# Partnership for Wissahickon Floodplain Reconnection

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## Highlights

- Wissahickon Trails and Biohabitats developed a stream and floodplain restoration plan for Wissahickon Creek.
- Collaboration with several project partners, funders, and landowners was critical to this effort.
- The project was used to meet MS4 permit goals for water quality improvements and impervious area.

## Introduction

Wissahickon Trails and Biohabitats developed a stream and floodplain restoration plan for a headwater reach of Wissahickon Creek in Upper Gwynedd Township, Montgomery County, Pennsylvania. Collaboration with project landowners, including PECO and Merck Corporation, was critical to this effort. Funding for the project was obtained from many project partners including Department of Environmental Protection's Growing Greener Program, National Fish and Wildlife Federation, Merck Corp., Upper Gwynedd Township, and PECO. Aquatic Resource Restoration Company assisted with project construction.

## Background

Stream assessments found the channel to be over-widened and entrenched because of watershed urbanization. Reconnection of the stream channel to its adjacent floodplain, storage of stormwater on the floodplain, reducing erosive forces on the stream banks, and restoring riparian habitat were primary project goals.

The restoration design included development of significant floodplain benching and storage as well as moderate raises in channel invert to provide an enhanced connection between the stream and its floodplain. This channel raise was accomplished by the creation of riffle grade control structures and filling of the existing channel. No rise in 100-year flood elevations was accomplished by having a net excavation of material in the project channel and floodplain.

The project area has overhead power lines and utility poles throughout, which impacted project design (Figure 1). Grading in proximity to PECO poles was limited to the maximum extent practicable, while still fulfilling the project goals. Vegetation planting zones are proposed based on location of PECO transmission or distribution lines.

**Figure 1.** The project is in a high voltage electric transmission corridor, which influenced project design and requirements.

## Key Findings

The project was successfully completed in Fall 2020 despite experiencing an extreme precipitation event during construction. The resilience of the floodplain restoration approach was tested and proven during this extreme event. The Township is using this project to meet its MS4 permit goals for water quality improvements and impervious area mitigation.

**Figure 2.** View of the project site post-restoration including a view of the stream restoration and floodplain reconnection.

This project provides an example of successful partnership between Wissahickon Trails (an NGO), private corporations (PECO and Merck Corp.), local government (Upper Gwynedd Township), a University (Temple), and an ecological restoration firm (Biohabitats).

## Recommendations

Partnerships for floodplain restoration should be included in the toolbox for communities to achieve several goals including the following.

- Improved water quality from reduced erosion and sediment/nutrient delivery
- Increased flood storage to mitigate the impacts of extreme precipitation events
- Cost effective BMP implementation to meet MS4/TMDL goals
- Improved local ecology and wetland habitat
- Reduced maintenance costs from flood damage repair and/or maintained landscapes
- Restoration of the entire stream and floodplain system rather than a narrow focus on channel only

# French Creek West - Case Study Abstract

## Remediation and Redevelopment along a FEMA AE Floodplain

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## Highlights

- Redevelopment of former industrial site mapped within FEMA floodplain of French Creek
- Development removed two existing depilated bridges and remediated former industrial use
- Project complied with Borough of Phoenixville, PA no-increase Floodplain Ordinance

## Introduction

The 64 acre site of the former Phoenix Iron Works sat vacant since operations ceased in the 1980s. A primary constraint was the site's mapping as entirely within the FEMA floodplain of French Creek. Phoenixville Borough adopted a no-increase floodplain ordinance making a straightforward site raise for buildable area unworkable. Through detailed review of FEMA products and present topography, a design strategy was realized which removed two depilated bridges, replacing one, while filling the site above the flood elevation to remediate the industrial use and allow redevelopment. Detailed HEC-RAS modelling demonstrated no increase or decrease to the effective flood elevations. With the final floodplain result realized, designs for Post Construction Stormwater Management were prepared as well as erosion control measures to support the development within a floodplain environment that changed as construction commenced. The project required FEMA CLOMR, PADEP/ACOE Joint 404, Individual NPDES and Act 2 approvals.

## Background

### Effective FEMA Floodplain Review

Review of FEMA's products for French Creek indicated that the original floodplain analysis was prepared in 1977. Aside from a datum shift, no further updates had been made to the FEMA result since the original 1977 analysis. At the time of the original study the existing steel mill buildings were present and represented a large floodplain obstruction on the site. Also, a dam was depicted in the FEMA profile which was found to be 8 feet lower in the present condition. The Main Street Bridge was reconstructed in 1991, the FEMA study was based on a more obstructive stone arch bridge originally constructed in 1847. A 6,800 ft stream length HEC-RAS model was developed which included the present condition of these noted features to create a new baseline of existing conditions. The preliminary modelling indicated that some areas were higher or lower than FEMA effective elevations.

### Approach to Site Remediation and Fill

The HEC-RAS model was investigated with a straightforward filling of the site to raise a developable area above the flood elevation. This caused a rise in the floodplain elevation, smaller than expected, but with any rise being unacceptable. Two existing bridges were built for the former steel operation. One being a rail bridge with the deck set at top of bank elevation. Given the stream geometry at this location such a bridge configuration represented a major flow obstruction. This rail bridge was partly collapsed and hazardous, its removal for any project would be required. The model was revised to remove the bridge, and the developable area of a large portion of the site improved. Another area at the upstream portion of the site still flooded, but this was a result of the second derelict bridge (Paradise Street) also constructed with the deck at top of bank elevation. Removal of this bridge further improved the developable area. A last iteration proposed fill on the site with the bridges removed with a resulting flood elevation that was lower than the updated existing model, and the FEMA effective model. The amount of fill would also comply with Act 2 Remediation requirements of a minimum 2-foot cap. This proof-of-concept was presented to and favorably received by the Borough to initiate the Land Development Process.

### Post Construction Stormwater Management Design

The existing site condition was nearly entirely impervious. As a result of the post-development "greening" of the site with lawns and open spaces, stormwater rate and volume mitigation requirements were largely addressed. Stormwater infiltration was not recommended due to the Act 2 status of the site. Underground detention BMPs were provided to capture a "first flush" event and slowly discharge to water quality BMPs (a precursor to MRC, which was not yet formally approved) including surface vegetated raingardens and hydrodynamic devices, prior to stream discharge through backflow controlled flap gates.

### During Construction Erosion Control Design

The existing bridges were demolished first to allow import of large stockpile areas to fill and raise the site. A flooding condition no worse than present with the temporary stockpiles was demonstrated through additional HEC-RAS modelling. The loop road which paralleled the stream was next constructed that caused the development site to become a "bowl". This separated the development area from the floodplain and allowed during construction runoff to be captured and treated with flocculants, prior to discharge through ABACT sediment traps and basins.

## Key Findings

Validation of FEMA's product, outdated due to modeling improvements and topographic changes, yielded a viable redevelopment project which also remediated the former industrial use.

**Figure 1. Existing and Reconstructed Paradise Street Vehicular Access – New Deck Raised 6 Feet Above Existing**

**Figure 2. Existing Collapsed Rail Bridge and Restored Streambank Condition**

## Recommendations

FEMA products should be reviewed in the context of present conditions for land development projects as they may be outdated. A relatively low cost incremental approach to verifying FEMA results can be implemented based on publicly available LIDAR and basic field measurements to demonstrate a proof of concept to ultimately facilitate land development.

# Aquatic Resource Mitigation at Bensalem Township High School – PennDOT District 6-0

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## Highlights

- Stream and Wetland Mitigation to restore ecological diversity and resiliency in an urbanized watershed.
- Success of stream corridor stability and resiliency tested during 100-year post construction storm event.
- Stream and Floodplain Restoration for stormwater management and MS4 permit compliance.

## Introduction

PennDOT District 6-0 is completing roadway work for the SR 0001, Group 03S, Sections RC1 and RC2 corridor in Bensalem and Middletown Townships, Bucks County, Pennsylvania. As part of the roadway improvement project, certain unavoidable impacts to waters of the Commonwealth were necessary to accommodate this transportation corridor improvement project. To offset these unavoidable impacts, JMT developed a comprehensive permittee-responsible mitigation (PRM) plan for both stream and wetland impacts through a cost-effective, innovative, and sustainable design solution. The project not only proved to be a cost-effective design solution to address and satisfy mitigation requirements but has demonstrated long-term stability and ecological sustainability as a result of a greater than 100-year storm event which translates into minimal long-term operations and maintenance efforts through environmental resiliency. As a post-construction add-on, the Silver Lake Nature Center will be working with the Bensalem Township School District to use the stream and floodplain restoration project as an outdoor science classroom for school students to learn about water quality, various aquatic communities and stream and river mechanics.

## Methodology or Background (for case study)

JMT developed a comprehensive aquatic resource mitigation plan using a combination of field observations, historical research, watershed and geomorphological investigations, and partnerships with local entities. Early on in this endeavor, JMT reached out to the Silver Lake Nature Center for their local knowledge of the surrounding watersheds and through this partnership, JMT was able to identify the potential mitigation site on the Bensalem High School property. It was through a visual inspection of the two failed and dilapidated impoundment structures once used for agricultural purposes that prompted the proposed mitigation plan. See **Figure 1** for lower impoundment structure blocking entire stream valley corridor. With JMT's professional expertise and knowledge of aquatic and ecological resource impacts associated with these types of impoundment structures, JMT determined that the floodplain and stream system was not providing the hydrologic, hydraulic, and ecological functions and values that are inherent to naturally stable fluvial environments. This historical insight was a critical component for developing a cost-effective, innovative, and sustainable design approach as many of the streams in our watersheds are still adjusting to historical and current anthropogenic impacts. JMT's design approach of re-establishing a functional and well-connected floodplain to the proposed stream channel is founded upon the principles of fluvial geomorphology and the inter-connectedness of the functions and processes of streams, floodplains, and wetlands. In the proposed condition, groundwater will flow closer to the proposed floodplain surface contributing to the base flow of the stream and wetlands providing far greater hydrologic, hydraulic, and bio-geochemical benefits and diversity of biota that are typically inherent in undisturbed and/or stable stream and riparian floodplain wetland systems.

**Figure 1.** Existing concrete dam structure impairing aquatic organism passage and river continuity.

## Key Findings

To accomplish this innovative floodplain restoration design approach, JMT investigated the existing valley bottom sediments, geology and geomorphology using exploratory trenches to document pre- and post-settlement soil conditions and the impacts associated with these legacy sediments. Investigation of the soil layers revealed three distinctive layers of material that were consistent with the buried hydric soil layer and basal gravel layers that provided a basis for the low-energy, marsh-like fluvial system that thrived in the valley bottom prior to disturbance, as well as the legacy sediments resulting from structure impoundment on top of the buried historical layers. The design approach was to remove the legacy sediment from the valley bottom to provide access to the buried hydric soil and basal gravels throughout the restoration site. Due to a combination of controlling factors, such as the required upstream and downstream tie-in elevations, it was infeasible to truly intersect the elevation of the buried hydric soils and valley bottom basal gravels throughout the entire restoration reach. However, JMT's holistic design approach incorporated the importance of a frequent floodplain connection to minimize erosive forces during storm events and served to mimic the functions and values related to the pre-settlement valley conditions even in locations where the buried hydric soil and basal gravels were not able to be fully accessed. In addition to creating and establishing this low-energy wetland and fluvial system, JMT incorporated a number of in-stream and floodplain structures in order to provide the long-term vertical stability of stream corridor due to the above controlling factors. These structures included in-stream and buried floodplain log sills for vertical stability as well as a carbon source for bio-geochemical nutrient processing and a surrogate streambed underlayment due to the inability of tying into the valley bottom basal gravels. The stream and floodplain restoration design also had to incorporate four stormwater outfalls into the stream and floodplain design in order to safely convey stormwater discharges from the nearby high school grounds to the proposed floodplain in a low energy, sheet flow condition. See **Figure 2** for one of the proposed stormwater outfalls one year after construction that was part of the overall stream and floodplain mitigation design.

**Figure 2.** 54" stormwater outfall from high school parking lot discharging into preformed scour hole with level spreader to floodplain design.

## Recommendations

The goal of the aquatic resource mitigation plan was to restore and re-establish a self-maintaining and sustainable system that will grow and diversify with increasing ecological functions and values with little or no operations and maintenance needs. This ecological restoration approach maximizes environmental resiliency and diversity of our existing and impaired stream corridor systems, floodplains, and riparian areas to promote and enhance groundwater/surface water exchange processes which exemplifies a truly well-connected and sustainable aquatic resource system. On July 12, 2021, Bensalem Township, PA experienced a storm event that exceeded the 100-year storm event condition and demonstrated the long-term stability of this stream and floodplain restoration design as well as the four stormwater outfalls. This post storm-event condition enumerates the plentiful ecological benefits of this type of design approach, including water quality enhancements from sediment deposition within adjacent floodplains, groundwater infiltration within floodplain wetlands, refugia for biological communities, aquatic resource mitigation in a highly urbanized watershed, water quality benefits from stabilized stormwater outfalls, and an environmental education classroom for high school students, all the while remaining ecologically resilient and stable throughout this extraordinary storm event. See **Figure 3** for post construction 100-year storm event stream corridor condition. Incorporation of this proven stream and floodplain restoration design approach should be considered for all types of projects and not just for mitigation, including stormwater management and MS4 permit compliance, however, the rigors of environmental due diligence are a necessity and should be emphasized at project development.

**Figure 3.** Stream corridor condition after 100-year storm event. This is the same location as shown in Figure 1.

# Watershed-wide Flooding and Wet Weather Assessment and Mitigation Study in Fishing Creek Watershed, Columbia County, PA

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## Highlights

- Flooding and wet weather problem area assessment of a 227 square mile study area within the watershed.
- Recent and historic flooding issues are significant with up to 79% of municipal populations lying within the floodplain.
- 75 total problem areas identified, visited, evaluated with conceptual mitigation solutions, and prioritized for use in addressing and implementing projects.

## Introduction

The Fishing Creek Watershed Flood Mitigation Study was a comprehensive effort to identify flooding and wet weather issues within the Columbia County portion of the Fishing Creek Watershed and to investigate the mitigation options available from the site to watershed scale. The study summarized and prioritized 75 problem areas and the associated conceptual projects, recommended areas and issues for further study, and summarized the evaluation of prioritized options. The recommendations in the study were intended to provide public officials with the information to prioritize next steps for mitigating flooding conditions throughout the Watershed.

## Background

The Fishing Creek Flooding Assessment and Mitigation Study was the product of a comprehensive effort to identify flooding and wet weather issues within the Columbia County portion of the Fishing Creek Watershed and to investigate the mitigation options available from the site to watershed scale. It was intended to provide a framework for identifying potential projects that the county and its municipalities could implement to mitigate future flood risk. The study was undertaken to develop recommendations for improved stormwater and flood management practices, to mitigate potential negative impacts by future land uses, and to improve conditions within the County's portion of the Watershed.

**Recommended Problem Area Projects and Strategies**

The flooding and wet weather problem areas within Fishing Creek Watershed varied spatially and in magnitude. The project team developed a system to prioritize projects that considered technical analysis, engineering judgment, and input from public officials and interest groups that participated in the process. Thus, any County-wide or municipal capital improvement program may use these results to guide their scheduling and pursuit of funding. The project team recommended that the county and its municipalities address projects categorized as High Priority Problem Areas first.

**Problem Area Project Prioritization**

A set of criteria were developed to determine the priority of each problem area. Table 1 provides a list of criteria that were used to assess each problem area and potential mitigation concept project. Each problem/project was assigned a rating between 1 and 10 for each of the five criteria. The five criteria were equally weighted to calculate a single relative rating between 1 and 10 for each problem. Additionally, to aid in summarizing and communicating findings, Study Area watersheds were defined and split into 4 sub-areas defined primarily by municipal boundaries. Figure 1 shows all problem areas and the respective prioritization score with the 4 study areas defined by different color bars.

**Table 1.** Problem Area/Project Prioritization Rating Criteria.

| Criteria | Description | Rating |
|---|---|---|
| Frequency of Existing Problem | How frequent was the problem area issue reported to occur? | 1 to 10 |
| Property and Public Impacts | Does the problem area impact individual properties or busy public spaces? | 1 to 10 |
| Problem Reduction | How well does the mitigation concept improve flooding/wet weather conditions? | 1 to 10 |
| Resiliency | How long will the proposed solution last and/or how frequent does it require maintenance? | 1 to 10 |
| Cost of Solution | Will the solution cost less than $250,000, more than $250,000 but less than $1 million, greater than $1 million to resolve? | 1 to 10 |

## Key Findings and Recommendations

For the municipalities outside of the Bloomsburg-Orangeville-Stillwater-Benton corridor of the mainstem of Fishing Creek (Sugarloaf, Pine, Greenwood, Jackson, Millville, Madison), it was most prudent to fix each problem individually since there is not yet an identified dense pattern of problem areas that are directly related to watershed initiatives. Within the Hemlock Creek-Lower Fishing Creek, Middle Fishing Creek, and Upper Fishing Creek Study areas, there are two distinct types of problem areas: 1) shallow channels and large bedload movements and 2) floodplain encroachment. The mainstem Fishing Creek Watershed from Bloomsburg to Benton are impacted by development and agricultural land uses encroaching on the floodplain and stream channel. These areas have all identified problems in or near the creek and contribute flow downstream thus increasing the potential to exacerbate existing problems as the creek flow moves downstream towards Scott Township, Mt. Pleasant Township, the Town of Bloomsburg, Hemlock Township, and Montour Township. The mainstem of Fishing Creek from Benton to Bloomsburg has 23 of the Watershed's defined problem areas and 8 of them are designated as high priority problem areas.

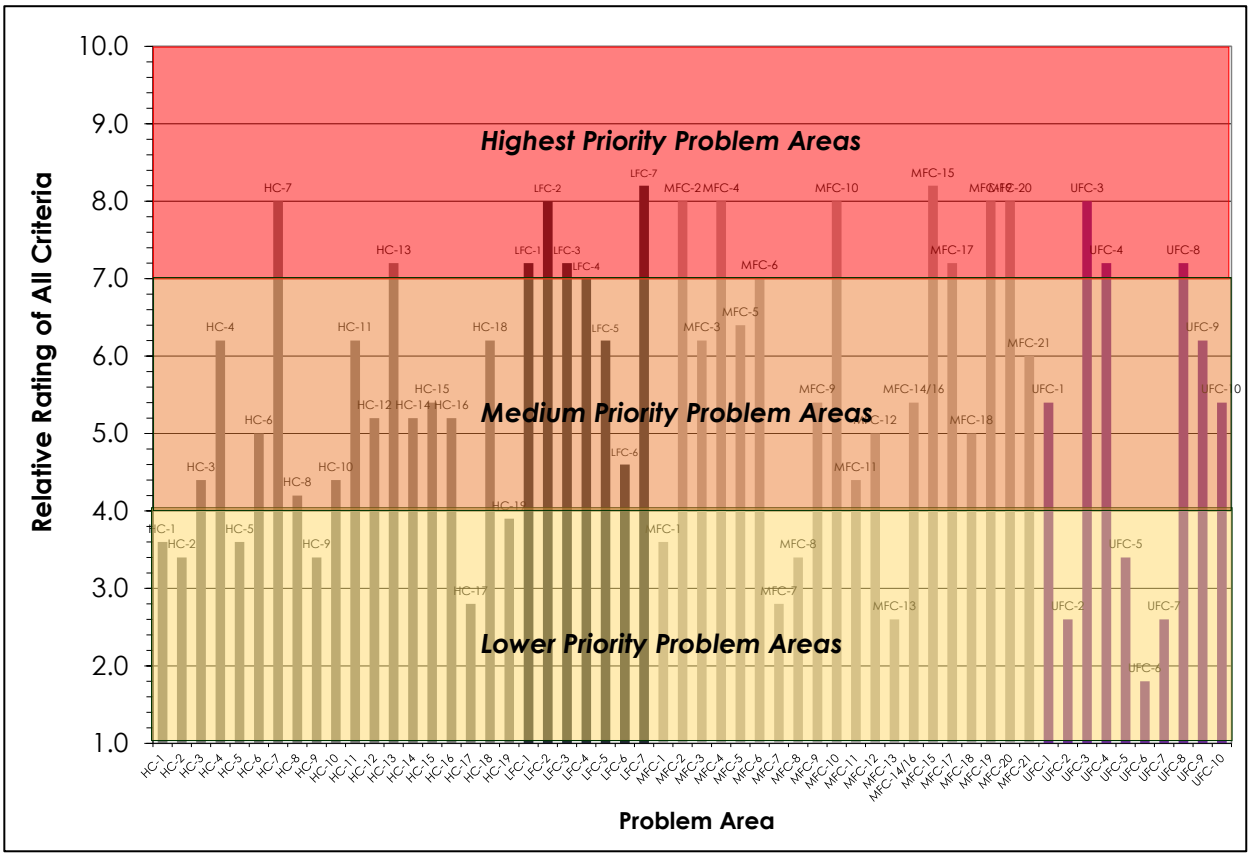


**Figure 1.** Fishing Creek Watershed Relative Problem Area Prioritization Rating.