E Pollutants of Concern for the Donegal Creek. Organic Enrichment and Low D.O. are surrogates for nutrient impairment.

In accordance with DEP's PRP Instructions, this report is required specifically for stormwater discharges of nutrients and sediment to surface waters for the Chesapeake Bay (Appendix D) and impaired waters (Appendix E).

Separate from the PRP, Pollutant Control Measures (PCMs) described in DEP's General Permit (3800-PM-BCW0100d) are to be implemented for Appendix A, B, and/or C pollutants of concern identified in the MS4 Requirements Table.

To address both the Appendix D and Appendix E requirements, Salisbury Township will select BMPs to reduce the sediment pollutant load by 10 percent, which is assumed to then reduce the TN and TP by 3 percent and 5 percent respectively according to DEP's PRP Instructions (3800-PM-BCW0100k). Therefore, only sediment load reductions within the MS4 planning areas are reported in this PRP.

As Salisbury Township is subject to both a CBPRP and an impaired waters PRP, it will select BMPs that target the impaired waters discharges first, as action toward the local impaired waters will have a beneficial impact on the Chesapeake Bay.

D. Existing Load for Pollutants of Concern

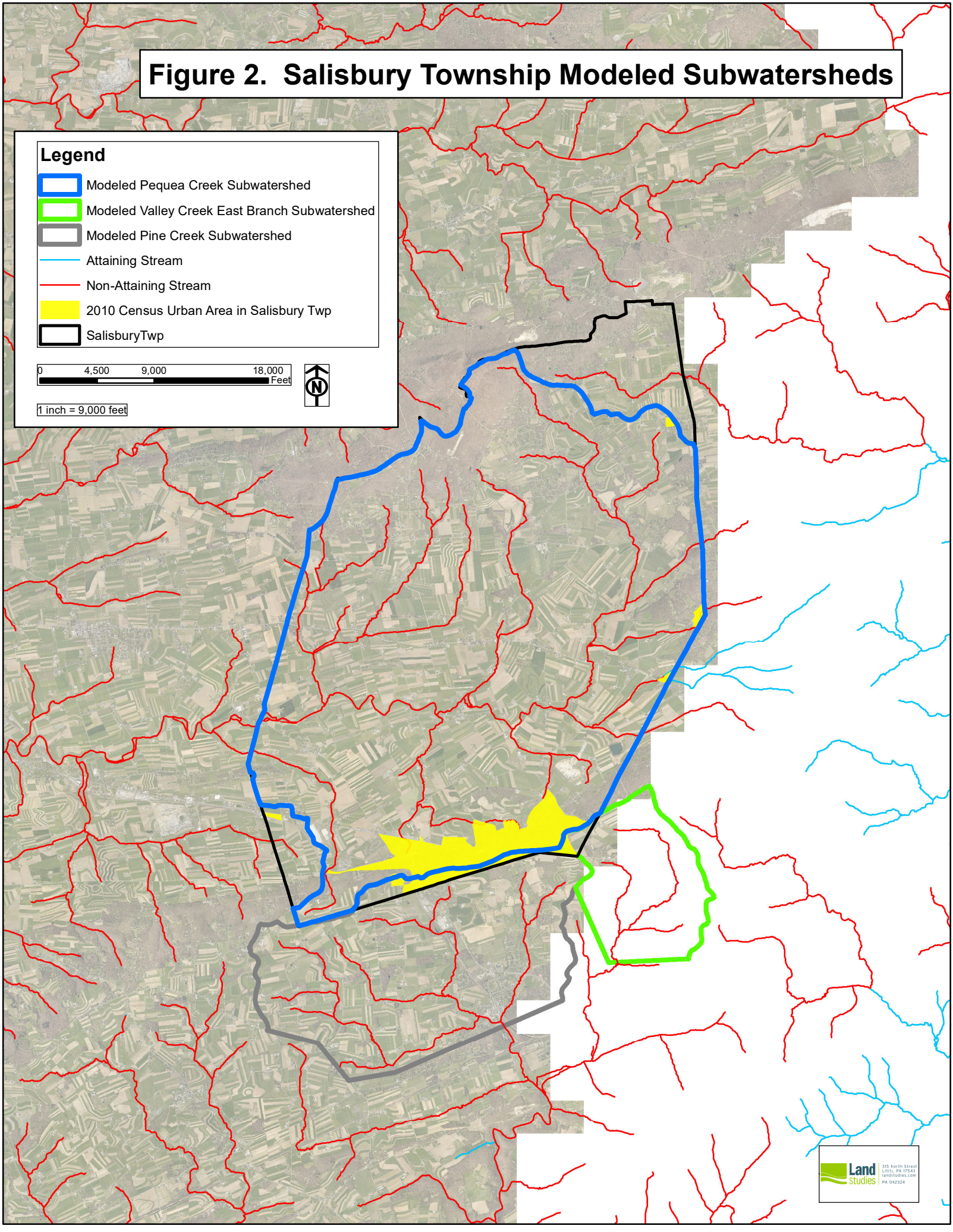
The Pequea Creek is the primary watershed within Salisbury Township since all of the surface waters within the MS4 Planning Areas are part of the Pequea Creek watershed. Small portions of the Pine Creek and Valley Creek East Branch Octoraro watersheds are included in the Township's MS4 Planning Areas because, although there are no impaired waters within these areas, they are located within the Chesapeake Bay drainage area and are part of the Township's Appendix D requirements.

The existing load for Salisbury Township's Pequea Creek, Pine Creek, and Valley Creek East Branch Planning Areas were calculated using Stroud Water Research Center's Wikiwatershed Model My Watershed.

The Pequea Creek watershed covers 37.6 square miles. The approximately 981-acre Pequea Creek Planning Area was mapped in ArcGIS and the planning area shapefile was imported into Model My Watershed (MMW). The Pequea Creek Planning Area was modeled based on the land use types and stream lengths within the planning area. Specific land use loading rates, streambank loading rates, and farm animal data for the watershed were incorporated into the model. The resulting baseline load data was exported into the MMW BMP Spreadsheet Tool (included in Appendix C).

Since the Pine Creek and Valley Creek East Branch Octoraro watersheds only cover 1.2% and 0.3% of the Township's land area, respectively, these watersheds were modified in ArcGIS to include only the areas that receive drainage from Salisbury Township. Portions of these watersheds that are outside of the Township's boundaries and do not receive drainage from the Township were not included in the revised watershed models. The revised watersheds that were modeled in MMW are shown in Figure 2. The Pine Creek watershed covers 11.8 square miles. The Valley Creek East Branch Octoraro watershed covers 3.8 square miles. The Pine Creek Planning Area (approximately 92 acres) and Valley Creek East Branch Planning Area (approximately 22 acres) were mapped in ArcGIS and imported into MMW along with the modified watershed shapefiles for modeling. The baseline load results for both Pine Creek and Valley Creek are shown in Appendix C in the MMW BMP Spreadsheet Tool for each watershed.

Figure 2. Salisbury Township Modeled Subwatersheds



D.1 Pequea Creek Planning Area Existing Load

Table 2 shows the sediment loading rates for each land use type for the Pequea Creek Planning Area.

Table 2. Total Sediment Loading Rate per Land Use Type – Pequea Creek

Land Use Type	Acreage	Sediment Loading Rate (lbs/acre)	Total Sediment Load (lbs)
Developed, Open Space	205.38	783.78	160,974
Developed, Low Intensity	160.72	783.78	125,966
Developed, Medium Intensity	28.32	2191.65	62,065
Developed, High Intensity	14.81	3464.28	51,323
Deciduous Forest	378.66	235.74	89,267
Evergreen Forest	2.47	235.74	582
Mixed Forest	2.47	235.74	582
Shrub/Scrub	64.20	235.74	15,134
Grassland/Herbaceous	22.22	270.03	6,001
Pasture/Hay	59.48	337.34	20,065
Cultivated Crops	42.20	1653.14	69,757
Total Existing Sediment Load - Pequea Creek Planning Area:			***601,716***

No existing urban or agricultural BMPs were included in the existing load calculations for the Pequea Creek Planning. Salisbury Township is actively working with the local agricultural community to implement and maintain agricultural conservation practices on the farms within the Township; however, these non-structural agricultural BMPs (i.e. cover crops and conservation plans) are not eligible for PRP pollutant load reduction credit per DEP's MS4 NPDES Permits – Frequently Asked Questions (October, 2019).

Based on these existing load calculations it was determined that the Pequea Creek Planning Area existing loading is 601,716 lbs. The minimum sediment reduction required for this Planning Area is 60,172lbs.

D.2 Pine Creek Planning Area Existing Load

Table 3 shows the sediment loading rates for each land use type for the Pine Creek Planning Area.

Table 3. Total Sediment Loading Rate per Land Use Type – Pine Creek

Land Use Type	Acreage	Sediment Loading Rate (lbs/acre)	Total Sediment Load (lbs)
Developed, Open Space	26.14	255.53	6,680
Developed, Low Intensity	22.38	255.53	5,718
Developed, Medium Intensity	2.22	700.19	1,551
Developed, High Intensity	0.22	1065.29	236
Deciduous Forest	22.82	98.78	2,254
Mixed Forest	0.22	98.78	22
Shrub/Scrub	4.43	98.78	438
Pasture/Hay	9.53	257.20	2,450
Cultivated Crops	3.99	2332.35	9,301
Total Existing Sediment Load - Pine Creek Planning Area:			***28,650***

No existing urban or agricultural BMPs were included in the existing load calculations for the Pine Creek Planning.

Based on these existing load calculations it was determined that the Pine Creek Planning Area existing loading is 28,650 lbs. The minimum sediment reduction required for this Planning Area is 2,865 lbs.

D.3 Valley Creek East Branch Planning Area Existing Load

Table 4 shows the sediment loading rates for each land use type for the Valley Creek East Branch Planning Area.

Table 4. Total Sediment Loading Rate per Land Use Type – Valley Creek East Branch

Land Use Type	Acreage	Sediment Loading Rate (lbs/acre)	Total Sediment Load (lbs)
Developed, Open Space	10.19	137.21	1,398
Developed, Low Intensity	4.87	137.21	669
Shrub/Scrub	2.66	57.09	152
Pasture/Hay	2.44	167.37	408
Cultivated Crops	1.99	1720.70	3,431
Total Existing Sediment Load - Valley Creek East Branch Planning Area:			***6,058***

No existing urban or agricultural BMPs were included in the existing load calculations for the Pine Creek Planning.

Based on these existing load calculations it was determined that the Valley Creek East Branch Planning Area existing loading is 6,058 lbs. The minimum sediment reduction required for this Planning Area is 606 lbs.

D.4 Salisbury Township's Total Aggregated Existing Load

Salisbury received approval from DEP on January 16, 2020 to aggregate all of the watershed planning area loads for the municipality into a total aggregated load for Salisbury Township. Table 5 shows planning area loads and the total aggregated load for Salisbury Township.

Table 5. Total Existing Load for Salisbury Township.

Planning Area Name	Final Planning Area Existing Load (lbs)
Pequea Creek	601,716
Pine Creek	28,650
Valley Creek East Branch	6,058
Total Aggregated Load for Salisbury Twp	**636,423**
10% Sediment Reduction Requirement for Aggregated Load	**63,642**

E. BMPs Selected to Achieve the Minimum Required Reductions in Pollutant Loading

Based on the 10% sediment reduction targets established above, Salisbury Township has identified a strategy to meet the minimum load reductions within 5 years following DEP's approval of permit coverage. The nutrient reduction requirements for the impaired waters are assumed to be addressed by the 10 percent sediment reductions.

Summary of Alternatives and Selection of BMPs

Salisbury Township evaluated multiple BMPs considering the following criteria:

- Sediment reductions;
- Cost per pound of pollutant reduction;
- Ownership (public versus private land);

- Funding and Workforce availability;
- Community benefit (site accessibility, visibility to the public, ability of public to experience benefits);
- Connectivity to other completed or proposed stormwater BMPs;
- Timeframe to implement;

The purpose of the evaluation was to determine the BMPs that would reduce the most pollutants for the least amount of money while getting closer to the goal of removing streams from the impaired waters list and protecting the Chesapeake Bay.

The Township has determined that there are limited opportunities to implement stormwater BMPs throughout the planning areas that can satisfy the PRP load reduction requirements; however, there are multiple stream restoration projects located directly downstream from the planning areas that provide opportunities to significantly reduce streambank erosion and sediment loading in the Pequea Creek watershed.

There are sections of the Umbletown Road Stream Restoration Project (BMP 3) that are located within the UA; however, all of the other proposed stream restoration projects are located directly downstream from the UA in active agricultural areas. These proposed BMPs and their non-UA locations were discussed with DEP. A narrative was provided to DEP to justify why these non-UA proposed BMPs should be eligible for full pollutant load reduction credit under FAQ 69 from DEP's MS4 NPDES Permits Frequently Asked Questions from October 21, 2019. On June 9, 2020, DEP concurred that these projects would be eligible for full pollutant load reduction credit as long as they meet DEP's stream restoration project guidance (see Appendix E – Proposed BMP Justification).

Additionally, DEP will need verification that the agricultural lands on which these potential stream restoration projects are proposed are working towards or in compliance with agricultural conservation plans. Once Salisbury Township has moved beyond the preliminary planning phase and has selected a specific reach of stream for restoration, the Township will provide DEP with site specific information on the conservation plan(s) along the proposed reach of stream if that site is in agriculture.

The highest priority BMPs evaluated by Salisbury Township are summarized in Table 6 as potential BMPs that could be implemented to satisfy the load reduction requirements.

Table 6. Proposed BMPs for Salisbury Township

Stream BMPs - Sediment and Nutrient Reduction Calculations*			
Site	BMP ID	Length (ft)	Sediment Removal (lbs)
Lincoln Highway Stream Restoration	1	1,400	161,000
Spring Garden Road Stream Restoration	2	1,300	149,500
Umbletown Road Stream Restoration	3	11,000	1,265,000
Houston Run Stream Restoration	4	4,800	552,000
*Sediment Load Reductions Calculated at 115 lbs./lf based on PADEP's PRP Instructions			

The implementation of any of the above stream restoration projects would exceed Salisbury Township's 10% sediment reduction requirement. Salisbury Township is not committing to implement all of these projects, but plans to select a segment for restoration from one of the site identified above. The final selection of the length and location of the stream restoration will be based on detailed design criteria, cost, and landowner coordination. The chosen BMP(s) will meet the 10 percent required sediment reduction and will be implemented by the end of the five-year permit cycle.

BMP 1 – Lincoln Highway Stream Restoration

Salisbury Township is considering a stream restoration project of approximately 1,400 LF that would be implemented along an Unnamed Tributary to the Pequea Creek (COMID 57464113). The Township has identified BMP1 as the highest priority BMP for implementation. According to the DEP PRP Instructions, a 115 lbs. /ft. sediment load reduction can be applied to this project resulting in 161,000 lbs. of sediment reduction if the full 1,400-foot reach is restored. This reach of stream is located between Lincoln Highway, upstream, and the Salisbury Township Community Park, downstream. The majority of this project is located on active agricultural lands. This project will require coordination with these private landowners. The exact location and length of this stream restoration project will be based on the final design details.

BMP 2 – Spring Garden Road Stream Restoration

The Spring Garden Road Stream Restoration project of approximately 1,300 LF is another BMP opportunity located further downstream from BMP1 along the same Unnamed Tributary to the Pequea Creek (COMID 57464113). According to the DEP PRP Instructions, a 115 lb. /ft. sediment load reduction can be applied to this project resulting in 149,500 lbs. of sediment reduction if the full 1,300-foot reach is restored. This reach of stream is located

between Spring Garden Road, upstream, and White Horse Road, downstream. This project is located on active agricultural lands. This project will require coordination with a private landowner. The exact location and length of this stream restoration project will be based on the final design details.

BMP 3 – Spring Garden Road Stream Restoration

The Umbletown Road Stream Restoration project of approximately 11,000 LF is another BMP opportunity located further downstream from BMP1 along the same Unnamed Tributary to the Pequea Creek (COMID 57464113). According to the DEP PRP Instructions, a 115 lb. /ft. sediment load reduction can be applied to this project resulting in 149,500 lbs. of sediment reduction if the full 1,300-foot reach is restored. This reach of stream is located between Spring Garden Road, upstream, and White Horse Road, downstream. This project is located on active agricultural lands. This project will require coordination with a private landowner. The exact location and length of this stream restoration project will be based on the final design details.

F. Funding Mechanism Identification

In order to install and maintain any of the BMPs listed in Section E, Salisbury Township proposes the following sponsors/partners and funding sources:

- Salisbury Township Budget Funds
- Local Business Tax
- Potential Grant Funding: DCNR, DEP, NFWF, Lancaster Clean Water Partners, etc.

G. Responsible Parties for Operation and Maintenance (O&M) of BMPs

If the BMP is located on private land, landowner agreements and/or easements must be developed to enforce the on-going O&M of the BMP, and to identify the parties responsible for the O&M, and to provide access for periodic inspections and maintenance, as needed. Actual O&M activities will be listed in the Annual MS4 Status Report sent to the PADEP under the General Permit.

The Township's Public Works staff will perform O&M activities associated with the proposed BMPs, unless otherwise agreed upon and specified in the BMP landowner agreement. After the first few years of post-construction maintenance, the O&M responsibilities may transfer to the landowner. If the O&M responsibility does transfer, this would be specified in the landowner agreement.

Specific O&M activities / frequencies to be performed will be based upon design criteria established as part of the BMP development. Generally, inspections will occur quarterly and following significant rain events. General O&M activities for these stream restoration BMPs include:

- Maintenance of desirable vegetation and control of weeds and invasive plants;
- Repair of eroded and damaged areas and replanting the damaged area with appropriate plant material;
- Proper management of agricultural activities;
- Removal of debris hindering the function of the system;

H. Works Cited

Pennsylvania Department of Environmental Protection (PADEP). 2014. 2014 Final Pennsylvania Integrated Water Quality Monitoring and Assessment Report – Clean Water Act Section 305(b) Report and 303(d) List. Office of Water Management, Bureau of Water Supply & Wastewater Management, Water Quality Assessment and Standards Division. Harrisburg, PA.

Pennsylvania Department of Environmental Protection (PADEP). 2016. 2016 Final Pennsylvania Integrated Water Quality Monitoring and Assessment Report – Clean Water Act Section 305(b) Report and 303(d) List. Office of Water Management, Bureau of Water Supply & Wastewater Management, Water Quality Assessment and Standards Division. Harrisburg, PA.

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Pennsylvania Department of Environmental Protection (PADEP). 2018. 2018 Pennsylvania Integrated Water Quality Monitoring and Assessment Report – Clean Water Act Section 305(b) Report and 303(d) List. Office of Water Management, Bureau of Water Supply & Wastewater Management, Water Quality Assessment and Standards Division. Harrisburg, PA. Retrieved May 1, 2020 at https://www.depgis.state.pa.us/2018_integrated_report/index.html

Pennsylvania Department of Environmental Protection (PADEP). 2019. MS4 NPDES Permits Frequently Asked Questions (FAQ) – Revised October 21, 2019. Bureau of Clean Water. Harrisburg, PA.

Stroud Water Research Center. WikiWatershed Model My Watershed. Retrieved January 15 – May 15, 2020 at https://modelmywatershed.org/.

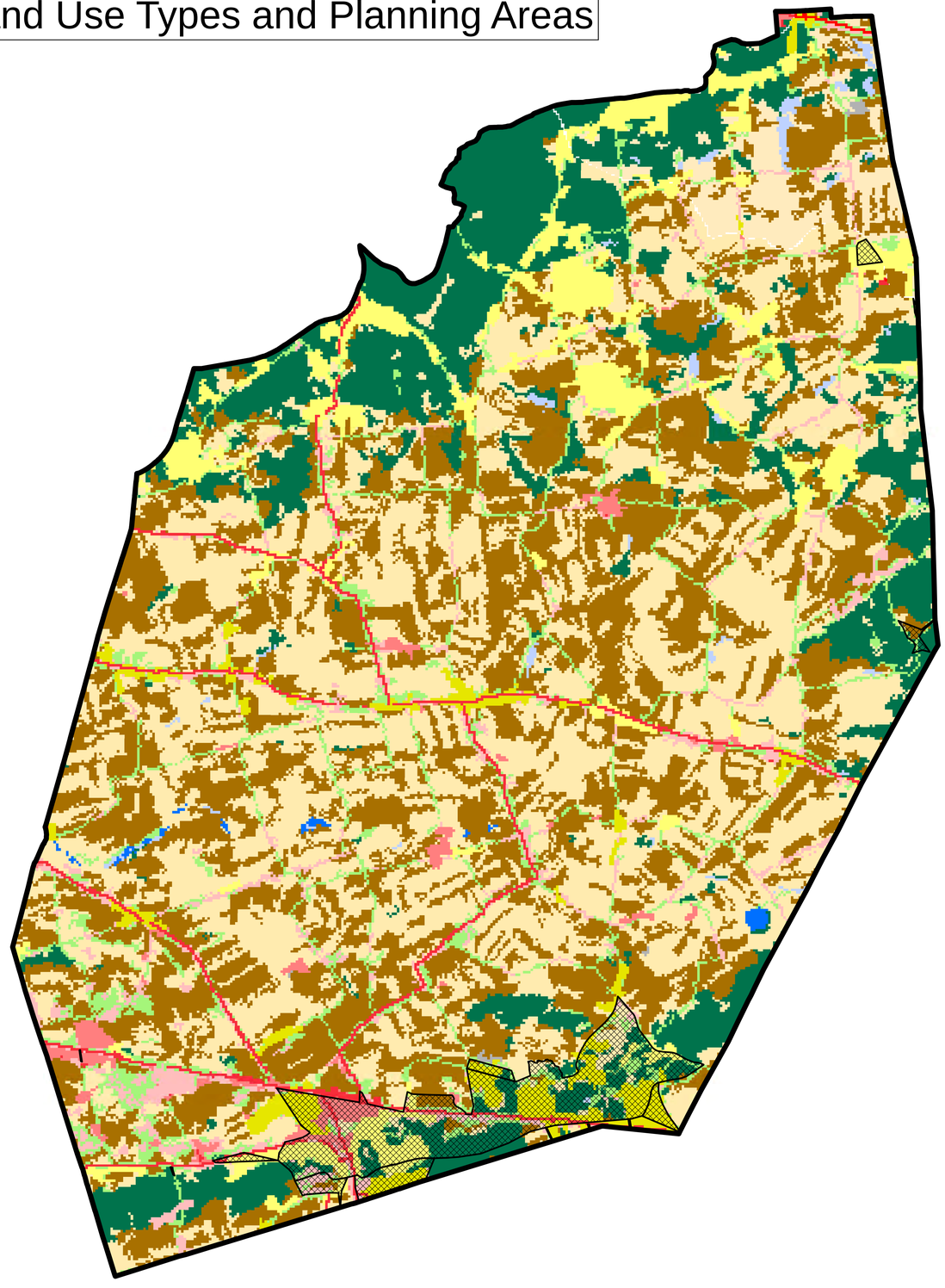
Appendix A

Public Participation: Item A1. Public Notice; Item A2. Written Public Comments; Item A3. Record of Consideration of Written Public Comments

Appendix B

Map B1 - Salisbury Township Land Use Types; Map B2 - Planning Area Overview; Map B3– Planning Areas South; Map B4– Planning Areas East; Map B5 – Proposed BMPs

MAP B1. Salisbury Township Land Use Types and Planning Areas



Legend

- SalisburyTwp
- Pine Creek Planning Area
- Valley Creek East Branch Planning Area
- Pequea Creek Planning Area

Land Use Type

- Cropland
- Disturbed
- Forest
- Hay / Pasture
- High-Density Mixed Urban
- Low-Density Mixed Urban
- Low-Density Residential
- Medium-Density Mixed Urban
- Medium-Density Residential
- Open Land
- Water
- Wetland
- Excluded Area

N

1 inch = 2,400 feet

0 2,400 4,800 9,600 Feet

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Map B2 - Salisbury Township PRP Planning Area Map Overview

Map B3 - Salisbury Township PRP Planning Area Map - South

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No MS4 Infrastructure, Drainage to PENNDOT road
Drains outside of UA

No MS4 Infrastructure, Drainage to PENNDOT road
Drains outside of UA

No MS4 Infrastructure,
Drains outside of Township boundary

No MS4 Infrastructure, Drainage to PENNDOT road
Drains outside of Township boundary

Legend

Stormwater Infrastructure

Type

- Outfall
- Observation Point
- Outlet
- Attaining Stream
- Non-Attaining Stream

Salisbury Twp Roads

OWNER

- MUNICIPAL
- PRIVATE
- STATE
- HUC 12 Subwatershed
- Pequea Creek Planning Area
- Pine Creek Planning Area
- Valley Creek East Branch Planning Area
- Excluded Area
- SalisburyTwp
- 2010 Census Urban Area in Salisbury Twp

1 inch = 825 feet

0 825 1,650 3,300 Feet

Map B2 - Salisbury Township PRP Planning Area Map Overview

Map B4 - Salisbury Township PRP Planning Area Map - East

TIMOTHY DR
LORRY LN
EMERY RD
MAST RD
MAST RD
MT ZION RD
EVANS RD
NORTHEIMER RD
MEADEVILLE RD
NORTH ST
MAIN ST
BROAD ST
KENNEDY ST
CHURCHTOWN RD
KINGSFIELD DR
RED HILL RD
Pequea Creek
FISHER DR
BUCHLAND RD
Pequea Creek
ROSEHILL DR
THISTLE DR
KOSER RD
JACOBS RD
ROSS RD
STONY KNOLL DR
GAULT RD
CAMBRIDGE RD
RED HILL RD
SPOTTS RD
MT PLEASANT RD
WANNER RD
GUY RD
BYERLY RD
BEAVER DAM RD
ENGLETOWN RD
PLANK RD
SPRINGHEAD RD
DELPHIA PIKE
BLANK RD
CAINS RD
Indian Spring Run
Indian Spring Run
BUENA VISTA RD

Map B2 - Salisbury Township PRP Planning Area Map Overview

No MS4 Infrastructure,
Direct drainage to stream

No MS4 Infrastructure, Drainage to PENNDOT road
Direct drainage to stream

Legend

Stormwater Infrastructure Type
- Outfall
- Observation Point
- Outlet
- Attaining Stream
- Non-Attaining Stream

Salisbury Twp Roads
OWNER
- MUNICIPAL
- PRIVATE
- STATE
- HUC 12 Subwatershed
- 2010 Census Urban Area in Salisbury Twp
- Pequea Creek Planning Area
- Pine Creek Planning Area
- Valley Creek East Branch Planning Area
- Excluded Area
- SalisburyTwp

1 inch = 825 feet

0 650 1,300 2,600 3,900 Feet

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Map B5 - Salisbury Township PRP Proposed BMPs

Appendix C
Baseline Load Calculations

The baseline load calculations for all three of the planning areas in Salisbury Township (shown in Table 5 of the report) were calculated through the Stroud Water Research Center's Wikiwatershed Model My Watershed online modeling program. For the Pequea Creek Planning Area, Pine Creek Planning Area, and Valley Creek East Branch Planning Area, shapefiles of these specific planning areas were loaded into the online Model My Watershed modeling program to obtain *area-specific* values on stream lengths and stream bank loading rates, acreages per land use type, land use loading rates, and farm animal data.

From the specific planning area shapefiles modeled online, a Model My Watershed (MMW) BMP Spreadsheet Tool is developed to determine the existing load for the specific watershed and the planning area within that watershed. An overview of the MMW BMP Spreadsheet Tool is shown here:

Model My Watershed BMP Spreadsheet Tool

Load Reductions from BMP Implementation in Urban and Rural Areas

Version: 2020-01-30 at 1:00pm ET

Developed by: Barry Evans, Drexel University & Penn State University
Anthony Aufdenkampe, LimnoTech
Mike Hickman, Center for Watershed Protection
Reid Christianson, Center for Watershed Protection & University of Illinois

Repository & Archives: https://github.com/WikiWatershed/MMW-BMP-spreadsheet-tool
Latest Version: https://raw.githubusercontent.com/WikiWatershed/MMW-BMP-spreadsheet-tool/master/MMW_BMP_Spreadsheet_Tool.xlsx,
User Manual: https://raw.githubusercontent.com/WikiWatershed/MMW-BMP-spreadsheet-tool/master/docs/MMW_BMP_Spreadsheet_Tool_UserManual.docx

OVERVIEW:

This tool provides the ability to use output results from a Model My Watershed "multi-year" model run for the purpose of estimating loading rates for different "source areas", and then subsequently calculating potential load reductions that might result from the implementation of both urban and agricultural BMPs in a given watershed.

The tool is based on the concept of "composite" loading rates whereby both "upland" and "streambank-eroded" loads are combined to facilitate the estimation of load reductions based on the use of various BMPs as applied to different developed land and agricultural land categories.

THIS TOOL INCLUDES:

Section 2 (Land Use Loading Rates Look-Up Table) contains the Look-Up Table with final land use loading rates that incorporate Land Use (upland source), Stream Bank (erosion) and Farm Animal Loads. The "Total" (pollutant) Loading Rate values in this Table are used to calculate Baseline and Existing loads as well as "future" loads from proposed urban and agricultural BMP load reductions.

* In the MMW model run, Stream Bank and Farm Animal loads are modeled as separate sources/outputs, and therefore must be apportioned into the land use loads. This calculation has been completed herein and the results are summarized on the Look-up Table. Stream Bank loads are mostly attributable to developed lands. Farm Animal loads are attributed to Cropland and Hay/Pasture land uses.

* The Look-Up Table also shows loads calculated by the MMW model from septic, groundwater and point sources. However, per PA DEP guidance, these loads are NOT included in the land use loading rates presented in the Table. These loads are not loads that enter the MS4 and therefore these loads are not a pollutant load that is required to be addressed in the MS4 program. Please note, when comparing the nitrogen and phosphorus loading rates to other literature values for a watershed, the rates in this workbook may appear lower by land use for nutrients because of these adjustments. Groundwater loading of nitrogen and phosphorus are generally attributed to long-term agricultural practices.

Section 3 (MMW Output) contains results from the MMW output file data that are used for calculations throughout this workbook.

Sections 4 to 7 Contain supporting documentation that show how the calculations were performed to arrive at the values for the watershed that were presented in the Look-up Table in Section 2.

Tabs that require or allow user input
No input required. Tabs contain calculated values or provide descriptive information.
Final results tab.

Detailed Instructions are provided in a user manual that can be obtained at the follc https://raw.githubusercontent.com/WikiWatershed/MMW-BMP-spreadsheet-tool/master/docs/MMW_BMP_Spreadsheet_Tool_UserManual.docx

LIMITATIONS:

This Excel workbook tool was originally developed for use by municipalities that have MS4 discharges and load reduction responsibilities in Pennsylvania. This tool calculates land use pollutant loading rates for TSS, TN and TP using calculations, methodology, assumptions, and data based on, and consistent with, the MapShed model used in PA, and is also consistent with PADEP's 2017 TMDL and PRP instructions for MS4s. Now that the modeling routines in MapShed have been incorporated into Model My Watershed, this tool can also utilize output from a MMW run for a given watershed. Similarly, it can be used in other geographic areas where similar load reduction estimates have to be made.

The total existing load calculations for Salisbury Township were calculated by running the MMW BMP Spreadsheet Tool for the Pequea Creek Planning Area, Pine Creek Planning Area, and Valley Creek East Branch Planning Area and then summing the total of these loads. No existing Urban and Agricultural BMPs were input into the MMW BMP Spreadsheet Tool for any of the planning areas. Inputs and outputs from the MMW BMP Spreadsheet Tool are shown below for each of the planning areas. As noted above, the focus of the PRP is on sediment loads. Therefore, screenshots of the animal loading rates and the stream bank nitrogen and phosphorus loading rates are not included herein.

NOTE: 25 acres of medium developed land use was subtracted out of the planning area acreage to account for the footprint of the PENNDOT Road Right-of-Ways within the planning areas.

The Pequea Creek Headwaters Watershed and the Pequea Creek Planning Area:

MMW Model Output – Pequea Creek

Look-Up Table for MMW Land Use Loading Rates

Watershed: Headwaters Pequea
Year: 2020

Section 3: ***MMW Model Output***

This page is where the output data from a mult-year MMW model run is to be copied and pasted into this workbook and is the source data for calculations throughout the workbook.

1. Source File Name - User-specified filename for the output file from MMW (optional).
2. Watershed Name - User-specified name of a watershed for which land use loading rates are being calculated (optional).
3. Source file - The annual pollutant data, in English Units, is copied directly from the MMW output file to the table below.
4. Year - the year modeled (optional).

Data Entered By: *User Specified*
Date Data Entered: *2020-06-08*
Source File Name: *User Specified*
Watershed: *Headwaters Pequea Creek*
Year: *2020*

Model My Watershed OUTPUT DATA

Source	Area	Sediment	Tot N	Tot P
Units	acres	tons/year	lbs/year	lbs/year
Hay/Past	10,306.97	533.95	5,229.65	2,069.57
Cropland	11,083.95	7,965.52	59,506.49	19,323.03
Forest	6,935.89	6.47	179.71	21.50
Wetland	113.59	0.52	35.59	2.09
Disturbed	-	-	-	-
Turfgrass	-	-	-	-
Open_Land	140.74	2.54	69.05	6.32
Bare_Rock	14.81	0.01	7.45	0.26
Sandy_Areas	-	-	-	-
Unpaved_Road	-	-	-	-
Ld_Mixed	3,896.39	6.91	344.64	36.93
Md_Mixed	207.41	6.66	256.97	26.22
Hd_Mixed	39.51	1.24	47.61	4.85
Ld_Residential	-	-	-	-
Md_Residential	-	-	-	-
Hd_Residential	-	-	-	-
Farm Animals		-	147,968.93	36,807.84
Tile Drainage		-	-	-
Stream Bank		5,073.29	6,473.88	2,898.52
Groundwater		-	858,526.14	6,853.34
Point Source		-	2,220.44	262.40
Septic Systems		-	649.60	-
Totals	*32,538.27*	*13,495.92*	*1,080,745.23*	*67,913.89*

STREAM LENGTHS*	KM*	FEET	Sed lb/ft	TN lb/ft	TP lb/ft
Total Length	168.79	356922.6	28.4	0.02	0.01
Ag Streams	62.78	206971.1			
Non-Ag Streams	46.01	150951.4			

* These values can be obtained from the "Stream" tab in the "Analyze" section of a Model My Watershed run

FARM ANIMAL DATA

TYPE*	NUMBER*	AVG WT KG	TOTAL KG	TOTAL AEU	KG N/AEU/DAY	KG P/AEU/DAY	TOTAL N/DAY	TOTAL P/DAY
Chickens, Broilers	420347	0.9	378312.3	378.3123	1.07	0.3	404.794161	113.49369
Chickens, Layers	0	1.8	0	0	0.85	0.29	0	0
Cows, Beef	234	360	84240	84.24	0.31	0.09	26.1144	7.5816
Cows, Dairy	4936	640	3159040	3159.04	0.44	0.07	1389.9776	221.1328
Horses	791	500	395500	395.5	0.28	0.06	110.74	23.73
Pigs/Hogs/Swine	15565	61	949465	949.465	0.48	0.15	455.7432	142.41975
Sheep	510	50	25500	25.5	0.37	0.1	9.435	2.55
Turkeys	9740	6.8	66206.4	66.2064	0.59	0.2	39.100976	13.25728
						Daily Totals	2435.91	524.17
						Poultry Totals	443.90	126.75
						Livestock Totals	1992.01	397.41
						Poultry Fraction	0.22284	0.31894
						Livestock Fraction	0.81777	0.75819

* These values can be obtained from the "Animal" tab in the "Analyze" section of a Model My Watershed run

MMW NLCD Land Cover Categories for Watershed (from "Analyze" csv file)

TYPE	AREA (km^2)	AREA (acres)
Open Water	0.21	51.85
Perennial Ice/Snow	0	-
Developed, Open Space	10.06	2,483.95
Developed, Low Intensity	4.91	1,212.35
Developed, Medium Intensity	0.84	207.41
Developed, High Intensity	0.16	39.51
Barren Land (Rock/Sand/Clay)	0.06	14.81
Deciduous Forest	24.54	6,059.26
Evergreen Forest	0.06	14.81
Mixed Forest	0.22	54.32
Shrub/Scrub	3.27	807.41
Grassland/Herbaceous	0.57	140.74
Pasture/Hay	41.74	10,306.17
Cultivated Crops	44.89	11,083.95
Woody Wetlands	0.33	81.48
Emergent Herbaceous Wetlands	0.13	32.10
Totals	*131.78*	*32,538.27*

Pollutant Load Conversion from Metric to Standard Units (from "Model" csv file)

SOURCE	SEDIMENT (kg)	TOTAL N (kg)	TOTAL P (kg)	SEDIMENT (tons)	TOTAL N (lbs)	TOTAL P (lbs)
Hay/Pasture	483,583.38	2,379.28	938.58	533.1506765	5239.6533	2069.5689
Cropland	7,134,254.16	26,987.07	8,763.28	7865.515211	59506.48935	19323.0324
Wooded Areas	5,870.69	81.50	9.75	6.472435725	179.7075	21.49875
Wetlands	108.24	18.14	0.95	0.1193346	39.5887	2.09475
Open Land	2,307.34	39.93	3.14	2.54384235	88.04565	6.9237
Barren Areas	7.94	3.38	0.12	0.00875385	7.4529	0.2646
Low-Density Mixed	8,263.08	156.30	16.75	6.9050457	344.6415	36.93375
Medium-Density Mixed	6,056.59	116.54	11.89	6.677390475	258.9707	26.21745
High-Density Mixed	1,122.12	21.59	2.20	1.2371373	47.60595	4.851
Other Upland Areas	12,824.94	320.05	34.29	14.13949635	705.71025	75.60945
Farm Animals	0.00	66,743.28	16,692.90	0	147188.9324	36807.8445
Stream Bank Erosion	4,601,628.00	2,936.00	1,224.00	5073.29487	6473.88	2698.92
Subsurface Flow	0.00	389,354.26	3,017.39	0	858526.1453	6653.34495
Point Sources	0.00	1,007.00	119.00	0	2220.435	262.395
Septic Systems	0.00	294.64	0.00	0	649.6812	0
Totals	*12,254,026.48*	*490,453.94*	*30,834.24*	*13,510.06*	*1,081,450.94*	*67,989.50*

Note: The information below is only used for allocation of "urban" loads within a larger watershed boundary

MMW NLCD Land Cover Categories for Urban Area (from second, smaller "Analyze" csv file)

TYPE	AREA (km^2)	AREA (acres)	TN (lb/yr)	TP (lb/yr)	Sediment (lb/yr)
Open Water	0	-			
Perennial Ice/Snow	0	-			
Developed, Open Space	0.83	204.94	129.11	45.09	160,626.56
Developed, Low Intensity	0.65	160.49	101.11	35.31	125,791.89
Developed, Medium Intensity	0.112	27.65	57.80	19.36	60,608.50
Developed, High Intensity	0.06	14.81	34.96	15.11	51,322.64
Barren Land (Rock/Sand/Clay)	0	-	0.00	0.00	0.00
Deciduous Forest	1.53	377.76	60.00	22.67	69,050.40
Evergreen Forest	0.01	2.47	0.44	0.15	502.00
Mixed Forest	0.01	2.47	0.44	0.15	502.00
Shrub/Scrub	0.26	64.20	11.56	3.85	15,134.11
Grassland/Herbaceous	0.09	22.22	17.33	2.44	6,000.57
Pasture/Hay	0.24	59.26	446.01	117.33	19,990.45
Cultivated Crops	0.17	41.98	520.49	147.75	69,391.00
Woody Wetlands	0	-	0.00	0.00	0.00
Emergent Herbaceous Wetlands	0	-	0.00	0.00	0.00
Totals	*3.96*	*978.27*	*1,388.07*	*409.21*	*599,088.28*

(Note: The values below only pertain to the smaller target area)

STREAM LENGTH	KM*	FEET
Total Length	9.49	31135.2
Ag Streams	2.43	7972.4
Non-Ag Streams	7.06	23162.7

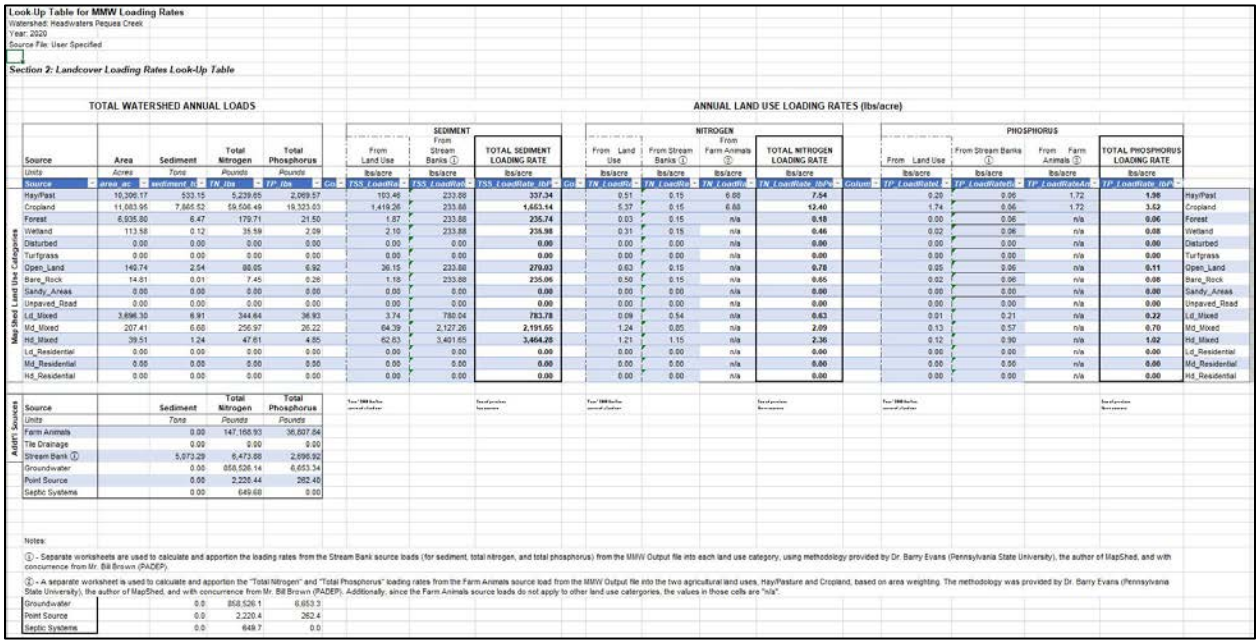
* These values can be obtained from the "Stream" tab in the "Analyze" section of a Model My Watershed run

TYPE	AREA (m^2)*	AREA (acres)			
Open Water	0	0.00			
Perennial Ice/Snow	0	0.00			
Developed, Open Space	1784.5	0.44	0.28	0.10	347.28
Developed, Low Intensity	897.24	0.22	0.14	0.05	173.64
Developed, Medium Intensity	2691.75	0.66	1.39	0.47	1,496.63
Developed, High Intensity	0	0.00	0.00	0.00	0.00
Barren Land (Rock/Sand/Clay)	0	0.00	0.00	0.00	0.00
Deciduous Forest	3529	0.89	0.16	0.05	208.91
Evergreen Forest	0	0.00	0.00	0.00	0.00
Mixed Forest	0	0.00	0.00	0.00	0.00
Shrub/Scrub	0	0.00	0.00	0.00	0.00
Grassland/Herbaceous	0	0.00	0.00	0.00	0.00
Pasture/Hay	897.25	0.22	1.67	0.44	74.74
Cultivated Crops	897.25	0.22	2.75	0.78	388.24
Woody Wetlands	0	0.00	0.00	0.00	0.00
Emergent Herbaceous Wetlands	0	0.00	0.00	0.00	0.00
Totals	*10766.99*	*2.66*	*6.38*	*1.88*	*2,627.44*

*Only use this input block if land cover distribution is given in square meters (m^2).
This occurs when AOI is less than about 2 square kilometer2.

TOTAL LOADS			1,394.45	411.09	601,715.72

Land Use Loading Rates – Pequea Creek



Look-Up Table for MMW Loading Rates
Watershed: Headwaters Pequea Creek
Year: 2020
Source File: User Specified

Section 2: Landcover Loading Rates Look-Up Table

TOTAL WATERSHED ANNUAL LOADS

Source	Area	Sediment	Total Nitrogen	Total Phosphorus
Units	Acres	Tons	Pounds	Pounds
Source	area_ac	sediment_tons	TN_lbs	TP_lbs
Hay/Past	10,399.17	533.15	5,239.65	2,069.57
Cropland	11,083.95	7,865.52	59,506.49	19,323.03
Forest	6,935.80	6.47	179.71	21.50
Wetland	113.58	0.12	35.59	2.09
Disturbed	0.00	0.00	0.00	0.00
Turfgrass	0.00	0.00	0.00	0.00
Open_Land	140.74	2.54	88.05	6.92
Bare_Rock	14.81	0.01	7.45	0.26
Sandy_Areas	0.00	0.00	0.00	0.00
Unpaved_Road	0.00	0.00	0.00	0.00
Ld_Mixed	3,696.30	6.91	344.64	36.93
Md_Mixed	207.41	6.68	256.97	26.22
Hd_Mixed	39.51	1.24	47.61	4.95
Ld_Residential	0.00	0.00	0.00	0.00
Md_Residential	0.55	0.55	0.55	0.55
Hd_Residential	0.00	0.00	0.00	0.00

Map Shed Land Use Categories

ANNUAL LAND USE LOADING RATES (lbs/acre)

	SEDIMENT			NITROGEN				PHOSPHORUS			
Source	From Land Use	From Stream Banks ①	TOTAL SEDIMENT LOADING RATE	From Land Use	From Stream Banks ①	From Farm Animals ②	TOTAL NITROGEN LOADING RATE	From Land Use	From Stream Banks ①	From Farm Animals ②	TOTAL PHOSPHORUS LOADING RATE
Units	lbs/acre	lbs/acre	lbs/acre	lbs/acre	lbs/acre	lbs/acre	lbs/acre	lbs/acre	lbs/acre	lbs/acre	lbs/acre
Source	TSS_LoadRate	TSS_LoadRate_lbPer	TSS_LoadRate_lbPer	TN_LoadRate	TN_LoadRate	TN_LoadRate_lbPer	TN_LoadRate_lbPer	TP_LoadRate_L	TP_LoadRate_St	TP_LoadRate_An	TP_LoadRate_lbPer
Hay/Past	193.46	233.88	**337.34**	0.51	0.15	6.88	**7.54**	0.20	0.06	1.72	**1.98**
Cropland	1,419.26	233.88	**1,653.14**	5.37	0.15	6.88	**12.40**	1.74	0.06	1.72	**3.52**
Forest	1.87	233.88	**235.74**	0.03	0.15	n/a	**0.18**	0.00	0.06	n/a	**0.06**
Wetland	2.10	233.88	**236.98**	0.31	0.15	n/a	**0.46**	0.02	0.06	n/a	**0.08**
Disturbed	0.00	0.00	**0.00**	0.00	0.00	n/a	**0.00**	0.00	0.00	n/a	**0.00**
Turfgrass	0.00	0.00	**0.00**	0.00	0.00	n/a	**0.00**	0.00	0.00	n/a	**0.00**
Open_Land	36.15	233.88	**270.03**	0.63	0.15	n/a	**0.78**	0.05	0.06	n/a	**0.11**
Bare_Rock	1.18	233.88	**235.06**	0.50	0.15	n/a	**0.65**	0.02	0.06	n/a	**0.08**
Sandy_Areas	0.00	0.00	**0.00**	0.00	0.00	n/a	**0.00**	0.00	0.00	n/a	**0.00**
Unpaved_Road	0.00	0.00	**0.00**	0.00	0.00	n/a	**0.00**	0.00	0.00	n/a	**0.00**
Ld_Mixed	3.74	780.04	**783.78**	0.09	0.54	n/a	**0.63**	0.01	0.21	n/a	**0.22**
Md_Mixed	64.39	2,127.26	**2,191.65**	1.24	0.85	n/a	**2.09**	0.13	0.57	n/a	**0.70**
Hd_Mixed	62.63	3,401.65	**3,464.28**	1.21	1.15	n/a	**2.36**	0.12	0.90	n/a	**1.02**
Ld_Residential	0.00	0.00	**0.00**	0.00	0.00	n/a	**0.00**	0.00	0.00	n/a	**0.00**
Md_Residential	0.55	0.55	**0.00**	0.00	0.00	n/a	**0.00**	0.00	0.55	n/a	**0.00**
Hd_Residential	0.00	0.00	**0.00**	0.00	0.00	n/a	**0.00**	0.00	0.00	n/a	**0.00**

Addn'l Sources

Source	Sediment	Total Nitrogen	Total Phosphorus
Units	Tons	Pounds	Pounds
Farm Animals	0.00	147,168.93	36,807.84
Tile Drainage	0.00	0.00	0.00
Stream Bank ①	5,873.29	6,473.66	2,696.92
Groundwater	0.00	858,526.14	6,653.34
Point Source	0.55	2,226.44	282.40
Septic Systems	0.00	649.68	0.00

Notes:

① - Separate worksheets are used to calculate and apportion the loading rates from the Stream Bank source loads (for sediment, total nitrogen, and total phosphorus) from the MMW Output file into each land use category, using methodology provided by Dr. Barry Evans (Pennsylvania State University), the author of MapShed, and with concurrence from Mr. Bill Brown (PADEP).

② - A separate worksheet is used to calculate and apportion the "Total Nitrogen" and "Total Phosphorus" loading rates from the Farm Animals source load from the MMW Output file into the two agricultural land uses, Hay/Pasture and Cropland, based on area weighting. The methodology was provided by Dr. Barry Evans (Pennsylvania State University), the author of MapShed, and with concurrence from Mr. Bill Brown (PADEP). Additionally, since the Farm Animals source loads do not apply to other land use categories, the values in those cells are "n/a".

Groundwater	0.0	858,526.1	6,653.3
Point Source	0.0	2,220.4	282.4
Septic Systems	0.0	649.7	0.0

Streambank Loading Rates (Sediment) – Pequea Creek

Look-Up Table for MMW Loading Rates
Watershed: Headwaters Pequea Creek
Year: 2020

Section 5: Stream Bank Sediment Loading Rates Worksheet
This worksheet calculates and apportions the loading rates from the Stream Bank source load for sediment from the MMW

Step 1. The Stream Bank Sediment Load, in tons, and land areas for each land use category, in acres, are presented below.

	Sediment		
Stream Bank	5,073.29	tons	Note: The sediment load is taken from Cell D38 in the MMW Output worksheet

Land Use Categories from MapShed	Source	Area (acres)
	Hay/Pasture	10,306.17
	Cropland	11,083.95
	Forest	6,935.80
	Wetland	113.58
	Disturbed	0.00
	Turfgrass	0.00
	Open_Land	140.74
	Bare_Rock	14.81
	Sandy_Areas	0.00
	Unpaved_Road	0.00
	Ld_Mixed	3,696.30
	Md_Mixed	207.41
	Hd_Mixed	39.51
	Ld_Residential	0.00
	Md_Residential	0.00
	Hd_Residential	0.00
	Total Acres, Watershed	**32,538.27**

Step 2. Convert the Stream Bank Sediment Load to pounds by multiplying tons by 2,000 pounds per ton.

	Sediment Load, pounds		
Stream Bank	10,146,580.00	pounds	= [5073.29 tons x 2,000 pounds per ton]

Step 3. Sum the total acres in the Headwaters Pequea Creek watershed.

Total Acres in watershed	32,538.27	acres

Step 4. Calculate the total acres in the watershed that are considered "Developed," which includes Low Density Mixed (Ld_Mixed), Medium Density Mixed (Md_Mixed), High Density Mixed (Hd_Mixed); and Low Density Residential (Ld_Residential), Medium Density Residential (Md_Residential), and High Density Residential (Hd_Residential).

Area of Developed Lands	*acres*	*percent*	
Low Density Developed	3,696.30	94%	[Ld_Mixed + Ld_Residential]
Medium Density Developed	207.41	5%	[Md_Mixed + Md_Residential]
High Density Developed	39.51	1%	[Hd_Mixed + Hd_Residential]
Total	3,943.21	100%	[All "Developed" land use categories]

Step 5. Calculate the portion of the Stream Bank Sediment Load resulting from "Developed" Lands

This is A) 75% of the Stream Bank Sediment Load times the percent of developed lands in the watershed plus B) 25% of the Stream Bank Sediment Load:

Stream Bank Sediment Load	10,146,580.00	pounds		from Step 2
Total Developed Acres	3,943.2	acres		from Step 4
Total Acres in watershed	32,538.3	acres		from Step 3
Percent of Developed lands in watershed	12%		=	[3943.21 acres / 32538.27 acres]
A) 75% x Stream Bank Sediment Load x Percent of Developed Lands	922,223.87	pounds	=	[75% x 10146580 pounds x 12%]
B) 25% x Stream Bank Sediment Load	2,536,645.00	pounds	=	[25% x 10146580 pounds]
Load Assigned to Developed Lands	3,458,868.87	pounds		

Step 6. Calculate the portion of the Stream Bank Sediment Load from "Developed" Lands that is assigned to each of the land use categories by calculating relative components from "Impervious" surfaces and from the

Estimated Percent of Impervious Area for corresponding land use categories (MapShed Values)	
Low Density Developed	15%
Medium Density Developed	52%
High Density Developed	87%

Step 7. Calculate how many acres within the watershed are "Impervious" by multiplying the acres in Step 4 by the percent in Step 6:

Estimated Impervious Surfaces for Developed Lands				
Low Density Developed	554.44	acres	=	[3696.3 acres x 15 percent]
Medium Density Developed	107.85	acres	=	[207.41 acres x 52 percent]
High Density Developed	34.37	acres	=	[39.51 acres x 87 percent]
Total Developed Impervious Surface Area	696.67	acres		

Step 8. Calculate the percent of total developed Impervious Surface for each land use:

Percent of Total Impervious Surfaces			
Low Density Developed	80%	=	[554.44 acres / 696.67 acres]
Medium Density Developed	15%	=	[107.85 acres / 696.67 acres]
High Density Developed	5%	=	[34.37 acres / 696.67 acres]
Total	100%		

Step 9. Distribute the "Total Load Assigned to Developed Lands" from Step 5 to each Developed Land type based on "Impervious" surfaces and the percent of land area in the land use category:

Load Assigned to Developed Lands	3,458,868.87	pounds =	[result of Step 5]
Load assigned to Total Developed Land	922,223.87	pounds =	[result of Step 5]
Load assigned for Total Impervious Land	2,536,645.00	pounds =	[result of Step 5]

Step 10. Apportion Load Assigned to "Impervious" surfaces to each "Developed" land use category by multiplying the 'Percent of Total Impervious Surfaces' (Step 8) by 2536645 pounds (calculated in Step 9):

Stream Bank Sediment Load Assigned to Impervious Surface, pounds		
Low Density Developed	2,018,797.22	= [80 % x 2536645 pounds]
Medium Density Developed	392,701.24	= [15 % x 2536645 pounds]
High Density Developed	125,146.55	= [5 % x 2536645 pounds]

Step 11. Apportion Load Assigned to Total Land Area to each "Developed" land use category by multiplying the 'Percent of Area of Developed Lands' (from Step 4) by 922223.87 pounds (calculated in Step 9):

Stream Bank Sediment Load Assigned to Total Developed Land Area, pounds		
Low Density Developed	864,476.60	= [94 % x 922223.87 pounds]
Medium Density Developed	48,507.71	= [5 % x 922223.87 pounds]
High Density Developed	9,239.56	= [1 % x 922223.87 pounds]

Step 12. Combine the loads apportioned to "Impervious" surfaces, from Step 10, and the loads apportioned to Total Developed Land Area, from Step 11:

Total Stream Bank Sediment Load per Land Use, pounds		
Low Density Developed	2,883,273.82	= [2018797.22 pounds + 864476.6 pounds]
Medium Density Developed	441,208.94	= [392701.24 pounds + 48507.71 pounds]
High Density Developed	134,386.11	= [125146.55 pounds + 9239.56 pounds]

Step 13. Calculate the Stream Bank Loading Rate for each "Developed" Land Use, in pounds per acre, by dividing the load from Step 12 by the acres in Step 4:

Stream Bank Sediment Land Use Loading Rate	pounds	Land Use area, acres	Stream Bank Sediment
Low Density Developed	2,883,273.82	3,696.30	**780.04** = [2883273.82 lbs / 3696.3 acres]
Medium Density Developed	441,208.94	207.41	**2,127.26** = [441208.94 lbs / 207.41 acres]
High Density Developed	134,386.11	39.51	**3,401.65** = [134386.11 lbs / 39.51 acres]

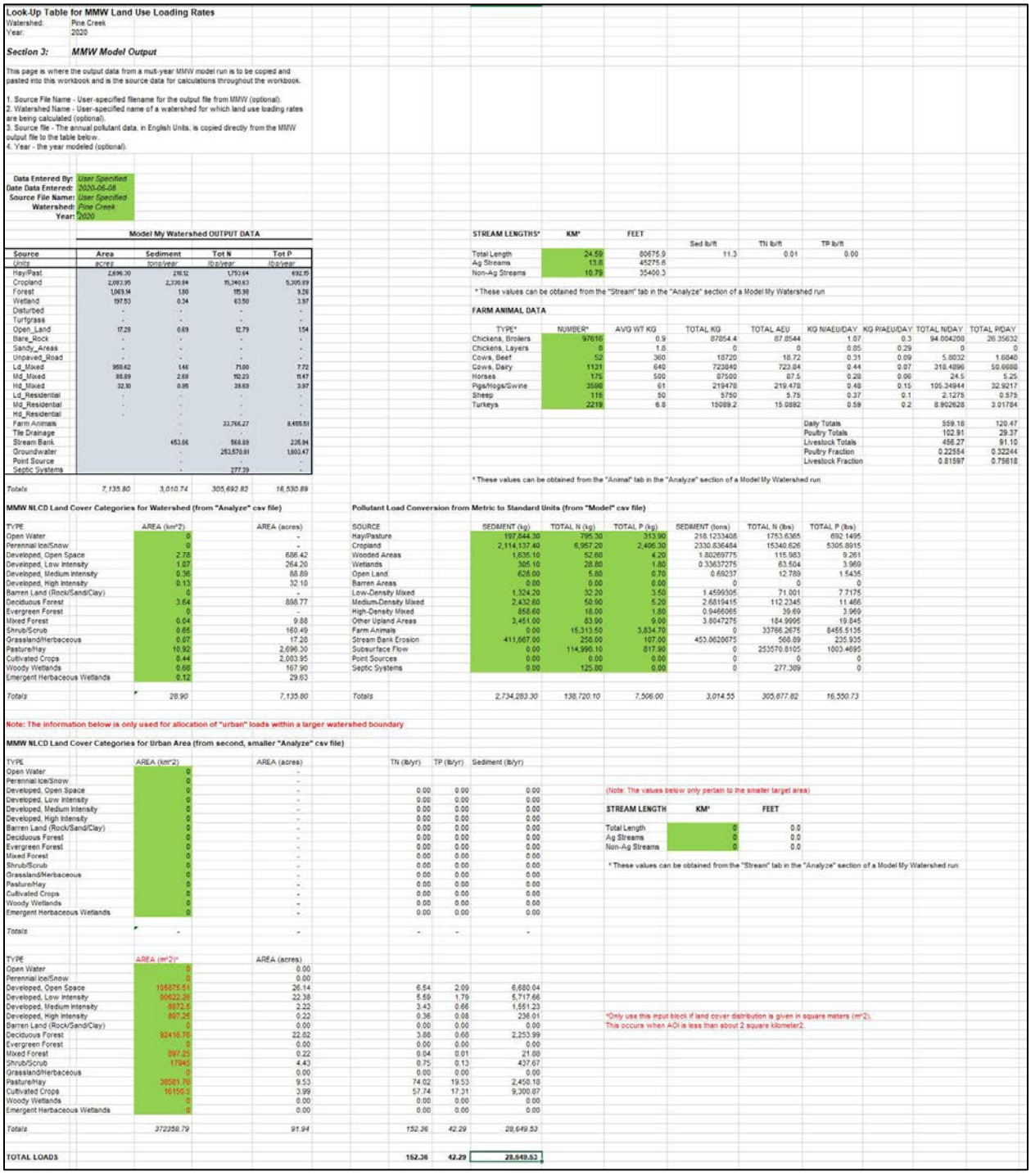
Step 14. Calculate the Stream Bank Loading Rate for "Undeveloped Land" (all other land use categories):

Total Stream Bank Load	10,146,580.00	pounds =	[from Step 3]
Load assigned to Developed Lan	3,458,868.87	pounds =	[from Step 5]
Remaining Load assigned to Undeveloped Lands	6,687,711.13	pounds =	[10146580 pounds - 3458868.87 pounds]
Acres of Undeveloped Lands	28,595.06	acres =	[sum of "Undeveloped Land" from Step 1]
Stream Bank Sediment Loading rate for Undeveloped Lands	**233.88**	**pounds per acre**	= [6687711.13 pounds / 28595.06 acres]

Step 15. Add these Stream Bank Sediment Land Use Loading Rates to the Land Use (upland source) Loading Rates for each of the corresponding land uses in the Land Use Loading Rates Look-Up Table to calculate the Total Sediment Loading Rate.

The Pine Creek Watershed and the Pine Creek Planning Area:

MMW Model Output – Pine Creek



Look-Up Table for MMW Land Use Loading Rates

Watershed: Pine Creek
Year: 2020

Section 3: ***MMW Model Output***

This page is where the output data from a multi-year MMW model run is to be copied and pasted into this workbook and is the source data for calculations throughout the workbook.

1. Source File Name - User-specified filename for the output file from MMW (optional).
2. Watershed Name - User-specified name of a watershed for which land use loading rates are being calculated (optional).
3. Source file - The annual pollutant data, in English Units, is copied directly from the MMW output file to the table below.
4. Year - the year modeled (optional).

Data Entered By:	*User Specified*
Date Data Entered:	*2020-06-08*
Source File Name:	*User Specified*
Watershed:	*Pine Creek*
Year:	*2020*

Model My Watershed OUTPUT DATA

Source	Area	Sediment	Tot N	Tot P
Units	acres	tons/year	lbs/year	lbs/year
Hay/Past	2,696.30	218.12	1,753.64	692.15
Cropland	2,083.95	2,330.84	15,340.63	5,305.89
Forest	1,063.14	1.80	115.30	9.28
Wetland	197.53	0.34	63.50	3.97
Disturbed	-	-	-	-
Turfgrass	-	-	-	-
Open_Land	17.28	0.69	12.79	1.54
Bare_Rock	-	-	-	-
Sandy_Areas	-	-	-	-
Unpaved_Road	-	-	-	-
Ld_Mixed	959.62	1.46	71.00	7.72
Md_Mixed	88.89	2.68	192.23	11.47
Hd_Mixed	32.10	0.95	39.69	3.97
Ld_Residential	-	-	-	-
Md_Residential	-	-	-	-
Hd_Residential	-	-	-	-
Farm Animals		-	33,766.27	8,455.51
Tile Drainage		-	-	-
Stream Bank		453.86	568.89	235.94
Groundwater		-	253,570.81	1,603.47
Point Source		-	-	-
Septic Systems		-	277.39	-
Totals	*7,135.80*	*3,010.74*	*305,692.82*	*16,530.89*

STREAM LENGTHS*	**KM***	**FEET**	**Sed lb/ft**	**TN lb/ft**	**TP lb/ft**
Total Length	24.59	80675.9	11.3	0.01	0.00
Ag Streams	13.8	45275.6			
Non-Ag Streams	10.79	35400.3			

* These values can be obtained from the "Stream" tab in the "Analyze" section of a Model My Watershed run

FARM ANIMAL DATA

TYPE*	NUMBER*	AVG WT KG	TOTAL KG	TOTAL AEU	KG N/AEU/DAY	KG P/AEU/DAY	TOTAL N/DAY	TOTAL P/DAY
Chickens, Broilers	97616	0.9	87854.4	87.8544	1.07	0.3	94.004208	26.35632
Chickens, Layers	0	1.8	0	0	0.85	0.29	0	0
Cows, Beef	52	360	18720	18.72	0.31	0.09	5.8032	1.6848
Cows, Dairy	1131	640	723840	723.84	0.44	0.07	318.4896	50.66688
Horses	175	500	87500	87.5	0.28	0.06	24.5	5.25
Pigs/Hogs/Swine	3598	61	219478	219.478	0.48	0.15	105.34944	32.9217
Sheep	115	50	5750	5.75	0.37	0.1	2.1275	0.575
Turkeys	2219	6.8	15089.2	15.0892	0.59	0.2	8.902628	3.01784

Daily Totals	559.18	120.47
Poultry Totals	102.91	29.37
Livestock Totals	456.27	91.10
Poultry Fraction	0.22554	0.32244
Livestock Fraction	0.81597	0.75618

* These values can be obtained from the "Animal" tab in the "Analyze" section of a Model My Watershed run

MMW NLCD Land Cover Categories for Watershed (from "Analyze" csv file)

TYPE	AREA (km^2)	AREA (acres)
Open Water	0	-
Perennial Ice/Snow	0	-
Developed, Open Space	2.78	686.42
Developed, Low Intensity	1.07	264.20
Developed, Medium Intensity	0.36	88.89
Developed, High Intensity	0.13	32.10
Barren Land (Rock/Sand/Clay)	0	-
Deciduous Forest	3.64	898.77
Evergreen Forest	0	-
Mixed Forest	0.04	9.88
Shrub/Scrub	0.65	160.49
Grassland/Herbaceous	0.07	17.28
Pasture/Hay	10.92	2,696.30
Cultivated Crops	8.44	2,083.95
Woody Wetlands	0.66	167.90
Emergent Herbaceous Wetlands	0.12	29.63
Totals	*28.90*	*7,135.80*

Pollutant Load Conversion from Metric to Standard Units (from "Model" csv file)

SOURCE	SEDIMENT (kg)	TOTAL N (kg)	TOTAL P (kg)	SEDIMENT (tons)	TOTAL N (lbs)	TOTAL P (lbs)
Hay/Pasture	197,844.30	795.30	313.90	218.1233408	1753.6365	692.1495
Cropland	2,114,137.40	6,957.20	2,406.30	2330.836484	15340.626	5305.8915
Wooded Areas	1,635.10	52.60	4.20	1.80269775	115.983	9.261
Wetlands	305.10	28.80	1.80	0.33637275	63.504	3.969
Open Land	626.00	6.80	0.70	0.69237	12.789	1.5435
Barren Areas	0.00	0.00	0.00	0	0	0
Low-Density Mixed	1,324.20	32.20	3.50	1.4599305	71.001	7.7175
Medium-Density Mixed	2,432.60	50.90	5.20	2.6819415	112.2345	11.466
High-Density Mixed	858.60	18.00	1.80	0.9466065	39.69	3.969
Other Upland Areas	3,451.00	83.90	9.00	3.8047275	184.9995	19.845
Farm Animals	0.00	15,313.50	3,834.70	0	33766.2675	8455.5135
Stream Bank Erosion	411,667.00	256.00	107.00	453.8628675	568.09	235.935
Subsurface Flow	0.00	114,990.10	817.90	0	253570.8105	1803.4695
Point Sources	0.00	0.00	0.00	0	0	0
Septic Systems	0.00	125.80	0.00	0	277.309	0
Totals	*2,734,283.30*	*138,720.10*	*7,506.00*	*3,014.55*	*305,877.82*	*16,550.73*

Note: The information below is only used for allocation of "urban" loads within a larger watershed boundary

MMW NLCD Land Cover Categories for Urban Area (from second, smaller "Analyze" csv file)

TYPE	AREA (km^2)	AREA (acres)	TN (lb/yr)	TP (lb/yr)	Sediment (lb/yr)
Open Water	0	-			
Perennial Ice/Snow	0	-			
Developed, Open Space	0	-	0.00	0.00	0.00
Developed, Low Intensity	0	-	0.00	0.00	0.00
Developed, Medium Intensity	0	-	0.00	0.00	0.00
Developed, High Intensity	0	-	0.00	0.00	0.00
Barren Land (Rock/Sand/Clay)	0	-	0.00	0.00	0.00
Deciduous Forest	0	-	0.00	0.00	0.00
Evergreen Forest	0	-	0.00	0.00	0.00
Mixed Forest	0	-	0.00	0.00	0.00
Shrub/Scrub	0	-	0.00	0.00	0.00
Grassland/Herbaceous	0	-	0.00	0.00	0.00
Pasture/Hay	0	-	0.00	0.00	0.00
Cultivated Crops	0	-	0.00	0.00	0.00
Woody Wetlands	0	-	0.00	0.00	0.00
Emergent Herbaceous Wetlands	0	-	0.00	0.00	0.00
Totals	-	-	-	-	-

(Note: The values below only pertain to the smaller target area)

STREAM LENGTH	**KM***	**FEET**
Total Length	0	0.0
Ag Streams	0	0.0
Non-Ag Streams	0	0.0

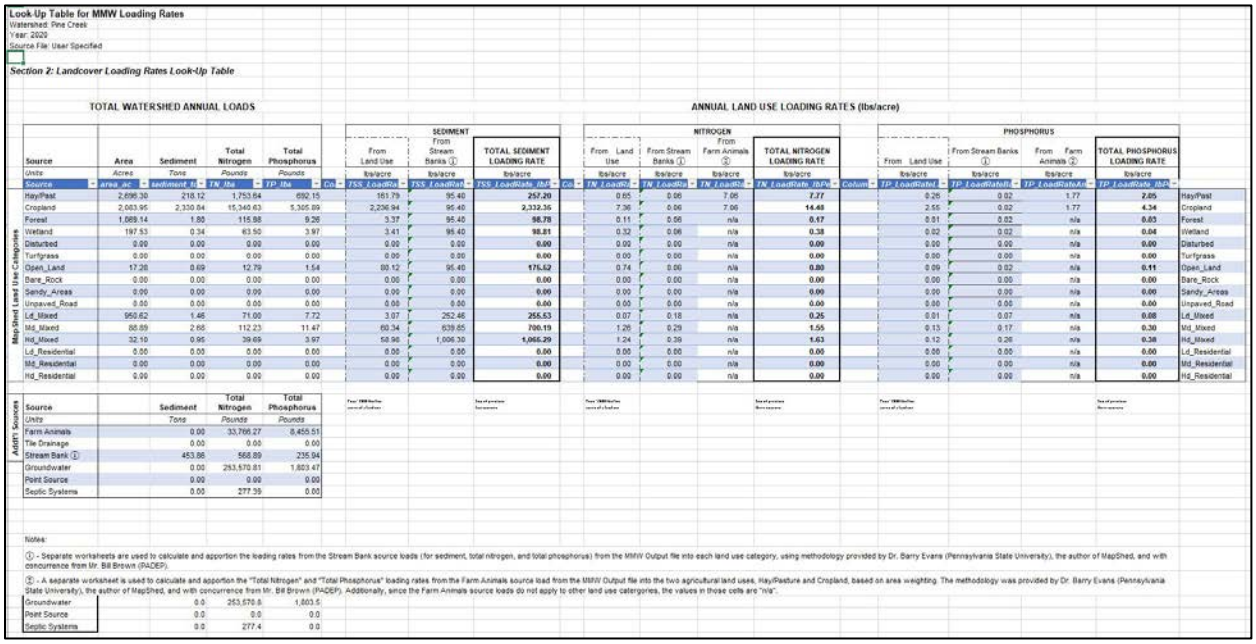
* These values can be obtained from the "Stream" tab in the "Analyze" section of a Model My Watershed run

TYPE	AREA (m^2)*	AREA (acres)	TN (lb/yr)	TP (lb/yr)	Sediment (lb/yr)
Open Water	0	0.00			
Perennial Ice/Snow	0	0.00			
Developed, Open Space	105875.51	26.14	6.54	2.09	6,680.04
Developed, Low Intensity	90622.39	22.38	5.59	1.79	5,717.66
Developed, Medium Intensity	8972.5	2.22	3.43	0.66	1,551.23
Developed, High Intensity	897.25	0.22	0.36	0.08	236.01
Barren Land (Rock/Sand/Clay)	0	0.00	0.00	0.00	0.00
Deciduous Forest	90410.76	22.02	3.66	0.68	2,253.99
Evergreen Forest	0	0.00	0.00	0.00	0.00
Mixed Forest	897.25	0.22	0.04	0.01	21.68
Shrub/Scrub	17945	4.43	0.75	0.13	437.67
Grassland/Herbaceous	0	0.00	0.00	0.00	0.00
Pasture/Hay	30581.76	9.53	74.02	19.53	2,450.18
Cultivated Crops	16150.5	3.99	57.74	17.31	9,300.87
Woody Wetlands	0	0.00	0.00	0.00	0.00
Emergent Herbaceous Wetlands	0	0.00	0.00	0.00	0.00
Totals	*372358.79*	*91.94*	*152.36*	*42.29*	*28,649.53*

*Only use this input block if land cover distribution is given in square meters (m^2). This occurs when AOI is less than about 2 square kilometer2.

TOTAL LOADS		**152.36**	**42.29**	**28,649.53**

Land Use Loading Rates – Pine Creek



Look-Up Table for MMW Loading Rates
Watershed: Pine Creek
Year: 2020
Source File: User Specified

Section 2: Landcover Loading Rates Look-Up Table

TOTAL WATERSHED ANNUAL LOADS

Source	Area	Sediment	Total Nitrogen	Total Phosphorus
Units	Acres	Tons	Pounds	Pounds
Source	Area_ac	Sediment_lb	TN_lbs	TP_lbs
Hay/Past	2,696.30	218.12	1,753.64	692.15
Cropland	2,083.95	2,330.84	15,340.63	5,305.89
Forest	1,089.14	1.86	115.88	9.26
Wetland	197.53	0.34	63.50	3.97
Disturbed	0.00	0.00	0.00	0.00
Turfgrass	0.00	0.00	0.00	0.00
Open_Land	17.26	0.69	12.79	1.54
Bare_Rock	0.00	0.00	0.00	0.00
Sandy_Areas	0.00	0.00	0.00	0.00
Unpaved_Road	0.00	0.00	0.00	0.00
Ld_Mixed	950.62	1.46	71.00	7.72
Md_Mixed	86.69	2.66	112.23	11.47
Hd_Mixed	32.19	0.95	39.65	3.97
Ld_Residential	0.00	0.00	0.00	0.00
Md_Residential	0.00	0.00	0.00	0.00
Hd_Residential	0.00	0.00	0.00	0.00

ANNUAL LAND USE LOADING RATES (lbs/acre)

	SEDIMENT			NITROGEN				PHOSPHORUS			
	From Land Use	From Stream Banks ①	TOTAL SEDIMENT LOADING RATE	From Land Use	From Stream Banks ①	From Farm Animals ②	TOTAL NITROGEN LOADING RATE	From Land Use	From Stream Banks ①	From Farm Animals ②	TOTAL PHOSPHORUS LOADING RATE
Units	lbs/acre	lbs/acre	lbs/acre	lbs/acre	lbs/acre	lbs/acre	lbs/acre	lbs/acre	lbs/acre	lbs/acre	lbs/acre
Source	TSS_LoadRate	TSS_LoadRate	TSS_LoadRate_lbAc	TN_LoadRate	TN_LoadRate	TN_LoadRate	TN_LoadRate_lbAc	TP_LoadRate	TP_LoadRate	TP_LoadRateAn	TP_LoadRate_lbAc
Hay/Past	161.79	95.40	**257.20**	0.65	0.06	7.06	**7.77**	0.26	0.02	1.77	**2.05**
Cropland	2,236.94	95.40	**2,332.35**	7.36	0.06	7.06	**14.48**	2.55	0.02	1.77	**4.34**
Forest	1,089.14	95.40	**98.78**	0.11	0.06	n/a	**0.17**	0.01	0.02	n/a	**0.03**
Wetland	197.53	95.40	**98.81**	0.32	0.06	n/a	**0.38**	0.02	0.02	n/a	**0.04**
Disturbed	0.00	0.00	**0.00**	0.00	0.00	n/a	**0.00**	0.00	0.00	n/a	**0.00**
Turfgrass	0.00	0.00	**0.00**	0.00	0.00	n/a	**0.00**	0.00	0.00	n/a	**0.00**
Open_Land	17.26	95.40	**175.52**	0.74	0.00	n/a	**0.80**	0.09	0.02	n/a	**0.11**
Bare_Rock	0.00	0.00	**0.00**	0.00	0.00	n/a	**0.00**	0.00	0.00	n/a	**0.00**
Sandy_Areas	0.00	0.00	**0.00**	0.00	0.00	n/a	**0.00**	0.00	0.00	n/a	**0.00**
Unpaved_Road	0.00	0.00	**0.00**	0.00	0.00	n/a	**0.00**	0.00	0.00	n/a	**0.00**
Ld_Mixed	1.46	254.17	**255.63**	0.07	0.18	n/a	**0.25**	0.01	0.07	n/a	**0.08**
Md_Mixed	2.66	697.99	**700.19**	1.26	0.29	n/a	**1.55**	0.13	0.17	n/a	**0.30**
Hd_Mixed	0.95	1,065.34	**1,066.29**	1.24	0.39	n/a	**1.63**	0.12	0.26	n/a	**0.38**
Ld_Residential	0.00	0.00	**0.00**	0.00	0.00	n/a	**0.00**	0.00	0.00	n/a	**0.00**
Md_Residential	0.00	0.00	**0.00**	0.00	0.00	n/a	**0.00**	0.00	0.00	n/a	**0.00**
Hd_Residential	0.00	0.00	**0.00**	0.00	0.00	n/a	**0.00**	0.00	0.00	n/a	**0.00**

Addn'l Sources

Source	Sediment	Total Nitrogen	Total Phosphorus
Units	Tons	Pounds	Pounds
Farm Animals	0.00	33,766.27	8,455.51
Tile Drainage	0.00	0.00	0.00
Stream Bank ①	453.86	568.89	235.94
Groundwater	0.00	253,570.81	1,803.47
Point Source	0.00	0.00	0.00
Septic Systems	0.00	277.39	0.00

Notes:

① - Separate worksheets are used to calculate and apportion the loading rates from the Stream Bank source loads (for sediment, total nitrogen, and total phosphorus) from the MMW Output file into each land use category, using methodology provided by Dr. Barry Evans (Pennsylvania State University), the author of MapShed, and with concurrence from Mr. Bill Brown (PADEP).

② - A separate worksheet is used to calculate and apportion the "Total Nitrogen" and "Total Phosphorus" loading rates from the Farm Animals source load from the MMW Output file into the two agricultural land uses, Hay/Pasture and Cropland, based on area weighting. The methodology was provided by Dr. Barry Evans (Pennsylvania State University), the author of MapShed, and with concurrence from Mr. Bill Brown (PADEP). Additionally, since the Farm Animals source loads do not apply to other land use categories, the values in those cells are "n/a".

Groundwater	0.0	253,570.8	1,803.5
Point Source	0.0	0.0	0.0
Septic Systems	0.0	277.4	0.0

Streambank Loading Rates (Sediment) – Pine Creek

Look-Up Table for MMW Loading Rates

Watershed: Pine Creek
Year: 2020

Section 5: Stream Bank Sediment Loading Rates Worksheet

This worksheet calculates and apportions the loading rates from the Stream Bank source load for sediment from the MMW

Step 1. The Stream Bank Sediment Load, in tons, and land areas for each land use category, in acres, are presented below.

	Sediment		
Stream Bank	453.86	tons	Note: The sediment load is taken from Cell D38 in the MMW Output worksheet

Land Use Categories from MapShed	Source	Area (acres)
	Hay/Pasture	2,696.30
	Cropland	2,083.95
	Forest	1,069.14
	Wetland	197.53
	Disturbed	0.00
	Turfgrass	0.00
	Open_Land	17.28
	Bare_Rock	0.00
	Sandy_Areas	0.00
	Unpaved_Road	0.00
	Ld_Mixed	950.62
	Md_Mixed	88.89
	Hd_Mixed	32.10
	Ld_Residential	0.00
	Md_Residential	0.00
	Hd_Residential	0.00
	Total Acres, Watershed	**7,135.80**

Step 2. Convert the Stream Bank Sediment Load to pounds by multiplying tons by 2,000 pounds per ton.

	Sediment Load, pounds		
Stream Bank	907,720.00	pounds	= [453.86 tons x 2,000 pounds per ton]

Step 3. Sum the total acres in the Pine Creek watershed.

Total Acres in watershed	7,135.80	acres

Step 4. Calculate the total acres in the watershed that are considered "Developed," which includes Low Density Mixed (Ld_Mixed), Medium Density Mixed (Md_Mixed), High Density Mixed (Hd_Mixed); and Low Density Residential (Ld_Residential), Medium Density Residential (Md_Residential), and High Density Residential (Hd_Residential).

Area of Developed Lands	*acres*	*percent*	
Low Density Developed	950.62	89%	[Ld_Mixed + Ld_Residential]
Medium Density Developed	88.89	8%	[Md_Mixed + Md_Residential]
High Density Developed	32.10	3%	[Hd_Mixed + Hd_Residential]
Total	1,071.60	100%	[All "Developed" land use categories]

Step 5. Calculate the portion of the Stream Bank Sediment Load resulting from "Developed" Lands

This is A) 75% of the Stream Bank Sediment Load times the percent of developed lands in the watershed
plus B) 25% of the Stream Bank Sediment Load:

Stream Bank Sediment Load	907,720.00	pounds		from Step 2
Total Developed Acres	1,071.6	acres		from Step 4
Total Acres in watershed	7,135.8	acres		from Step 3
Percent of Developed lands in watershed	15%		=	[1071.6 acres / 7135.8 acres]
A) 75% x Stream Bank Sediment Load x Percent of Developed Lands	102,236.28	pounds	=	[75% x 907720 pounds x 15%]
B) 25% x Stream Bank Sediment Load	226,930.00	pounds	=	[25% x 907720 pounds]
Load Assigned to Developed Lands	329,166.28	pounds		

Step 6. Calculate the portion of the Stream Bank Sediment Load from "Developed" Lands that is assigned to each of the land use categories by calculating relative components from "Impervious" surfaces and from the

Estimated Percent of Impervious Area for corresponding land use categories (MapShed Values)	
Low Density Developed	15%
Medium Density Developed	52%
High Density Developed	87%

Step 7. Calculate how many acres within the watershed are "Impervious" by multiplying the acres in Step 4 by the percent in Step 6:

Estimated Impervious Surfaces for Developed Lands				
Low Density Developed	142.59	acres	=	[950.62 acres x 15 percent]
Medium Density Developed	46.22	acres	=	[88.89 acres x 52 percent]
High Density Developed	27.93	acres	=	[32.1 acres x 87 percent]
Total Developed Impervious Surface Area	216.74	acres		

Step 8. Calculate the percent of total developed Impervious Surface for each land use:

Percent of Total Impervious Surfaces			
Low Density Developed	66%	=	[142.59 acres / 216.74 acres]
Medium Density Developed	21%	=	[46.22 acres / 216.74 acres]
High Density Developed	13%	=	[27.93 acres / 216.74 acres]
Total	100%		

Step 9. Distribute the "Total Load Assigned to Developed Lands" from Step 5 to each Developed Land type based on "Impervious" surfaces and the percent of land area in the land use category:

Load Assigned to Developed Lands	329,166.28	pounds =	[result of Step 5]
Load assigned to Total Developed Land	102,236.28	pounds =	[result of Step 5]
Load assigned for Total Impervious Land	226,930.00	pounds =	[result of Step 5]

Step 10. Apportion Load Assigned to "Impervious" surfaces to each "Developed" land use category by multiplying the 'Percent of Total Impervious Surfaces' (Step 8) by 226930 pounds (calculated in Step 9):

Stream Bank Sediment Load Assigned to Impervious Surface, pounds		
Low Density Developed	149,296.05	= [66 % x 226930 pounds]
Medium Density Developed	48,395.19	= [21 % x 226930 pounds]
High Density Developed	29,238.76	= [13 % x 226930 pounds]

Step 11. Apportion Load Assigned to Total Land Area to each "Developed" land use category by multiplying the 'Percent of Area of Developed Lands' (from Step 4) by 102236.28 pounds (calculated in Step 9):

Stream Bank Sediment Load Assigned to Total Developed Land Area, pounds		
Low Density Developed	90,693.48	= [89 % x 102236.28 pounds]
Medium Density Developed	8,480.43	= [8 % x 102236.28 pounds]
High Density Developed	3,062.38	= [3 % x 102236.28 pounds]

Step 12. Combine the loads apportioned to "Impervious" surfaces, from Step 10, and the loads apportioned to Total Developed Land Area, from Step 11:

Total Stream Bank Sediment Load per Land Use, pounds		
Low Density Developed	239,989.53	= [149296.05 pounds + 90693.48 pounds]
Medium Density Developed	56,875.62	= [48395.19 pounds + 8480.43 pounds]
High Density Developed	32,301.14	= [29238.76 pounds + 3062.38 pounds]

Step 13. Calculate the Stream Bank Loading Rate for each "Developed" Land Use, in pounds per acre, by dividing the load from Step 12 by the acres in Step 4:

Stream Bank Sediment Land Use Loading Rate	pounds	Land Use area, acres	**Stream Bank Sediment**	
Low Density Developed	239,989.53	950.62	**252.46**	= [239989.53 lbs / 950.62 acres]
Medium Density Developed	56,875.62	88.89	**639.85**	= [56875.62 lbs / 88.89 acres]
High Density Developed	32,301.14	32.10	**1,006.30**	= [32301.14 lbs / 32.1 acres]

Step 14. Calculate the Stream Bank Loading Rate for "Undeveloped Land" (all other land use categories):

Total Stream Bank Load	907,720.00	pounds =	[from Step 3]
Load assigned to Developed Lan	329,166.28	pounds =	[from Step 5]
Remaining Load assigned to Undeveloped Lands	578,553.72	pounds =	[907720 pounds - 329166.28 pounds]
Acres of Undeveloped Lands	6,064.20	acres =	[sum of "Undeveloped Land" from Step 1]
Stream Bank Sediment Loading rate for Undeveloped Lands	**95.40**	**pounds per acre**	= [578553.72 pounds / 6064.2 acres]

Step 15. Add these Stream Bank Sediment Land Use Loading Rates to the Land Use (upland source) Loading Rates for each of the corresponding land uses in the Land Use Loading Rates Look-Up Table to calculate the Total Sediment Loading Rate.

The Valley Creek East Branch Octoraro Watershed and the Valley Creek East Branch Planning Area:

MMW Model Output – Valley Creek East Branch Octoraro

Look Up Table for MMW Land Use Loading Rates

Watershed: Valley Creek-East E
Year: 2020

Section 3: ***MMW Model Output***

This page is where the output data from a multi-year MMW model run is to be copied and pasted into this workbook and is the source data for calculations throughout the workbook.

1. Source File Name - User-specified filename for the output file from MMW (optional).
2. Watershed Name - User-specified name of a watershed for which land use loading rates are being calculated (optional).
3. Source file - The annual pollutant data, in English Units, is copied directly from the MMW output file to the table below.
4. Year - the year modeled (optional).

Data Entered By: *User Specified*
Date Data Entered: *2020-06-09*
Source File Name: *User Specified*
Watershed: *Valley Creek-East Branch Octoraro Creek*
Year: 2020

Model My Watershed OUTPUT DATA

Source	Area	Sediment	Tot N	Tot P
Units	acres	tons/year	lb's/year	lb's/year
Hay/Past	407.41	34.43	319.28	127.01
Cropland	955.56	796.32	5,627.38	1,897.62
Forest	372.84	0.56	16.30	1.98
Wetland	56.79	0.11	10.66	1.10
Disturbed	-	-	-	-
Turfgrass	-	-	-	-
Open_Land	9.88	0.26	0.60	0.68
Bare_Rock	-	-	-	-
Sandy_Areas	-	-	-	-
Unpaved_Road	-	-	-	-
Ld_Mixed	407.41	0.43	19.95	2.21
Md_Mixed	22.22	0.73	31.53	3.35
Hd_Mixed	9.88	0.32	13.89	1.32
Ld_Residential	-	-	-	-
Md_Residential	-	-	-	-
Hd_Residential	-	-	-	-
Farm Animals			2,496.94	571.76
Tile Drainage		-	-	-
Stream Bank		67.90	160.25	46.31
Groundwater		-	49,315.05	403.52
Point Source		-	-	-
Septic Systems		-	72.65	-
Totals	*2,441.98*	*921.07*	*58,050.59*	*3,056.79*

STREAM LENGTHS* | **KM*** | **FEET** | Sed lb/ft | TN lb/ft | TP lb/ft

Total Length	10.57	34678.5	5.1	0.00	0.00
Ag Streams	4.31	14140.4			
Non-Ag Streams	6.26	20538.1			

* These values can be obtained from the "Stream" tab in the "Analyze" section of a Model My Watershed run

FARM ANIMAL DATA

TYPE*	NUMBER*	AVG WT KG	TOTAL KG	TOTAL AEU	KG N/AEU/DAY	KG P/AEU/DAY	TOTAL N/DAY	TOTAL P/DAY
Chickens, Broilers	1368	0.9	1231.2	1.2312	1.07	0.3	1.317384	0.36936
Chickens, Layers	0	1.8	0	0	0.85	0.29	0	0
Cows, Beef	9	360	3240	3.24	0.31	0.09	1.0044	0.2916
Cows, Dairy	92	640	58880	58.88	0.44	0.07	25.9072	4.1216
Horses	45	500	22500	22.5	0.28	0.06	6.3	1.35
Pigs/Hogs/Swine	138	61	8418	8.418	0.48	0.15	4.04064	1.2627
Sheep	19	50	950	0.95	0.37	0.1	0.3515	0.095
Turkeys	262	6.8	1781.6	1.7816	0.59	0.2	1.051144	0.35632
					Daily Totals		39.97	7.85
					Poultry Totals		2.37	0.73
					Livestock Totals		37.60	7.12
					Poultry Fraction		0.06299	0.10191
					Livestock Fraction		0.94075	0.90752

* These values can be obtained from the "Animal" tab in the "Analyze" section of a Model My Watershed run

MMW NLCD Land Cover Categories for Watershed (from "Analyze" csv file)

TYPE	AREA (km^2)	AREA (acres)
Open Water	0	-
Perennial Ice/Snow	0	-
Developed, Open Space	1.33	328.40
Developed, Low Intensity	0.32	79.01
Developed, Medium Intensity	0.09	22.22
Developed, High Intensity	0.04	9.88
Barren Land (Rock/Sand/Clay)	0	-
Deciduous Forest	1.32	325.93
Evergreen Forest	0	-
Mixed Forest	0.01	2.47
Shrub/Scrub	0.18	44.44
Grassland/Herbaceous	0.04	9.88
Pasture/Hay	2.46	607.41
Cultivated Crops	3.87	955.56
Woody Wetlands	0.23	56.79
Emergent Herbaceous Wetlands	0	-
Totals	*9.89*	*2,441.98*

Pollutant Load Conversion from Metric to Standard Units (from "Model" csv file)

SOURCE	SEDIMENT (kg)	TOTAL N (kg)	TOTAL P (kg)	SEDIMENT (tons)	TOTAL N (lbs)	TOTAL P (lbs)
Hay/Pasture	31,232.70	144.80	57.60	34.43405175	319.284	127.008
Cropland	722,282.60	2,552.10	860.60	796.3165665	5627.3805	1897.623
Wooded Areas	523.50	7.30	0.90	0.57715875	16.0965	1.9845
Wetlands	95.90	8.20	0.50	0.10572975	18.081	1.1025
Open Land	240.10	3.80	0.30	0.26471025	8.5995	0.6615
Barren Areas	0.00	0.00	0.00	0	0	0
Low-Density Mixed	388.50	9.00	1.00	0.42831825	19.845	2.205
Medium-Density Mixed	662.00	14.30	1.50	0.729855	31.5315	3.3075
High-Density Mixed	288.70	6.30	0.60	0.31829175	13.8915	1.323
Other Upland Areas	1,587.90	36.90	4.00	1.75065975	81.3645	8.82
Farm Animals	0.00	1,132.40	259.30	0	2496.942	571.7565
Stream Bank Erosion	79,726.00	56.00	21.00	87.897915	110.25	46.305
Subsurface Flow	0.00	22,365.10	183.00	0	49315.0455	403.515
Point Sources	0.00	0.00	0.00	0	0	0
Septic Systems	0.00	33.40	0.00	0	73.647	0
Totals	*837,025.90*	*26,363.70*	*1,390.30*	*922.82*	*58,131.96*	*3,065.61*

Note: The information below is only used for allocation of "urban" loads within a larger watershed boundary

MMW NLCD Land Cover Categories for Urban Area (from second, smaller "Analyze" csv file)

TYPE	AREA (km^2)	AREA (acres)	TN (lb/yr)	TP (lb/yr)	Sediment (lb/yr)
Open Water		-			
Perennial Ice/Snow		-			
Developed, Open Space		-	0.00	0.00	0.00
Developed, Low Intensity		-	0.00	0.00	0.00
Developed, Medium Intensity		-	0.00	0.00	0.00
Developed, High Intensity		-	0.00	0.00	0.00
Barren Land (Rock/Sand/Clay)		-	0.00	0.00	0.00
Deciduous Forest		-	0.00	0.00	0.00
Evergreen Forest		-	0.00	0.00	0.00
Mixed Forest		-	0.00	0.00	0.00
Shrub/Scrub		-	0.00	0.00	0.00
Grassland/Herbaceous		-	0.00	0.00	0.00
Pasture/Hay		-	0.00	0.00	0.00
Cultivated Crops		-	0.00	0.00	0.00
Woody Wetlands		-	0.00	0.00	0.00
Emergent Herbaceous Wetlands		-	0.00	0.00	0.00
Totals	-	-	-	-	-

(Note: The values below only pertain to the smaller target area)

STREAM LENGTH | **KM*** | **FEET**

Total Length	0	0.0
Ag Streams	0	0.0
Non-Ag Streams	0	0.0

* These values can be obtained from the "Stream" tab in the "Analyze" section of a Model My Watershed run

TYPE	AREA (m^2)*	AREA (acres)	TN (lb/yr)	TP (lb/yr)	Sediment (lb/yr)
Open Water	0	0.00			
Perennial Ice/Snow	0	0.00			
Developed, Open Space	41273.46	10.19	1.43	0.51	1,398.35
Developed, Low Intensity	19739.48	4.87	0.60	0.24	668.77
Developed, Medium Intensity	0	0.00	0.00	0.00	0.00
Developed, High Intensity	0	0.00	0.00	0.00	0.00
Barren Land (Rock/Sand/Clay)	0	0.00	0.00	0.00	0.00
Deciduous Forest	0	0.00	0.00	0.00	0.00
Evergreen Forest	0	0.00	0.00	0.00	0.00
Mixed Forest	0	0.00	0.00	0.00	0.00
Shrub/Scrub	10766.99	2.66	0.19	0.05	151.77
Grassland/Herbaceous	0	0.00	0.00	0.00	0.00
Pasture/Hay	9869.74	2.44	5.26	1.44	407.88
Cultivated Crops	8075.24	1.99	14.99	4.73	3,430.88
Woody Wetlands	0	0.00	0.00	0.00	0.00
Emergent Herbaceous Wetlands	0	0.00	0.00	0.00	0.00
Totals	*89724.91*	*22.15*	*22.55*	*6.97*	*6,057.66*

*Only use this input block if land cover distribution is given in square meters (m^2).
This occurs when AOI is less than about 2 square kilometer2.

TOTAL LOADS | **22.55** | **6.97** | **6,057.66**

Land Use Loading Rates – Valley Creek East Branch Octoraro

Look Up Table for MMW Loading Rates
Watershed: Valley Creek-East Branch Octoraro Creek
Year: 2020
Source File: User Specified

Section 2: Landcover Loading Rates Look-Up Table

TOTAL WATERSHED ANNUAL LOADS

Source	Area	Sediment	Total Nitrogen	Total Phosphorus
Units	Acres	Tons	Pounds	Pounds
Source	area_ac	sedTonnes_tn	TN_lbs	TP_lbs
Hay/Past	607.41	34.43	319.28	127.01
Cropland	955.56	796.32	5,627.38	1,897.62
Forest	272.84	0.58	16.10	1.98
Wetland	56.79	0.11	18.05	1.10
Disturbed	0.00	0.00	0.00	0.00
Turfgrass	0.00	0.00	0.00	0.00
Open_Land	9.88	0.26	8.60	0.66
Bare_Rock	0.00	0.00	0.00	0.00
Sandy_Areas	0.00	0.00	0.00	0.00
Unpaved_Road	0.00	0.00	0.00	0.00
Ld_Mixed	407.41	0.43	19.85	2.21
Md_Mixed	22.22	0.73	31.53	3.31
Hd_Mixed	9.88	0.32	13.09	1.32
Ld_Residential	0.00	0.00	0.00	0.00
Md_Residential	0.00	0.00	0.00	0.00
Hd_Residential	0.00	0.00	0.00	0.00

ANNUAL LAND USE LOADING RATES (lbs/acre)

Source	SEDIMENT: From Land Use	SEDIMENT: From Stream Banks ①	SEDIMENT: TOTAL SEDIMENT LOADING RATE	NITROGEN: From Land Use	NITROGEN: From Stream Banks ①	NITROGEN: From Farm Animals ②	NITROGEN: TOTAL NITROGEN LOADING RATE	PHOSPHORUS: From Land Use	PHOSPHORUS: From Stream Banks ①	PHOSPHORUS: From Farm Animals ②	PHOSPHORUS: TOTAL PHOSPHORUS LOADING RATE	
Units	lbs/acre	lbs/acre	lbs/acre	lbs/acre	lbs/acre	lbs/acre	lbs/acre	lbs/acre	lbs/acre	lbs/acre	lbs/acre	
Source	TSS_LoadRate	TSS_LoadRate	TSS_LoadRate_lbAc	TN_LoadRate	TN_LoadRate	TN_LoadRate	TN_LoadRate_lbAc	TP_LoadRateLa	TP_LoadRateBa	TP_LoadRateAn	TP_LoadRate_lbAc	
Hay/Past	113.38	53.99	**167.37**	0.53	0.03	1.60	**2.16**	0.21	0.01	0.37	**0.59**	Hay/Past
Cropland	1,666.71	53.99	**1,720.70**	5.89	0.03	1.60	**7.52**	1.99	0.01	0.37	**2.37**	Cropland
Forest	3.10	53.99	**57.09**	0.04	0.03	n/a	**0.07**	0.01	0.01	n/a	**0.02**	Forest
Wetland	3.72	53.99	**57.72**	0.32	0.03	n/a	**0.35**	0.02	0.01	n/a	**0.03**	Wetland
Disturbed	0.00	0.00	**0.00**	0.00	0.00	n/a	**0.00**	0.00	0.00	n/a	**0.00**	Disturbed
Turfgrass	0.00	0.00	**0.00**	0.00	0.00	n/a	**0.00**	0.00	0.00	n/a	**0.00**	Turfgrass
Open_Land	53.60	53.99	**107.60**	0.87	0.03	n/a	**0.90**	0.07	0.01	n/a	**0.08**	Open_Land
Bare_Rock	0.00	0.00	**0.00**	0.00	0.00	n/a	**0.00**	0.00	0.00	n/a	**0.00**	Bare_Rock
Sandy_Areas	0.00	0.00	**0.00**	0.00	0.00	n/a	**0.00**	0.00	0.00	n/a	**0.00**	Sandy_Areas
Unpaved_Road	0.00	0.00	**0.00**	0.00	0.00	n/a	**0.00**	0.00	0.00	n/a	**0.00**	Unpaved_Road
Ld_Mixed	1.41	0.22	**1.63**	0.05	0.09	n/a	**0.14**	0.01	0.04	n/a	**0.05**	Ld_Mixed
Md_Mixed	1.42	0.16	**1.58**	0.15	0.09	n/a	**0.24**	0.15	0.09	n/a	**0.24**	Md_Mixed
Hd_Mixed	1.41	0.22	**1.63**	0.13	0.14	n/a	**0.27**	0.13	0.14	n/a	**0.27**	Hd_Mixed
Ld_Residential	0.00	0.09	**0.09**	0.00	0.00	n/a	**0.00**	0.00	0.00	n/a	**0.00**	Ld_Residential
Md_Residential	0.00	0.09	**0.09**	0.00	0.00	n/a	**0.00**	0.00	0.00	n/a	**0.00**	Md_Residential
Hd_Residential	0.00	0.09	**0.09**	0.00	0.00	n/a	**0.00**	0.00	0.00	n/a	**0.00**	Hd_Residential

Add'l Sources

Source	Sediment	Total Nitrogen	Total Phosphorus
Units	Tons	Pounds	Pounds
Farm Animals	0.00	2,496.94	571.76
Tile Drainage	0.00	0.00	0.00
Stream Bank ①	87.90	110.25	46.31
Groundwater	0.00	49,315.05	403.52
Point Source	0.00	0.00	0.00
Septic Systems	0.00	73.65	0.00

Notes:

① - Separate worksheets are used to calculate and apportion the loading rates from the Stream Bank source loads (for sediment, total nitrogen, and total phosphorus) from the MMW Output file into each land use category, using methodology provided by Dr. Barry Evans (Pennsylvania State University), the author of MapShed, and with concurrence from Mr. Bill Brown (PADEP).

② - A separate worksheet is used to calculate and apportion the "Total Nitrogen" and "Total Phosphorus" loading rates from the Farm Animals source load from the MMW Output file into the two agricultural land uses, Hay/Pasture and Cropland, based on area weighting. The methodology was provided by Dr. Barry Evans (Pennsylvania State University), the author of MapShed, and with concurrence from Mr. Bill Brown (PADEP). Additionally, since the Farm Animals source loads do not apply to other land use categories, the values in those cells are "n/a".

Groundwater	0.0	49,315.0	403.5
Point Source	0.0	0.0	0.0
Septic Systems	0.0	73.6	0.0

Streambank Loading Rates (Sediment) – Valley Creek East Branch Octoraro

Look-Up Table for MMW Loading Rates
Watershed: Valley Creek-East Branch Octoraro Creek
Year: 2020

Section 5: Stream Bank Sediment Loading Rates Worksheet
This worksheet calculates and apportions the loading rates from the Stream Bank source load for sediment from the MMW

Step 1. The Stream Bank Sediment Load, in tons, and land areas for each land use category, in acres, are presented below.

	Sediment		
Stream Bank	87.90	tons	Note: The sediment load is taken from Cell D38 in the MMW Output worksheet

Land Use Categories from MapShed	Source	Area (acres)
	Hay/Pasture	607.41
	Cropland	955.56
	Forest	372.84
	Wetland	56.79
	Disturbed	0.00
	Turfgrass	0.00
	Open_Land	9.88
	Bare_Rock	0.00
	Sandy_Areas	0.00
	Unpaved_Road	0.00
	Ld_Mixed	407.41
	Md_Mixed	22.22
	Hd_Mixed	9.88
	Ld_Residential	0.00
	Md_Residential	0.00
	Hd_Residential	0.00
	Total Acres, Watershed	**2,441.98**

Step 2. Convert the Stream Bank Sediment Load to pounds by multiplying tons by 2,000 pounds per ton.

	Sediment Load, pounds		
Stream Bank	175,800.00	pounds	= [87.9 tons x 2,000 pounds per ton]

Step 3. Sum the total acres in the Valley Creek-East Branch Octoraro Creek watershed.

Total Acres in watershed	2,441.98	acres

Step 4. Calculate the total acres in the watershed that are considered "Developed," which includes Low Density Mixed (Ld_Mixed), Medium Density Mixed (Md_Mixed), High Density Mixed (Hd_Mixed); and Low Density Residential (Ld_Residential), Medium Density Residential (Md_Residential), and High Density Residential (Hd_Residential).

Area of Developed Lands	*acres*	*percent*	
Low Density Developed	407.41	93%	[Ld_Mixed + Ld_Residential]
Medium Density Developed	22.22	5%	[Md_Mixed + Md_Residential]
High Density Developed	9.88	2%	[Hd_Mixed + Hd_Residential]
Total	439.51	100%	[All "Developed" land use categories]

Step 5. Calculate the portion of the Stream Bank Sediment Load resulting from "Developed" Lands

This is A) 75% of the Stream Bank Sediment Load times the percent of developed lands in the watershed plus B) 25% of the Stream Bank Sediment Load:

Stream Bank Sediment Load	175,800.00	pounds		from Step 2
Total Developed Acres	439.5	acres		from Step 4
Total Acres in watershed	2,442.0	acres		from Step 3
Percent of Developed lands in watershed	18%		=	[439.51 acres / 2441.98 acres]
A) 75% x Stream Bank Sediment Load x Percent of Developed Lands	23,730.33	pounds	=	[75% x 175800 pounds x 18%]
B) 25% x Stream Bank Sediment Load	43,950.00	pounds	=	[25% x 175800 pounds]
Load Assigned to Developed Lands	67,680.33	pounds		

Step 6. Calculate the portion of the Stream Bank Sediment Load from "Developed" Lands that is assigned to each of the land use categories by calculating relative components from "Impervious" surfaces and from the

Estimated Percent of Impervious Area for corresponding land use categories (MapShed Values)	
Low Density Developed	15%
Medium Density Developed	52%
High Density Developed	87%

Step 7. Calculate how many acres within the watershed are "Impervious" by multiplying the acres in Step 4 by the percent in Step 6:

Estimated Impervious Surfaces for Developed Lands				
Low Density Developed	61.11	acres	=	[407.41 acres x 15 percent]
Medium Density Developed	11.56	acres	=	[22.22 acres x 52 percent]
High Density Developed	8.59	acres	=	[9.88 acres x 87 percent]
Total Developed Impervious Surface Area	81.26	acres		

Step 8. Calculate the percent of total developed Impervious Surface for each land use:

Percent of Total Impervious Surfaces			
Low Density Developed	75%	=	[61.11 acres / 81.26 acres]
Medium Density Developed	14%	=	[11.56 acres / 81.26 acres]
High Density Developed	11%	=	[8.59 acres / 81.26 acres]
Total	100%		

Step 9. Distribute the "Total Load Assigned to Developed Lands" from Step 5 to each Developed Land type based on "Impervious" surfaces and the percent of land area in the land use category:

Load Assigned to Developed Lands	67,680.33	pounds =	[result of Step 5]
Load assigned to Total Developed Land	23,730.33	pounds =	[result of Step 5]
Load assigned for Total Impervious Land	43,950.00	pounds =	[result of Step 5]

Step 10. Apportion Load Assigned to "Impervious" surfaces to each "Developed" land use category by multiplying the 'Percent of Total Impervious Surfaces' (Step 8) by 43950 pounds (calculated in Step 9):

Stream Bank Sediment Load Assigned to Impervious Surface, pounds		
Low Density Developed	33,052.64	= [75 % x 43950 pounds]
Medium Density Developed	6,249.95	= [14 % x 43950 pounds]
High Density Developed	4,647.40	= [11 % x 43950 pounds]

Step 11. Apportion Load Assigned to Total Land Area to each "Developed" land use category by multiplying the 'Percent of Area of Developed Lands' (from Step 4) by 23730.33 pounds (calculated in Step 9):

Stream Bank Sediment Load Assigned to Total Developed Land Area, pounds		
Low Density Developed	21,997.22	= [93 % x 23730.33 pounds]
Medium Density Developed	1,199.85	= [5 % x 23730.33 pounds]
High Density Developed	533.27	= [2 % x 23730.33 pounds]

Step 12. Combine the loads apportioned to "Impervious" surfaces, from Step 10, and the loads apportioned to Total Developed Land Area, from Step 11:

Total Stream Bank Sediment Load per Land Use, pounds		
Low Density Developed	55,049.86	= [33052.64 pounds + 21997.22 pounds]
Medium Density Developed	7,449.80	= [6249.95 pounds + 1199.85 pounds]
High Density Developed	5,180.67	= [4647.4 pounds + 533.27 pounds]

Step 13. Calculate the Stream Bank Loading Rate for each "Developed" Land Use, in pounds per acre, by dividing the load from Step 12 by the acres in Step 4:

Stream Bank Sediment Land Use Loading Rate	pounds	Land Use area, acres	Stream Bank Sediment
Low Density Developed	55,049.86	407.41	**135.12** = [55049.86 lbs / 407.41 acres]
Medium Density Developed	7,449.80	22.22	**335.24** = [7449.8 lbs / 22.22 acres]
High Density Developed	5,180.67	9.88	**524.54** = [5180.67 lbs / 9.88 acres]

Step 14. Calculate the Stream Bank Loading Rate for "Undeveloped Land" (all other land use categories):

Total Stream Bank Load	175,800.00	pounds =	[from Step 3]
Load assigned to Developed Lan	67,680.33	pounds =	[from Step 5]
Remaining Load assigned to Undeveloped Lands	108,119.67	pounds =	[175800 pounds - 67680.33 pounds]
Acres of Undeveloped Lands	2,002.47	acres =	[sum of "Undeveloped Land" from Step 1]
Stream Bank Sediment Loading rate for Undeveloped Lands	**53.99**	**pounds per acre**	= [108119.67 pounds / 2002.47 acres]

Step 15. Add these Stream Bank Sediment Land Use Loading Rates to the Land Use (upland source) Loading Rates for each of the corresponding land uses in the Land Use Loading Rates Look-Up Table to calculate the Total Sediment Loading Rate.

Appendix D
Proposed BMP Load Reduction Calculations

Stream BMPs - Sediment and Nutrient Reduction Calculations*			
Site	BMP ID	Length (ft)	Sediment Removal (lbs)
Lincoln Highway Stream Restoration	1	1,400	161,000
Spring Garden Road Stream Restoration	2	1300	149,500.00
Umbletown Road Stream Restoration	3	11000	1,265,000.00
Houston Run Stream Restoration	4	4,800	552,000.00
*Sediment Load Reductions Calculated at 115 lbs./lf Based on PADEP's PRP Instructions			

Appendix E
Proposed BMP Justifications

Salisbury Township, Lancaster County
MS4 PRP
BMP Justification: Stream / Floodplain Restoration Opportunities Outside of the Urban Area
June 3, 2020

BMP Justification Summary:

In the April 23, 2020 conference call with staff from DEP's Central Office, South Central Regional Office, and Southeast Regional Office, LandStudies discussed three stream reaches located less than 1 mile downstream of Salisbury Township's Urban Area that are potential stream / floodplain restoration opportunities to be incorporated into the Township's PRP (see attached map and details). As was discussed during the conference call, these three restoration opportunities would be eligible towards meeting the Township's PRP reduction goals under FAQ 69 from DEP's MS4 NPDES Permits Frequently Asked Questions from October 21, 2019.

Since Salisbury Township's three potential stream restoration reaches are within the Chesapeake Bay watershed, they would fall under the Bay's TMDL requirements. Under the Bay TMDL, there is no "baseline" requirement as referenced in FAQ 69b. Therefore, it is assumed that a restoration project along any of these three reaches would be eligible for full pollutant load reduction credit as long as the project qualifies as a stream restoration project per DEP guidance.

As was also discussed in the April 23 conference call, DEP will need verification that the agricultural lands on which these potential stream restoration projects are proposed are working towards or in compliance with agricultural conservation plans. In working with agricultural consultants, Salisbury Township has verified that the farms located along these three reaches have conservation plans or are in the process of developing conservation plans. Once the Township has selected a specific project reach for implementation, site specific information on the conservation plan(s) for that location will be provided to DEP.