

Little Mahanoy Creek Headwaters Watershed Restoration Plan

**Borough of Frackville, West Mahanoy, Butler and New Castle Townships
Mahanoy Watershed, Schuylkill County, Pennsylvania**

November 2, 2022



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Kora S. Clauser

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1.0 INTRODUCTION

Little Mahanoy Creek in Schuylkill County, Pennsylvania presents an opportunity to address impairment at the source and improve downstream water quality. The headwaters of Little Mahanoy Creek are highly developed and listed as impaired due to urban runoff and sewer drainage, but the downstream areas of the Little Mahanoy Creek Watershed are unimpaired. Downstream sections even support the natural reproduction of trout. By acting now to restore the headwaters of Little Mahanoy Creek, the downstream areas will be protected against impairment into the future. Communities spanning from Frackville to the Borough of Gordon may reap the benefits of the improved water quality and increased resiliency of the native trout fishery.

Little Mahanoy Creek is a tributary to Mahanoy Creek, which flows into the Susquehanna River. From its origin in Frackville, Little Mahanoy Creek flows through the steep valley between the Broad Mountain and Ashland Mountain. The creek has one named tributary, Rattling Run, which it picks up before terminating in Gordon.

Little Mahanoy Creek is noted as being one of only two tributaries to Mahanoy Creek that is not impacted by acid mine drainage. Despite the lack of impairment from mine drainage, the headwaters of Little Mahanoy Creek are impaired for aquatic life. The causes of this impairment include urban runoff and storm sewer drainage from the town of Frackville. Little Mahanoy Creek flows 7.5 miles from its headwaters in the Borough of Frackville to its confluence with Mahanoy Creek near the town of Gordon. Mahanoy Creek is considered an impaired stream as it is listed by the Pennsylvania Department of Environmental Protection (DEP) on its Integrated Water Quality Monitoring Assessment Report (303(d) list) of impaired stream reaches (DEP 2018). Little Mahanoy Creek is included in the TMDL for Mahanoy Creek. The TMDL cites three main pollutants to Mahanoy Creek Watershed. These pollutants are acid mine drainage, agriculture, and raw sewage (DEP). Documentation of the impairment of Little Mahanoy Creek dates to 1913, when pollutants to Little Mahanoy Creek were documented in the sixth annual report of the Pennsylvania Commissioner of Health. Little Mahanoy Creek has a Pennsylvania Code, Title 25, Chapter 93 water quality designation of Cold-Water Fishery/Migratory Fishery (CWF/MF).

In recent years, many residents within the Borough of Frackville have experienced flooding and streambank erosion. As residents struggling with issues along the Little Mahanoy Creek began to contact the Schuylkill Conservation District for assistance, the importance of prioritizing projects that would help to protect residents of Frackville, an environmental justice community, from damages and dangers related to flooding became apparent. In areas of the Borough of Frackville identified as an environmental justice community, 20-43% of the population lives below the poverty line. Families living below the poverty line in this community lack the resources to deal with flooding and streambank issues. There has been a strong push from residents and the Frackville Borough Council to design and implement projects that will help with the restoration and resiliency of Little Mahanoy Creek. Here, we identify and prioritize the transformative projects necessary to restore the headwaters of the Little Mahanoy Creek Watershed. The resulting implementation projects will have lasting benefits within the Little Mahanoy

Creek Watershed and downstream throughout the Mahanoy Creek, Susquehanna River, and ultimately Chesapeake Bay.

Here, a restoration plan for the Little Mahanoy Creek Headwaters is presented to address specific areas of impairment. In the spring and summer of 2022, Schuylkill Conservation District worked with Clauser Environmental, LLC to assess the sources of impairment and potential restoration projects within the watershed that are outlined here. Best Management Practices (BMPs) that are suggested for installation within the watershed include floodplain restoration, streambank stabilization, and riparian buffer enhancement. As the solutions outlined within this restoration plan are implemented, substantial progress will be made in restoring this portion of the Chesapeake Bay Watershed. This restoration plan addresses stormwater discharges at the source as well as urban planning opportunities. Water quality, instream habitats, and riparian zone integrity will improve because of this restoration. By holistically approaching the restoration of the headwaters of Little Mahanoy Creek, the stream will be improved and protected for the safety and enjoyment of this and future generations.

2.0 METHODOLOGY

To determine the areas within the headwaters of Little Mahanoy Creek Watershed in need of the most attention, Wayne Lehman, Allison Butler, and Will Koch of Schuylkill Conservation District joined Kora Clauser and Aaron S. Clauser, Ph.D. of Clauser Environmental, LLC to conduct a stream walk on June 29, 2022. The entire mainstem of Little Mahanoy Creek within the study area was walked. Photographs, field notes, and GPS coordinates were collected at areas identified as points of interest. Additionally, impacted areas were identified by conducting windshield surveys from roadways and reviewing aerial photography provided by the Schuylkill County GIS Department. Sources of impairment were identified at the parcel level.

Clauser Environmental, LLC located the points of interest within the watershed using a Trimble Geo7X Global Positioning System (GPS) receiver with H-Star and Floodlight enabled decimeter accuracy configuration during the site visit. The instrument smart settings were used per manufacturer's recommendation. Logging interval was set at 1 second with typically a minimum of 30 readings collected at each point. Data collected in the field was downloaded to a personal computer for differential correction using GPS Pathfinder Office software (Version 5.6). Correction files were obtained from dedicated base stations located in Schuylkill Haven, Bethlehem, Stroudsburg, Wilkes-Barre and Coatesville, Pennsylvania. Mission planning, parameter settings, and post processing typically allow an accuracy of 10 centimeters (Trimble Navigation 2014). The precision of GPS collected data is subject to variation caused by canopy cover, atmospheric interference, time of day, and satellite geometry.

For sub-watershed analysis, the headwaters of Little Mahanoy Creek Watershed was divided into 2 sub-watersheds (Appendix A). For each sub-watershed, land use was analyzed through the use of USGS Streamstats version 4.3.11 (Appendix C). To provide greater depth in understanding of the potential impacts of the impervious cover within

each sub-watershed, stormwater best management practices (BMPs) were identified. By combining a review of high-resolution aerial photography and ground-truthing, structural stormwater BMPs were identified and included in watershed mapping (Appendix A). In order to gain a greater understanding of historical land use, aerial photographs from 1938, 1947, and 1971 were compiled, geo-referenced, plotted, and reviewed (Appendix B).

3.0 WATERSHED PROBLEMS AND SOLUTIONS

3.1 *Sub-watershed Analysis Results*

The Little Mahanoy Creek Watershed is a mix of developed and forested areas. Currently, the watershed is approximately 71.5% forested (Table 1). The areas that are not forested are comprised of developed areas, valleys, and open fields. The upper portion of Little Mahanoy Creek Watershed has the highest percentage of urban cover with 56.8% of the land covered with developed areas and impervious surfaces and only 39.0% that portion of the watershed forested. The upper portion sub-watershed is the part of the watershed located upstream of the Frackville Area Wastewater Treatment Facility, with the town of Frackville composing the majority of this sub-watershed. The lower portion sub-watershed includes all of the overall watershed downstream of the Frackville Area Wastewater Treatment Facility. This section of the watershed has low impervious cover and is substantially more forested than the upstream area. Approximately 88.7% of the lower portion of the watershed is forested, and a mere 2.5% is developed.

Table 1
Little Mahanoy Creek Watershed
Percentage Forest and Urban Cover Data

Sub-watershed	Approx. Total Square Miles	Approx. Forest Percent	Approx. Urban Percent
Upper Portion	1.35	39.0	56.8
Lower Portion	2.56	88.7	2.5
Total	3.91	71.5	21.2

The next section focuses on the sources and causes of impairment within the Little Mahanoy Creek Watershed and potential restoration practices that can be completed to address the noted impacts for high and medium priority areas. Low priority restoration projects are included in Appendix D. Each impacted segment identification number can be cross-referenced with its approximate location on the map in Appendix A.

3.2 High Priority Projects

Impacted Stream Segment #1:

The area is overrun with invasive species including Japanese barberry (*Berberis thunbergii*), multiflora rose (*Rosa multiflora*), Japanese knotweed (*Reynoutria japonica*), garlic mustard (*Alliaria petiolata*) and packing grass (*Microstegium vimineum*). Mile-a-minute (*Persicaria perfoliata*) is an additional invasive species that is becoming established in the downstream portion of the study area. Invasive species dominate throughout the watershed. This high priority project applies to not only this area, but the entire watershed.



Solution:

Restoration of the watershed should include the removal of invasive species. For each area where the invasives are removed, the need for planting of native species as replacements should be considered. Typically, removal of the invasive species within this watershed will include selective herbicide application on multiple occasions. Within the watershed as a whole, restoration projects should include a longterm maintenance plan that includes managing invasive species with an integrated pest management plan approach.

Impacted Stream Segment #1-3:

The headwaters of the Little Mahanoy consists of several intermittent channels located downstream of a recently reclaimed coal spoil pile. The stream enters into a stream enclosure taking the water under the road downstream of this segment. Within this stream segment, the stream channel is 2-4' deep and is actively eroding coal silt soils.



Solution:

A stormwater bioretention area with constructed wetlands should be considered for the restoration of this area. Installation of the wetlands will require excavation and removal of the waste coal soils that are in this area. The hydrology from the intermittent stream channels should aid in the creation of sustainable wetland systems. In areas where the streams are not incorporated into the wetland cells, the streambanks should be graded to stable slopes. The constructed wetlands and restored streambanks should be replanted with native species.

Impacted Stream Segment #7-11:

This stream segment includes a failed stream enclosure. The stream enclosure, originally consisting of an underground pipe, requires removal. In the upstream portion of this stream segment, the channel is eroded. The stream flows under a road through a double culvert pipe, which is now partially blocked. Downstream of the stream enclosure, the banks are 3-4' high and actively eroding.



Solution:

The restoration of this area includes installation of a stream enclosure by the municipality. The project is funded and was under construction during the streamwalk. The installation of this project



was not included in the preliminary probable cost opinion. The project may serve as matching funds for future projects depending on the funding source. Future improvements to this area could include installation of bioretention areas and stormwater retrofits, such as under pavement inlet filtration and storage systems.

Impacted Stream Segment #22-24:



This stream segment is directly downstream of a Natural Resources Conservation Service (NRCS) riprap project. Banks are heavily eroding and as steep as 6' high in parts of this stream segment. There is a concrete encased abandoned sewer line obstructing the stream in this segment. There is an existing manhole adjacent to the stream, and streambanks are eroded 3-4' high near the obstruction. Several stormwater drainage pipes discharge into this segment of the stream.

Solution:

Restoration of this stream section should target work within the channel to stabilize the actively eroding streambanks. The old sewer line should be removed from the stream channel. Floodplain restoration is required on the northern bank of this section of stream. Downstream, the south side of the stream has a connected floodplain and the streambanks are stable.



3.3 Medium Priority Projects



Impacted Stream Segment #16-17:

Within this stream section, the streambanks are actively eroding. Currently, the streambanks are eroded approximately 4' high. The floodplain is disconnected from this stretch of stream. This section of stream is located between two stream crossings. Within the residential area just downstream, citizens are at an increased risk of flooding due to lack of floodplain connection and wetland areas.

Solution:

Within this portion of the watershed, restoration efforts should target the stabilization of the actively eroding streambanks. Reconnection to the floodplain will mitigate the risk of flooding in this area and downstream. Wetland construction within the restored floodplain will aid in retaining floodwaters, filter pollutants, and improve wildlife habitat. Downstream of this section, the floodplain is connected to the stream and the streambanks are stable.

Impacted Stream Segment #20:

This area consists of a recently constructed stormwater inlet. The upstream end of the inlet (see picture below) is composed of concrete blocks which constrict the channel. The constriction of the channel in the upstream end is problematic because the shape of the inlet makes the structure more prone to blockage by debris during storm events. When the channel is blocked, flooding conditions may be exacerbated and the downstream properties and homes are likely to be flooded.



Solution:

Because of the topographical conditions of the property directly upstream of the stormwater inlet, creation of a constructed wetland upstream would be feasible. The creation of a wetland would work to mitigate flooding downstream, while working with the current confines of the existing stormwater inlet. If the property owner is amenable to the project, a constructed wetland to the east of the stream, just upstream of the reconfigured stormwater inlet could be created.

Impacted Stream Segment #47-50:

Within the upstream portion of this stream segment, the southern banks are actively eroding, and are currently eroded 6-10 feet high. Downstream, the stream channel is incised, and eroded 4-10 ft high upstream of the Malones Road Bridge. Downstream of the bridge, the streambanks are stable.





Solution:

Streambank restoration should be utilized to enhance and protect the stream. The streambanks should be pulled back and stabilized with native vegetation. The use of natural stream design techniques that appropriately incorporate log and rock habitat enhancement structures such as vanes, root wads, j-hooks, and mud sills should be considered.

4.0 RESTORATION IMPLEMENTATION

Restoration of the headwaters of Little Mahanoy Creek Watershed will require a combination of best management practices (BMPs) that are especially tailored to each project area. Appendix F provides information related to the implementation of each of the proposed restoration BMPs. The format is such that each of the individual BMP sheets may be selected as needed for a particular property/project and provided to the individual landowner.

5.0 COST ESTIMATES

As the restoration of the headwaters of Little Mahanoy Creek Watershed moves from the assessment and planning stages into the funding and implementation stages, it is imperative that an understanding of both the benefits and costs of completing each project is held by the partnering agencies and landowners. In the previous sections, the benefits of stream restoration are described. In this section, the design and implementation costs for each high and medium priority restoration project are estimated.

Clauser Environmental, LLC prepared a preliminary construction cost opinion based upon its experience in the field and costs for various best management practices based on recently completed stream and floodplain restoration projects in Eastern Pennsylvania. The estimates should serve as a general order of magnitude guideline for the approximate project costs (Appendix G). For each project, a maximum and minimum estimated cost is presented as a guideline based on design flexibility.

Costs associated with stream restoration are quite variable depending upon the overall restoration goals, landowner objectives, project funding requirements, availability of building materials and rock, site conditions, volunteer hours, level of detail required for survey and design, and permitting costs.

The total estimated cost to implement the high and medium priority projects within the watershed that are not currently in construction is approximately \$1,225,000 to \$2,085,000. These costs include installation of buffer plantings, floodplain reconnection, water obstruction replacement, streambank restoration, invasive species removal, and professional services.

To set each project in motion, the project partners will need to seek out interested landowners and funding opportunities. As many of the identified projects are located on private parcels, landowner support and objectives will need to be at the forefront of every decision during the design, permitting, and construction stages of the projects. After reviewing the project on the ground with the landowner, a more refined cost opinion should be developed and utilized as a guide to seek funding for the project. Important considerations should include access to the project site, locations of resources of special concern (i.e. wetlands, etc.), funding limitations, volunteer matches available, and permitting requirements.

After the project is funded and design and permitting are complete, a set of bid documents should be prepared. The bidding process should be conducted in accordance with accepted practices and at least three bids should be sought. The selection of a contractor should be based upon experience with the type of project being conducted, a check of references, capacity to complete the project within the desired timeline, and cost.

6.0 OBTAINING SUPPORT AND MONITORING PROGRESS

Community outreach and attaining landowner support is often the most challenging step in restoring a watershed. As many of the high and medium priority projects within the Little Mahanoy Creek Watershed are located on private property, developing a positive relationship with landowners is particularly critical. An important next step is to provide a forum to disseminate information to the community. One possible outreach activity is an open forum type presentation at a community center such as the Frackville Borough Hall or Frackville Free Public Library. Another option is a watershed science fair festival modeled after Schuylkill Conservation District's popular Bear Creek Festival where families may attend and not only learn about the restoration plan objectives but become engaged through activities and exhibits targeting the watershed.

Within the headwaters of Little Mahanoy Creek Watershed, many of the landowners have existing relationships with local governments, businesses and conservation organizations. It is essential for Schuylkill Conservation District to nurture and support these relationships as collaborative partners. Some of the key teaming partners for the watershed include:

- The Borough of Frackville, Butler, West Mahanoy, and New Castle Townships (Adoption of protective municipal ordinance language to protect critical watershed resources)
- Schuylkill County Planning & Zoning Commission (Manage development and watershed resources)
- Schuylkill County Conservancy (Land preservation)
- Pennsylvania Department of Environmental Protection (Water quality grant opportunities)
- Pennsylvania Department of Conservation & Natural Resources (Land preservation, resource management and grant opportunities)
- Pennsylvania Fish & Boat Commission (Fisheries protection, resource management, and aquatic habitat improvement)
- Pennsylvania Game Commission (Wildlife protection and habitat improvement)
- Ducks Unlimited (Volunteers and funding assistance)
- Trout Unlimited (Volunteers and funding assistance)
- Local Scout and Civic Groups (Riparian buffer planting volunteers)

The effectiveness of installed restoration projects should be monitored within the watershed. Monitoring will aid in not only understanding what Best Management Practices are having the greatest impact and guiding future projects but will also provide crucial supporting data to demonstrate success and leverage funding of future projects.

With continued progress in the watershed, the water quality of Little Mahanoy Creek will continue to improve.

7.0 LITERATURE CITED

Pennsylvania Department of Environmental Protection (DEP). 2007. *Mahanoy Creek Watershed TMDL: Columbia, Northumberland, and Schuylkill Counties*.

Pennsylvania Department of Health. 1913. *Annual Report of the Commissioner of Health of the Commonwealth of Pennsylvania*. Harrisburg Publishing Company, (etc.). 6th ed.

Trimble Navigation Limited. 2014. *Geo7X Series Operation Manuals*. 935 Stewart Drive, Sunnyvale, California 94085.

APPENDIX A
FIELD INVESTIGATION MAP

Little Mahanoy Creek Headwaters Restoration Plan Map

Legend

- Watershed Boundary
- Little Mahanoy Creek
- Sub-watershed Boundary
- Stormwater Facilities
- Municipal Boundaries
- Parcel Boundaries
- High Priority Stream Segment
- Medium Priority Stream Segment
- Low Priority Stream Segment
- GPS Point
- High Priority Point
- Medium Priority Point
- Low Priority Point



Data Sources:
 Schuylkill County GIS Department
 Clauser Environmental, LLC
 USDA 2017 Aerial Photograph
www.pasda.psu.edu





APPENDIX B
HISTORIC AERIAL PHOTOGRAPHY

Little Mahanoy Creek Headwaters

1938 Aerial Photography

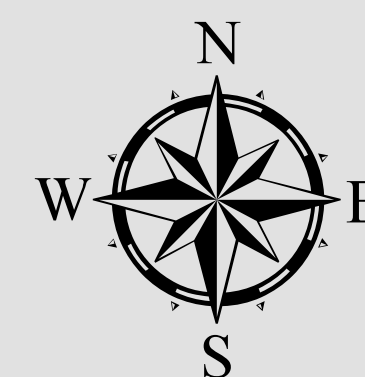
Legend

-  Watershed Boundary
-  Little Mahanoy Creek



Data Sources:
US Agricultural Adjustment Administration
Aerial Photos Taken: November 20, 1938
Schuylkill County GIS Department
Clauser Environmental, LLC
PennPilot



0 1,250 2,500 5,000 Feet



Little Mahanoy Creek Headwaters

1947 Aerial Photography

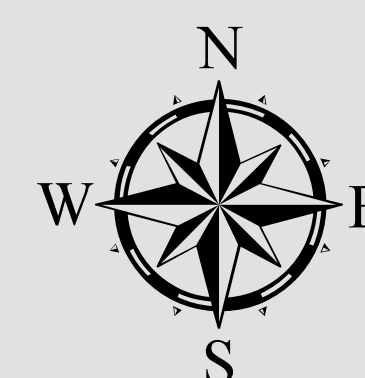
Legend

-  Watershed Boundary
-  Little Mahanoy Creek



Data Sources:
US Agricultural Adjustment Administration
Aerial Photos Taken: September 17, 1947
Schuylkill County GIS Department
Clauser Environmental, LLC
PennPilot



0 1,250 2,500 5,000 Feet

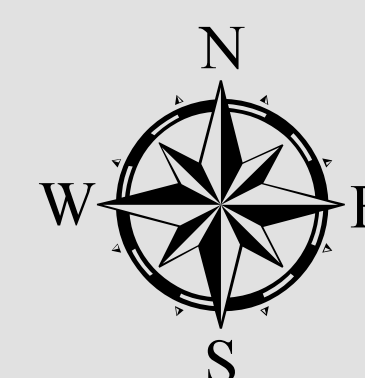


Little Mahanoy Creek Headwaters

1971 Aerial Photography

Legend

-  Watershed Boundary
-  Little Mahanoy Creek



Data Sources:
US Agricultural Adjustment Administration
Aerial Photos Taken: August 12, 1971
Schuylkill County GIS Department
Clauser Environmental, LLC
PennPilot

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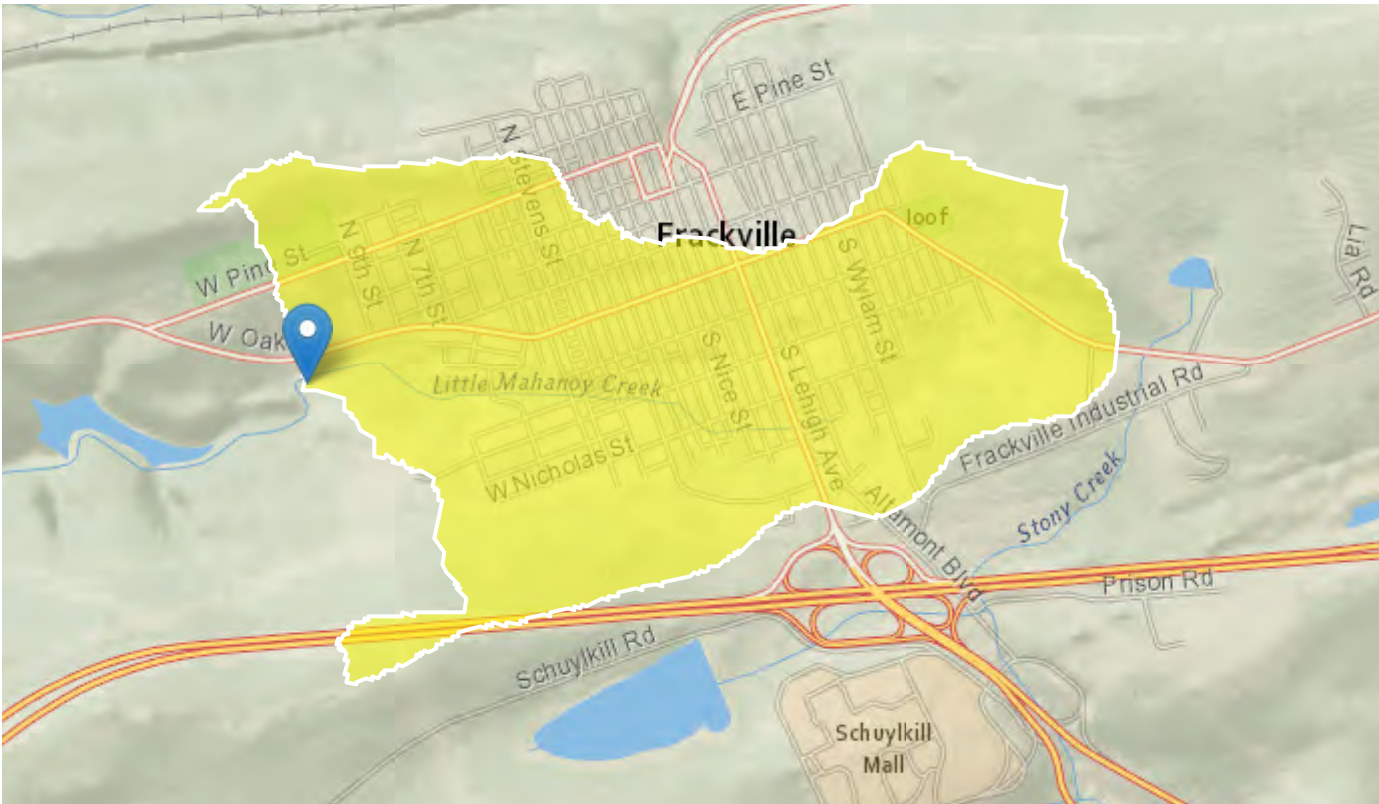


APPENDIX C
STREAMSTATS DATA

Little Mahanoy Creek Headwaters (Upper Sub-Watershed)

StreamStats Report

Region ID: PA
Workspace ID: PA20221027165745246000
Clicked Point (Latitude, Longitude): 40.77992, -76.24889
Time: 2022-10-27 12:58:05 -0400



This report is for the portion of the watershed upstream of the Frackville Area Wastewater Treatment Facility.

[+ Collapse All](#)

Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
BSLOPD	Mean basin slope measured in degrees	5.6099	degrees
BSLOPDRAW	Unadjusted basin slope, in degrees	5.8183	degrees

Parameter Code	Parameter Description	Value	Unit
BSLPDRPA20	Unadjusted basin slope, in degrees, from PA v1	4.8839	degrees
CARBON	Percentage of area of carbonate rock	0	percent
CENTROXA83	X coordinate of the centroid, in NAD_1983_Albers, meters	149071.6097	meters
CENTROYA83	Basin centroid horizontal (y) location in NAD 1983 Albers	199195.7943	meters
DRN	Drainage quality index from STATSGO	3.1	dimensionless
DRNAREA	Area that drains to a point on a stream	1.35	square miles
ELEV	Mean Basin Elevation	1516	feet
ELEVMAX	Maximum basin elevation	1714	feet
FOREST	Percentage of area covered by forest	38.9946	percent
GLACIATED	Percentage of basin area that was historically covered by glaciers	0	percent
IMPNLCD01	Percentage of impervious area determined from NLCD 2001 impervious dataset	21.057	percent
LC01DEV	Percentage of land-use from NLCD 2001 classes 21-24	59.0864	percent
LC11DEV	Percentage of developed (urban) land from NLCD 2011 classes 21-24	60.4608	percent
LC11IMP	Average percentage of impervious area determined from NLCD 2011 impervious dataset	22.0533	percent
LONG_OUT	Longitude of Basin Outlet	-76.248914	degrees
MAXTEMP	Mean annual maximum air temperature over basin area from PRISM 1971-2000 800-m grid	56.3	degrees F
OUTLETXA83	X coordinate of the outlet, in NAD_1983_Albers,meters	147785.7372	meters
OUTLETYA83	Y coordinate of the outlet, in NAD_1983_Albers, meters	199094.6004	meters
PRECIP	Mean Annual Precipitation	49	inches
ROCKDEP	Depth to rock	4.8	feet

Parameter Code	Parameter Description	Value	Unit
STORAGE	Percentage of area of storage (lakes ponds reservoirs wetlands)	0.28	percent
STRDEN	Stream Density -- total length of streams divided by drainage area	1.04	miles per square mile
STRMTOT	total length of all mapped streams (1:24,000-scale) in the basin	1.4	miles
URBAN	Percentage of basin with urban development	56.8736	percent

➤ Peak-Flow Statistics

Peak-Flow Statistics Parameters [Peak Flow Region 3 SIR 2019 5094]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.35	square miles	1.42	1280
CARBON	Percent Carbonate	0	percent	0	100

Peak-Flow Statistics Disclaimers [Peak Flow Region 3 SIR 2019 5094]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors.

Peak-Flow Statistics Flow Report [Peak Flow Region 3 SIR 2019 5094]

Statistic	Value	Unit
50-percent AEP flood	84.7	ft ³ /s
20-percent AEP flood	162	ft ³ /s
10-percent AEP flood	230	ft ³ /s
4-percent AEP flood	335	ft ³ /s
2-percent AEP flood	428	ft ³ /s
1-percent AEP flood	533	ft ³ /s
0.5-percent AEP flood	651	ft ³ /s
0.2-percent AEP flood	833	ft ³ /s

Roland, M.A., and Stuckey, M.H., 2019, Development of regression equations for the estimation of flood flows at ungaged streams in Pennsylvania: U.S. Geological Survey Scientific Investigations Report 2019-5094, 36 p. (<https://doi.org/10.3133/sir20195094>)

➤ Low-Flow Statistics

Low-Flow Statistics Parameters [Low Flow Region 2]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.35	square miles	4.93	1280
PRECIP	Mean Annual Precipitation	49	inches	35	50.4
STRDEN	Stream Density	1.04	miles per square mile	0.51	3.1
ROCKDEP	Depth to Rock	4.8	feet	3.32	5.65
CARBON	Percent Carbonate	0	percent	0	99

Low-Flow Statistics Disclaimers [Low Flow Region 2]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors.

Low-Flow Statistics Flow Report [Low Flow Region 2]

Statistic	Value	Unit
7 Day 2 Year Low Flow	0.406	ft ³ /s
30 Day 2 Year Low Flow	0.525	ft ³ /s
7 Day 10 Year Low Flow	0.193	ft ³ /s
30 Day 10 Year Low Flow	0.245	ft ³ /s
90 Day 10 Year Low Flow	0.364	ft ³ /s

Stuckey, M.H.,2006, Low-flow, base-flow, and mean-flow regression equations for Pennsylvania streams: U.S. Geological Survey Scientific Investigations Report 2006-5130, 84 p. (<http://pubs.usgs.gov/sir/2006/5130/>)

➤ Annual Flow Statistics

Annual Flow Statistics Parameters [Statewide Mean and Base Flow]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.35	square miles	2.26	1720
ELEV	Mean Basin Elevation	1516	feet	130	2700
PRECIP	Mean Annual Precipitation	49	inches	33.1	50.4
FOREST	Percent Forest	38.9946	percent	5.1	100
URBAN	Percent Urban	56.8736	percent	0	89

Annual Flow Statistics Disclaimers [Statewide Mean and Base Flow]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors.

Annual Flow Statistics Flow Report [Statewide Mean and Base Flow]

Statistic	Value	Unit
Mean Annual Flow	3	ft ³ /s

Annual Flow Statistics Citations

Stuckey, M.H.,2006, Low-flow, base-flow, and mean-flow regression equations for Pennsylvania streams: U.S. Geological Survey Scientific Investigations Report 2006-5130, 84 p. (<http://pubs.usgs.gov/sir/2006/5130/>)

➤ General Flow Statistics

General Flow Statistics Parameters [Statewide Mean and Base Flow]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.35	square miles	2.26	1720
PRECIP	Mean Annual Precipitation	49	inches	33.1	50.4
CARBON	Percent Carbonate	0	percent	0	99
FOREST	Percent Forest	38.9946	percent	5.1	100
URBAN	Percent Urban	56.8736	percent	0	89

General Flow Statistics Disclaimers [Statewide Mean and Base Flow]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors.

General Flow Statistics Flow Report [Statewide Mean and Base Flow]

Statistic	Value	Unit
Harmonic Mean Streamflow	0.953	ft ³ /s

General Flow Statistics Citations

Stuckey, M.H., 2006, Low-flow, base-flow, and mean-flow regression equations for Pennsylvania streams: U.S. Geological Survey Scientific Investigations Report 2006-5130, 84 p. (<http://pubs.usgs.gov/sir/2006/5130/>)

➤ Base Flow Statistics

Base Flow Statistics Parameters [Statewide Mean and Base Flow]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.35	square miles	2.26	1720
PRECIP	Mean Annual Precipitation	49	inches	33.1	50.4
CARBON	Percent Carbonate	0	percent	0	99
FOREST	Percent Forest	38.9946	percent	5.1	100

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
URBAN	Percent Urban	56.8736	percent	0	89

Base Flow Statistics Disclaimers [Statewide Mean and Base Flow]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors.

Base Flow Statistics Flow Report [Statewide Mean and Base Flow]

Statistic	Value	Unit
Base Flow 10 Year Recurrence Interval	1.06	ft^3/s
Base Flow 25 Year Recurrence Interval	0.96	ft^3/s
Base Flow 50 Year Recurrence Interval	0.905	ft^3/s

Base Flow Statistics Citations

Stuckey, M.H.,2006, Low-flow, base-flow, and mean-flow regression equations for Pennsylvania streams: U.S. Geological Survey Scientific Investigations Report 2006-5130, 84 p. (<http://pubs.usgs.gov/sir/2006/5130/>)

➤ Bankfull Statistics

Bankfull Statistics Parameters [Statewide Bankfull Noncarbonate 2018 5066]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.35	square miles	2.62	207
CARBON	Percent Carbonate	0	percent		

Bankfull Statistics Parameters [Appalachian Highlands D Bieger 2015]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.35	square miles	0.07722	940.1535

Bankfull Statistics Parameters [Valley and Ridge P Bieger 2015]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
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Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.35	square miles	0.100386	395.999604

Bankfull Statistics Parameters [USA Bieger 2015]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.35	square miles	0.07722	59927.7393

Bankfull Statistics Disclaimers [Statewide Bankfull Noncarbonate 2018 5066]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors.

Bankfull Statistics Flow Report [Statewide Bankfull Noncarbonate 2018 5066]

Statistic	Value	Unit
Bankfull Area	15.7	ft^2
Bankfull Streamflow	60.8	ft^3/s
Bankfull Width	16.4	ft
Bankfull Depth	1	ft

Bankfull Statistics Flow Report [Appalachian Highlands D Bieger 2015]

Statistic	Value	Unit
Bieger_D_channel_width	17.2	ft
Bieger_D_channel_depth	1.22	ft
Bieger_D_channel_cross_sectional_area	21.3	ft^2

Bankfull Statistics Flow Report [Valley and Ridge P Bieger 2015]

Statistic	Value	Unit
Bieger_P_channel_width	15.5	ft
Bieger_P_channel_depth	1.08	ft
Bieger_P_channel_cross_sectional_area	17.9	ft^2

Bankfull Statistics Flow Report [USA Bieger 2015]

Statistic	Value	Unit
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Statistic	Value	Unit
Bieger_USA_channel_width	13.8	ft
Bieger_USA_channel_depth	1.29	ft
Bieger_USA_channel_cross_sectional_area	20.1	ft^2

Bankfull Statistics Flow Report [Area-Averaged]

Statistic	Value	Unit
Bankfull Area	15.7	ft^2
Bankfull Streamflow	60.8	ft^3/s
Bankfull Width	16.4	ft
Bankfull Depth	1	ft
Bieger_D_channel_width	17.2	ft
Bieger_D_channel_depth	1.22	ft
Bieger_D_channel_cross_sectional_area	21.3	ft^2
Bieger_P_channel_width	15.5	ft
Bieger_P_channel_depth	1.08	ft
Bieger_P_channel_cross_sectional_area	17.9	ft^2
Bieger_USA_channel_width	13.8	ft
Bieger_USA_channel_depth	1.29	ft
Bieger_USA_channel_cross_sectional_area	20.1	ft^2

Bankfull Statistics Citations

Clune, J.W., Chaplin, J.J., and White, K.E.,2018, Comparison of regression relations of bankfull discharge and channel geometry for the glaciated and nonglaciated settings of Pennsylvania and southern New York: U.S. Geological Survey Scientific Investigations Report 2018–5066, 20 p. (<https://doi.org/10.3133/sir20185066>)
Bieger, Katrin; Rathjens, Hendrik; Allen, Peter M.; and Arnold, Jeffrey G.,2015, Development and Evaluation of Bankfull Hydraulic Geometry Relationships for the Physiographic Regions of the United States, Publications from USDA-ARS / UNL Faculty, 17p. (https://digitalcommons.unl.edu/usdaarsfacpub/1515?utm_source=digitalcommons.unl.edu%2Fusdaarsfacpub%2F1515&utm_medium=PDF&utm_

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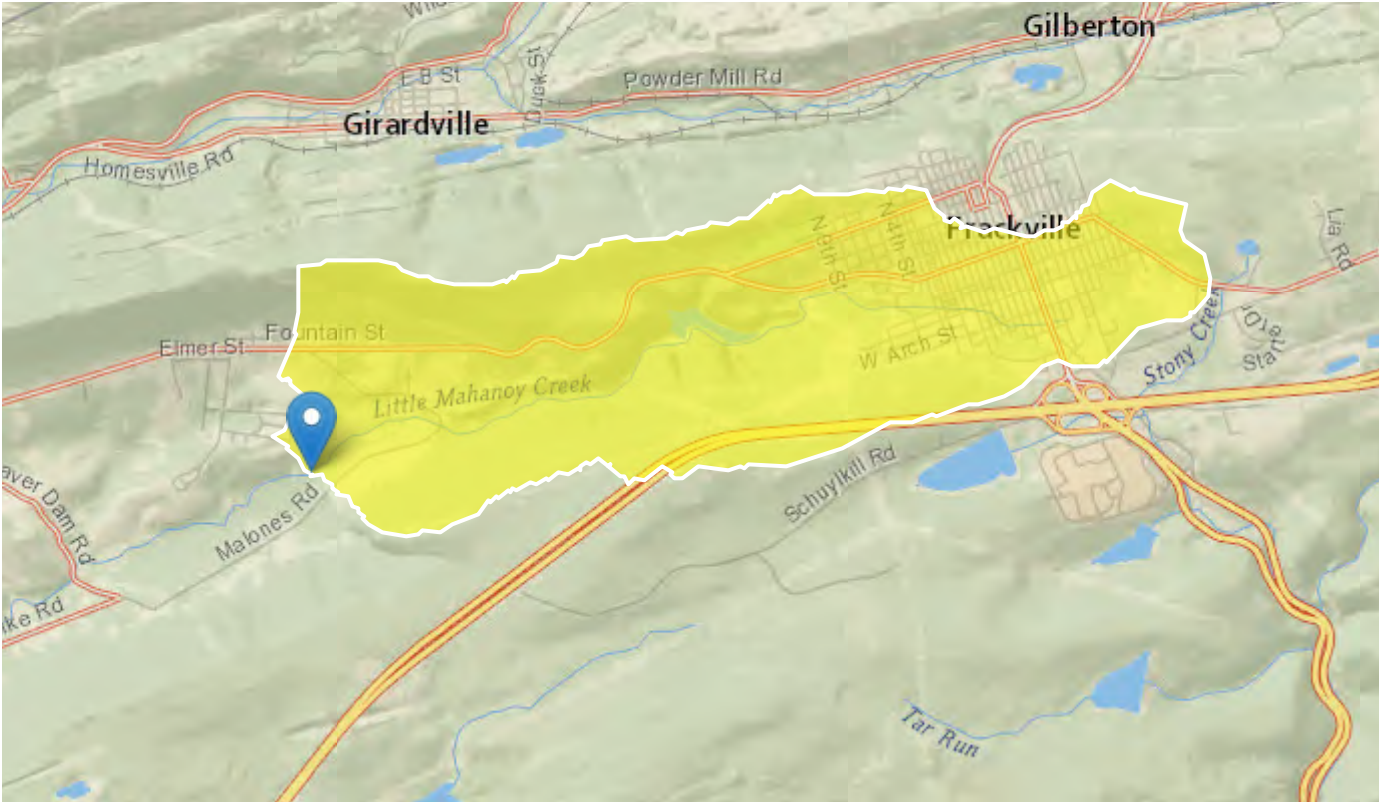
Application Version: 4.11.1

StreamStats Services Version: 1.2.22

NSS Services Version: 2.2.1

Little Mahanoy Creek Headwaters (Entire Study Area) StreamStats Report

Region ID: PA
Workspace ID: PA20221027171505087000
Clicked Point (Latitude, Longitude): 40.76874, -76.29132
Time: 2022-10-27 13:15:28 -0400



 Collapse All

➤ Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
BSLOPD	Mean basin slope measured in degrees	9.1584	degrees
BSLOPDRAW	Unadjusted basin slope, in degrees	9.3875	degrees
BSLPDRPA20	Unadjusted basin slope, in degrees, from PA v1	9.0618	degrees
CARBON	Percentage of area of carbonate rock	0	percent

Parameter Code	Parameter Description	Value	Unit
CENTROXA83	X coordinate of the centroid, in NAD_1983_Albers, meters	147097.5314	meters
CENTROYA83	Basin centroid horizontal (y) location in NAD 1983 Albers	198775.2401	meters
DRN	Drainage quality index from STATSGO	3.1	dimensionless
DRNAREA	Area that drains to a point on a stream	3.91	square miles
ELEV	Mean Basin Elevation	1440	feet
ELEVMAX	Maximum basin elevation	1795	feet
FOREST	Percentage of area covered by forest	71.5191	percent
GLACIATED	Percentage of basin area that was historically covered by glaciers	0	percent
IMPNLCD01	Percentage of impervious area determined from NLCD 2001 impervious dataset	8.08	percent
LC01DEV	Percentage of land-use from NLCD 2001 classes 21-24	29.1157	percent
LC11DEV	Percentage of developed (urban) land from NLCD 2011 classes 21-24	29.7959	percent
LC11IMP	Average percentage of impervious area determined from NLCD 2011 impervious dataset	8.5393	percent
LONG_OUT	Longitude of Basin Outlet	-76.291356	degrees
MAXTEMP	Mean annual maximum air temperature over basin area from PRISM 1971-2000 800-m grid	56.6	degrees F
OUTLETXA83	X coordinate of the outlet, in NAD_1983_Albers,meters	144228.3984	meters
OUTLETYA83	Y coordinate of the outlet, in NAD_1983_Albers, meters	197789.7965	meters
PRECIP	Mean Annual Precipitation	48	inches
ROCKDEP	Depth to rock	4.7	feet
STORAGE	Percentage of area of storage (lakes ponds reservoirs wetlands)	0.61	percent
STRDEN	Stream Density -- total length of streams divided by drainage area	1.14	miles per square mile

Parameter Code	Parameter Description	Value	Unit
STRMTOT	total length of all mapped streams (1:24,000-scale) in the basin	4.46	miles
URBAN	Percentage of basin with urban development	21.2353	percent

➤ Peak-Flow Statistics

Peak-Flow Statistics Parameters [Peak Flow Region 3 SIR 2019 5094]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	3.91	square miles	1.42	1280
CARBON	Percent Carbonate	0	percent	0	100

Peak-Flow Statistics Flow Report [Peak Flow Region 3 SIR 2019 5094]

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	ASEp
50-percent AEP flood	206	ft ³ /s	41.7
20-percent AEP flood	381	ft ³ /s	39.6
10-percent AEP flood	533	ft ³ /s	38.3
4-percent AEP flood	767	ft ³ /s	38.5
2-percent AEP flood	970	ft ³ /s	38.9
1-percent AEP flood	1200	ft ³ /s	40.1
0.5-percent AEP flood	1460	ft ³ /s	41.3
0.2-percent AEP flood	1850	ft ³ /s	43.7

Peak-Flow Statistics Citations

Roland, M.A., and Stuckey, M.H.,2019, Development of regression equations for the estimation of flood flows at ungaged streams in Pennsylvania: U.S. Geological Survey Scientific Investigations Report 2019–5094, 36 p.
(<https://doi.org/10.3133/sir20195094>)

➤ Low-Flow Statistics

Low-Flow Statistics Parameters [Low Flow Region 2]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	3.91	square miles	4.93	1280
PRECIP	Mean Annual Precipitation	48	inches	35	50.4
STRDEN	Stream Density	1.14	miles per square mile	0.51	3.1
ROCKDEP	Depth to Rock	4.7	feet	3.32	5.65
CARBON	Percent Carbonate	0	percent	0	99

Low-Flow Statistics Disclaimers [Low Flow Region 2]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors.

Low-Flow Statistics Flow Report [Low Flow Region 2]

Statistic	Value	Unit
7 Day 2 Year Low Flow	1.07	ft ³ /s
30 Day 2 Year Low Flow	1.38	ft ³ /s
7 Day 10 Year Low Flow	0.523	ft ³ /s
30 Day 10 Year Low Flow	0.666	ft ³ /s
90 Day 10 Year Low Flow	0.983	ft ³ /s

Low-Flow Statistics Citations

Stuckey, M.H.,2006, Low-flow, base-flow, and mean-flow regression equations for Pennsylvania streams: U.S. Geological Survey Scientific Investigations Report 2006-5130, 84 p. (<http://pubs.usgs.gov/sir/2006/5130/>)

➤ Annual Flow Statistics

Annual Flow Statistics Parameters [Statewide Mean and Base Flow]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	3.91	square miles	2.26	1720
ELEV	Mean Basin Elevation	1440	feet	130	2700
PRECIP	Mean Annual Precipitation	48	inches	33.1	50.4
FOREST	Percent Forest	71.5191	percent	5.1	100
URBAN	Percent Urban	21.2353	percent	0	89

Annual Flow Statistics Flow Report [Statewide Mean and Base Flow]

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SE	ASEp
Mean Annual Flow	8.22	ft ³ /s	12	12

Annual Flow Statistics Citations

Stuckey, M.H.,2006, Low-flow, base-flow, and mean-flow regression equations for Pennsylvania streams: U.S. Geological Survey Scientific Investigations Report 2006-5130, 84 p. (<http://pubs.usgs.gov/sir/2006/5130/>)

➤ General Flow Statistics

General Flow Statistics Parameters [Statewide Mean and Base Flow]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	3.91	square miles	2.26	1720
PRECIP	Mean Annual Precipitation	48	inches	33.1	50.4
CARBON	Percent Carbonate	0	percent	0	99
FOREST	Percent Forest	71.5191	percent	5.1	100
URBAN	Percent Urban	21.2353	percent	0	89

General Flow Statistics Flow Report [Statewide Mean and Base Flow]

PIl: Prediction Interval-Lower, Plu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SE	ASEp
Harmonic Mean Streamflow	2.42	ft ³ /s	38	38

General Flow Statistics Citations

Stuckey, M.H.,2006, Low-flow, base-flow, and mean-flow regression equations for Pennsylvania streams: U.S. Geological Survey Scientific Investigations Report 2006-5130, 84 p. (<http://pubs.usgs.gov/sir/2006/5130/>)

➤ Base Flow Statistics

Base Flow Statistics Parameters [Statewide Mean and Base Flow]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	3.91	square miles	2.26	1720
PRECIP	Mean Annual Precipitation	48	inches	33.1	50.4
CARBON	Percent Carbonate	0	percent	0	99
FOREST	Percent Forest	71.5191	percent	5.1	100
URBAN	Percent Urban	21.2353	percent	0	89

Base Flow Statistics Flow Report [Statewide Mean and Base Flow]

PIl: Prediction Interval-Lower, Plu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SE	ASEp
Base Flow 10 Year Recurrence Interval	3.42	ft ³ /s	21	21
Base Flow 25 Year Recurrence Interval	3.1	ft ³ /s	21	21
Base Flow 50 Year Recurrence Interval	2.92	ft ³ /s	23	23

Base Flow Statistics Citations

Stuckey, M.H.,2006, Low-flow, base-flow, and mean-flow regression equations for Pennsylvania streams: U.S. Geological Survey Scientific Investigations Report 2006-5130, 84 p. (<http://pubs.usgs.gov/sir/2006/5130/>)

➤ Bankfull Statistics

Bankfull Statistics Parameters [Statewide Bankfull Noncarbonate 2018 5066]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	3.91	square miles	2.62	207
CARBON	Percent Carbonate	0	percent		

Bankfull Statistics Parameters [Appalachian Highlands D Bieger 2015]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	3.91	square miles	0.07722	940.1535

Bankfull Statistics Parameters [Valley and Ridge P Bieger 2015]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	3.91	square miles	0.100386	395.999604

Bankfull Statistics Parameters [USA Bieger 2015]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	3.91	square miles	0.07722	59927.7393

Bankfull Statistics Flow Report [Statewide Bankfull Noncarbonate 2018 5066]

PIl: Prediction Interval-Lower, Plu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SE
Bankfull Area	36.5	ft^2	64
Bankfull Streamflow	151	ft^3/s	74
Bankfull Width	26.7	ft	59
Bankfull Depth	1.41	ft	56

Bankfull Statistics Flow Report [Appalachian Highlands D Bieger 2015]

Statistic	Value	Unit
Bieger_D_channel_width	26.8	ft

Statistic	Value	Unit
Bieger_D_channel_depth	1.66	ft
Bieger_D_channel_cross_sectional_area	45	ft^2

Bankfull Statistics Flow Report [Valley and Ridge P Bieger 2015]

Statistic	Value	Unit
Bieger_P_channel_width	24.2	ft
Bieger_P_channel_depth	1.48	ft
Bieger_P_channel_cross_sectional_area	37.2	ft^2

Bankfull Statistics Flow Report [USA Bieger 2015]

Statistic	Value	Unit
Bieger_USA_channel_width	20	ft
Bieger_USA_channel_depth	1.61	ft
Bieger_USA_channel_cross_sectional_area	35.7	ft^2

Bankfull Statistics Flow Report [Area-Averaged]

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SE
Bankfull Area	36.5	ft^2	64
Bankfull Streamflow	151	ft^3/s	74
Bankfull Width	26.7	ft	59
Bankfull Depth	1.41	ft	56
Bieger_D_channel_width	26.8	ft	
Bieger_D_channel_depth	1.66	ft	
Bieger_D_channel_cross_sectional_area	45	ft^2	
Bieger_P_channel_width	24.2	ft	
Bieger_P_channel_depth	1.48	ft	
Bieger_P_channel_cross_sectional_area	37.2	ft^2	
Bieger_USA_channel_width	20	ft	
Bieger_USA_channel_depth	1.61	ft	

Statistic	Value	Unit	SE
Bieger_USA_channel_cross_sectional_area	35.7	ft^2	

Bankfull Statistics Citations

Clune, J.W., Chaplin, J.J., and White, K.E.,2018, Comparison of regression relations of bankfull discharge and channel geometry for the glaciated and nonglaciated settings of Pennsylvania and southern New York: U.S. Geological Survey Scientific Investigations Report 2018–5066, 20 p. (<https://doi.org/10.3133/sir20185066>)
Bieger, Katrin; Rathjens, Hendrik; Allen, Peter M.; and Arnold, Jeffrey G.,2015, Development and Evaluation of Bankfull Hydraulic Geometry Relationships for the Physiographic Regions of the United States, Publications from USDA-ARS / UNL Faculty, 17p. (https://digitalcommons.unl.edu/usdaarsfacpub/1515?utm_source=digitalcommons.unl.edu%2Fusdaarsfacpub%2F1515&utm_medium=PDF&utm_

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Application Version: 4.11.1

StreamStats Services Version: 1.2.22

NSS Services Version: 2.2.1

APPENDIX D
GPS POINT DESCRIPTIONS AND ACTION ITEMS

GPS Point Descriptions and Action Items

Point #	Description	Action Item	Key Partners	Priority	Comments
1	Several intermittent channels converge in this area. Upstream of this point was a recently reclaimed coal spoil pile. The area is overrun with invasive species including Japanese barberry (<i>Berberis thunbergii</i>), multiflora rose (<i>Rosa multiflora</i>), Japanese knotweed (<i>Reynoutria japonica</i>), garlic mustard (<i>Alliaria petiolata</i>) and packing grass (<i>Microstegium vimineum</i>).	Invasive species removal	Landowners, Conservation District	High	
2	The stream channel is intermittent in this section. Upstream of this point, a bioretention area or constructed wetland could be installed to aid in stormwater retention. Downstream of this point, erosion gullies are approximately 2-4' deep.	Construct a stormwater bioretention area or constructed wetlands, Invasive species removal	Landowners, West Mahanoy Township, Conservation District	High	
3	The channel upstream of this point is 2-4' deep and actively eroding coal silt soils. Downstream of this point, the stream enters a stream enclosure.	Construct a bioretention area and stabilize streambanks upstream. Downstream stormwater retrofits should be installed.	Landowners, West Mahanoy Township, Conservation District	High	
4	A stream enclosure upstream of this point that is in need of replacement discharges to a downstream stream enclosure in this area.	The stream enclosure upstream of this point is being replaced by the Borough with FEMA funding. Stormwater retrofits such as native plantings and rain gardens should be considered for this area.	Landowners, Borough of Frackville, Conservation District	Low	

GPS Point Descriptions and Action Items

Point #	Description	Action Item	Key Partners	Priority	Comments
5	The downstream end of a stream enclosure is located at this point. Multiple culvert pipes discharge directly to the stream in this location without stormwater controls.	Stormwater retrofits	Landowners, Borough of Frackville, Conservation District	Low	
6	Water from a culvert pipe discharges to the stream in this area. The flow appears to be from groundwater. The flow infiltrates within the streambed and then reappears downstream.				
7	A culvert pipe located downstream of this point has failed. The stream is actively eroding the edge of the Econo Lodge parking area.	The existing failing pipes and eroding banks are being replaced with a new stream enclosure, Install stormwater retrofits to enhance water quality entering the stream enclosure	Borough of Frackville	High	
8	Upstream of this point is a failed stream enclosure.	The existing failing pipes and eroding banks are being replaced with a new stream enclosure, Install stormwater retrofits to enhance water quality entering the stream enclosure	Borough of Frackville	High	

GPS Point Descriptions and Action Items

Point #	Description	Action Item	Key Partners	Priority	Comments
9	A double culvert pipe stream crossing is located at this point.	The existing failing pipes and eroding banks are being replaced with a new stream enclosure, Install stormwater retrofits to enhance water quality entering the stream enclosure	Borough of Frackville	High	
10	Upstream of this point, the channel is eroded to the downstream end of the culvert at point #9. Beginning downstream of the stream enclosure, the streambanks are 3-4' high and actively eroding.	The existing failing pipes and eroding banks are being replaced with a new stream enclosure, Install stormwater retrofits to enhance water quality entering the stream enclosure	Borough of Frackville	High	

GPS Point Descriptions and Action Items

Point #	Description	Action Item	Key Partners	Priority	Comments
11	Upstream of this point, the existing stream enclosure is to being replaced under a FEMA funded project.	The existing failing pipes and eroding banks are being replaced with a new stream enclosure, Install stormwater retrofits to enhance water quality entering the stream enclosure	Borough of Frackville	High	
12	Upstream of this point, the northern riparian zone is approximately 15 feet wide. The channel is stable and connected to a floodplain on the southern bank.	Riparian buffer enhancement, Tree planting to expand the forested buffer on the north side of the stream	Landowners, Conservation District	Low	
13	Trash and debris are prevalent on the northern streambank.	Litter cleanup	Landowners	Low	
14	Streambanks are 3-4' high and actively eroding from this point to approximately 50' downstream of this point.	Streambank stabilization	Landowners, Borough of Frackville, Conservation District	Low	
15	Existing recently replaced stream crossing: Stormwater from inlets along the roadway discharges through the storm sewer without control.	Stormwater retrofits, Install small bioretention area to filter water from the roadway	Landowners, Borough of Frackville, Conservation District	Low	Both sides of the culvert had small fish in the stream

GPS Point Descriptions and Action Items

Point #	Description	Action Item	Key Partners	Priority	Comments
16	The streambanks downstream of this point are eroded approximately 4' high to point #17 . The floodplain is disconnected.	Floodplain restoration, wetland creation, streambank stabilization	Landowners, Borough of Frackville, Conservation District	Medium	
17	Upstream of this point, the streambanks are actively eroding and approximately 4' high with a disconnected floodplain. Downstream of this point, there is a connected floodplain and stable banks.	Floodplain restoration, wetland creation, streambank stabilization	Landowners, Borough of Frackville, Conservation District	Medium	
18	An intake structure for a small offline pond is located at this point. The stream is stable in this area.				
19	Wooden piles line the western streambank for stabilization downstream of this point				
20	This stream crossing has an upstream inlet that is constricted by concrete blocks so that the inlet could be completed within the right-of-way. Upstream of the enclosure, the topography would work well for a constructed wetland creation if the property owner would be amenable to the project.	Construct wetlands to the east of the stream	Landowners, Borough of Frackville, Conservation District	Medium	
21	Downstream end of stream enclosure. Several buildings are located on the valley floor and are at risk of flooding if the enclosure is blocked. Downstream of this point, NRCS has completed a riprap bank stabilization.	Restrict additional development within the natural floodway	Borough of Frackville	Low	
22	An NRCS riprap streambank stabilization project is located upstream of this point. Downstream of this point, the streambanks are 6' high and actively eroding.	Streambank stabilization	Landowners, Borough of Frackville, Butler Township, Conservation District	High	

GPS Point Descriptions and Action Items

Point #	Description	Action Item	Key Partners	Priority	Comments
23	A concrete encased abandoned sewer line is an obstruction within the stream channel in this location. There is an existing sewer manhole adjacent to the stream. The streambanks are eroding and are 3-4' high. Downstream of this point, the topography would allow for a floodplain restoration project to be completed on the northern bank of the stream.	Floodplain restoration, Streambank stabilization, Remove obstruction (old sewer line) in stream channel	Landowners, Borough of Frackville, Butler Township, Conservation District	High	The borough owns a portion of this property
24	Upstream of this point, the streambanks are 5-7' high and actively eroding. Downstream of this point, the streambanks are stable and the floodplain is connected to the stream channel. Several stormwater pipes discharge to the stream in this location.	Floodplain restoration	Landowners, Borough of Frackville, Butler Township, Conservation District	High	This point is the downstream end of the proposed floodplain restoration project to the north of the stream.
25	A recently replaced stream crossing is located downstream of this point. Upstream of this point, the floodplain is connected and streambank erosion is minimal (1-2' high).				
26	Downstream of this point the streambank is 8' high and actively eroding for a length of approximately 150'.	Streambank stabilization	Landowners, Butler Township, Conservation District	Low	
27	Upstream of this point, the streambanks are actively eroding. Downstream of this point, the streambanks are stable and the floodplain is connected.	Streambank stabilization	Landowners, Butler Township, Conservation District	Low	
28	Upstream of this point is stable and connected. Downstream of this point, the streambanks are eroded and 4-5' high along the southern bank for approximately 100'.	Streambank stabilization	Landowners, Butler Township, Conservation District	Low	
29	An abandoned dam located at this point is breached. The dam remnants aid in creating an upstream wetland and likely help to retain some of the flood flows in this area.				

GPS Point Descriptions and Action Items

Point #	Description	Action Item	Key Partners	Priority	Comments
30	Approximately 2' high eroded streambanks exist on the northern side of the stream. Approximately 60% of the northern bank is eroded to point #31	Streambank stabilization	Frackville Area Municipal Authority, Butler Township, Conservation District	Low	
31	Culvert crossing of stream channel. The downstream channel is stable and connected to the floodplain. A constructed wetland discharges to the stream from the north				
32	The northern streambank downstream of this point is armored with riprap to point #33. The sewer plant is at the top of the bank.				
33	The sewer plant discharges to the creek at this point.				
34	An existing stream crossing for utility line access is blocked with debris at this location.	Maintain crossing	PP&L	Low	An erosion gully is forming where the flow is blocked by the debris
35	An existing dam is filled to the invert with sediment and creates wetlands upstream of this point. The dam blocks fish passage except when a storm event causes flooding. Removal of the dam and sediment would substantially impact the upstream wetlands.	Restore fish passage	Ashland Area Municipal Authority, Conservation District, Butler Township, American Rivers	Low	
36	In this area, a constructed berm forces the mainstem to the side of the valley to keep the water from it out of the downslope reservoir. The channel is stable. A tributary is carried over the top of the mainstem via a metal pipe. Adjacent to the pipe, an abandoned aquaduct is in disrepair.	Remove abandoned aquaduct	Ashland Area Municipal Authority	Low	
37	Mainstem is in an aquaduct over a tributary maintained by the water authority				

GPS Point Descriptions and Action Items

Point #	Description	Action Item	Key Partners	Priority	Comments
38	The dam breast for Ashland Reservoir is located at this point. The mainstem is kept along the south side of the valley and does not flow into the reservoir. Falls at the dam breast block fish passage.	Restore fish passage	Ashland Area Municipal Authority, Conservation District, Butler Township, American Rivers	Low	
39	A stone wall along the northern streambank that protects water authority infrastructure is slightly eroded at the bottom.	Maintain toe of existing wall	Ashland Area Municipal Authority	Low	
40	The stream transitions to connected floodplains downstream of this point. There is a small area of streambank erosion upstream.	Streambank stabilization	Ashland Area Municipal Authority, Conservation District, Butler Township	Low	
41	A weir for flow monitoring below Ashland Reservoir provides grade control at this point.				
42	Streambanks are eroded about 10' high on the southern side of the stream downstream of this point.	Install rock deflectors at toe of slope	Ashland Area Municipal Authority, Conservation District, Butler Township	Low	The bank is steep and could not be reasonably pulled back due to the topography of this area.
43	Remnants of a breached dam are located in the floodplain in this area. The streambanks are stable downstream of this point.				

GPS Point Descriptions and Action Items

Point #	Description	Action Item	Key Partners	Priority	Comments
44	There is a utility line crossing with riprap on the northern bank and erosion control matting on the southern bank at this point. An access road is at the top of the streambank.	Monitor live stake success and replace them as needed	Utility company	Low	
45	The toe of slope of the northern streambank is eroding.	Install rock deflectors at toe of slope	Ashland Area Municipal Authority, Conservation District, Butler Township	Low	Due to the steep slope to the access road above the streambank, the streambank in this area could not reasonably be pulled back.
46	The downstream streambanks are stable.				
47	Downstream of this point, the streambank is eroded approximately 3-4' and the channel is incised.	Streambank stabilization	Ashland Area Municipal Authority, Conservation District, Butler Township	Medium	
48	Upstream of this point, the southern streambank is actively eroding and is 4-6' high.	Streambank stabilization	Landowners, Conservation District, Butler Township	Medium	
49	The stream channel is incised and eroded approximately 4-10' high downstream of this point.	Streambank stabilization	Landowners, Conservation District, Butler Township	Medium	
50	The Malones Road Bridge is located at this point. Upstream, the streambanks are actively eroding. Downstream, the streambanks are stable.	Streambank stabilization	Landowners, Conservation District, Butler Township	Medium	

GPS Point Descriptions and Action Items

Point #	Description	Action Item	Key Partners	Priority	Comments
51	Downstream of this point, the southern riparian zone is mowed to the stream edge.	Riparian buffer enhancement	Landowners, Conservation District	Low	
52	Upstream of this point, the streambank is mowed to the stream edge. Downstream of this point, there is a vegetated buffer on both sides of the stream. Japanese knotweed (<i>Reynoutria japonica</i>) dominates this and many other areas throughout the watershed.	Riparian buffer enhancement, Invasive species removal	Landowners, Conservation District	Low	
53	Upstream of this point, the streambanks are stable. Downstream, the streambanks are eroded approximately 3-4' high.	Streambank stabilization	North Schuylkill School District, Conservation District, Butler Township	Low	
54	Upstream of this point, the streambanks are 2-4' high and actively eroding. Downstream, the streambanks are stable.	Streambank stabilization	North Schuylkill School District, Conservation District, Butler Township	Low	
55	Downstream of this point, the streambanks are 3-4' high and actively eroding. Mile-a-minute (<i>Persicaria perfoliata</i>) is present in this area and was not observed elsewhere in the watershed during the streamwalk.	Invasive species removal, Streambank stabilization	North Schuylkill School District, Conservation District, Butler Township	Low	

GPS Point Descriptions and Action Items

Point #	Description	Action Item	Key Partners	Priority	Comments
56	Upstream of this point, the streambanks are 3-4' high and actively eroding. Downstream, the streambanks are stable and connected to a floodplain	Streambank stabilization	North Schuylkill School District, Conservation District, Butler Township	Low	

APPENDIX E
POINT LOCATION DATA

Point Location Data

Point #	Northing	Easting
1	530794.13	2391302.02
2	530586.84	2391246.85
3	530460.23	2391091.70
4	530316.65	2390750.83
5	530250.09	2390633.18
6	530239.26	2390610.03
7	530184.76	2390533.84
8	530142.87	2390451.95
9	530139.16	2390447.81
10	530086.66	2390264.43
11	529956.55	2389507.45
12	530022.39	2389233.60
13	530048.01	2389192.04
14	530032.61	2388937.03
15	530069.90	2388906.27
16	530129.76	2388814.59
17	530206.23	2388731.48
18	530234.67	2388660.64
19	530251.57	2388624.90
20	530479.38	2388447.51
21	530354.02	2387896.64
22	530382.80	2387710.58
23	530507.23	2387480.43
24	530539.76	2387082.54
25	530404.22	2386476.30
26	530362.17	2386335.25
27	530409.39	2386204.13
28	530339.43	2385889.46
29	530557.13	2385422.46
30	530709.69	2385139.08
31	530856.59	2385018.44
32	530660.29	2384442.27
33	530544.55	2384169.56
34	530264.58	2384262.02
35	530062.77	2384090.30

Point #	Northing	Easting
36	529942.33	2383965.82
37	529497.55	2382494.76
38	529426.21	2381171.81
39	529427.62	2381100.89
40	529415.24	2380929.53
41	529467.45	2380685.56
42	528749.42	2380153.55
43	528657.47	2380096.51
44	528478.41	2379845.72
45	528216.14	2378197.37
46	528226.12	2378004.54
47	527765.29	2377285.53
48	527662.51	2377010.33
49	527347.15	2375830.92
50	527436.50	2375614.05
51	527526.50	2375480.65
52	527573.08	2375138.73
53	527424.76	2374100.38
54	527205.57	2373795.74
55	527163.48	2373549.24
56	527187.01	2373481.07

Coordinate System: State Plane, PA South, NAD83 datum

APPENDIX F
RESTORATION BMP HANDOUTS

Streambank Stabilization

Within the Little Mahanoy Creek Watershed, some stream segments are impaired by erosion and sedimentation within the stream itself. When streambanks erode, sediment that is discharged to the stream channel smothers the small nooks and crannies between the rocks on the streambed that provide micro-habitat areas for the instream community. Sediment discharges are often partnered with the release of soil bound nutrients. Within these areas, stream restoration and stabilization are often effective tools to improve in-

stream habitat and water quality.

Stream restoration within the watershed should focus on long-term stability of the stream by looking at the stream's pattern, profile, and dimension.

Where streambanks are actively eroding, stabilization that focuses on establishing native vegetation is often the best



long-term option. As the vegetation becomes established, a combination of rip-rap and vegetation are often implemented to provide stabilization. The use of well positioned in-stream deflectors, cross-vanes, j-hooks, and straight vanes can help to hold the streambanks in place as the vegetation becomes established. These structures, when utilized effectively, minimize streambank erosion by reducing the force of water that is scouring the bank surface and provide habitat for many types of aquatic life.

For more information please contact:
Schuylkill Conservation District
1206 AG Center Drive
Pottsville, PA 17901
(570) 622-3742 ext. 5



Floodplain Restoration



In many areas of the Little Mahanoy Creek Watershed, past human activities have placed fill in or caused extensive sedimentation within the riparian zone. The excess material along the edge of the stream channel has disconnected the

stream from the floodplain. Floodplain restoration projects are designed to remove excess soil from the floodplain so that the stream is reconnected to an active floodplain. Active floodplains are important to not only reduce the volume and velocity of floodwaters, but also to filter nutrients and pollutants from floodwaters and to provide habitat for a diverse riparian community. The restored streambanks and floodplain area can be planted with native wildflowers, grasses, shrubs, and trees to help stabilize the riparian zone and promote use of the area by a diversity of native wildlife. Floodplain restoration projects can range from establishing a small bankfull bench to help disperse flows to large scale excavation projects that uncover the historic valley floor.



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Constructed Wetlands

Many areas within the Little Mahanoy Creek Watershed lack connections to wetlands, specifically in the top portion of the watershed in Frackville, PA. Creation of constructed wetlands in the watershed will have multiple positive impacts on the watershed. Foremost, constructed wetlands can serve to remove contaminants and pollutants caused by human activity from the water supply through the same processes of naturally occurring wetlands. These processes help to remove and break down contaminants. Constructed wetlands not only offer the benefit of water quality improvements through a natural and holistic process, but also provide a variety of niche habitats for local plants and wildlife. Wetlands are considered to be one of the most productive ecosystems on Earth, and provide habitat for birds, mammals, amphibians, reptiles, as well as diverse plants and fungi in the area. Constructed wetlands can help to reduce the impacts caused by erosion as complex root systems of wetland species helps to anchor soils. Additionally, wetlands can mitigate the impacts of flooding and aid in groundwater recharge. This phenomenon occurs because of the ability of wetlands to hold significant amounts of water, which otherwise might pose a threat to urban areas nearby and downstream.



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Forested Stream Buffer Zone

Clearing and mowing of stream corridors to the stream edge impacts water quality and the community of creatures that live within the stream. Streams flowing through open areas are exposed to high levels of sunlight and lack a filter to minimize sediment and nutrients from discharging to the stream. As sunlight warms the water, it is able to hold less dissolved oxygen, which is essential for a healthy stream community. When combined with elevated levels of nutrients, excessive sun exposure contributes to the severity of algal blooms. As the algae dies and decays, dissolved oxygen is utilized by the bacteria that thrive on the dying algae.



Forested stream buffers provide shade and help moderate daily stream temperature changes during both winter and summer months. Pollutants can be successfully filtered and trapped by the physical structure of the vegetation itself and be taken up through the root systems and stored in the tree and shrub's wood. In addition, forested buffers provide a home for a diversity of wildlife and function as a corridor to allow wildlife to move from one pocket of habitat to another.

For more information please contact:
Schuylkill Conservation District
1206 AG Center Drive
Pottsville, PA 17901
(570) 622-3742 ext. 5



In-stream Restoration Structures

In-stream rock and log deflectors, cross-vanes, j-hooks, and boulder placements are effective tools for creating in-stream fish habitat and aiding in the stabilization of streambanks. The structures are typically constructed based on what materials are available on the site or are locally available. Root wads from clearing operations may be



flows or aligned to roll the stream flow away from the bank and into the center of the channel. In-stream structures are typically designed to manage low to moderate flow conditions and help shape and maintain a natural stream configuration. During high flow events, the structures are designed to stay in place beneath the floodwaters.

Root wads from clearing operations may be anchored into the streambanks to slow the flow of water in the stream and create habitat for fish and aquatic life. Log sections may be used to create vanes and deflectors to protect banks and create in-stream habitat. Where needed, boulders can be placed either randomly for fish habitat and to disperse



For more information please contact:
Schuylkill Conservation District
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Pottsville, PA 17901
(570) 622-3742 ext. 5



Invasive Species Removal

Throughout the Little Mahanoy Creek Watershed, invasive species pose a threat to the ecosystem and native species. Of particular concern in the watershed is Japanese knotweed (*Fallopia japonica*) which is a noxious weed that can dominate acres of forests rapidly if left uncontrolled. Japanese knotweed grows in thick clusters, sometimes reaching over 11 feet tall and preventing sunlight from reaching native plants below. Invasive species wreak havoc on ecosystems by dominating niches belonging to native plants. This results in changes in the populations of all types of creatures, changes in soil and water quality overtime, and eventually a reduction in native biodiversity.



Control of most invasive plant species over large areas typically requires selective herbicide application on multiple occasions. It is crucial that soil containing invasive plant roots and seeds is appropriately managed and that tires and tracks from construction equipment is cleaned in such a way as to minimize the risk of the plants spreading to other areas.

For more information please contact:
Schuylkill Conservation District
1206 AG Center Drive
Pottsville, PA 17901
(570) 622-3742 ext. 5



Litter Cleanup

Throughout the watershed, the impact of human activity is noticeable through the litter laying along the streambanks and streambed. In the part of the watershed that runs through the town of Frackville, larger pieces of litter (such as tires, old construction materials, and pieces of metal) line the banks of the stream. Litter can change public perception of stream ecosystems, resulting in reduced interest in keeping the stream healthy for both wildlife and human use. This litter not only takes away from the aesthetic value of the stream but can also be detrimental to the stream ecosystems and water quality.



Volunteer litter clean ups may be used to collect litter that is small and easily carried. Large litter will require a more involved effort to remove safely.

For more information please contact:
Schuylkill Conservation District
1206 AG Center Drive
Pottsville, PA 17901
(570) 622-3742 ext. 5



Restore Fish Passage

Alterations to the original course of a stream can result in barriers to fish passage. Barriers include when the velocity of the stream is too high, when jumps fish must make to move through the stream are too high, and when the stream is too shallow for the fish. Fish need to pass through a variety of waterways to reach the ideal conditions to reproduce and feed. At each step of the way, fish balance the nutrient levels within their ecosystems with their waste. If fish are not able



to move between waterways, the entire ecosystems they help to sustain are at risk of failure. Healthy fish populations can help to promote community buy-in to conservation projects. This is because of the value of fish for recreation activities such as fishing and wildlife spotting. There are multiple avenues for restoring fish passage. Some avenues include culvert replacements, installation of rock ramps, dam removal, and by-pass channels.

For more information please contact:
Schuylkill Conservation District
1206 AG Center Drive
Pottsville, PA 17901
(570) 622-3742 ext. 5



Stormwater Management Retrofits

As the amount of developed land increases within the watershed, the landscape is altered by an increase in impervious cover. Impervious areas shed runoff and increase stormwater discharges to the streams. Increased stormwater flows contribute to flooding, degrade water quality, and accelerate in-stream erosion.

In order to decrease the impacts of stormwater on the watershed, effective best management practices should be installed with new construction. Where existing stormwater structures are present, they should be evaluated for effectiveness and retrofitted where necessary.



Common stormwater retrofits focus on improving the function of existing structures so that they more closely reflect the natural hydrological cycle. Within existing stormwater basins, native species may be planted or allowed to become established. Minimizing mowing and labor in this way provides for additional wildlife habitat, reduces nutrient discharges to the stream, and allows for the vegetation to return more of the stormwater to the atmosphere through evapo-transpiration. Other strategies for stormwater retrofits include installing cisterns to allow for water reuse and infiltration trenches to increase the return of stormwater to the groundwater.

For more information please contact:
Schuylkill Conservation District
1206 AG Center Drive
Pottsville, PA 17901
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APPENDIX G
PRELIMINARY PROBABLE CONSTRUCTION COST OPINION

Little Mahanoy Creek Watershed Probable Construction Cost Opinion

Site	Priority	Min Cost	Max Cost
1	High	\$150,000	\$350,000
1-3	High	\$350,000	\$475,000
16-17	Medium	\$95,000	\$175,000
20	Medium	\$105,000	\$185,000
22-24	High	\$250,000	\$375,000
47-50	Medium	\$275,000	\$525,000
		\$1,225,000	\$2,085,000

Clauser Environmental, LLC is not a construction contractor and therefore probable construction cost opinions are made on the basis of Clauser Environmental, LLC's experience and qualifications as an environmental consultant and represent the consultant's best judgment as experienced and qualified design professionals generally familiar with the industry. This requires a number of assumptions as to actual conditions which will be encountered on the site; the specific decisions of other design professionals engaged; the means and methods of construction the contractor will employ; contractors' techniques in determining prices and market conditions at the time, and other factors over which Clauser Environmental, LLC has no control. Given these assumptions which must be made, Clauser Environmental, LLC states that the above probable construction cost opinion is a fair and reasonable estimate for construction costs but cannot and does not guarantee that actual construction costs will not vary from the Probable Construction Cost Opinion. The restoration of stream segment #7-11 is not included in the Probable Construction Cost Opinion as the project was under construction at the time of the writing of this restoration plan.

APPENDIX H
PROFESSIONAL QUALIFICATIONS

Aaron S. Clauser, Ph.D., CPESC

At Clauser Environmental, LLC, he serves as the technical/production lead on scientific projects. Dr. Clauser has his bachelor's degree in Biology and Environmental Studies from East Stroudsburg University of Pennsylvania and a doctorate in Environmental Science from Lehigh University. Dr. Clauser is a Certified Professional in Erosion and Sediment Control. He has experience as an environmental regulator with the Berks and Schuylkill Conservation Districts where he has served at both the technician and managerial levels. Dr. Clauser began consulting as a Senior Environmental Scientist and Project Manager for RETTEW Associates, Inc. He has given oral presentations at conferences held by the Ecological Society of America, American Society of Limnology and Oceanography, Coldwater Heritage Partnership, Partnership for the Delaware Estuary, Delaware Riverkeeper, Pocono Comparative Lakes Program and Schuylkill and Berks Conservation Districts and has collaborated on an article published about Pacific Northwest amphibians in a peer-reviewed journal. Dr. Clauser has completed numerous training courses including DEP sponsored NPDES, Chapter 102 and 105 technical seminars, Applied Fluvial Geomorphology for Engineers (FGE) by Wildland Hydrology, Inc., and Environmentally Sensitive Maintenance of Dirt and Gravel Roads Training. Dr. Clauser served in the PA Air National Guard where he attained the rank of Staff Sergeant. His doctoral dissertation entitled "Zooplankton to Amphibians: Sensitivity to UVR in Temporary Pools" includes quantitative optical and organismal level models that are extended to landscape level variations in pool optical properties and population level sensitivity to Ultraviolet Radiation.

Kora S. Clauser, B.S.

Kora works as a biologist with Clauser Environmental, LLC. She has experience with watershed studies, wetland delineation, scientific field investigations, and project delivery. She is currently enrolled in an M.A. in Mental Health Counseling program at Kutztown University. She completed her bachelor's degree in Biological Science with a minor in Psychology at Rowan University.

Krista S. Clauser, M. Ed.

As the president of Clauser Environmental, LLC, she is responsible for overall client satisfaction, quality assurance, educational outreach programs, and project management. Krista has her bachelor's degree in Special Education and Elementary Education from Kutztown University of Pennsylvania. She has her Master of Education degree from the University of Georgia, with a concentration in Learning, Leadership, and Organization Development. While at the University of Georgia, she focused her research on the positive effects of mindfulness practices for business leaders and created the "Mind Your Own Business" Leadership Workshop Series. Krista has completed additional graduate level coursework at Kutztown University of Pennsylvania and Indiana Wesleyan University. Currently, she is a doctoral student, pursuing her Ed. D at Drexel University in Leadership and Management, concentrating in Creativity and Innovation. She is a certified yoga teacher, breathwork coach, reiki teacher, and qi gong teacher. She has experience as a special education teacher at Schuylkill Intermediate Unit and as a homeschool educator at the elementary, middle, and high school levels. Krista has expertise in integrating environmental/outdoor curricula into a diversity of subjects and educational settings.