CONOY CREEK

Watershed Implementation Plan

Lancaster County Conservation District

University of Idaho

Acknowledgements

This plan was developed to shine a spotlight on the Conoy Creek watershed in Lancaster County, summarize data in the watershed, and encourage faster implementation. Thank you to all of the partners who have worked for decades to get the watershed to where it is today.

Next, I'd like to thank many of the key partners who helped develop the plan. The Chesapeake Bay Foundation's Brian Gish provided endless support with GIS mapping and his personal experience writing Watershed Implementation Plans (WIPs). The University of Idaho's Professor Dr. Mariana Dobre provided key insight and guidance in the entire development of the plan as an advisor. The Lancaster County Conservation District staff: Grace Chamberlain, Matt Kofroth, Noelle Cudney, Tyler Keefer, and Chris Thompson all supported the WIPs development and provided resources and critiques.

Next I'd like to thank all members of the Conoy Partnership group who continue to implement BMPs in the watershed and provided feedback throughout the plan development. The group includes the municipalities Mount Joy Township, Elizabethtown Borough, Conoy Township, East Donegal Township, and West Donegal Township; Penn State Agriculture & Environment Center; Professor Dr. David Bowne; Lancaster Clean Water Partners, David Miller Associates, and the Susquehanna River Basin Commission.

I look forward to the future of the Conoy Creek watershed knowing we are all working together.

- Plan Developer, Amanda Goldsmith, Lancaster County Conservation District, 2025

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Background

A. Project Process and Goals

Watershed Implementation Plans (WIPs) are valuable tools to prioritize restoration, organize watershed information, and detail available funding and technical resources in a region. Multiple WIPs or Advanced Restoration Plans (ARPs) have been developed already for Lancaster County, Pennsylvania including the Pequea Creek WIP, Mill Creek WIP and supplement Mill Creek Tributaries WIP, Conowingo Creek WIP, Conewago Creek WIP, and Fishing Creek ARP. Two plans are in the development and approval stage, including the Upper Conestoga WIP and the Columbia-Manor River Tributaries WIP.

The Conoy Creek watershed does not have an existing Total Maximum Daily Load (TMDL), WIP, or ARP, illustrating a key knowledge gap. The goal of this WIP is to fulfill Section 303(d) of the Clean Water Act (CWA) and all key elements of a Watershed Plan according to the Environmental Protection Agency (EPA). The plan will first describe the watershed and both stream impairments and attainments. Then, it will set a sediment reduction goal using a reference watershed and design a model to achieve those goals. Last, it will set a timeline for restoration including available funding, education, and partners to reach those goals and how we will monitor them.

The Conoy Creek WIP will serve as a starting point for the watershed, building on decades of past work and collaboration. Most importantly, the plan is a living document focused on flexibility and model estimates. It is not exact but a guiding resource to help partners achieve regional goals set by the Lancaster Countywide Action Plan (CAP) and the Chesapeake Bay Phase III WIP. There are six major goals that the Conoy Creek WIP hopes to achieve:

1. **Reach the sediment reduction goal to achieve a healthy, drinkable, swimmable Conoy Creek.** Partners will strategically implement best management practices (BMPs), focused on higher priority areas to restore sub-watersheds.
2. **Encourage municipality collaboration and proactive restoration for MS4 (Municipal Separate Storm Sewer System) credits.** Municipalities are some of the key partners in restoration, and we hope this plan serves as a guiding resource to accelerate restoration.
3. **Set targets for restoration, planning for flexibility given future scenarios.** The plan is based on a model and should be used as an overall estimate for watershed restoration. Given climate change, evolving resources, and BMP advancement, it is key to stay flexible and pivot to the best possible scenario for restoration.
4. **Highlight the watershed and organize available information, amplifying partner capacity and funding for restoration.** The plan will include maps, current funding resources, active partners, and potential BMP costs to serve as a one-stop-shop for Conoy Creek data.

5. **Build a watershed group that will educate the community and advance restoration efforts.** Grassroots organizations form the foundation of watershed restoration and the WIP will support the actively forming Conoy Creek Conservation Crew (CCCC).
6. **Foster innovative BMPs, focusing on wholistic restoration that supports healthy streams for aquatic life and a productive society.** While sediment reduction is the goal of the Conoy Creek WIP, aquatic habitat improvement, nutrient management, flood mitigation, native plantings, and recreation are just a few of the secondary goals of the plan. Through education, innovative BMPs, and whole-watershed planning, multiple goals can be achieved at once.

B. Watershed Characterization

The Conoy Creek watershed is based in Lancaster County, Pennsylvania, United States, and spans the following townships: West Donegal Township, Conoy Township, Elizabethtown Borough, East Donegal Township, and Mount Joy Township. It is 19 square miles or 12,181.61 acres. The population is approximately 23,000 (2020 US Census Data). The land use is mixed with over 50% agricultural land, over 30% developed zones, and less than 15% vegetated areas. The two primary towns in the Conoy Creek watershed are Bainbridge and Elizabethtown. The watershed consists only of Conoy Creek, and unnamed tributaries to the Conoy Creek. It outlets directly to the Susquehanna River, a tributary to the Chesapeake Bay. It is a part of Hydrologic Unit Code (HUC) 10 #0205030617 Susquehanna River watershed and is in the HUC 12 watershed #020503061701.

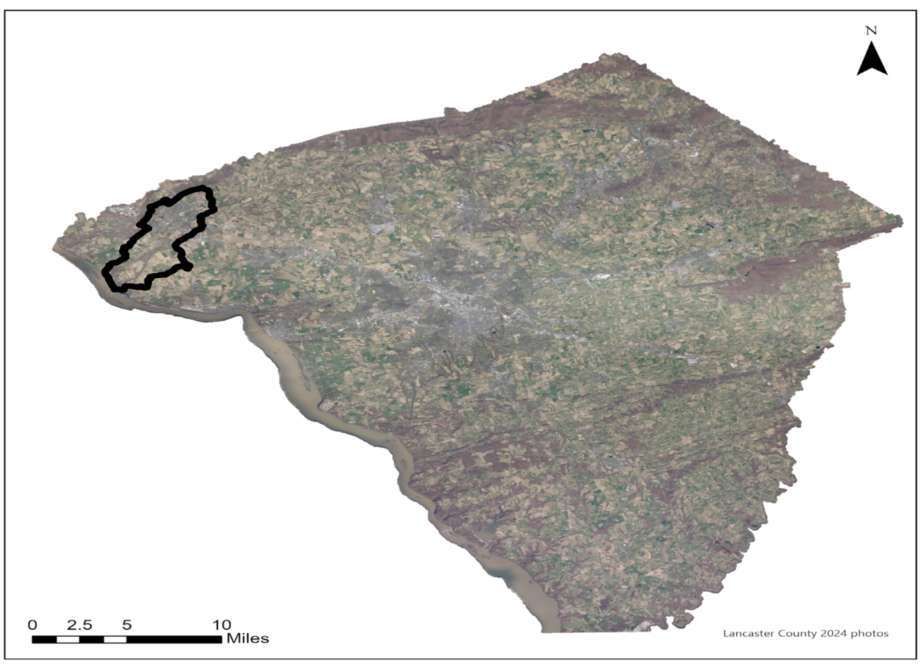


Figure 1. Conoy Creek (black outline) in Lancaster County. Conoy Creek is one of the smaller watersheds in the county. It is west of the Chiques watershed, including Donegal and Little Chiques Creek, and east of the Conewago Watershed.

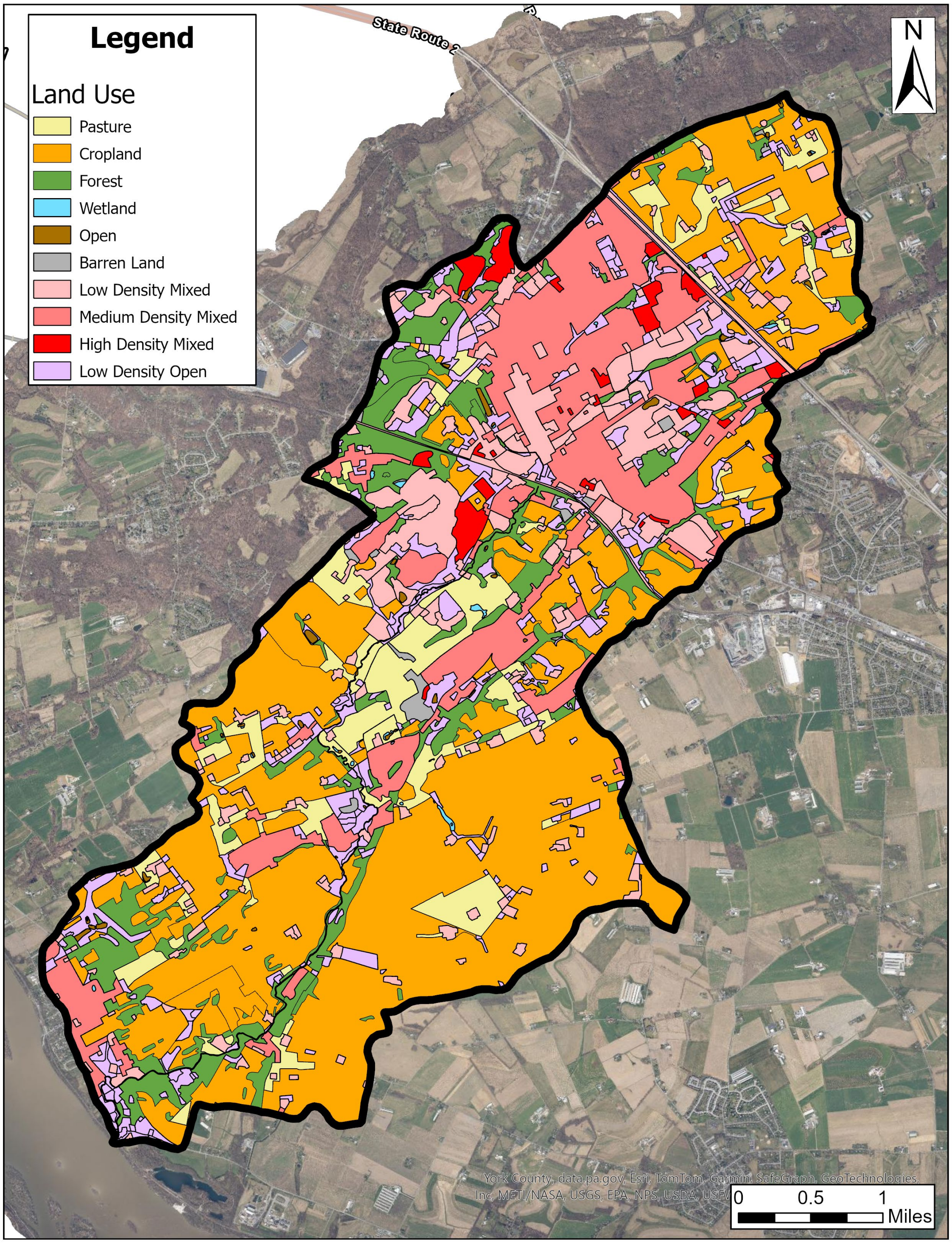


Figure 2. Land use in the Conoy Creek watershed. Most of the watershed is cropped with some pastured areas, leading to agricultural nonpoint source pollution. In Elizabethtown and Bainbridge, the area is mostly low density but is still entirely developed, increasing stormwater runoff and issues. Only small portions of the watershed are forested and left wild.

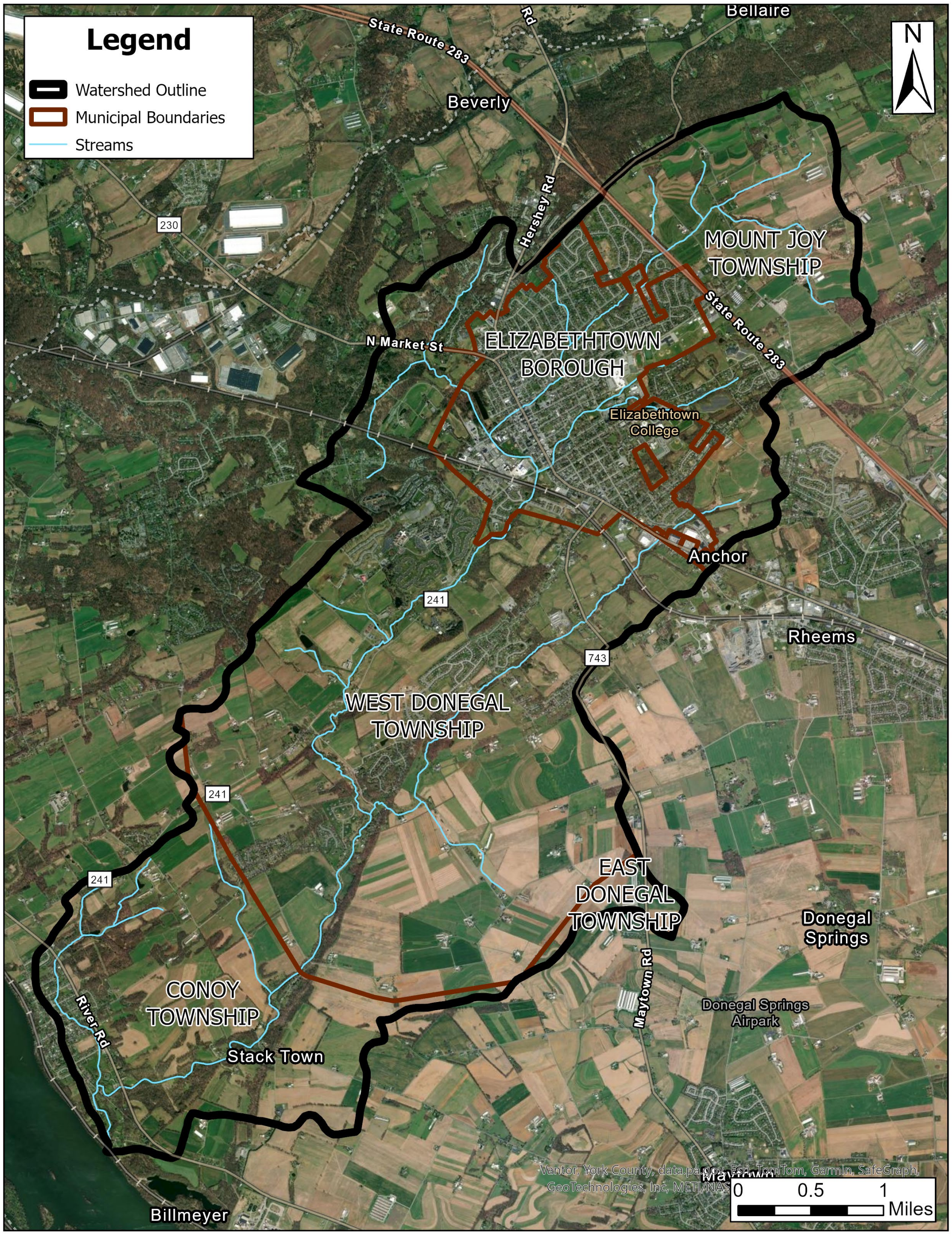


Figure 3. Townships in the Conoy Creek watershed include Mount Joy Township in the north, Elizabethtown Borough, West Donegal Township covering most of the watershed; Conoy Township at the mouth, and East Donegal Township in the southeast portion of the watershed. All townships have MS4 (Municipal Separate Storm Sewer System) permit obligations, except for Conoy Township, requiring pollution reduction projects such as stream restoration projects.

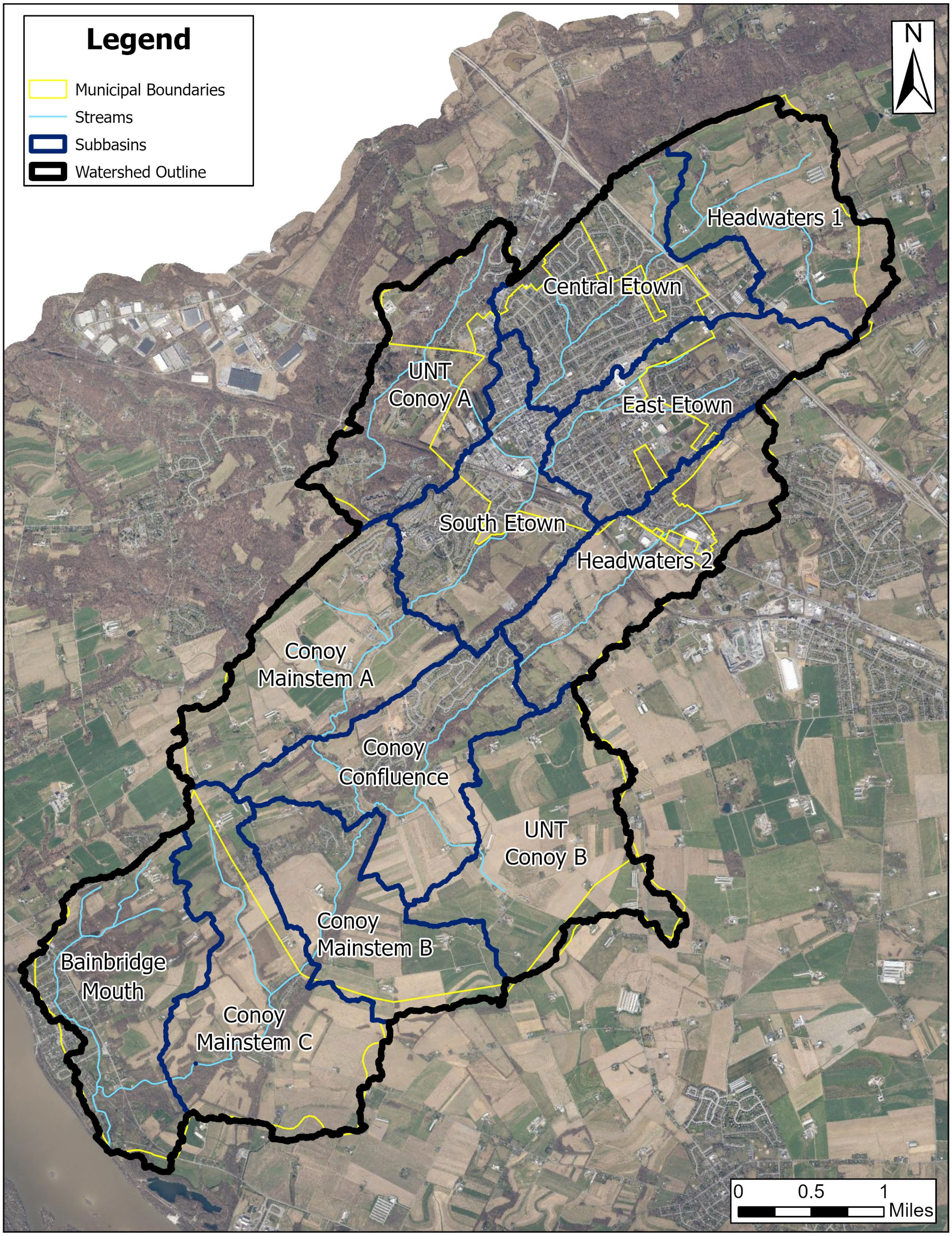


Figure 4. Subbasins delineated using a 3.2 meter digital elevation model and Watershed tool, each averaging 1-2 square miles. These will be described throughout the WIP and prioritized for best management practice implementation.

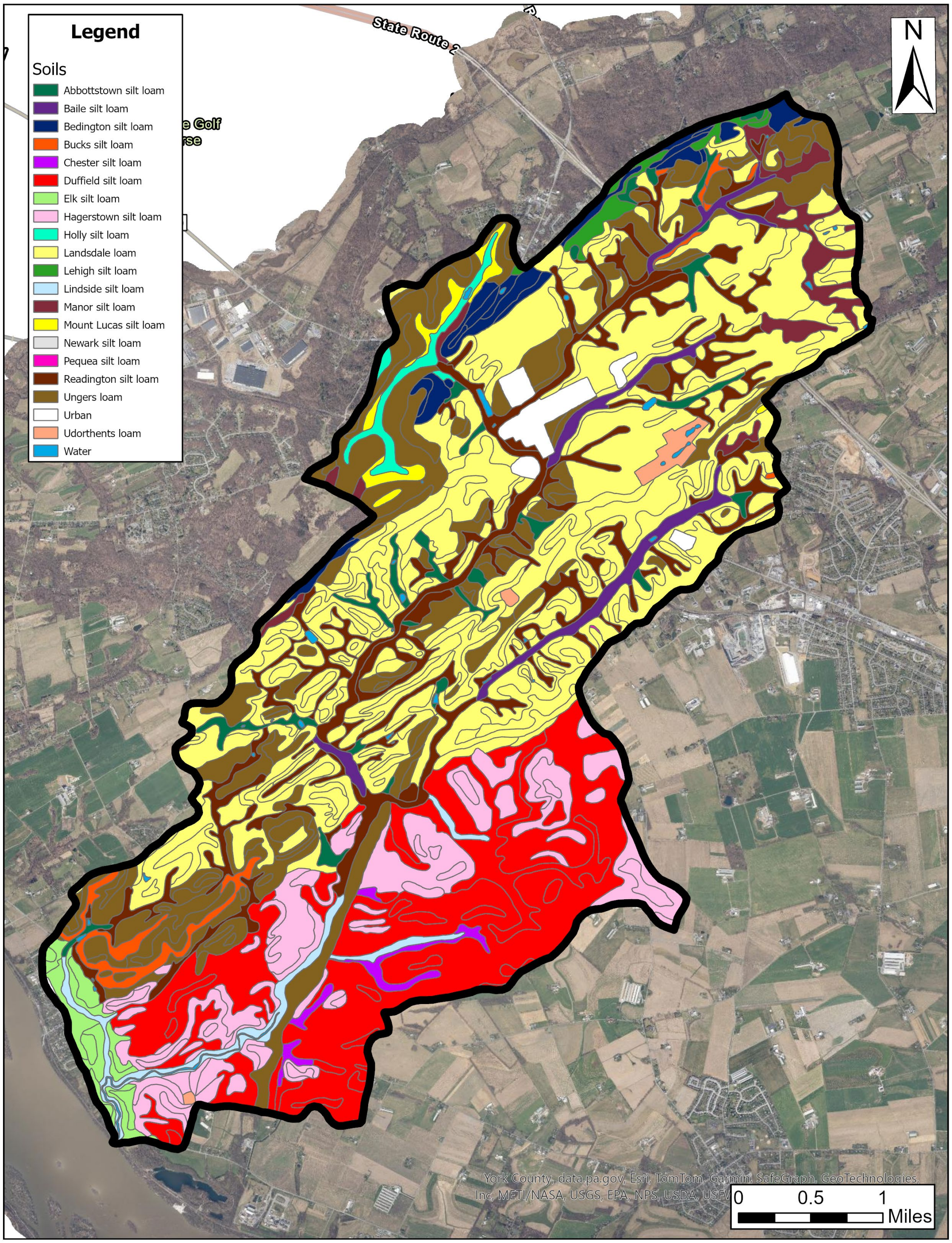


Figure 5. Soil types in the Conoy Creek watershed. Primary soils are Lansdale silt loam, Duffield silt loam, Ungers loam, and Hagerstown silt loam. Most soils in Conoy Creek are prime farmland including: Bedington, Bucks, Chester, Duffield, Elk, Hagerstown (exception HbC, HbD, Landsdale (exception LaD), Lehigh (exception LbC), Lindside, Manor (3-8% only), Ungers (3-8% only). Many are also “farmland of statewide importance.”

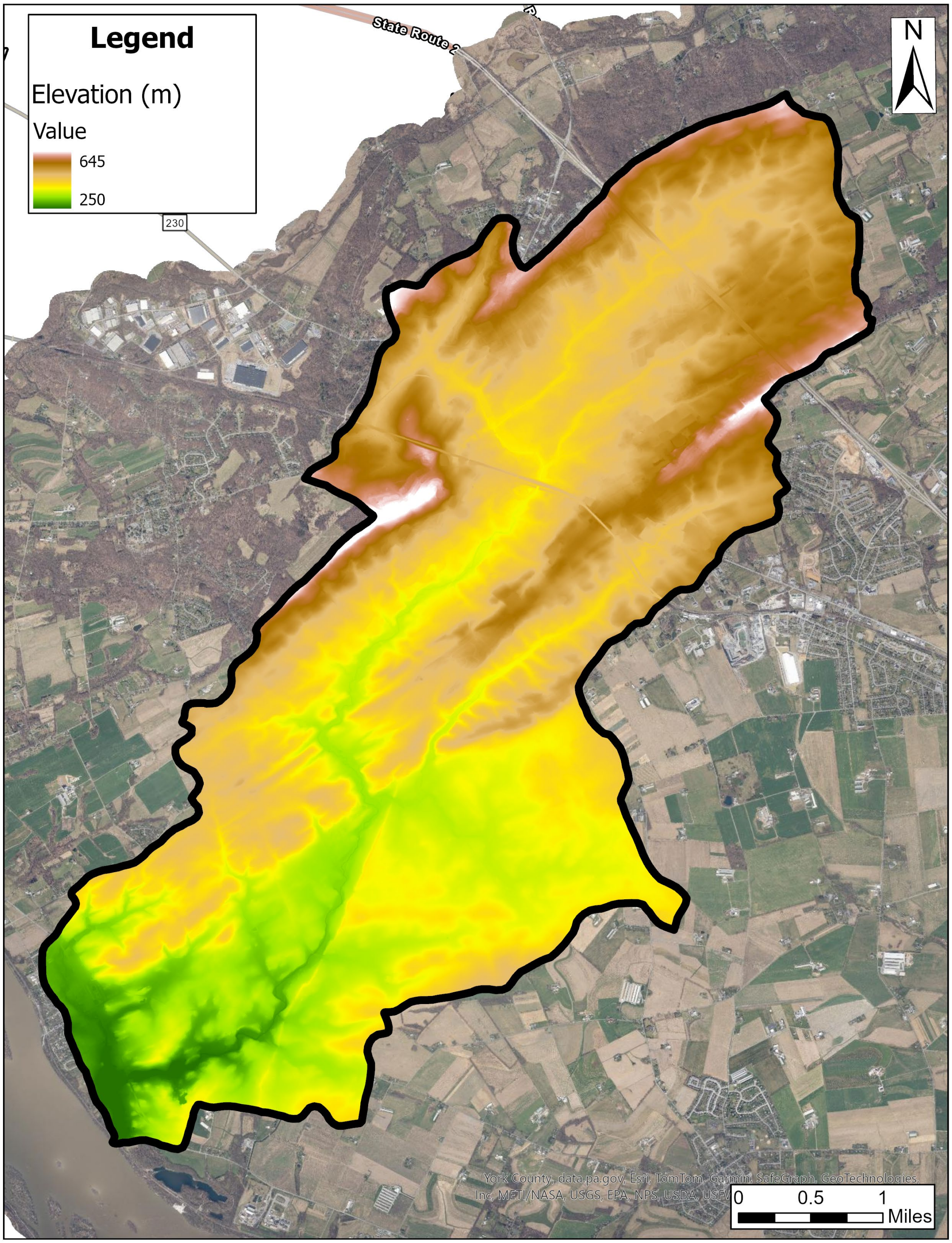


Figure 6. Elevation gradient in the Conoy Creek watershed. The watershed is low gradient, with an average elevation of 453' and an average slope of 4.4%. The stream slope is also low gradient, averaging 1.12% in first order streams and 0.45% in second order streams according to Model My Watershed. This can contribute to increased sediment deposition in streams due to slow moving water that doesn't flush particles.

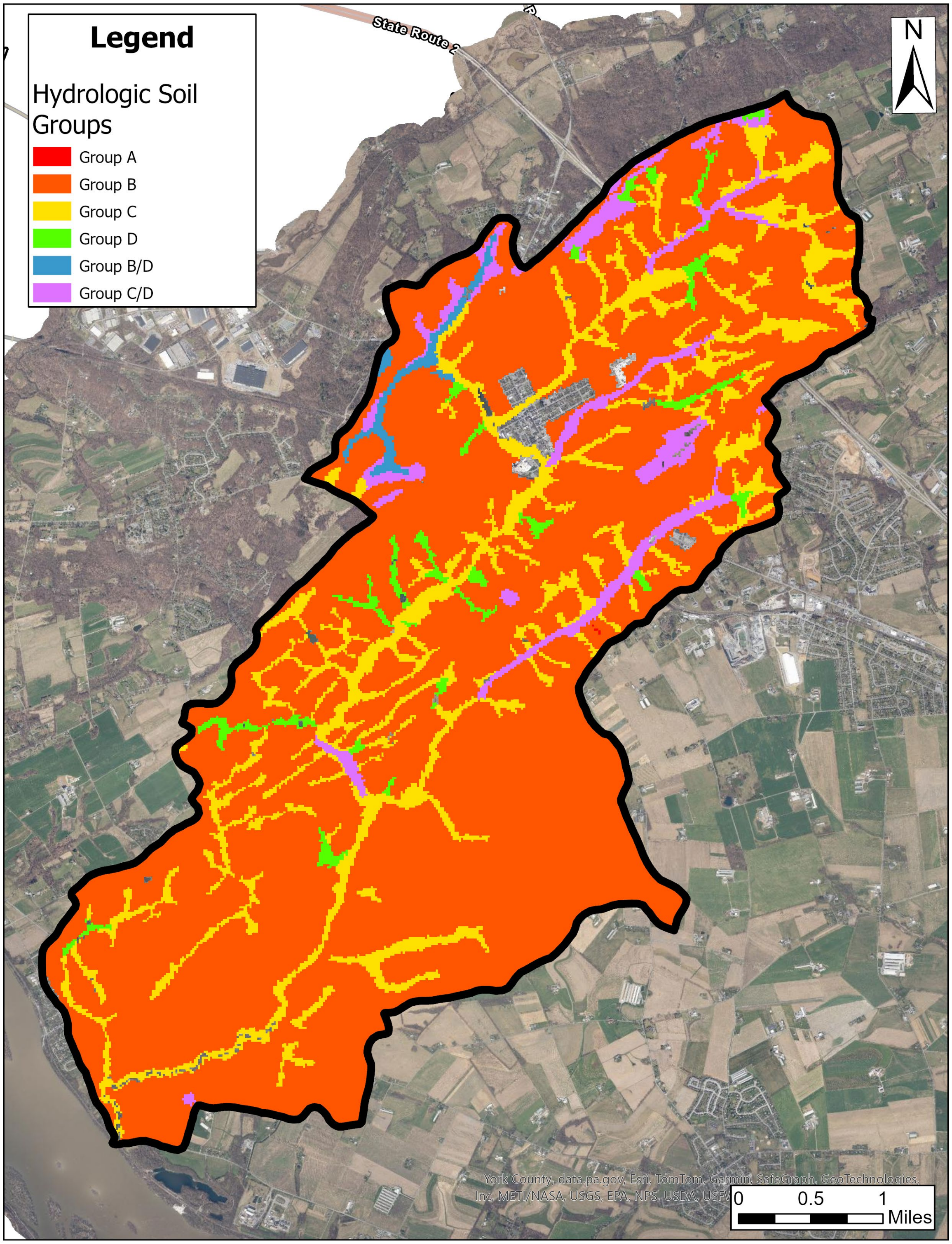


Figure 7. Hydrologic soil groups. Most of the watershed is Group B indicating moderate infiltration with some small pockets as C (low infiltration), C/D (low/very low infiltration), D (very low infiltration), and B/D (medium/very low infiltration). Moderate infiltration helps reduce runoff potential in the watershed, especially during high volume storm events.

Water Quality

A. Stream Impairments

The Conoy Creek watershed is entirely listed as impaired for aquatic life for all stream segments and impaired for recreation for all stream segments assessed for recreation. However, five sections assessed for potable water were listed as attaining.

Table 1. Stream Attainment Table, data acquired from the Pennsylvania Department of Environmental Protection (PA DEP).

Stream Name	Attains ID: PA-SCR + 8 digit number	Assessment Use Category	Assessment Determination	Assessment Year
Unnamed Tributary to Conoy Creek	57462849; 57462855; 57462947; 57463005; 57463079.	Potable Water Supply	Supporting	2007

Table 2. Stream Impairment Table, data acquired from the Pennsylvania Department of Environmental Protection (PA DEP).

Stream Name	Attains ID: PA-SCR + 8 digit number	Assessment Use Category (Determination)	Impairment Cause (Impairment Source)	Assessment Year
Conoy Creek	57462669; 57462677; 57462699; 57462705; 57462707; 57462709; 57462757; 57462773; 57462775; 57462789; 57462849; 57462855; 57462893; 57462895; 57462947; 57462949; 57462953; 57462967; 57462969; 57463003; 57463005; 57463051; 57463053; 57463079; 57463253; 57463931; 57463933; 57464015; 57464251.	Recreational (Impaired)	1. Pathogens (Source Unknown)	2012 (all except IDs listed below) & 2014 (57463931; 57463933; 57464015; 57464251)
Conoy Creek	57464417; 57464513; 57464015; 57464251; 57463931; 57463313; 57463501; 57462707; 57462773; 57462677; 57463157; 57463457; 57463499.	Aquatic Life (Impaired)	1. Habitat Alterations (Habitat Modification – Other than Hydromodification) 2. Siltation (Agriculture, Habitat	2018

			Modification – Other than Hydromodification)	
Unnamed Tributary (UNT) to Conoy Creek	57463157; 57463457; 57463499; 57462699; 57462705; 57462789; 57463933; 57463695; 57463707; 57463825; 57462859; 57464221; 57464225; 57462709; 57462757; 57462775; 57463079; 57463255; 57463311; 57463315; 57463471; 57463519; 57463527; 57463583; 57463823; 57463861.	Aquatic Life (Impaired)	1. Habitat Alterations (Habitat Modification – Other than Hydromodification) 2. Siltation (Agriculture, Habitat Modification – Other than Hydromodification)	2018
Conoy Creek	57463253; 57463053; 57462893; 57463003; 57462949; 57462953; 57462967; 57463051.	Aquatic Life (Impaired)	1. Habitat Alterations (Habitat Modification – Other than Hydromodification) 2.Siltation (Agriculture Habitat Modification – Other than Hydromodification, Urban Runoff/Storm Sewers)	2018
UNT to Conoy Creek	57462949; 57462953; 57462967; 57463051; 57462849; 57462855; 57462947; 57463005; 57462669; 57462811; 57462895; 57462969.	Aquatic Life (Impaired)	1. Habitat Alterations (Habitat Modification – Other than Hydromodification) 2. Siltation (Agriculture, Habitat Modification – Other than Hydromodification, Urban Runoff/Storm Sewers)	2018

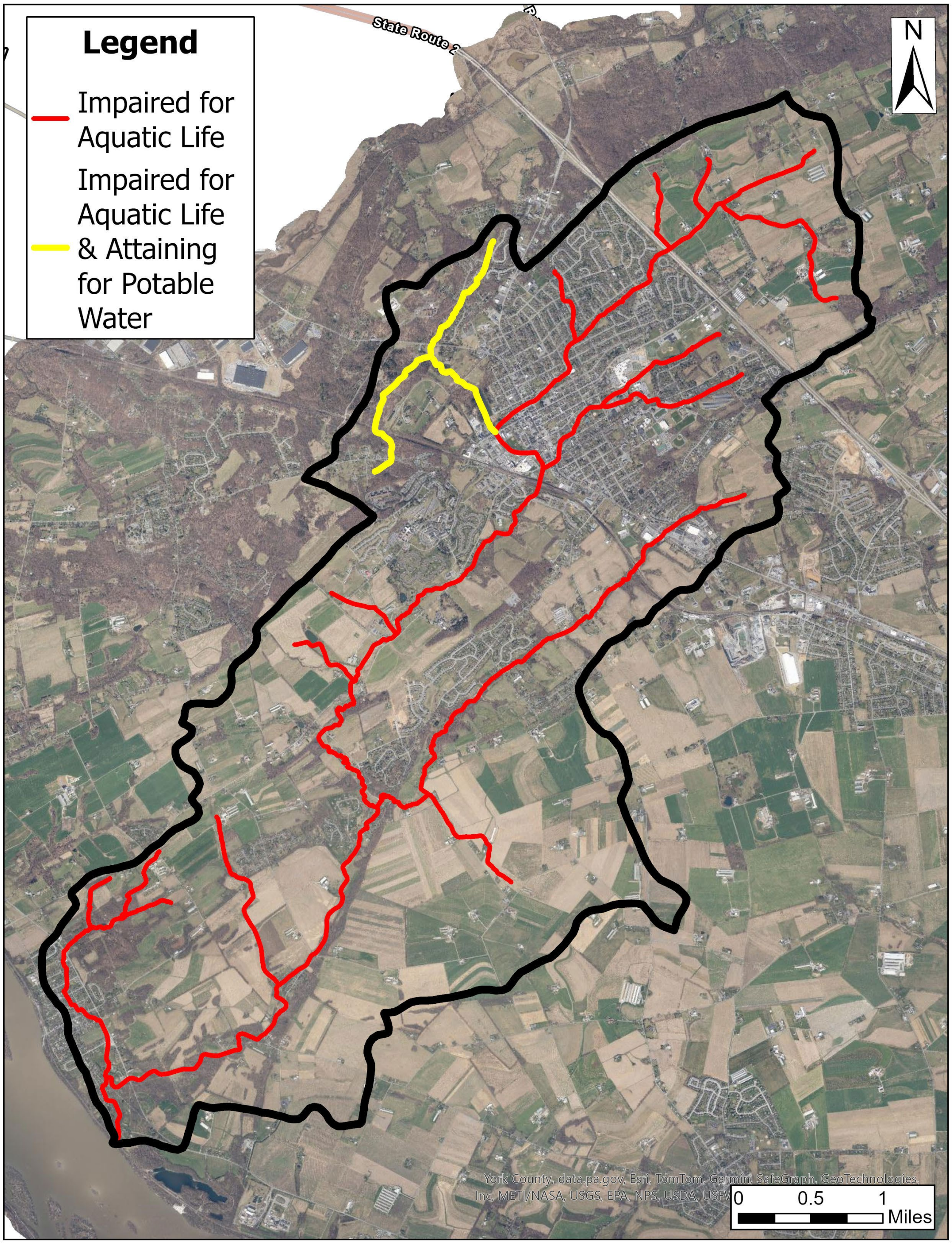


Figure 8. Conoy Creek impairments and attainment according to the PA DEP's 2024 Integrated Report. 100% of the Conoy Creek watershed is impaired for aquatic life, recognizing a dire need to restore the biotic conditions.

Table 3. Source of primary pollutants (nitrogen (N), phosphorous (P), and sediment) to the Conoy Creek Watershed. Data obtained from Model My Watershed.

Sources	**Sediment (lbs/yr)**	**Total N (lbs/yr)**	**Total P (lbs/yr)**
Hay/Pasture	168,750.5	858.8	240.4
Cropland	8,576,509.5	34,341.2	7,678.4
Wooded Areas	3,051.7	79.1	6.1
Wetlands	138.9	20.0	1.1
Open Land	1,438.7	17.9	1.4
Barren Areas	2.1	0.7	0.0
Low-Density Mixed	17,959.1	478.4	50.9
Medium-Density Mixed	48,740.2	963.9	98.5
High-Density Mixed	11,479.1	227.0	23.2
Low-Density Open Space	18,308.3	487.7	51.9
Farm Animals	0.0	65,038.1	16,310.5
Stream Bank Erosion	3,275,899.9	2,433.9	639.3
Subsurface Flow	0.0	285,911.1	2,236.4
Point Sources	0.0	14,517.5	2,131.9
Septic Systems	0.0	2,454.3	0.0

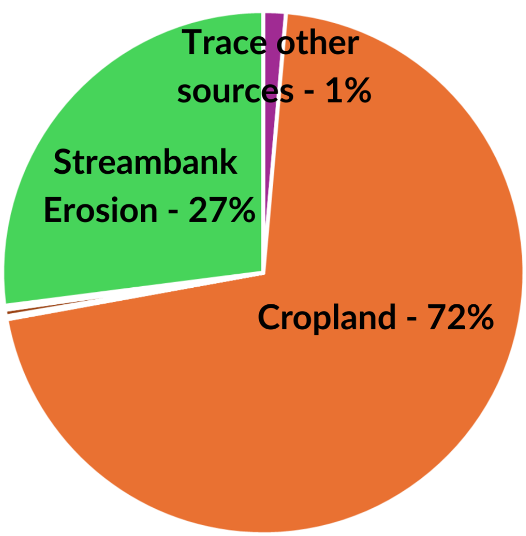


Figure 9. Sources of sediment in the Conoy Creek watershed according to Model My Watershed. Cropland and streambank erosion are the primary sources of sediment and will be targeted in the plan.

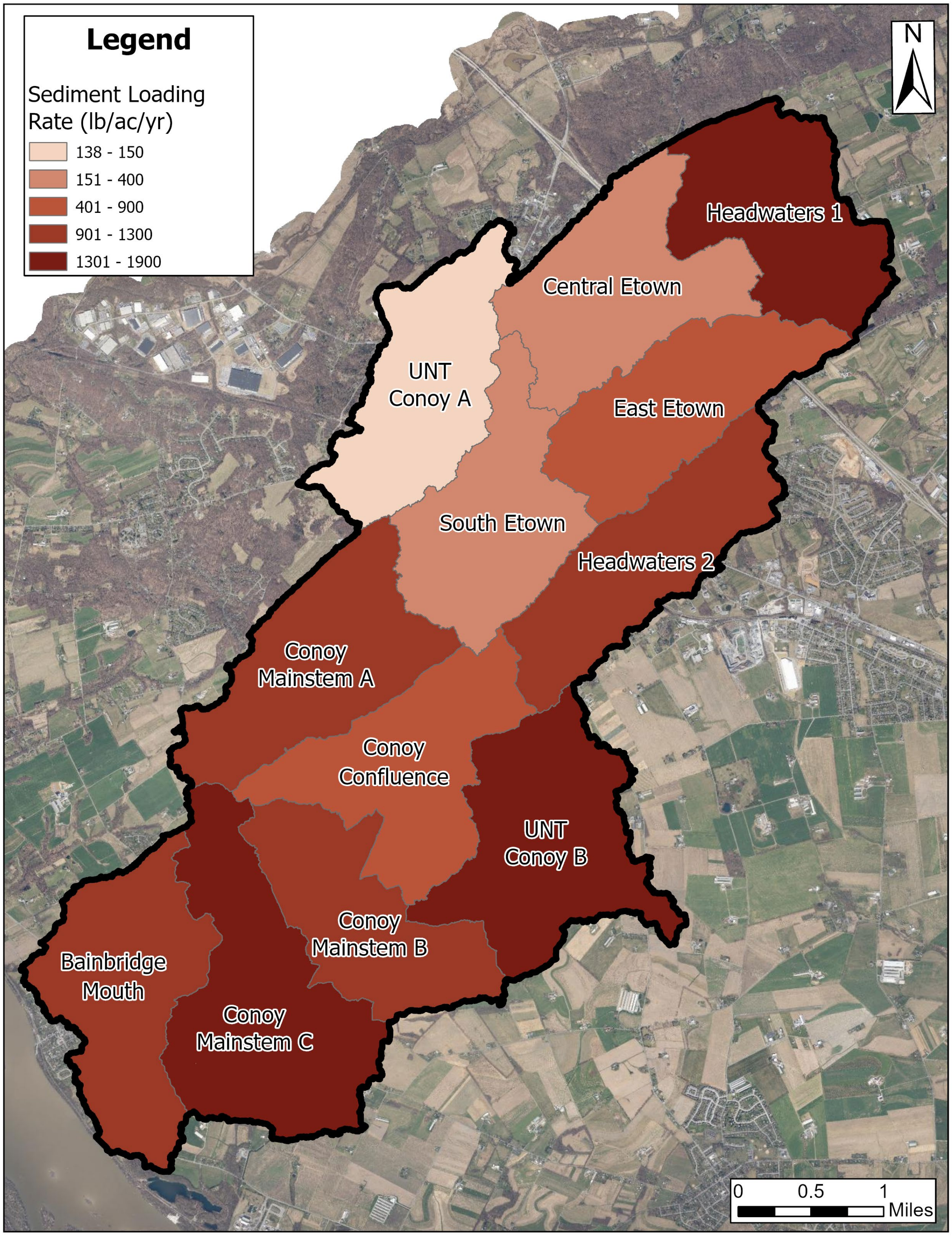


Figure 10. Sediment loading rate (lbs/ac/yr) in the Conoy Creek watershed according to Model my Watershed, given current best management practice (BMP) implementation. Primary sources of sediment are cropland and streambank erosion.

B. Monitoring Data

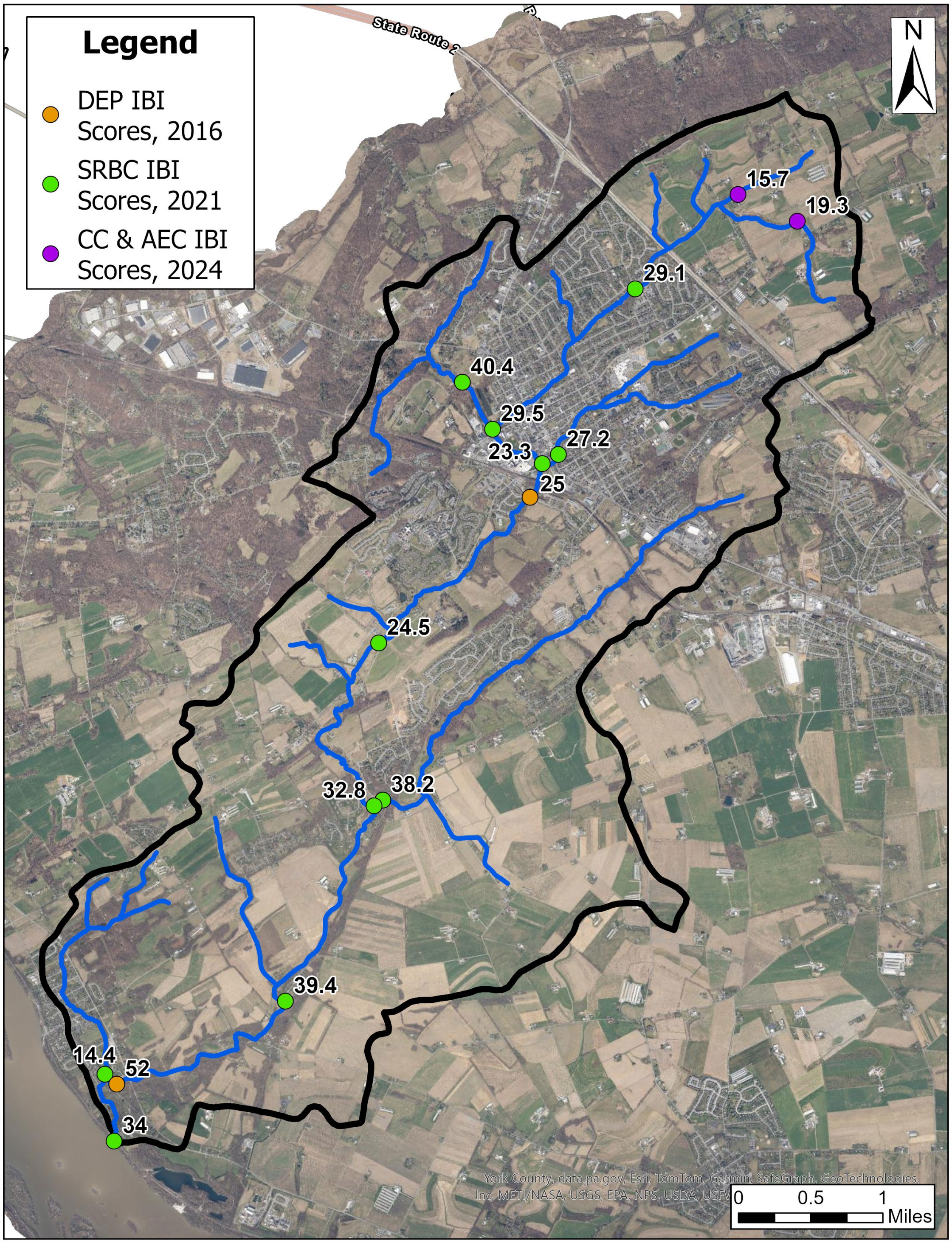


Figure 11. Macroinvertebrate Index Biologic Integrity (IBI) scores. Results were obtained by the Pennsylvania Department of Environmental Protection (DEP) in 2016; the Susquehanna River Basin Commission (SRBC) in 2021; and the Chesapeake Conservancy's (CC) and the Penn State

Agriculture and Environment Center (AEC) in 2024. All values indicate that the Conoy Creek watershed is impaired for aquatic life. Note: IBI Values less than 50 indicate that a stream is impaired for aquatic life. One collection obtained from DEP was above 50, however it failed other qualifiers and was still determined impaired for aquatic life.

C. Pollution Reduction Goal

Reference Watershed Method

A Total Maximum Daily Load (TMDL), or pollution reduction target, is necessary to prescribe a restoration strategy for the Conoy Watershed. However, the Pennsylvania Department of Environmental Protection (DEP) has not developed a TMDL for the Conoy as of the plan's development. In place of a TMDL, a pollution reduction target will be prescribed based on the reference watershed method, as an abridged version of the Deer Creek TMDL developed by Mike Morris. In this method, loading rates from Model my Watershed for similar unimpaired watersheds are used to calculate TMDLs. For this plan, sediment was chosen as the target pollutant that has been assessed as a cause of impairment. Nutrients including nitrogen and phosphorous were not assessed by the Pennsylvania DEP. However, that does not mean that excess nutrients do not also contribute to stream impairment in the watershed. It is important to note that most conservation practices that target sediment pollution will also reduce nutrient pollution.

Reference Watershed Data & Selection

Using DEP assessment criteria from DEP Integrated Reports, two unimpaired watersheds were identified with similar characteristics to Conoy Creek, including size, stream slope, and land use characteristics (Table 4). No watersheds in the same physiographic province were available that were unimpaired and similar in size. Because Ontelaunee has the closest land use distribution and stream channel slope, this reference watershed was chosen as the target for reduction goals.

Table 4. Watershed reference comparison using data from Model My Watershed.

	Conoy	Ontelaunee	Trout
Physiographic Province	Piedmont Province: Piedmont Lowland Section	Ridge & Valley Province: Great Valley and Blue Mountain Section	Ridge & Valley Province: Great Valley and Blue Mountain Section
Land Area (mi)	19	28	22
Land Use	Agriculture – 54.46% Forest/Natural Vegetation – 12.58% Developed – 32.96%	Agriculture – 45.48% Forest/Natural Vegetation – 43.23% Developed – 11.29%	Agriculture – 29.79 Forest/Natural Vegetation – 54.4% Developed – 15.81%

Soil Infiltration	Group A – 0% Group A/D - 0% Group B – 78.64% Group B/D - 0.75% Group C – 13.57% Group C/D - 5.18% Group D – 1.86%	Group A – 6.96% Group A/D - 0% Group B – 65.64% Group B/D - 4.85% Group C – 6.14% Group C/D - 0% Group D – 11.61%	Group A – 6.96% Group A/D - 0% Group B – 60.82% Group B/D - 2.29% Group C – 14.61% Group C/D - 0% Group D – 15.33%
Precipitation (in/yr)	41.2	46.4	47.2
Average Surface Runoff (in/yr)	3.19	2.07	2.45
Average Elevation (ft)	453	686	732
Average Slope (%)	4.4	10.2	9.9
Average Stream Chanel Slope (%)	1st order – 1.12% 2nd order – 0.45%	1st order – 1.46% 2nd order – 0.36%	1st order – 1.55% 2nd order – 0.71%

Table 5. Loading rates for Conoy Creek and Ontelaunee Creek using data from Model My Watershed. Conoy Creek's sediment loading rate is based on model inputs that are described in the Appendix.

Watershed	**Sediment Loading Rate**	**Area, mi^2**
Conoy	1,021.28 lbs/(ac*yr)	19
Ontelaunee, delineated to 19 square miles	422.01 lbs/(ac*yr)	19

Pollution Reduction Goal for Conoy

Using Ontelaunee Watershed as a reference watershed and adjusting watershed size, Conoy Creek needs to reduce sediment from 12,440,834 lbs to 5,984,781 lbs annually or a 52% reduction. In short, drastic reductions and BMP implementation are needed to restore the watershed due to heavy agricultural use and land modification. See the Methodology section on the next page for information on model inputs for Model My Watershed used to calculate this value.

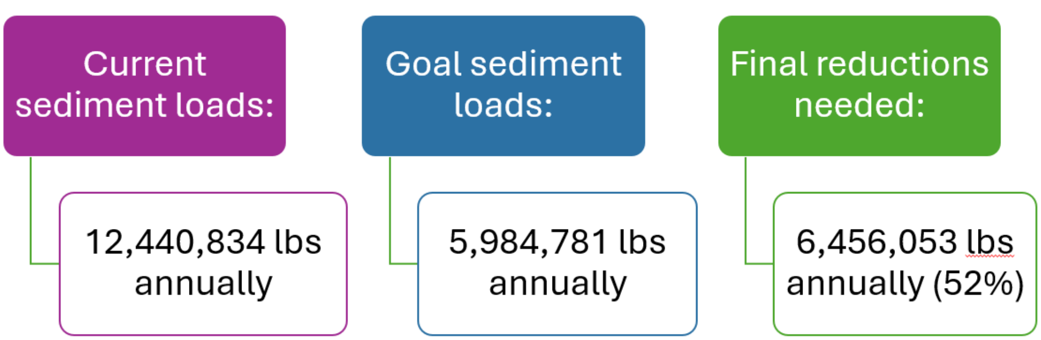


Figure 12. Sediment reduction goals for the Conoy Creek watershed.

Table 6. Summary of sediment pollution in each subwatershed. Note that due to modelling errors, the sum of all twelve subbasins doesn't equal the same amount as the entire watershed but is within a reasonable error margin.

Subbasin	Area, mi^2	Loading Rate, lbs/(ac*yr)	Total Load, lbs
1 – Headwaters 1	981.73	1,628.55	1,598,797.16
2 – Central Etown	1,036.70	287.31	297,855.24
3 – East Etown	096.77	404.07	366,399.12
4 – UNT Conoy A	956.94	137.72	131,790.33
5 – South Etown	1,066.93	923.35	985,147.39
6 – Conoy Mainstem A	956.41	1,066.90	1,020,391.39
7 – Headwaters 2	969.76	1,054.19	1,022,310.93
8 – UNT Conoy B	1,168.45	1,826.99	2,134,742.33
9 - Confluence	1,1014.01	841.47	433,771.13
10 – Conoy Mainstem B	977.65	1,080.45	948,256.84
11 – Conoy Mainstem C	1,323.48	1,313.45	1,738,319.69
12 – Bainbridge Mouth	1,066.93	923.35	985,147.39

Watershed Prioritization & Model

A. Methodology

Throughout this plan, Model My Watershed is used as the primary model to display basic watershed characteristics, sources of impairment, and current pollution loading rates. Other models to better understand watersheds and simulate BMP reductions exist such as Chesapeake Assessment Scenario Tool (CAST), Hydrologic simulation Program – FORTAN (HSPF). These are great references; however, Model My Watershed was chosen for its simplicity, accessibility to partners, and timeframe to complete the plan. The goal of the plan is largescale planning, and extremely fine refining model inputs is outside the scope of the Conoy Creek WIP. Model My Watershed was developed by Stroud Water Research Center and employs local research and data to model loading rates and summarize watershed characteristics.

After the model was selected, subwatersheds were delineated so that the watershed could be prioritized, organized, and modelled for ease of implementation. Twelve subwatersheds were delineated to about one to two square miles using ArcGIS Pro's watershed tool and PASDA data including stream layers and the 3.2 meter digital elevation model. One to two square miles is an ideal size for modelling in Model My Watershed. Tools used in the entire process include sequentially: Fill – Spatial Analyst to remove depressions, Flow Direction Tool, Flow Accumulation – Spatial Analyst, Classify and ReClassify – Spatial Analyst to map out streams, Create Features to create drain points, and finally Watershed – Spatial Analyst.

Once subwatersheds were created, best management practice data were compiled from the Lancaster County Conservation District PracticeKeeper database. To be counted in the model, the BMPs must be within the NRCS practice code lifespan, except for annual BMPs like cover crop and no-till which were assumed to be implemented. For example, BMPs such as manure storages were assumed to be non-functioning, if they were older than the lifespan of 20 years. Because of the vast catalogue of BMPs, it would be extremely difficult and time-intensive to check all BMPs. For riparian buffers, the length of stream buffered was determined using the Penn State Agriculture & Environment Center's GIS model. Then, all BMPs were summarized for each subwatershed, and added to the model.

Other model input changes included animal numbers and land use. Land use percentages were changed based on Lancaster County's GIS landcover data, compared to the national dataset. Animal numbers were based on LCCD's PracticeKeeper data warehouse, which tracks animal numbers on farms. Last, weather data were changed to 2000-2019 to account for climate change and the increase of extreme storm events, impacting the rate and volume of nutrient delivery. All other parameters were left using standard inputs.

Once model inputs were finalized, sediment loading rates for both the subwatershed and entire watershed were determined and used to determine the pollution reduction goal or modified TMDL.

Note, there are multiple limitations with Model My Watershed. First, there are limited BMPs that can be used in the model (Table 7). For a complete list of potential BMPs available for implementation in the Conoy Creek watershed, see the Natural Resource Conservation Service eFOTG or the BMP list from the CAST model created by the Chesapeake Bay Foundation. While agricultural BMPs such as cover crops and no-till were targeted in this plan, each property and project should be looked at critically to meet the resource concerns. Other common BMPs in Lancaster County that are effective in sediment reduction include grassed waterways, contour farming, terraces, and diversions. Another limitation is the riparian buffer BMP in the model. It assumes a 100' riparian buffer, when most riparian buffers average about 35' in the Conoy Creek watershed. To account for this difference, all calculated buffers were halved in each subwatershed; however, those numbers should be treated with caution because there isn't an exact equivalent that can be inputted into the model.

Table 7. Best Management Practices (BMPs) available on Model My Watershed and how they were used in the Conoy Creek WIP. As stated before, BMPs are still effective and should be implemented, even if not in the plan.

BMP	Description, obtained from MMW	Included in Plan (Yes/No)
Cover Crop	Use of annual or perennial plant cover to protect the soil from erosion during the time between the harvesting and planting of the primary crop. In addition	Yes

	to reducing soil erosion, cover crops can also limit nitrogen loss from cropped areas. Use of annual or perennial plant cover to protect the soil from erosion during the period between the harvesting and planting of the primary crop. In addition to reducing soil erosion, cover crops can also limit nitrogen loss from cropped areas.	
No Till Agriculture	The purpose of this BMP is to leave some residue from harvested crops on the soil surface to reduce soil erosion. This practice is similar to the "Conservation Tillage" and "Reduced Tillage" practices and only differs with respect to the amount of residue left on the ground. In this case, it is assumed that ground coverage with residual matter is at or greater than 60%.	Yes
Conservation/ Mulch Tillage	The purpose of this BMP is to leave some residue from harvested crops on the soil surface to reduce soil erosion. This practice is similar to the "No Till Agriculture" and "Reduced Tillage" practices and only differs with respect to the amount of residue left on the ground. In this case, it is assumed that ground coverage with residual matter is between 30-60%.	No, most farmers in Lancaster are already doing conservation or reduced no tillage.
Reduced Tillage	The purpose of this BMP is to leave some residue from harvested crops on the soil surface to reduce soil erosion. This practice is like the "No Till Agriculture" and "Conservation Tillage" practices, and only differs with respect to the amount of residue left on the ground. In this case, it is assumed that ground coverage with residual matter is between 15-30%.	No, most farmers in Lancaster are already doing conservation or reduced no tillage.
Nutrient Management	Planned use of organic and/or inorganic nutrients to sustain optimum crop production while at the same time protecting the quality of nearby water resources. This practice usually includes a farm-wide nutrient management plan that minimizes the use of animal waste or commercial fertilizers to the greatest degree practicable.	Yes, but not focus of plan, but key for reducing nitrogen and phosphorous pollution for humans and wildlife
Animal Waste Management Systems (Livestock)	These are systems that are designed to collect runoff and/or waste from confined animal operations for the purpose of breaking down organic wastes via aerobic or anaerobic processes. Typical examples include waste lagoons or holding tanks that collect the waste and prevent their discharge to nearby streams.	No, not focus of plan, but key for reducing nitrogen and phosphorous pollution for humans and wildlife

Animal Waste Management Systems (Poultry)	These are systems that are designed to collect runoff and/or waste from confined animal operations for the purpose of breaking down organic waste via aerobic or anaerobic processes. Typical examples include waste lagoons or holding tanks that collect the waste and prevent their discharge to nearby streams.	No, not focus of plan, but key for reducing nitrogen and phosphorous pollution for humans and wildlife
Vegetative Buffer Strip (Rural and Urban)	Areas of trees and/or grasses planted along streams or lakes that are designed to capture and renovate surface runoff and shallow subsurface flow from agricultural and urban areas via the processes of filtration, infiltration, absorption, adsorption, uptake, denitrification, volatilization, and deposition. A buffer width of 30 m (roughly 100 ft) is assumed.	Yes
Streambank Fencing	Construction of fencing that prohibits cattle from trampling stream banks, destroying protective vegetation, stirring up sediment in the streambed, and depositing organic waste directly into the stream.	Yes
Streambank Stabilization (Rural and Urban)	Rip-rap, gabion walls, or a "bio-engineering" solution of some type along the edges of a stream to protect the banks during periods of heavy stream flow, thereby reducing direct stream bank erosion. The banks may also be covered with rocks, grass, trees, shrubs, and other protective surfaces to reduce erosion as well.	Yes
Surface Water Retention	With this practice, surface runoff from impervious areas is detained via this use of designed structures (e.g., retention/detention basins, constructed wetlands) for the purpose of reducing peak flows and promoting the reduction of nutrient and sediment loads primarily via sedimentation and/or plant uptake.	No, not focus of plan, but very key for groundwater recharge and stormwater management in urban areas
Infiltration & Bioretention	Various approaches that achieve runoff reduction and the treatment of urban pollutants (primarily nutrients) through the promotion of infiltration, evapotranspiration and renovation via subsurface flow. Examples include the use of pervious materials/porous pavement, infiltration basins/trenches, and vegetated roofs. It is assumed that runoff from a 2.54 cm (I.0 in) rainfall event is captured.	No, not focus of plan, but very key for groundwater recharge and stormwater management in urban areas

As emphasized throughout this plan, Model My Watershed is a model, and all values should be treated with caution. The focus of the plan is on agriculture, so agriculture BMPs and stream restoration BMPs cause significant sediment reductions while urban BMPs, while solving other key issues, don't. However, this doesn't mean those BMPs shouldn't be implemented – it just depends on the focus and goal of each project. The goal of this plan is to serve as a target to aim for to reach sediment reductions, knowing the path will change as research improves and implementation evolves.

B. Priority Subwatersheds

Once the base data was created for the Conoy Creek watershed, subwatersheds were prioritized to create a realistic plan for implementation. The following parameters were evaluated to determine effective management strategies:

1. Macroinvertebrate Scores and Potential for Delisting

   Macroinvertebrate Scores (Index of Biologic Integrity – IBI) are one of the primary factors used to delist streams and list them as attaining for aquatic life. Generally, scores that are closer to 50 are closer to delisting, and those subwatersheds should be prioritized.

2. Past BMP Implementation

   Best management practice (BMP) data is essential to determine what practices have been installed and where outreach has been already done to plan outreach. BMP data from PracticeKeeper, which houses all BMPs recorded by the Lancaster County Conservation District, was used to organize current and past implementation efforts. Generally, more BMPs planned or installed indicate that outreach will be easier in that area and it will be an quicker lift to complete existing, planned BMPs.

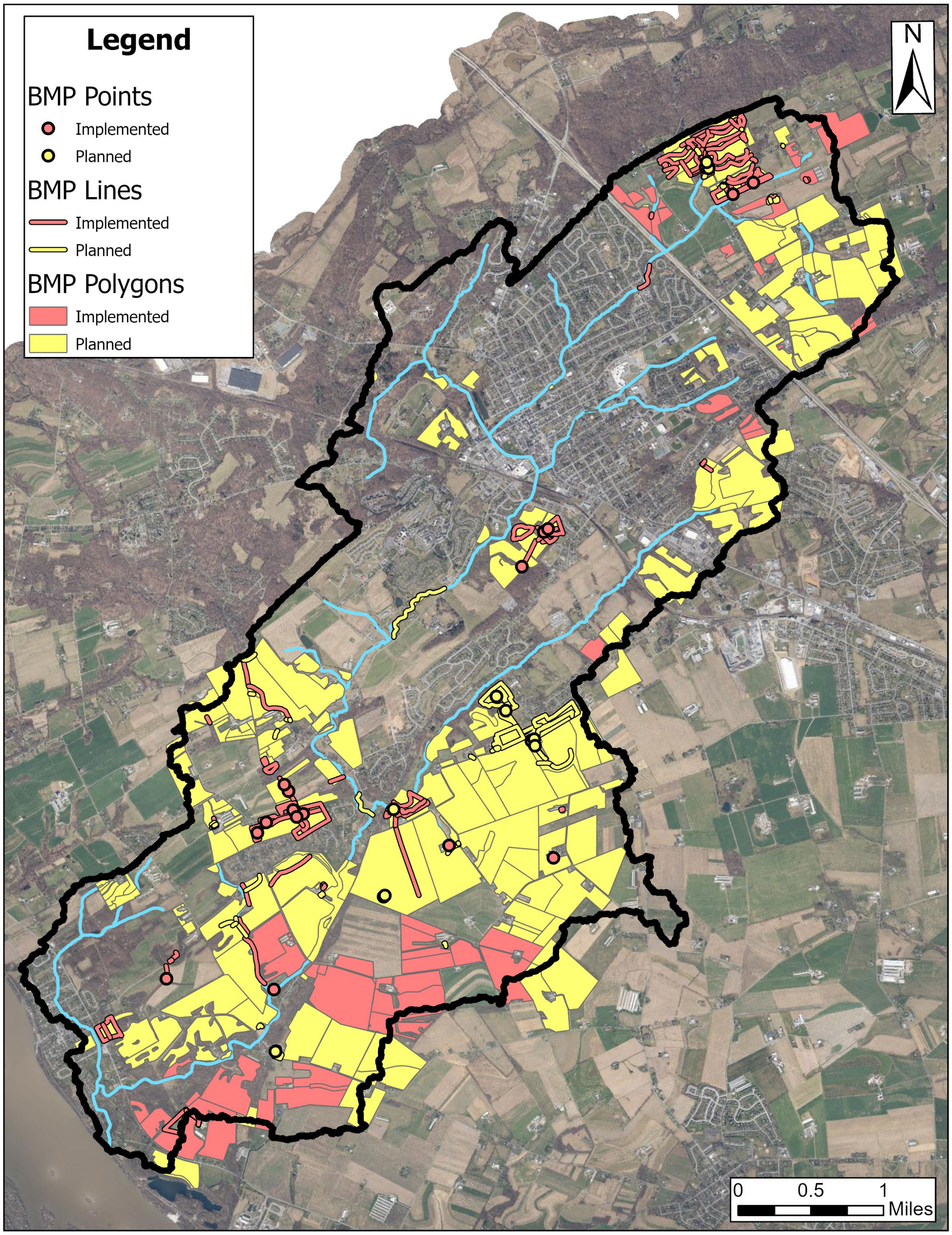


Figure 13. Implemented and planned BMPs in the Conoy Creek watershed. Point BMPs include waste storages, watering facilities, and other BMPs that exist at one spot. Line BMPs include grassed waterways, terraces, riparian buffers, and other BMPs that span from point A to point B. Polygon BMPs include conservation plans, manure management plans, cover crops, and other farm BMPs that cover entire fields.

3. Feasibility and Cost of BMP Implementation in Present and Future

   Next, understanding what BMPs are realistic and where they can be feasibly installed, helps determine where more conservation work can happen. Farm BMPs, such as cover crops, no tillage, grassed waterways, terraces, and similar management practices are extremely cost-effective and are generally accepted by the community. Structural BMPs like waste storages and heavy use areas are important as well, but focus more on nutrient management, and are more costly, and weren't considered in the prioritization model.

   Stream restoration and riparian buffers are key components of watershed restoration however, adoptability varies. Stream restoration practices ranging from riprap to habitat installation to stream channel redesign can be very costly and will never be feasibly completed on all properties. Instead, it is key to look for subwatersheds that have ample stream lengths with limited habitat, significant disturbance from past use, and opportunity for ecological uplift. While interest in stream restoration has increased, many landowners will opt away from it due to cost, government influence, and land usage. The same goes for riparian buffers, while more cost-effective and easily adopted, they will not be adopted universally, so it cannot be the only BMP adopted in a subwatershed. Thus, looking for a mixture of BMP installation is key to varying cost and strategy for optimum restoration.

   Urban BMPs were not a focus of this plan and weren't a primary consideration in the prioritization scheme because they focus on stormwater over sediment. However, management strategies for these areas will still be emphasized to maximize a holistic restoration strategy.

4. Most Effective Restoration Strategies

   As research has advanced in watershed restoration, funders and practitioners have recognized funding is limited and not every single BMP will get implemented on every farm, stream and neighborhood. BMP installation higher in the watershed, or on side tributaries, will result in faster restoration and should be emphasized for cost-effectiveness.

5. Current Sediment Loading Rates and Plan Focus

   Subwatersheds with higher initial loading rates should be prioritized for implementation because there is a greater opportunity to reduce sediment pollution.

Based on these parameters, subwatersheds 1, 7 and 8 (Headwaters 1, Headwaters 2, and UNT Conoy B) were selected as Priority 1. Subwatersheds 6, 9, 10, and 11 (Conoy Mainstem A, Confluence, Conoy Mainstem B, and Conoy Mainstem C) were selected as Priority 2. Subwatersheds 3, 4, 5, and 12 (Central Etown, East Etown, UNT Conoy A, South Etown, and Bainbridge Mouth) were selected as Priority 3. From there, BMP rates were selected for each priority area to achieve sediment loading rates. Priority 1 aimed to reduce 50% of the loading rate of the watershed, Priority 2 aimed to reduce 45% of the loading rate of the watershed, and Priority 3 aimed to reduce 5% of the loading rate of the watershed, aiming for an even higher reduction of 10%. Other considerations for each watershed, in addition to the model, are included to emphasize a wholistic approach to watershed restoration.

Implementation

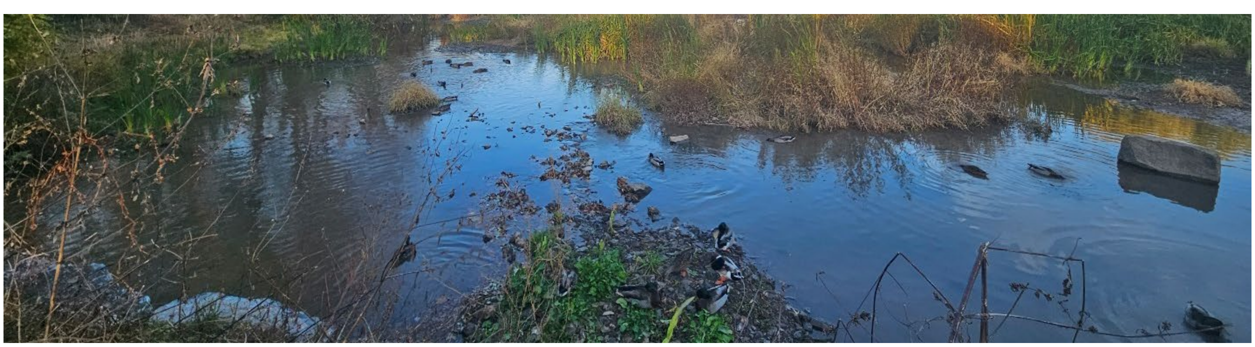
A. BMP Rates and Priority Area Considerations

Priority 1 Subbasins

Summary: Headwaters 1, Headwaters 2, and UNT Conoy B were selected as the three priority 1 subwatersheds for implementation, focusing on reducing 50% of the sediment load for the Conoy Creek watershed. These three subwatersheds were picked because of their high position in the watershed, opportunity for high rates of agriculture BMP implementation and some stream BMPs, and past high rates of outreach and implementation. Headwaters 1 includes Mount Township and is 100% farmed. Headwaters 2 includes Mount Joy Township, sections of Elizabethtown Borough, and West Donegal Township. It is mostly farmed with some urban and residential areas. UNT Conoy B includes East Donegal Township and is mostly made of West Donegal Township. It is 100% farmed.

Table 8. Existing sediment loading rates for each Priority 1 subwatershed, based on current BMPs already implemented.

Subbasin	Area, mi^2	Loading Rate (lbs/(ac*yr)	Total Load, lbs	Goal Loading Rate (lbs/(ac*yr)
1 – Headwaters 1	981.73	1,628.55	1,598,797.16	384.41
7 – Headwaters 2	969.76	1,054.19	1,022,310.93	124.99
8 – UNT Conoy B	1,168.45	1,826.99	2,134,742.33	825



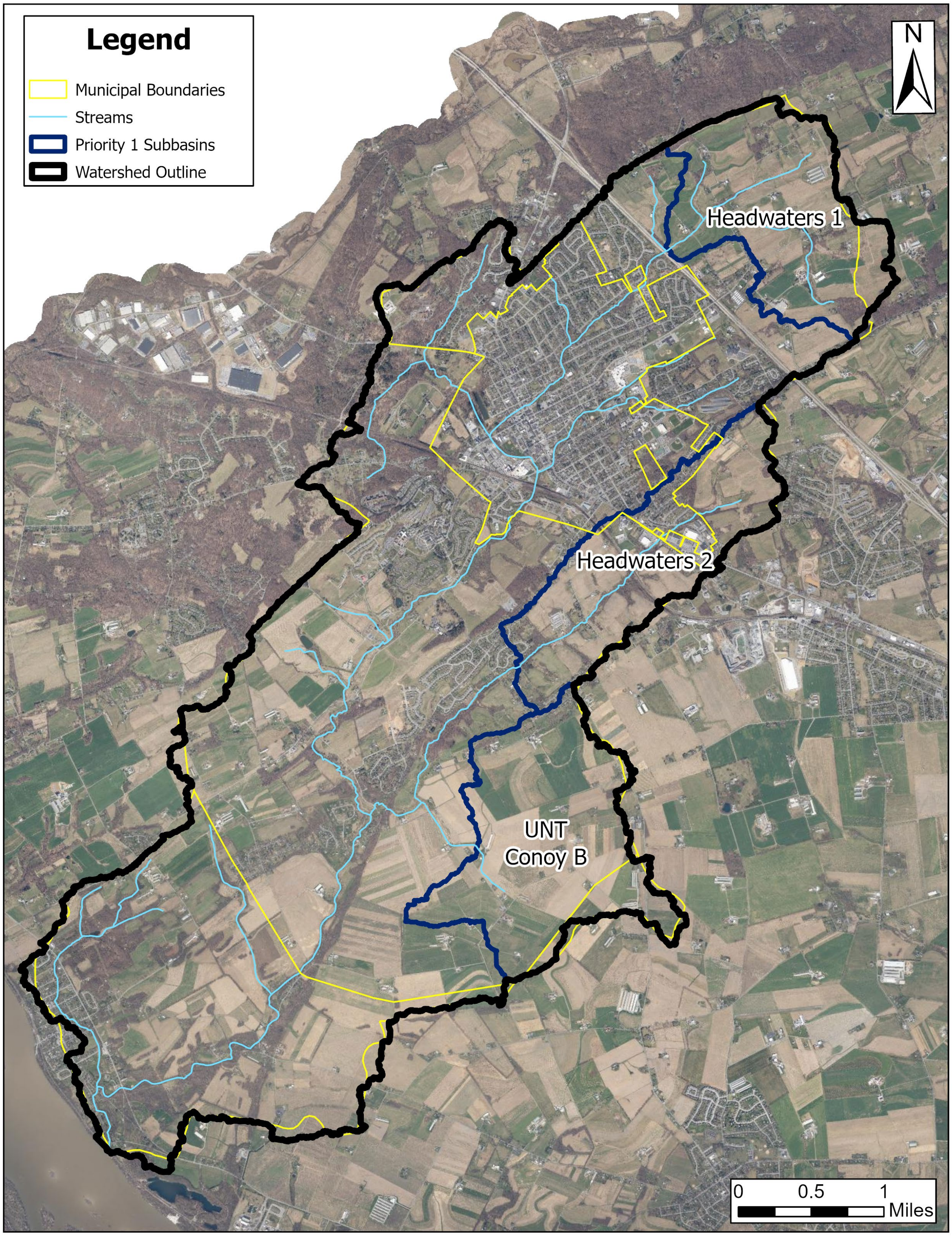


Figure 14. Priority 1 subwatersheds, including Headwaters 1, Headwaters 2, and UNT Conoy B. The plan aims to complete 50% of sediment reductions in these three priority watersheds.

Table 9. Existing BMPs implemented in Priority 1 subwatersheds. Note that the vegetated buffer strips are assuming 35' in this scenario, and their reduction is over-inflated in Model My Watershed. Also note that this is based on recorded BMPs, and actual implementation may be higher or lower than recorded.

Subbasin	Cover Crop (ac)	No Till (ac)	Mulch Till (ac)	Nutrient Management (ac)	Livestock Waste (AEUS)	Vegetated Buffer Strips (miles)	Streambank Stabilization (miles)
Headwaters 1	13	25	0	580	307	0.4	0
Headwaters 2	83	24	0	247	0	0.28	0
UNT Conoy B	0	38	0	589	0	0.05	0

Table 10. Proposed BMPs in Headwaters 1. Headwaters 1 provides ample opportunities for streams to plant and restore while increasing agriculture BMP implementation. Under this scenario, annual sediment loads will reduce by 1,221,410 lbs.

Metric	Cover Crop (ac)	No Till (ac)	Nutrient Management (ac)	Vegetated Buffer Strips (miles)	Livestock Fencing (miles)	Streambank Stabilization (miles)
Acreage	520	453	585	1.5	1.02	0.6
Implementation Rate (of total stream length or field area)	80%	70%	90%	50%	40%	20%

Table 11. Proposed BMPs in Headwaters 2. Headwaters 2 focuses on agriculture BMP implementation since most streams are already semi-forested and thus fencing and stabilization are not applicable. Instead, the goal is to expand existing forested buffers to reach at least 35', aiming for 100'. Under this scenario, annual sediment loads will reduce by 901,100 lbs.

Metric	Cover Crop (ac)	No Till (ac)	Nutrient Management (ac)	Vegetated Buffer Strips (miles)	Livestock Fencing (miles)	Streambank Stabilization (miles)
Acreage	385	290	430	1.05	0.2	0.25
Implementation Rate (of total stream length or field area)	80%	70%	90%	50%	40%	20%

Table 12. Proposed BMPs in UNT Conoy B. Because the subwatershed is entirely under agriculture production and contains under 500' of stream, no stream BMPs are included. Agriculture BMP implementation is the focus in this subwatershed. Under this scenario, annual sediment loads will reduce 1,088,911 lbs.

Metric	Cover Crop (ac)	No Till (ac)	Nutrient Management (ac)	Vegetated Buffer Strips (miles)	Livestock Fencing (miles)	Streambank Stabilization (miles)
Acreage	760	660	850	0	0	0
Implementation Rate (of total stream length or field area)	80%	70%	90%	0%	0%	0%

With all BMPs implemented at the proposed rate, suspended sediment in the Priority 1 subwatersheds will decrease from 4,755,850 lbs annually to 1,462,566 lbs. That will achieve a 50% reduction of 3,292,283 lbs annually.

Other Considerations & Recommendations for Priority 1:

1. Groundwater Recharge

Groundwater recharge is becoming an increasing issue and many BMPs address both water quality, while improving filtration for aquifers. Headwaters 2 and UNT Conoy B were especially highlighted as areas of high groundwater infiltration according to the Susquehanna River Basin Commission's CARA tool. Headwaters 1 is also a higher groundwater recharge area but wasn't ranked as high across the subwatershed. Practices such as cover crops and no tillage can help improve infiltration for local groundwater.

2. Urban & Stormwater BMPs

Headwaters 1 and UNT Conoy B are primarily agriculture land use and stormwater management is not as critical as nutrient and sediment management. However, farms can better manage stormwater through roof runoff structures and basins, when applicable for new construction. For residential sections of Headwater 2, rain gardens/bioswales, stormwater basin retrofits, porous pavement, and meadow plantings are great tools for municipalities and organizations. Residents can convert their lawn to a meadow and focus on stormwater management through rain barrels. These BMPS will increase infiltration for groundwater recharge while reducing flooding events that damage infrastructure in addition to degrading water quality.

3. Future Stream Restoration Projects

Headwaters 1 was targeted as an optimal area for stream restoration projects. Optimal restoration projects are: unforested with minimal aquatic and terrestrial habitat, at least 1000’ in length, and part of a conservation network of BMPs both upslope and upstream, among other considerations. Two recommended areas to target restoration are the tributary east of Etown Rd and the tributary parallelling Country Squire Rd.

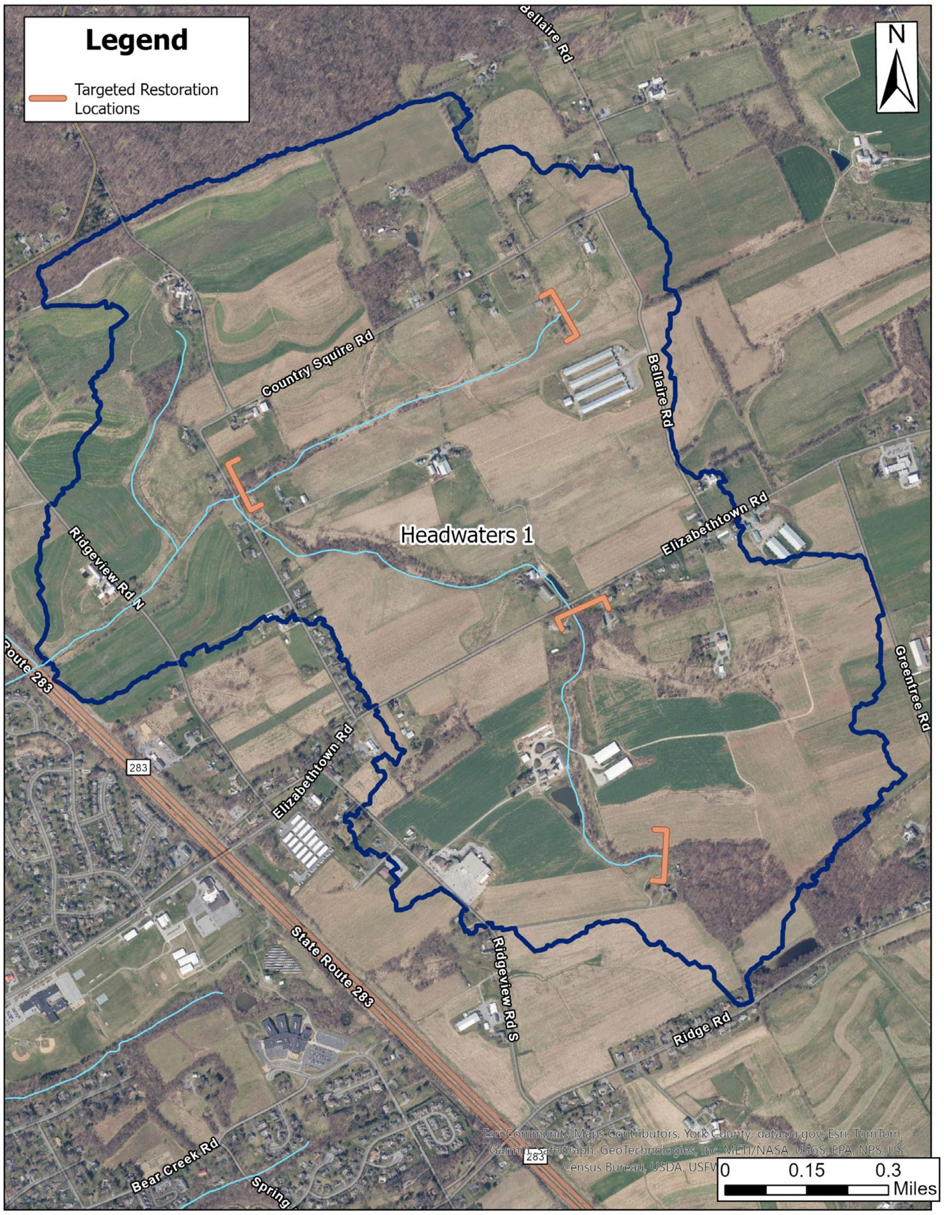


Figure 15. Potential stream restoration projects in Headwaters 1.

Priority 2 Subbasins

Summary: Conoy Mainstem A, Conoy Confluence, Conoy Mainstem B, and Conoy Mainstem C were selected as the four priority 2 subwatersheds for implementation, focusing on reducing 45% of the sediment load for the Conoy Creek watershed.

These four subwatersheds were picked because of ample opportunities for agriculture BMP implementation and stream BMPs, and past higher rates of outreach and implementation. They were ranked lower in priority because they have a lesser impact being lower in the watershed. However, farm BMPs are cost-effective at reducing sediment and were prioritized over urban areas to meet the plan's goals. Conoy Mainstem A includes West Donegal Township and is primarily farmed. Conoy Confluence includes West Donegal Township and is a mixture of residential and farm areas, especially along the stream frontage. Conoy Mainstem B includes West Donegal and Conoy Township and is primarily agriculture with some residential areas. Last, Conoy Mainstem C is in Conoy Township and is primarily farmed.

Table 14. Existing sediment loading rates for each Priority 2 subwatershed, based on current BMPs already implemented.

Subbasin	Area, mi^2	Loading Rate (lbs/(ac*yr)	Total Load, lbs	Goal Loading Rate (lbs/(ac*yr)
Conoy Mainstem A	956.41	1,066.90	1,020,391.39	523.67
Confluence	1,1014.01	841.47	433,771.13	317.93
Conoy Mainstem B	977.65	1,080.45	948,256.84	112.35
Conoy Mainstem C	1,323.48	1,313.45	1,738,319.69	421.49

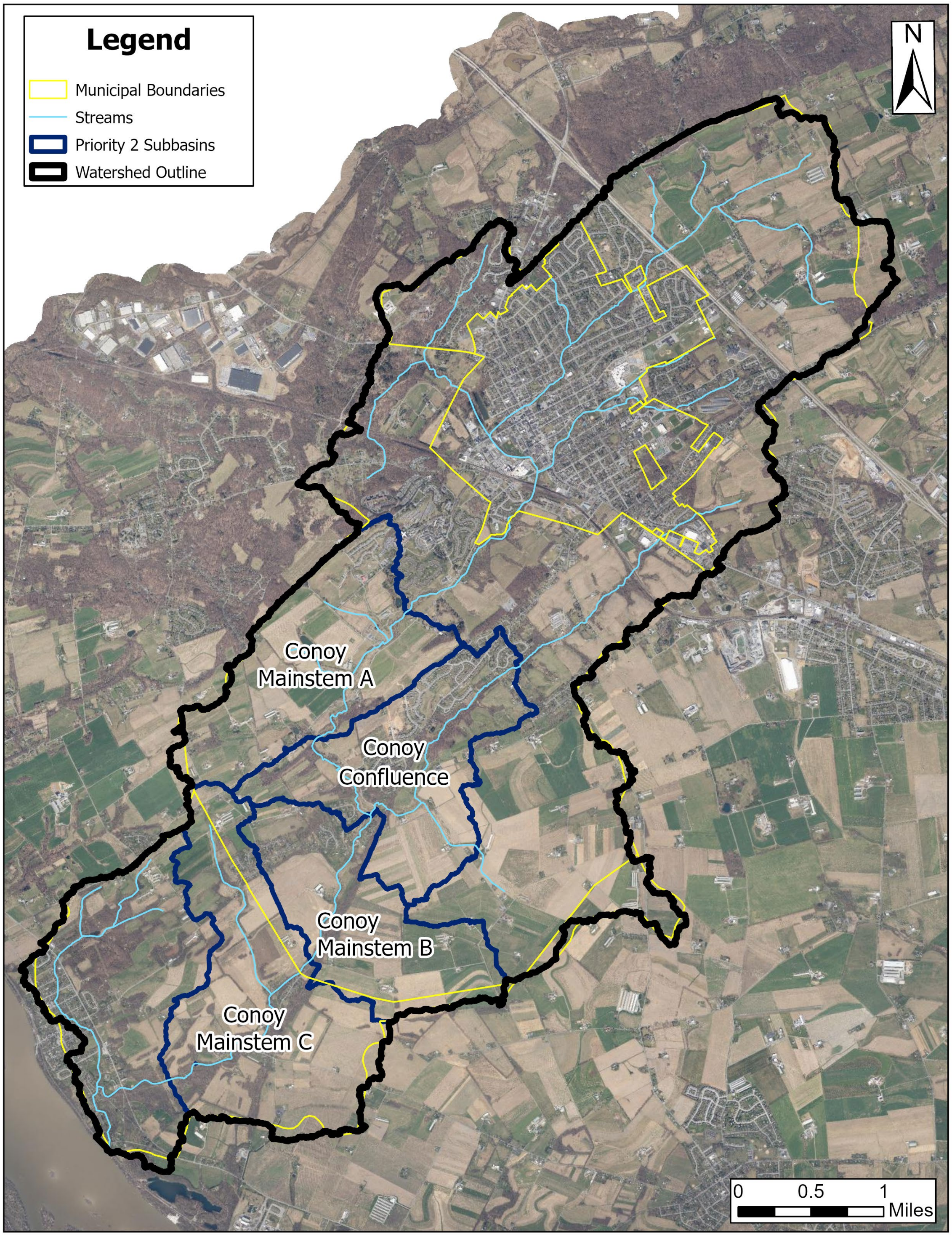


Figure 16. Priority 2 subwatersheds, including Conoy Mainstem A, Conoy Confluence, Conoy Mainstem B, and Conoy Mainstem C. The plan aims to complete 45% of sediment reductions in these four priority watersheds.

Table 15. Existing BMPs implemented in Priority 2 Subwatersheds. Note that the vegetated buffer strips are assuming 35’ in this scenario, and their reduction is over-inflated in Model My Watershed. Also note that this is based on recorded BMPs, and actual implementation may be higher or lower than recorded.

Subbasin	Cover Crop (ac)	No Till (ac)	Mulch Till (ac)	Nutrient Management (ac)	Livestock Waste (AEUS)	Vegetated Buffer Strips (miles)	Streambank Stabilization (miles)
Conoy Mainstem A	0	9	0	675	0	0.33	0
Conoy Confluence	0	91	0	386	0	0.83	0.18
Conoy Mainstem B	134	308	42	461	176	0.16	0
Conoy Mainstem C	0	0	0	352	458	0.54	0

Table 16. Proposed BMPs in Conoy Mainstem A. Conoy Mainstem A provides ample opportunities for streams to plant and restore while increasing agriculture BMP implementation. Under this scenario, annual sediment loads will reduce by 519,549 lbs.

Metric	Cover Crop (ac)	No Till (ac)	Nutrient Management (ac)	Vegetated Buffer Strips (miles)	Livestock Fencing (miles)	Streambank Stabilization (miles)
Acreage	294	196	675	0.75	0.5	0.25
Implementation Rate (of total stream length or field area)	60%	40%	60%	30%	20%	10%

Table 17. Proposed BMPs in Conoy Confluence. Stream BMPs focus on amplifying countless areas for riparian buffer with limited spots for livestock fencing in additional to traditional agriculture BMP implementation. Under this scenario, annual sediment loads will reduce by 530,872 lbs.

Metric	Cover Crop (ac)	No Till (ac)	Nutrient Management (ac)	Vegetated Buffer Strips (miles)	Livestock Fencing (miles)	Streambank Stabilization (miles)
Acreage	249	166	386	1	0.5	0.32

Implementation Rate (of total stream length or field area)	60%	40%	60%	30%	15%	10%

Table 18. Proposed BMPs in Conoy Mainstem B. Conoy Mainstem B focuses on agriculture BMP implementation while supplementing narrow, existing riparian buffers. No fencing was proposed because the subwatershed is currently cropped up to the stream. Under this scenario, annual sediment loads will reduce by 849,652 lbs.

Metric	Cover Crop (ac)	No Till (ac)	Nutrient Management (ac)	Vegetated Buffer Strips (miles)	Livestock Fencing (miles)	Streambank Stabilization (miles)
Acreage	360	240	461	0.29	N/A	0.2
Implementation Rate (of total stream length or field area)	60%	40%	60%	25%	0%	16%

Table 19. Proposed BMPs in Conoy Mainstem C. Conoy Mainstem C provides ample opportunities for streams to plant and restore while increasing agriculture BMP implementation. Stream BMPs were implemented at a slightly higher rate, focusing on the expanding existing riparian buffers on the side tributary and some targeted spots on the mainstem. Under this scenario, annual sediment loads will reduce by 1,180,487 lbs.

Metric	Cover Crop (ac)	No Till (ac)	Nutrient Management (ac)	Vegetated Buffer Strips (miles)	Livestock Fencing (miles)	Streambank Stabilization (miles)
Acreage	556	371	668	0.75	0.5	0.21
Implementation Rate (of total stream length or field area)	60%	40%	60%	25%	16%	6%

With all BMPs implemented at the proposed rate, suspended sediment in the Priority 2 subwatersheds will decrease from 4,560,222 lbs to 1,535,289 lbs. That will achieve a 45% reduction of 3,080,562 lbs annually.

Other Considerations & Recommendations:

1. Groundwater Recharge

Groundwater recharge is becoming an increasing issue and many BMPs address both water quality, while improving filtration for aquifers. Conoy Mainstem A was especially highlighted as areas of high groundwater infiltration according to the Susquehanna River Basin Commission's CARA tool. Conoy Mainstem B and C are also higher groundwater recharge areas but wasn't ranked as high across the subwatershed. Conoy Confluence was not ranked as a high priority for groundwater recharge. Practices such as cover crops and no tillage can help improve infiltration for local groundwater.

2. Urban & Stormwater BMPs

Conoy Mainstems A, B, and C are primarily agriculture land use and stormwater management is not as critical as nutrient and sediment management. However, farms can better manage stormwater through roof runoff structures and basins when applicable for new construction. For residential sections of Conoy Confluence, rain gardens/bioswales, stormwater basin retrofits, porous pavement, and meadow plantings are great tools for municipalities and organizations. Residents can convert their lawn to a meadow and focus on stormwater management through rain barrels. These BMPS will increase infiltration for groundwater recharge while reducing flooding events that damage infrastructure in addition to degrading water quality.

6. Future Stream Restoration Projects

All four subwatersheds present opportunities for stream restoration projects to restore key aquatic habitat conditions. Optimal restoration projects are: unforested with minimal aquatic and terrestrial habitat, at least 1000' in length, and part of a conservation network of BMPs both upslope and upstream, among other considerations.

Conoy Mainstem A potential locations:

A. North of Bainbridge Rd bridge, up to 2000' upstream, this site is already under consideration for restoration by partners
B. South of Bainbridge Rd bridge until end of subwatershed

Conoy Confluence potential locations:

Note: A residential area in West Donegal Township at 40.11309920824446, -76.62813896881946 was already restored, totaling 950'.

A. Main stem paralleling Miller Road
B. Any of the farms on the UNT to Conoy, after the forested section ends.

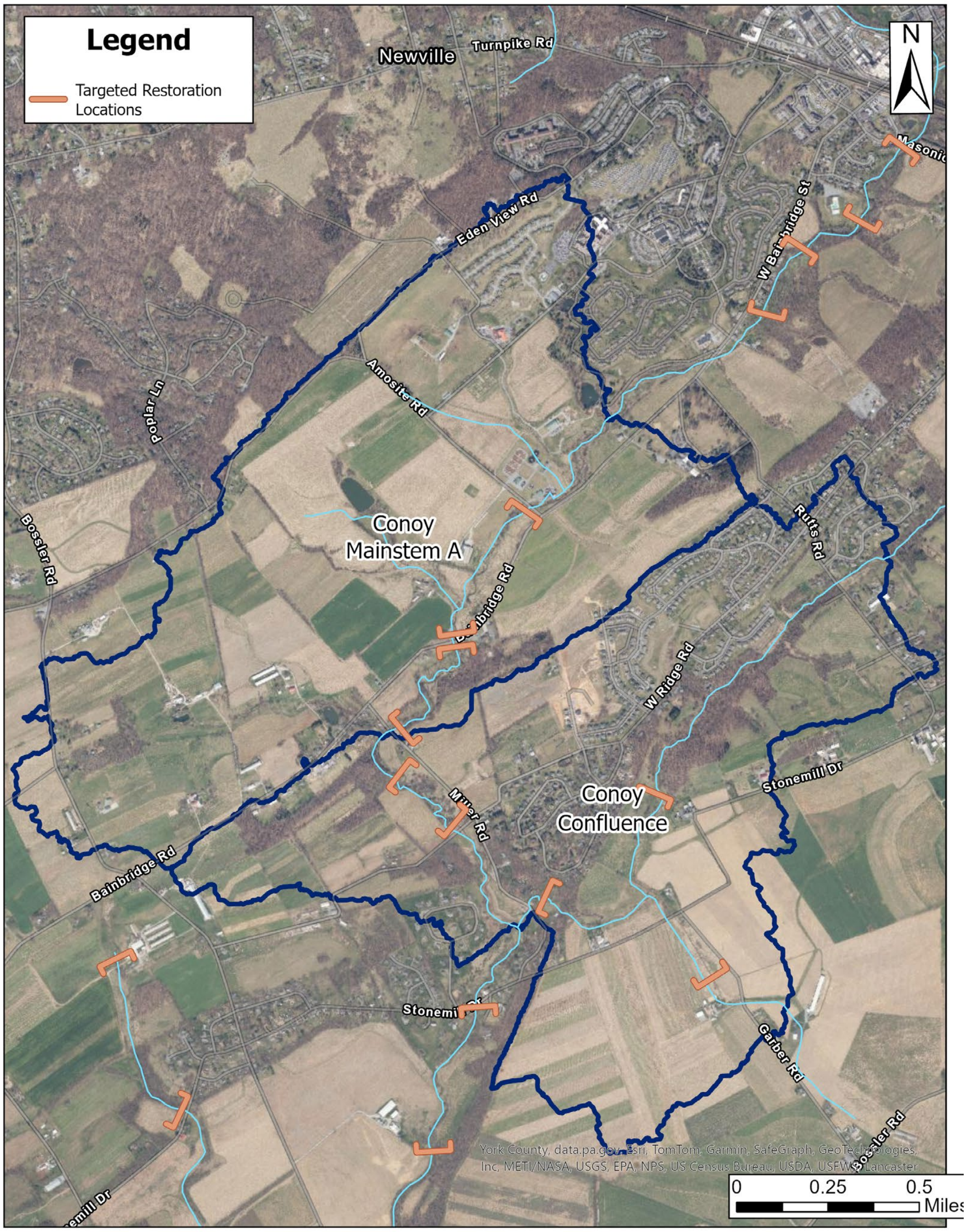


Figure 17. Conoy Confluence and Conoy Mainstem A potential restoration sites.

Conoy Mainstem B potential location:

A. South of Stonemill Rd before the forested section begins

Conoy Mainstem C potential location:

A. North of Stonemill Rd

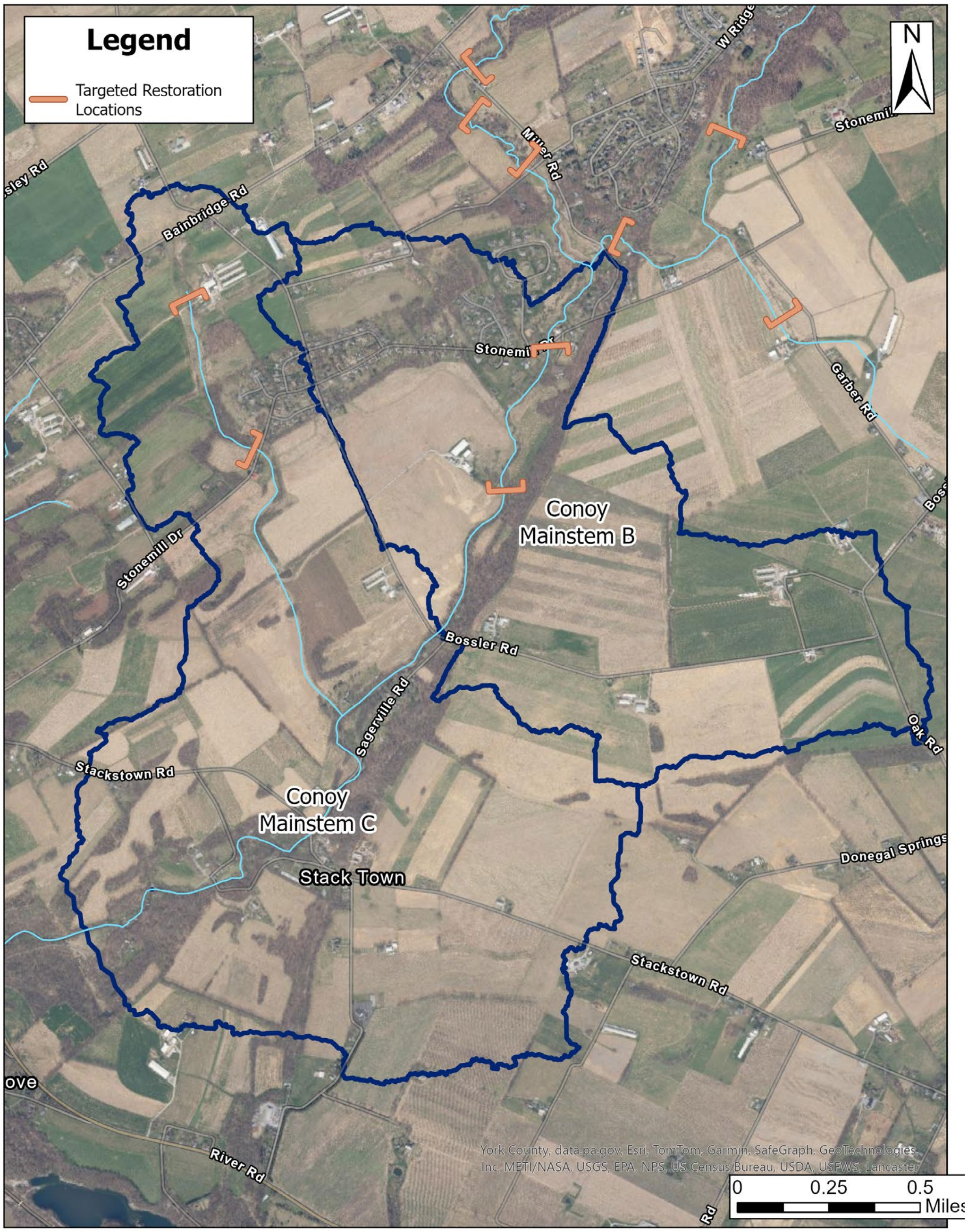


Figure 18. Conoy Mainstem B and Conoy Mainstem C potential restoration sites.

Priority 3 Subbasins

Summary: Central Etown, South Etown, East Etown, Conoy UNT, and Bainbridge Mouth were selected as the five priority 3 subwatersheds for implementation, focusing on reducing at least

5% of the sediment load for the Conoy Creek watershed, aiming for 10%, so we achieve 105% of Conoy Creek watershed's sediment reduction goals.

These five subwatersheds were picked as the third priority because they are contributing some of the least sediment load to the Conoy Creek watershed. However, that doesn't mean that BMP implementation should not happen here. Conservation work across the entire watershed is needed for holistic restoration. UNT Conoy A should first focus on preservation. Most of the tributaries are already forested and there are only a few farms in the subwatershed. Central, South, and East Etown are primarily developed and both contribute less sediment and their conservation focus should be on stormwater management. Bainbridge experiences a mix of the two groups: it has some urban area but many portions of the stream segments are forested, presenting fewer opportunities.

UNT Conoy A and South Etown are in Elizabethtown Borough and West Donegal Township. Central and East Etown are in Elizabethtown Borough and Mount Joy Township. Bainbridge Mouth consists of Conoy Township.

Table 20. Existing sediment loading rates for each Priority 3 subwatershed, based on current BMPs already implemented.

Subbasin	Area, mi^2	Loading Rate (lbs/(ac*yr)	Total Load, lbs	Goal Loading Rate (lbs/(ac*yr)
UNT Conoy A	956.94	137.72	131,790.33	137.72 (maintain)
Central Etown	1,036.7	287.31	297,855.24	190.96
East Etown	906.77	404.07	366,399.12	301.05
South Etown	956.41	367.81	351,776.32	300.98
Bainbridge Mouth	1,066.93	923.35	985,147.39	608.81

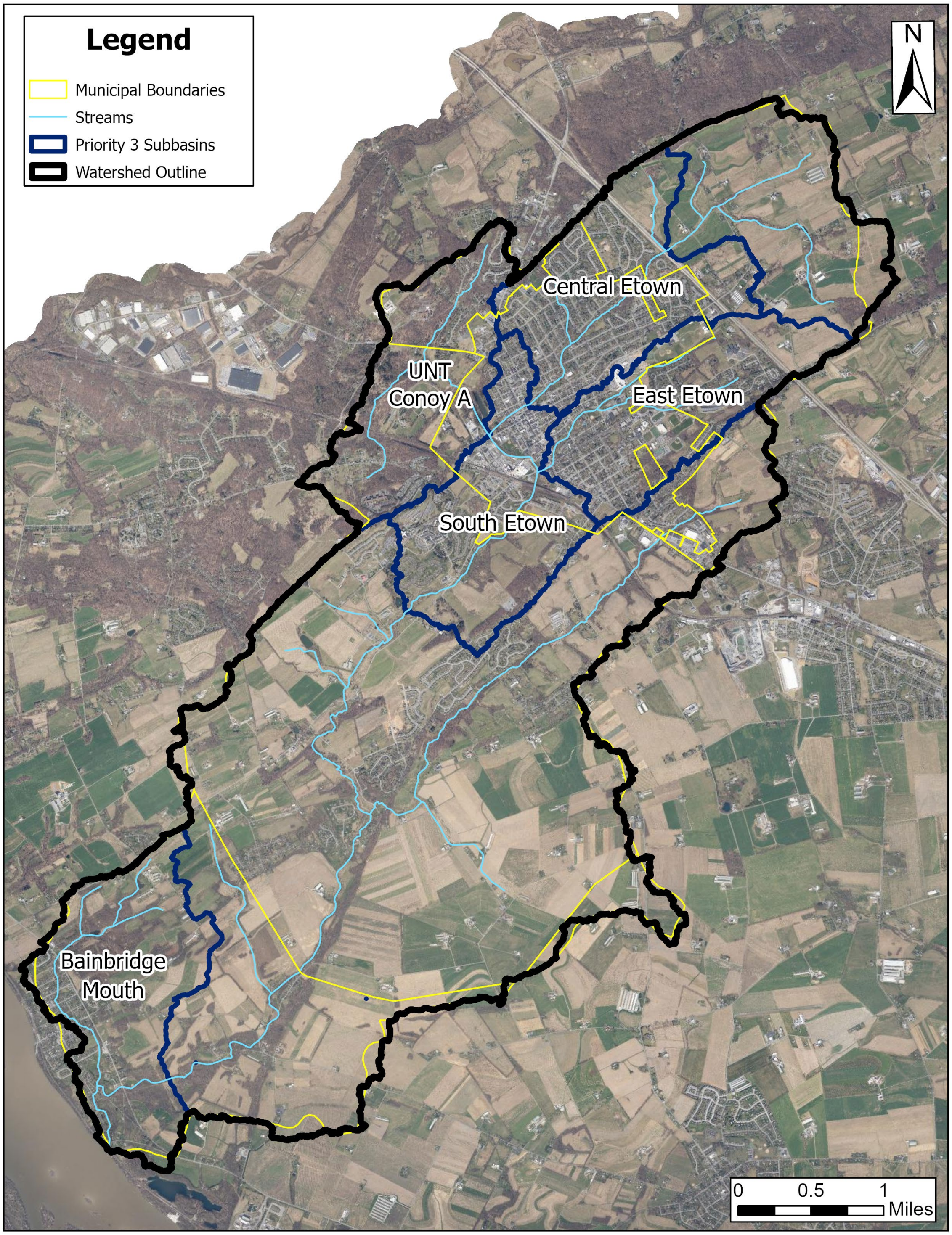


Figure 19. Priority 3 subwatersheds, including Central Etown, South Etown, East Etown, UNT Conoy A, and Bainbridge Mouth. The plan aims to complete 5% of sediment reductions in these five priority watersheds, aiming for 10% of sediment reduction.

Table 21. Existing BMPs implemented in Priority 3 Subwatersheds. Note that the vegetated buffer strips are assuming 35' in this scenario, and their reduction is over-inflated in Model My Watershed. Also note that this is based on recorded BMPs, and actual implementation may be higher or lower than recorded.

Subbasin	Cover Crop (ac)	No Till (ac)	Mulch Till (ac)	Nutrient Management (ac)	Livestock Waste (AEUS)	Vegetated Buffer Strips (miles)	Streambank Stabilization (miles)
UNT Conoy A	28	28	0	47	0	0.38	0
Central Etown	4	35	0	107	0	0.36	0.69
South Etown	4	4	0	65	0	0.31	0.24
East Etown	0	18	0	113	0	0.36	0
Bainbridge Mouth	0	0	0	352	458	0.54	0

Note: No BMPs were proposed for UNT Conoy A so the goal for the subwatershed is maintenance. Macroinvertebrate scores were very high there so the few farms there should be visited and checked with to ensure they are following their required conservation and nutrient management plans. If macroinvertebrate scores don't increase here over time, the subwatershed should be re-evaluated to see if additional work is needed for ecological uplift.

Table 22. Proposed BMPs in Central Etown. The focus of all Etown subwatersheds is a small increase in agriculture BMPs while focusing on supplementing stream restoration and riparian buffers in addition to previous restoration work. Under this scenario, annual sediment loads will reduce by 99,886 lbs.

Metric	Cover Crop (ac)	No Till (ac)	Nutrient Management (ac)	Vegetated Buffer Strips (miles)	Livestock Fencing (miles)	Streambank Stabilization (miles)
Acreage	36	36	107	0.3	N/A	0.3
Implementation Rate (of total stream length or field area)	30%	30%	No change	11%	N/A	11%

Table 23. Proposed BMPs in East Etown. BMP implementation is very similar to Central Etown, focusing on stream restoration and riparian buffers when possible and increasing agriculture

BMP implementation on a farm or two. Under this scenario, annual sediment loads will reduce by 93,416 lbs.

Metric	Cover Crop (ac)	No Till (ac)	Nutrient Management (ac)	Vegetated Buffer Strips (miles)	Livestock Fencing (miles)	Streambank Stabilization (miles)
Acreage	33	33	113	0.2	N/A	0.2
Implementation Rate (of total stream length or field area)	30%	30%	No change	7%	N/A	7%

Table 24. Proposed BMPs in South Etown. BMPs were focused on implementing remaining agriculture BMPs in the watershed while supplementing riparian buffers and targeting a few areas. Under this scenario, annual sediment loads will reduce by 63,917 lbs.

Metric	Cover Crop (ac)	No Till (ac)	Nutrient Management (ac)	Vegetated Buffer Strips (miles)	Livestock Fencing (miles)	Streambank Stabilization (miles)
Acreage	39	29	65	0.46	N/A	0.23
Implementation Rate (of total stream length or field area)	40%	30%	No change	20%	N/A	10%

Table 25. Proposed BMPs in Bainbridge Mouth. Here, the focus is increasing agriculture BMP implementation in the upper part of the watershed and focusing on stream BMPs in Bainbridge where the stream isn’t forested. Under this scenario, annual sediment loads will reduce by 1,180,487 lbs.

Metric	Cover Crop (ac)	No Till (ac)	Nutrient Management (ac)	Vegetated Buffer Strips (miles)	Livestock Fencing (miles)	Streambank Stabilization (miles)
Acreage	157	118	352	0.5	N/A	0.25
Implementation Rate (of total stream length or field area)	40%	30%	No change	15%	N/A	8%

With all BMPs implemented at the proposed rate, suspended sediment in the Priority 3 subwatersheds will decrease from 2,001,178.08 lbs to 1,408,368.05 lbs. That will achieve a 10% reduction of 592,810.02 lbs annually. This plan aims for above 100%, recognizing climate change, and the margin of error on this model.

Other Considerations & Recommendations:

1. Groundwater Recharge

Groundwater recharge is becoming an increasing issue and many BMPs address both water quality, while improving filtration for aquifers. All the urban subwatersheds Central Etown, South Etown, East Etown, and Bainbridge Mouth were ranked low for groundwater recharge potential, according to SRBC's model. Instead, practices on farms on UNT Conoy A and in the agriculture sections of South Etown and Bainbridge will help replenish groundwater for communities in these two towns. Practices such as cover crops and no tillage can help improve infiltration for local groundwater.

2. Urban & Stormwater BMPs

Small sections of agriculture in UNT Conoy A, South Etown, and Bainbrdige Mouth can better manage stormwater through roof runoff structures and basins when applicable for new construction. Elizabethtown and Bainbridge are absolutely key for stormwater improvements. Stream restoration projects that provide infiltration and reduce volume through practices such as floodplain restoration are key. Rain gardens/bioswales, stormwater basin retrofits, porous pavement, and meadow plantings are great tools for municipalities and organizations. Residents can convert their lawn to a meadow and focus on stormwater management through rain barrels. These BMPS will increase infiltration for groundwater recharge while reducing flooding events that damage infrastructure in addition to degrading water quality.

3. Future Stream Restoration Projects

All four subwatersheds present opportunities for stream restoration projects to restore key aquatic habitat conditions, except UNT Conoy A which aims to preserve existing conditions Optimal restoration projects are: unforested with minimal aquatic and terrestrial habitat, at least 1000' in length, and part of a conservation network of BMPs both upslope and upstream, among other considerations.

Central Etown

Note: North of Etown and South of Rt 283 at 40.16552723744985, -76.59023669570264 was already restored, totaling 1,100’ and at Elizabethtown Borough at 40.162608399277445, -76.59429487793805, totaling 2,550’

A. South of N Lime St., connecting existing restoration projects, to N. Cherry Ave
B. South of Masonic Dr, paralleling homes.

East Etown

A. Elizabethtown Borough Playground
B. Elizabethtown College campus should be visited, however restoration may not be needed given extensive riparian buffers

South Etown potential locations:

Note: Masonic Village at 40.13389502957038, -76.61992603737306, was already restored, totaling 1,250'.

A. Stretch paralleling W. Bainbridge St, critically close to homes
B. South of Masonic Dr, paralleling homes.

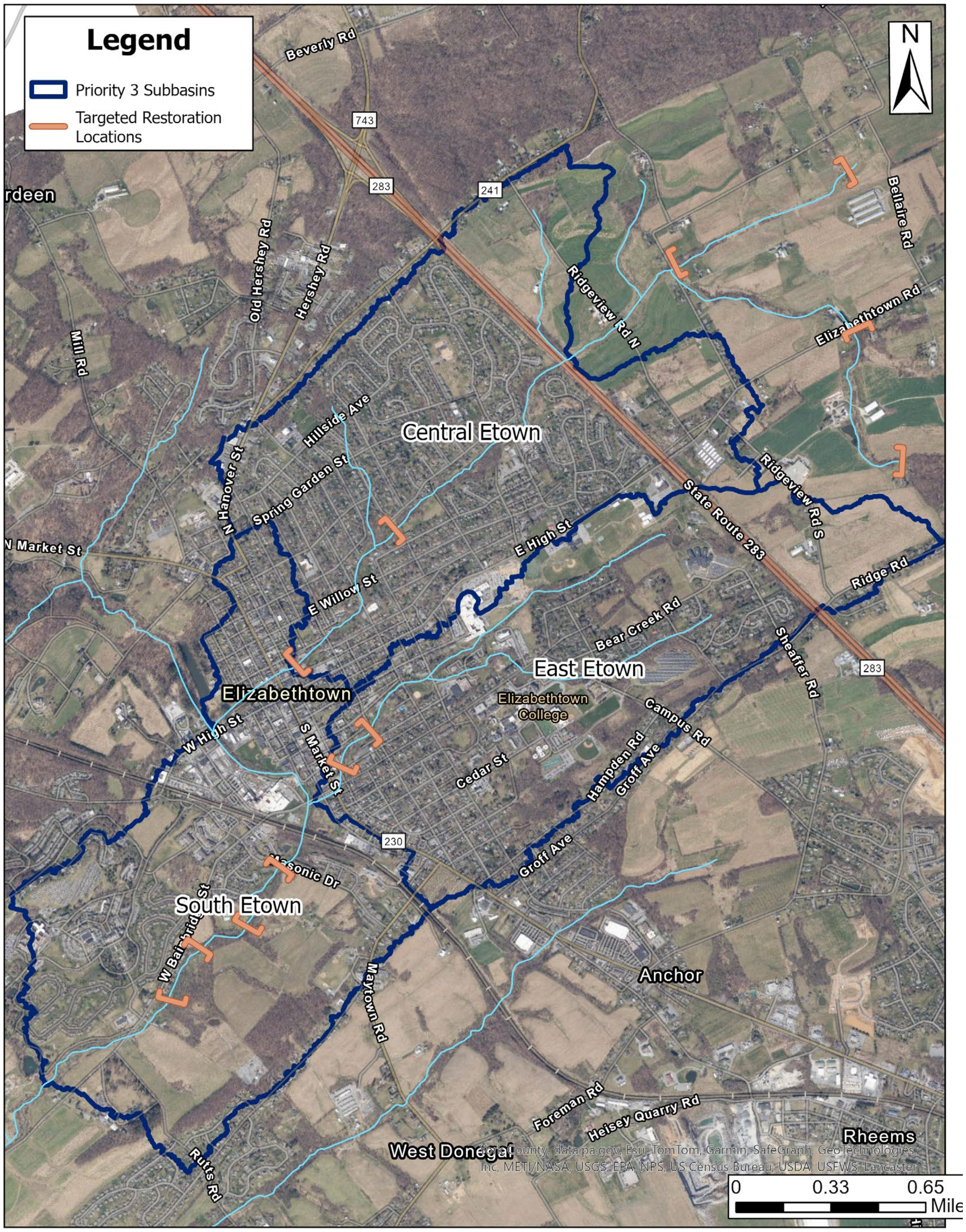


Figure 20. Potential restoration sites in East Etown, Central Etown, and South Etown.

Bainbridge Mouth potential location:

A. Bainbridge town, north of Market St. and south of River Rd

Figure 21. Potential restoration sites in Bainbridge Mouth.

Considerations for all subwatersheds:

1. Dirt & Gravel/Low Volume Roads

Farm lanes, dirt and gravel or unpaved roads are also a major source of sediment. Municipalities can use the Dirt & Gravel/Low Volume Roads funds for practices that repair roads that cause sediment pollution to streams. These include practices such as underground pipes to redirect water, streambank stabilization next to roads, and infiltration trenches.

2. Native Plants

Native plants are essential to restore aquatic and terrestrial habitat, while also reducing suspended sediment. Practitioners can work with Penn State Extension locally, Lancaster Conservancy's Habitat Advocacy Program, and state agencies such as the Department of Conservation of Natural Resources for more information.

3. Nutrient Management

Nutrient management plans were generally available for all farms in Priority 1 Subwatersheds. However, farmers should still be revisited at least every three to five years to discuss how crop and manure management has changed, optimizing nutrient management BMPs. Ecological uplift of local streams will not be possible if excess nitrogen and phosphorus are entering local creeks.

B. Timelines & Milestones

In watershed plans, patience is key. While funders and government officials expect quick results, ecological uplift and stream attaining takes many years. However, BMPs implemented and IBI score increases are a sign of improvement. The table below describes timelines and a schedule of implementation that could restore the watershed given a realistic timeline reflecting funding availability and current science. Other key milestones to attain are more residents reached and engaging in volunteer opportunities, increased education events such as Water Week, and voting for clean water legislation in their community.

To monitor these changes, macroinvertebrates should be formally collected every 5 years to obtain IBI scores. Chemistry samples and habitat samples should be taken simultaneously to corroborate data. Agencies such as SRBC, LCCD, PSUAEC, and DEP are all qualified as of this plan's writing to obtain these data and submit for stream reassessment.

Table 26. Summary of milestones for all three priority areas in the Conoy Creek watershed.

Milestone	10 years	20 years	30 years
Best Management Practice Implementation	50% of Priority 1 30% of Priority 2 20% of Priority 3	50% of Priority 1 30% of Priority 2 20% of Priority 3	40% of Priority 2 60% of Priority 3
IBI scores	Reach 30 IBI Score	Reach 40 IBI score	Reach 50 IBI score
Sediment Pollution Reduction Reached (lbs)	2,689,372.48	2,689,372.48	1,587,910.8

Table 27. Summary of BMP implementation schedule for Priority 1 Subwatersheds.

Best Management Practice	10 years	20 years	30 years
Cover Crop (ac)	832.5	823.5	N/A
No Tillage (ac)	725	725	N/A
Nutrient Management (ac)	923.5	923.5	N/A
Vegetated Buffer Strips (miles)	1	1	N/A
Streambank Fencing (miles)	0.61	0.61	NA
Streambank Stabilization (miles)	0.43	0.43	N/A

Table 28. Summary of BMP implementation schedule for Priority 2 Subwatersheds.

Best Management Practice	10 years	20 years	30 years
Cover Crop (ac)	437.7	437.7	583.6
No Tillage (ac)	291.9	291.9	389.2
Nutrient Management (ac)	No change	No change	No change
Vegetated Buffer Strips (miles)	0.84	0.84	1.11
Streambank Fencing (miles)	0.45	0.45	0.6
Streambank Stabilization (miles)	0.29	0.29	0.39

Table 29. Summary of BMP implementation schedule for Priority 3 Subwatersheds.

Best Management Practice	10 years	20 years	30 years
Cover Crop (ac)	53	53	159
No Tillage (ac)	36	36	108
Nutrient Management (ac)	No change	No change	No change
Vegetated Buffer Strips (miles)	0.29	0.29	0.88
Streambank Fencing (miles)	N/A	N/A	NA
Streambank Stabilization (miles)	0.2	0.2	0.59

C. Cost and Funding

The total cost to implement all conservation practices to meet the sediment reduction goal ranges from $2,221,032 to $15,738,478. Costs were determined using the Chesapeake Assessment Scenario Tool (CAST) and the Natural Resource Conservation Service's Payment Schedule.

Table 30. Cost to implement BMPs addressed in the plan in Priority 1 subwatersheds.

Best Management Practice	Implementation Amount	Price range, per unit	Total Cost
Cover Crop (ac)	1665	$79.27 to $88.31	$131,984.55 to $147,036.15
No Tillage (ac)	1450	$27.01	$39,164.50
Nutrient Management (ac)	1847	$6,864.25/plan	$137,285 (assuming 20 farms)
Vegetated Buffer Strips (acres)	16.96	$3,200/ac	$54,272.00
Streambank Fencing (ft)	6441.6	$6-$12/ft	$38,649.6 to $77,299.20
Streambank Stabilization (ft)	4540.8	$100/ft - $1,000/ft	$454,080 to $4,540,800
		Total Cost	$855,435.65 to $4,995,856.85

Table 31. Cost to implement BMPs addressed in the plan in Priority 2 subwatersheds.

Best Management Practice	Implementation Amount	Price range, per unit	Total Cost
Cover Crop (ac)	1,459	$79.27 to $88.31	$115,654.93 to $128,844.29
No Tillage (ac)	973	$27.01	$26,280.73
Nutrient Management (ac)	No change	N/A	N/A
Vegetated Buffer Strips (acres)	23.67	$3,200/ac	$75,752.73
Streambank Fencing (ft)	7,920	$6-$12/ft	$47,520 to $95,040
Streambank Stabilization (ft)	5,121	$100/ft - $1,000/ft	$512,160 to $5,121,500
		Total Cost	$777,368.39 to $5,447,517.75

Table 32. Cost to implement BMPs addressed in the plan in Priority 3 subwatersheds.

Best Management Practice	Implementation Amount	Price range, per unit	Total Cost
Cover Crop (ac)	265	$79.27 to $88.31	$21,006.55 to $23,402.15
No Tillage (ac)	180	$27.01	$4,861.80
Nutrient Management (ac)	No change	N/A	N/A
Vegetated Buffer Strips (acres)	12.39	$3,200/ac	$39,641.21
Streambank Fencing (ft)	N/A	N/A	N/A
Streambank Stabilization (ft)	5,227.2	$100/ft - $1,000/ft	$522,720 to $5,227,200
		Total Cost	$588,229.56 to $5,295,105.16

Table 33. Secondary BMPs that will also help achieve sediment reduction goals, but weren't a part of the model. An extensive list of practices can be found at the NRCS Field Office Technical Guide.

Best Management Practice	Cost per unit
Bioswale	$2,322.72
Wetland Restoration – Floodplain	$193.09/ac
Wetland Creation – Floodplain	$442.59/ac
Permeable Pavement	$3,200/ac
Waste Storage Facility (Manure Storage)	$0.52/ft3
Contour Farming	$11.62/ac
Diversion	$5.89/ft
Grassed Waterway	$6,530.53/ac
Roof Runoff Structure (gutters, pipes, downspouts, etc.)	$12.62/ft
Terrace	$5.91/ft
Stream Crossing	$90.18/ft2

Sampling of grants available to complete the sediment reduction goals:

- Resource Enhancement & Protection (REAP)
- Countywide Action Plan (Lancaster Clean Water Fund)
- Growing Greener

- Oak Hill Foundation
- National Fish and Wildlife Foundation: Small Watershed Grant (SWG), Most Effective Basin (MEB), and Innovative Nutrient & Sediment Reduction (INSR)
- Environmental Equality Incentives Program (EQIP), Regional Conservation Partnership Program (RCPP), Conservation Stewardship Program (CSP), and Conservation Reserve Enhancement Program (CREP) through the Natural Resource Conservation Service (NRCS)
- Constellation Habitat Improvement Program (available through the Lancaster County Conservation District and the Pennsylvania Fish & Boat Commission)
- Agriculture Conservation Assistance Program (ACAP, available through the Lancaster County Conservation District)
- Conservation Excellence Grant (CEG, available through the Lancaster County Conservation District)
- PENNVEST (available through the Lancaster County Conservation District or another sponsor)
- Susquehanna River Basin Commission: Small Watershed Enhancement Grant and Consumptive Us Grant
- Eurofins Foundation
- Campbell Foundation
- Foundation for Pennsylvania Watersheds
- Dirt & Gravel/Low Volume Roads Program (DGLVR, available through the Lancaster County Conservation District)
- Lancaster Conservancy, Susquehanna Riverlands Mini-Grant
- Department of Conservation of Natural Resources: Community Conservation Partnerships Program Grants (C2P2)
- Environmental Education Grants through the Pennsylvania Department of Environmental Protection
- Conservation and Manure Management Plan reimbursements, available through the Lancaster County Conservation District
- Flood Mitigation Program, Watershed Restoration and Protection Program (WRPP) and Small Water and Sewer Program (available through the Department of Commerce and Economic Development)
- Multifunctional Buffers, available through the Pennsylvania Association of Conservation Districts
- Pennsylvania Council of Trout Unlimited: Coldwater Conservation Grants

D. Partners

Lancaster County has some of the most engaged partners in the Chesapeake Bay watershed, strategizing restoration and amplifying efforts as a whole. Engaging existing partners and enabling new partnerships are essential strategies to expand restoration efforts.

Table 34. Key partners directly and actively working in the Conoy Creek watershed.

Organization	Category	Role & Resources
Lancaster County Conservation District	Government, Non-profit	• Technical service for landowners for stream and agriculture resource concerns • Grant funding for nonpoint source pollution reduction practices • Engineering, design, and permit assistance for landowners • Regulatory authority for farms and construction sites • Data warehouse of all BMPs in the Conoy Creek watershed • Can provide monitoring assistance to track progress
Penn State Agriculture & Environment Center (PSUAEC)	School Affiliate	• Technical service for landowners for stream and agriculture resource concerns • Grant funding for nonpoint source pollution reduction practices, focusing on "Buffer Bonus" dollars, providing BMP funding if a riparian buffer is planted • Focus watershed for the organization • Can provide monitoring assistance to track progress
West Donegal Township, East Donegal Township, Conoy Township, Elizabethtown Borough, Mount Joy Township	Municipality	• MS4 requirement for pollution reduction practices and education for all townships except Conoy Township • Proactive leaders installing floodplain restoration projects and assisting with education
David/Miller Associates	Consultant	• Stormwater engineer for multiple of the MS4 municipalities in the Conoy Creek watershed, serving as a liaison and designer for restoration work • Organizes all stormwater BMPs
Lancaster Clean Water Partners	Non-profit	• Supports all clean water organizations in Lancaster, providing funding and organizational support

Susquehanna River Basin Commission	Interstate agency	• Can provide monitoring assistance to track progress • Adviser for Conoy Creek restoration
Conoy Creek Conservation Crew	Watershed organization	• Newly forming watershed group, focusing on conservation in the Conoy Creek watershed through education, clean-ups, and restoration
Elizabethtown College	University	• Provides staff support, advisement, and education to local college students • Can also provide student volunteers for events and trainings

While there are key partners working in the Conoy, Lancaster has a network of over 80 partners working throughout the county that can also assist. For example, consultants include ARRO, LandStudies, C.S. Davidson, Mowery Environmental, Red Barn, Rettew, Weaver Environmental, HRG, and many others listed below. There are also key partners that can work at no or reduced costs for landowners such as the Alliance for the Chesapeake Bay, Lancaster Farmland Trust, Stroud Water Research Center, the Nature Conservancy, Chesapeake Bay Foundation, and Interfaith Partners for the Chesapeake, among others.

Table 35. Complete list of active partners in Lancaster county, provided by the Lancaster Clean Water Partners.

Alliance for the Chesapeake Bay	Lancaster Area Sewer Authority
ARRO Consulting, Inc.	Lancaster Chamber
Big Picture Consulting	Lancaster Conservancy
Blackbirds Environmental Justice	Lancaster County Community Foundation
Blue Green Connector	Lancaster County STEM Alliance
Borough of Ephrata	Lancaster Farmland Trust
Bright Side Opportunities Center	Landstudies, Inc.
C.S. Davidson, Inc.	LCSWMA
Center of Watershed Protection	Little Conestoga Watershed Alliance
Chesapeake Bay Foundation	Londonderry Township
Chesapeake Conservancy	Lower Susquehanna Riverkeepers Association
Chesapeake Conservation Landscaping Council	Mayapple Native Landscaping
Chesapeake Legal Alliance	Mount Joy Borough
Chiques Creek Watershed Alliance	Mowery Environmental, LLC
Choose Clean Water Coalition	Octoraro Watershed Association
City of Lancaster	PA DCNR Bureau of Recreation and Conservation
Cocalico Creek Watershed Association	Partners for Environmental Stewardship
College Park Climate Action Neighborhood	Quittapahilla Watershed Association

Conestoga River Club	Quub
Cox Consulting	Red Barn Consulting
Crossroads & Connections	RETTEW Associates
Department of Public Works, City of Lancaster, PA	RGS Associates
Donegal Chapter of Trout Unlimited	RK&K
East Cocalico Township Authority	Salisbury Township
East Lampeter Township	Schuylkill Highlands Conservation Landscape
Economic Development Company of Lancaster County	SoWe
The Edible Classroom	Spanish American Civic Association
Ephrata Concrete Cleaners	The Steinman Foundation
Flyway Excavating	Stroud Water Research Center
Friends of Fishing Creek	Sustainable Chesapeake
Gumption Design Co.	TeamAg, Inc.
Green Fin Studio	The Nature Conservancy PA/DE Chapter
Hazmat 2 Environmental Fire Rescue Company	Theodore Roosevelt Conservation Partnership
Hess Home Builders	Warwick Township
Hourglass	Water Science Institute
HRG	Waterkeepers Chesapeake
Individual	Waxwing Ecoworks Co.
Interfaith Partners for the Chesapeake	Weaver Environmental Consulting
Keystone 10 Million Trees Partnership	

E. Education

Education is the final part of the Conoy Creek watershed Implementation Plan, bringing together all key players: conservation practitioners, landowners that could implement conservation practices, government officials that can leverage funding, and the public. Without buy-in from all parties, the plan cannot be implemented.

First, there are existing education and outreach programs specific to the Conoy that should continue to be implemented. The Conoy Creek Initiative, led by the Penn State Agriculture & Environment Center, brings together all conservation practitioners, organizing conservation work in the watershed and education opportunities. This group should be leveraged and supported to aid watershed restoration efforts. Municipalities are also key for education as required by their MS4 permit. Education is a part of their pollution reduction plans, and any education opportunity in a MS4 municipality (Mount Joy, Elizabethtown, East Donegal, and West Donegal) should be collaborative so the township can get credit while meeting education goals. Last, the Conoy Creek Conservation Crew is a watershed group that is in development. Watershed groups should be fostered to support grassroots conservation, which is key to involve more members of the public. Watershed groups in Lancaster have historically led key restorations, education, and monitoring; which the CCCC can evolve too, as membership grows.

There are also existing countywide efforts that can be leveraged specifically in the Conoy for conservation work. First is Water Week by the Lancaster Conservancy, which has over 70 events during the late spring, bringing together the county for key watershed education and recreation opportunities. It has some of the biggest impact every year and is a great way to engage the public. Volunteers are also a great way to involve the public through programs such as Master Watershed Stewards (MWS) by Penn State, the Water Quality Volunteer Coalition (WQVC) by LCCD, and Riparian Rangers (RR) by Alliance for the Chesapeake Bay. WQVC provides water quality monitoring opportunities, connecting the public with water quality concerns and showing them how water quality improves over time. RR enables volunteers to maintain restoration sites, building investment in the community. MWS teaches the public to be educators and community leaders, often joining groups such as WQVC and RR.

All of these programs thus far focus on adults. Youth education can happen during Water Week and with rising environmental K-12 program because of new Pennsylvania education standards (STEEL). Specific programs for conservation include Envirothon, an international nature test for third graders to seniors, and Lancaster County Youth Conservation School, a weeklong school introducing conservation topics to 14–16-year-olds.

These education opportunities will engage the public in watershed conservation, building stewards that recreate, may convince their neighbor to install a conservation practice, and support legislation that brings more funding. Community buy-in is key to build momentum. Paired with education is specific outreach to implement conservation practices, which will be done by key Conoy Creek partners listed in Table 35 and also all partners a part of the Lancaster Clean Water Partners. Because of Lancaster's focus on collaboration, regular check-ins will happen at full partner meetings, watershed group meetings, the Conoy Creek Initiative meetings, and similar events. Throguh these efforts, we will work together on milestones, reaching goals, and keeping the public informed every step of the way.

Appendix

A. GIS Data Sources

1. Lancaster County GIS Department:
    a. Land use
    b. 2024 Imagery
2. PASDA:

a. HUC12: https://www.pasda.psu.edu/uci/DataSummary.aspx?dataset=2099

b. County Boundaries: https://www.pasda.psu.edu/uci/DataSummary.aspx?dataset=1260

c. Integrated List Attaining Streams: https://www.pasda.psu.edu/uci/DataSummary.aspx?dataset=887

d. Integrated List Non-Attaining Streams: https://www.pasda.psu.edu/uci/DataSummary.aspx?dataset=888

e. NHD Flowline Susquehanna: https://www.pasda.psu.edu/uci/DataSummary.aspx?dataset=758

f. DEM Data – Conoy Watershed (PAMAP_2008_South_tiles): https://www.pasda.psu.edu/uci/DataSummary.aspx?dataset=1247

g. Streams: https://www.pasda.psu.edu/uci/DataSummary.aspx?dataset=1263

h. Soils: https://www.pasda.psu.edu/uci/DataSummary.aspx?dataset=184

i. Municipalities: https://www.pasda.psu.edu/uci/DataSummary.aspx?dataset=41

3. Lancaster County Conservation District

   a. BMP Data Implemented, from PracticeKeeper system

4. USDA NRCS, Hydrologic Soil Groups: https://www.arcgis.com/home/item.html?id=be2124509b064754875b8f0d6176cc4c

B. Model My Watershed Data Inputs

Table 36. Land use inputs for the first six subwatersheds for Model My Watershed.

Land Use	Headwaters 1	Central Etown	East Etown	UNT Conoy A	South Etown	Conoy Mainstem A
Pasture	139.91	36.45	3.81	44.01	76.12	266.62
Cropland	648.25	121.85	112.52	47.26	97.08	490.80
Forest	51.39	34.42	79.56	370.64	104.53	44.44
Wetland	0.69	0.32	1.27	2.73	2.93	0.64
Open	3.89	0.02	4.96	6.86	5.18	11.15
Barren Land	2.66	0.00	6.93	4.70	6.43	12.30
Low Density Mixed	52.54	123.54	268.10	144.95	284.31	115.12

Medium Density Mixed	16.26	578.77	287.68	93.28	210.69	44.47
High Density Mixed	0.00	47.64	24.64	60.39	51.16	0.00
Low Density Open	65.55	93.83	115.80	176.58	118.08	73.60

Table 37. Land use inputs for the last six subwatersheds for Model My Watershed, using County GIS data.

Land Use	Headwaters 2	UNT Conoy B	Conoy Confluence	Conoy Mainstem B	Conoy Mainstem C	Bainbridge Mouth
Pasture	14.91	91.62	158.73	55.84	79.76	58.53
Cropland	482.13	944.58	416.27	600.81	928.85	394.31
Forest	97.43	17.57	100.85	50.10	157.01	244.26
Wetland	0.09	0.00	5.75	0.00	0.00	1.04
Open	0.72	0.24	5.30	3.68	6.36	10.54
Barren Land	0.65	0.00	26.75	0.86	0.00	1.44
Low Density Mixed	107.36	55.26	27.85	28.57	44.04	55.09
Medium Density Mixed	165.56	20.78	172.26	71.38	58.48	134.17
High Density Mixed	3.93	0.00	1.80	0.00	0.00	0.00
Low Density Open	97.05	38.47	98.24	66.47	48.95	166.51

Table 38. Animals in each subwatershed, based on Practice Keeper data, for Model My Watershed.

Subbasin	Dairy Cows	Beef Cows	Broilers	Layers	Hog	Sheep	Horses	Turkeys
Headwaters 1	595	-	141,940	-	12,600	-	6	-
Central Etown	54	-	-	-	200	-	-	-
East Etown	303	-	26,000	-	2,200	8	-	-
UNT Conoy A	2	-	-	-	1	2	31	-
South Etown	-	-	-	-	-	-	-	-

Conoy Mainstem A	515	673	16,333	-	2,000	-	10	-
Headwaters 2	440	-	-	-	7,200	-	3	-
UNT Conoy B	460	343	87,333	-	5,240	3	-	-
Confluence	-	-	-	-	-	-	-	-
Conoy Mainstem B	180	318	20,000	-	1,650	-	-	-
Conoy Mainstem C	360	97	50,000	30,117	1,665	5	-	-
Bainbridge Mouth	-	372	27	4	2,200	-	7	-
Sum	2,909	1,802	341,634	30,121	34,956	18	57	-