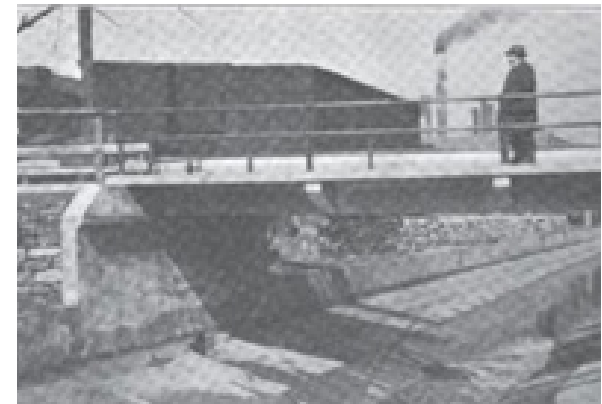


Pennsylvania Department of Transportation

Paxton Creek Master Plan

A Harrisburg Transportation Center Transit-Oriented
Development Supporting Study

February 2018



pennsylvania

DEPARTMENT OF TRANSPORTATION



HARRISBURG TRANSPORTATION CENTER

A TRANSIT-ORIENTED DESIGN VISION



Paxton Creek from pedestrian bridge on the Capital Area Greenway near the Susquehanna River

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Acknowledgements

This document and supporting technical studies referenced herein were prepared and published by the Pennsylvania Department of Transportation and its consultant Michael Baker International in cooperation with the City of Harrisburg and Capital Region Water.

Photo Credits and Graphics: Michael Baker International unless otherwise noted.



1 *Paxton Creek viewed from the State Street Bridge, viewed to the south*

Introduction

The Paxton Creek Restoration Master Plan (Master Plan) provides a comprehensive strategy to restore the natural ecological function of the creek's southern or lower reach, which extends approximately 6.2 miles (272,950 linear feet) from the Dauphin County (PA)-owned Wildwood Lake Morning Glory spillway structure in Susquehanna Township south through the City of Harrisburg to its confluence with the Susquehanna River (Figure 1). For the purpose of this Master Plan, this section is referred to as Paxton Creek.

Centuries of growth and development have had extensive impacts on Paxton Creek's ecological health and this Master Plan provides a feasible Natural Stream Channel Design (NSCD) approach to mitigate the creek's ecologically impaired condition. The NSCD approach will create a linear Urban Green Space (UGS) along the Paxton Creek corridor to its confluence with the Susquehanna River, offering recreational benefits, community connectivity and redevelopment opportunities, while addressing flood control, sediment control, clean water, and habitat restoration.

The lower segment of Paxton Creek represents the southern-most reach of the Paxton Creek Watershed, which drains a 27.3 square mile area to the Susquehanna River providing half of the Chesapeake Bay's freshwater inflow. Paxton Creek includes several tributaries - the largest being Asylum Run at 3.7 square miles. This lower portion serves as the study area for this Master Plan.

Paxton Creek Restoration Project

Goal
Transform Paxton Creek into an Urban Green Space (UGS) to restore the creek's ecosystem and improve its functions and services.

Objectives

- Create a natural stream channel with the appropriate dimension, pattern, and profile
- Provide adequate channel size and flood conveyance to reduce 100-year flood elevation to 314 feet
- Establish a riparian ecosystem that is supportive of natural biota
- Improve water quality by reduction of nutrients and chemical pollutants
- Provide balanced sediment transport
- Provide stormwater retention and treatment
- Create in-stream habitat and flow diversity
- Achieve bank stability and riparian buffers
- Create increased opportunities for passive recreation and aesthetics
- Provide a multi-use pathway for bicycle and pedestrian access through the corridor

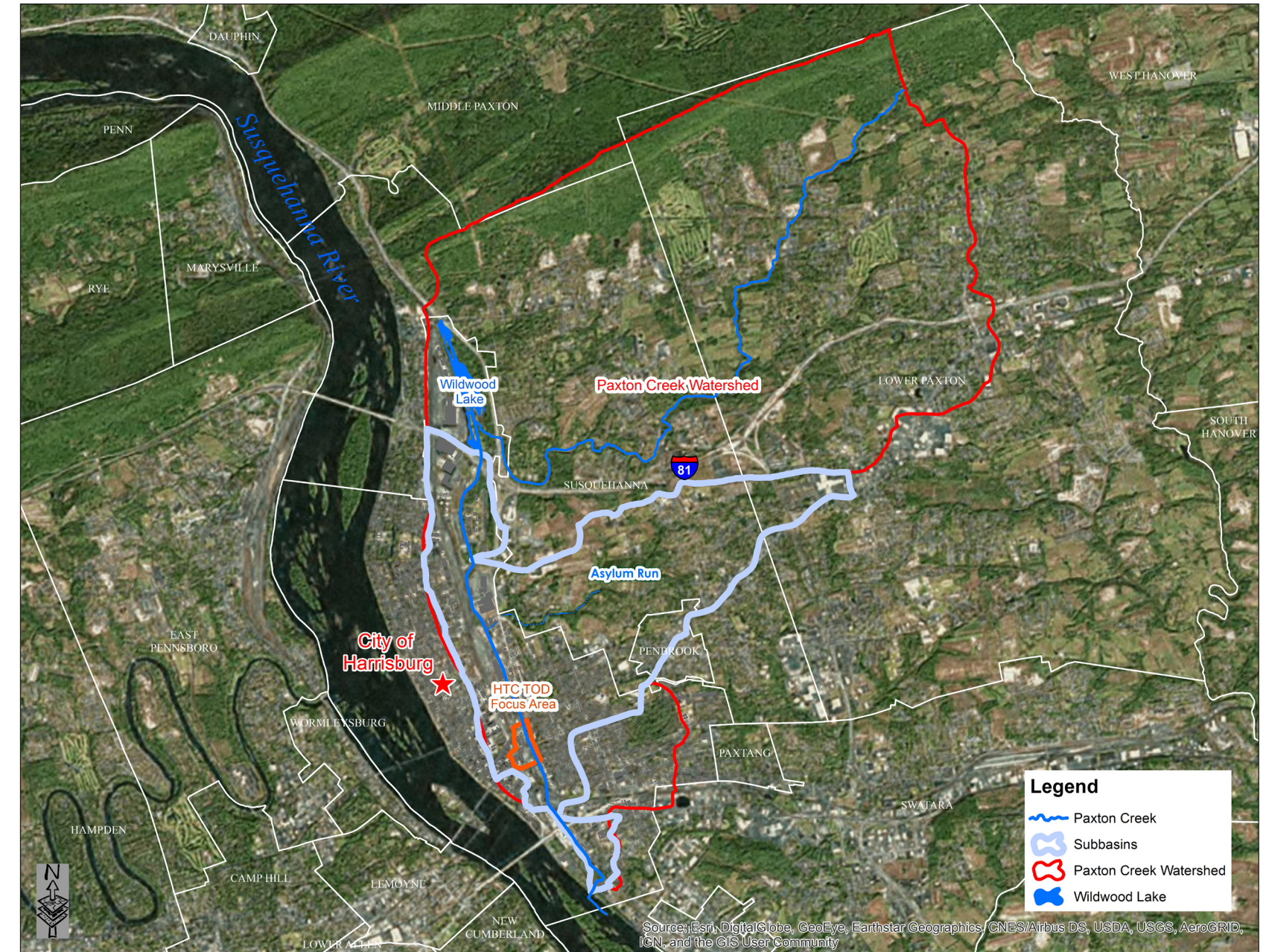


Figure 1: Paxton Creek Project Area [Esri DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community]



Purpose & Need

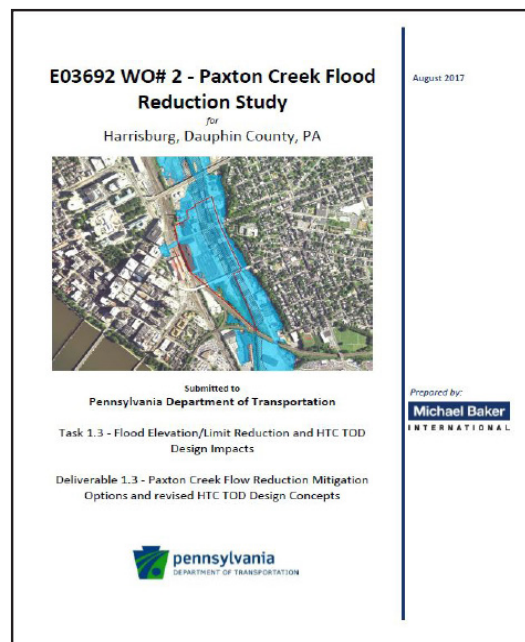
In 2016, the Pennsylvania Department of Transportation (PennDOT) in partnership with the City of Harrisburg, Harrisburg Redevelopment Authority, Amtrak, and Norfolk Southern completed a Transit Oriented Development (TOD) Master Plan for the Harrisburg Transportation Center (HTC) and surrounding Market Street corridor adjacent to Downtown Harrisburg. The **HTC TOD Master Plan** (December 2017) envisions the HTC and a number of surrounding properties for new, transit-oriented, mixed-use development that could be used to increase densities around the HTC and encourage wider use of rail, bicycle, and pedestrian transportation modes. **It further envisions that the portion of Paxton Creek extending through the TOD Focus Area be transformed into an urban green linear park connecting nearby neighborhoods and communities to multimodal transportation services and Downtown Harrisburg.**



HTC TOD Master Plan Cover

1. Pennsylvania Department of Transportation, Agreement E03692, Work Order #2, Tasks 1.1 – 1.3.

During the HTC TOD planning process, community participants repeatedly noted flooding as a major factor affecting development in the TOD area. In response, PennDOT tasked its technical consultant, Michael Baker International, with conducting a **Paxton Creek Flood Reduction Study**¹ to evaluate the dynamics of the flooding situation caused by the confluence of the Susquehanna River and Paxton Creek. Although the river’s flood elevation cannot be feasibly modified, the study’s hydrologic and hydraulic analyses did confirm the feasibility of reducing the width of Paxton Creek’s floodway and lowering the creek’s current flood elevation from 317 feet to 314 feet. These physical modifications to Paxton Creek can result in increasing the creek’s conveyance capacity, as well as increasing opportunities for water absorption and storage. **Lowering the flood elevation would not only maximize the redevelopment potential within the HTC TOD study area, but would greatly reduce the floodplain impacts to properties located north and south of the TOD area (Figure 2).**



Paxton Creek Flood Reduction Study Cover

Specifically, the study determined that approximately 133 acres (73 parcels) could be entirely removed from the FEMA 100-year floodplain and therefore no longer subject to flood insurance requirements. Similarly, approximately 275 acres of land (147 parcels) could be partially removed from the 100-year floodplain by raising building structures two feet or adding two feet of earthen fill for new development. While the latter category would still be required to maintain flood insurance, **a total of over 400 acres (220 parcels) along the Paxton Creek corridor would have improved development potential and be postured to improve the City’s tax base.**

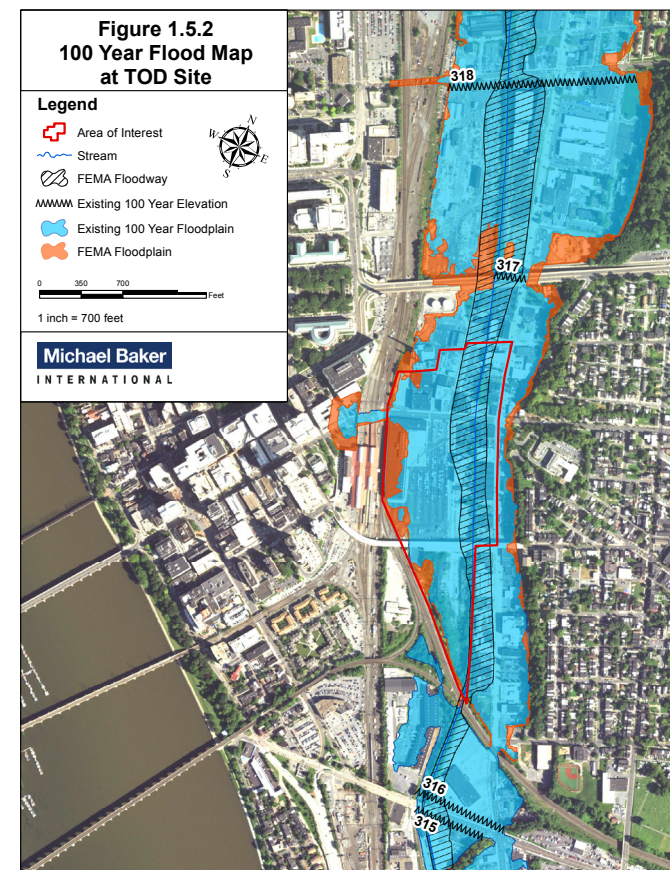


Figure 2: 100 Year Flood Map of TOD Site



Figure 3 illustrates the 220 parcels affected by reducing Paxton Creek’s flood elevation from 317 feet to 314 feet. The green colored parcels represent the areas that would be totally removed from the 100-year floodplain and the yellow parcels represent those that would be partially removed through engineering controls and earthen fill applications.

Figure 3: Paxton Creek Project Area



Existing Conditions

The majority (92 percent or 253,220 linear feet) of **Paxton Creek** is a highly modified concrete-lined channel that was constructed by the City of Harrisburg circa 1914 to remedy its heavily polluted and stagnant condition resulting from the City's rapid urban and industrial development beginning in the early 1800s. **Such growth and development has caused extensive ecological degradation to Paxton Creek and it currently suffers from Urban Stream Syndrome (USS).** Urban Stream Syndrome is typified by flash flooding, elevated concentrations of nutrients and contaminants, altered channel morphology, and reduced biotic richness with an increased dominance of non-native species.

Paxton Creek's USS condition ultimately led to the following determinations and regulatory actions taken by the Pennsylvania Department of Environmental Protection (PADEP) and the United States Environmental Protection Agency (USEPA).

- In 2013, the PADEP determined that 20 miles (approximately 40 percent) of Paxton Creek (including all of the project study area reach limits) are considered impaired by sediment, with over 86 percent of the sediment contributed by stream erosion. To address this impairment, the USEPA published a Total Maximum Daily Loading (TMDL) Report that required all entities discharging stormwater or combined sewer overflows to Paxton Creek to collectively reduce sediment loads by 35 percent.
- In 2015, the USEPA announced a partial settlement (Consent Decree) with the PADEP, the City of Harrisburg, and Capital Region Water (CRW) to resolve alleged Clean Water Act violations involving sewer overflows and discharges of polluted stormwater to the Susquehanna River and Paxton Creek.



Urban Development Adjacent to and Deterioration of Modified Stream Channel

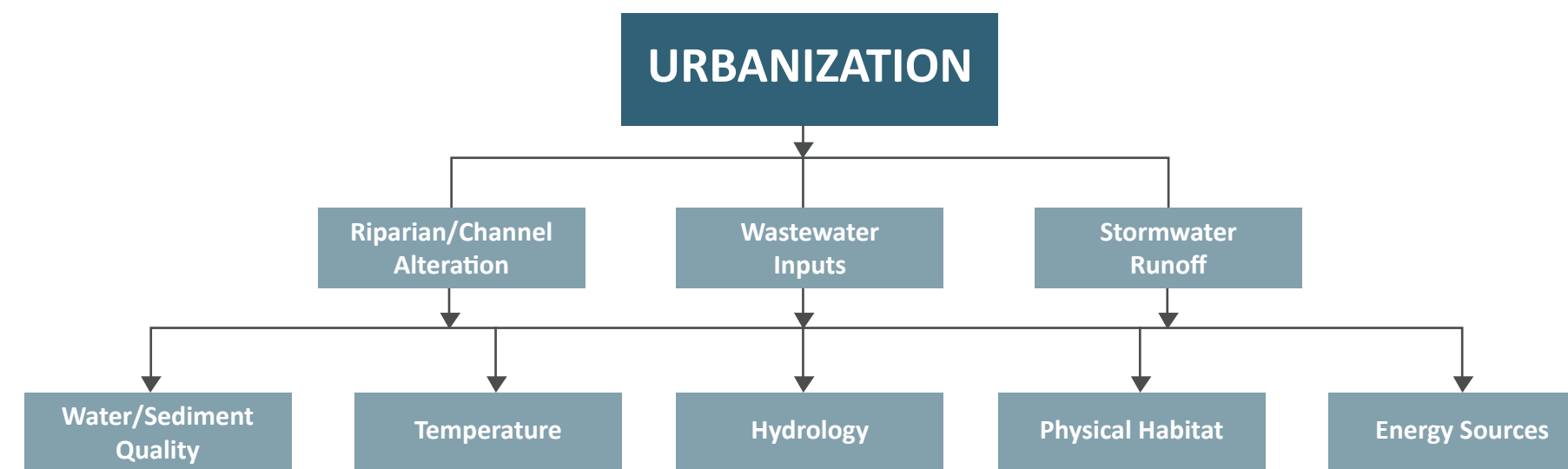


Figure 4: EPA Causal Analysis/Diagnosis Decision Information System (CADDIS) Urbanization Model to Determine USS

According to the EPA's Causal Analysis/Diagnosis Decision Information System (CADDIS) stressors like, water/sediment quality, temperature increases, stormwater, flooding, channel modifications, and loss of vegetated riparian zones lead to Urban Stream Syndrome (Figure 4). Urbanization alters stream biota and influences stream ecosystems. "Restoration (renaturalization, unchannelization) is the only way to achieve good ecological status (health) and only a source-focused restoration of urban creek channels and rehabilitation of physical habitats for aquatic biota will provide the expected increase of biodiversity"².

According to the PA Code Chapter 93 Water Quality Classifications, Paxton Creek has a Warm Water Fishes (WWF) and Migratory Fishes (MF) designation and is listed as impaired due to Combined Sewer Overflow-DO/BOD, Urban Runoff/Storm Sewers-Suspended Solids, Urban Runoff/Storm Sewers-Water/Flow Variability, and Urban Runoff/Storm Sewers-Other Habitat Alterations.

2. Komínková, Dana. (2012). The Urban Stream Syndrome – a Mini-Review. The Open Environmental & Biological Monitoring Journal. consent-decree-city-harrisburg-pa

The series of images depicted in **Figure 5** illustrate Paxton Creek’s impaired conditions including its channelization, low flow and stagnant pools, point source outfalls, trash and debris, invasive species, and lack of accessibility and recreational opportunities.



Figure 5: Impaired Conditions Along Paxton Creek



Paxton Creek's Degradation

Historically, the City of Harrisburg has been an important settlement, trade, and cultural area that was occupied by numerous Native American tribes dating back as early as 5,000 years ago. Since its formal settlement in the 1700s, Harrisburg emerged as an important regional commerce center serving as a gateway stop on east-west routes and north-south travel on the Susquehanna River. In 1812, Harrisburg became the State Capital, and by the 1830s the City was part of the Pennsylvania Canal System and a strategic juncture for the nation's burgeoning railroad transportation industry. Additionally, the steel industry, among others, played a major role in the economy of Harrisburg and it evolved into a highly industrialized urban center.



Source: Paxton Creek Rivers Conservation Plan

Penn Railroad PA Canal Paxton Creek

Harrisburg in 1855

Harrisburg civic leaders realized the negative environmental effects of urbanization and embraced the “City Beautiful Movement” (circa 1899) to promote clean air and green spaces for the community.³ In 1901, engineers and city planners were tasked with designing infrastructure and other public works projects to mitigate the City's growing sewage and urban blight issues. **Paxton Creek was a focus of Harrisburg's renaissance, and from 1900 to 1915, sewers, water filtration plants, asphalt roads, and parks were built. Of these projects, two are of most significance to the Paxton Creek Restoration Project: Paxton Creek Interceptor Sewer and Concrete Channelization of Paxton Creek.**

The Paxton Creek Interceptor Sewer largely remains intact per its original 19th century construction, and it is currently owned, maintained, and operated by Capital Region Water (CRW). The interceptor's age and alignment with the railroad and former Pennsylvania Canal create significant challenges for CRW to properly maintain the system. **This Master Plan provides the opportunity to assist CRW with updating the interceptor sewer infrastructure as part of the overall flood reduction and habitat restoration strategy and permitting requirements.**

Despite the construction of the Interceptor Sewer, Paxton Creek still suffered from tremendous pollution. **The creek bed's relatively flat gradient and dry season low flows created foul smelling stagnant pools that became breeding grounds for mosquitoes and other disease carrying vectors. To remedy this problem, the City constructed an approximately 15,000-foot reinforced concrete channel circa 1914.** The channel, which still exists today in various states of disrepair, extends from the creek's juncture with Asylum Run south through the City to a point just below Shanois Street.

In addition to infrastructure improvements, a plan (Figure 6) for the parks or ‘green belt,’ designed by a landscape architect Warren H. Manning, included enlarging the City's only existing park (Reservoir Park), the entire river front, some islands, and some parcels along Cameron Street and Wetzel Swamp (now Wildwood Lake). Although many projects were eventually abandoned, some City parks were constructed.

3. City Beautiful Movement and Harrisburg's Old 8th Ward. <http://www.old8thward.com/citybeautiful.htm>

An analysis of the Harrisburg City plan by Manning's office indicates that he considered the Paxton Creek corridor an important component of the City's green space network, using it as a central “spine” connecting the other green spaces. His commentary, while explicitly calling for the preservation of the vegetation along the creek, was ignored seven years later when the U.S. Government was in the midst of constructing the Panama Canal. In that era of grand projects, Paxton Creek was summarily

placed into the open concrete sewer system, designed smaller than required and intended to flush itself regularly. More than a century later, it is clear the channel is inadequate. The 2016 community effort of City Beautiful 2.0 notes Manning's vision, and while the current proposal to restore Paxton Creek may be bolder than City Beautiful 2.0 considered feasible, the project restores Manning's vision and strengthens the objectives of City Beautiful 2.0.

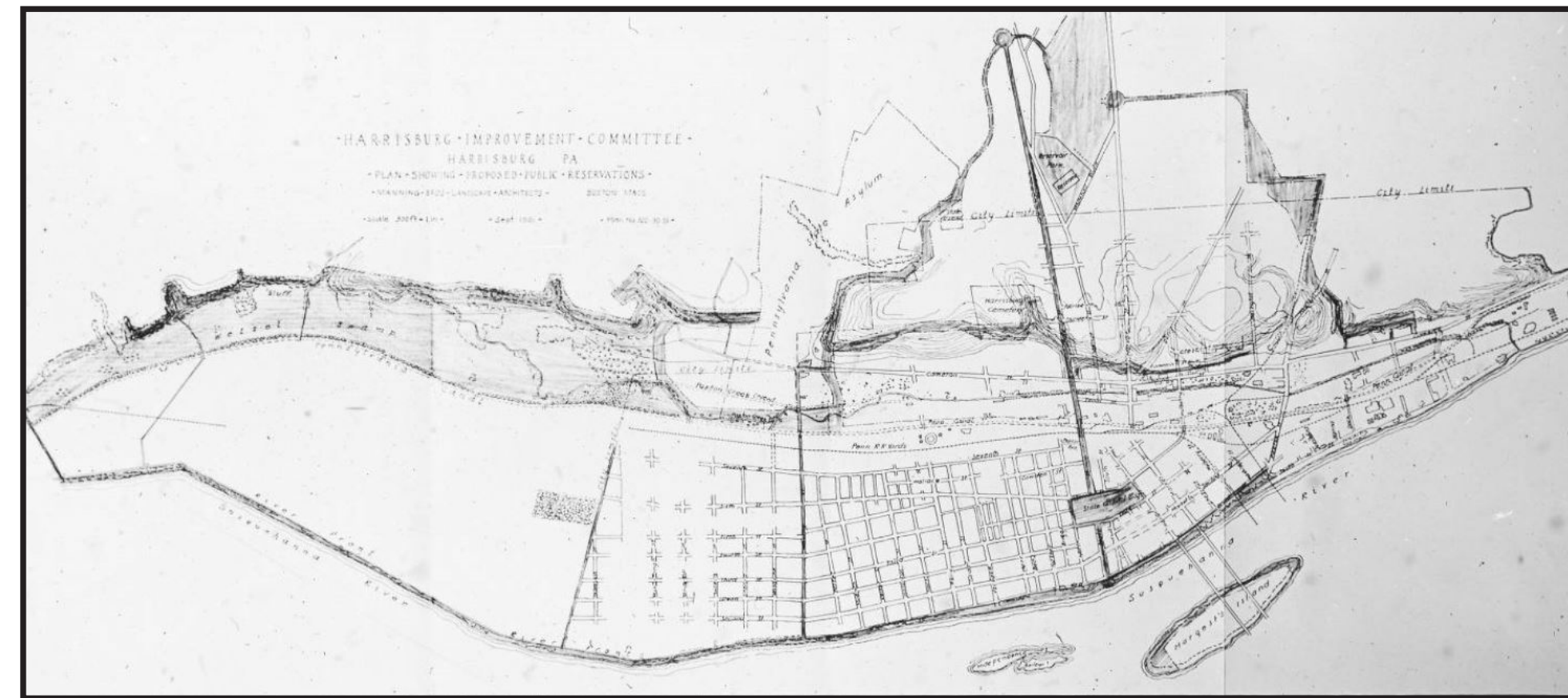
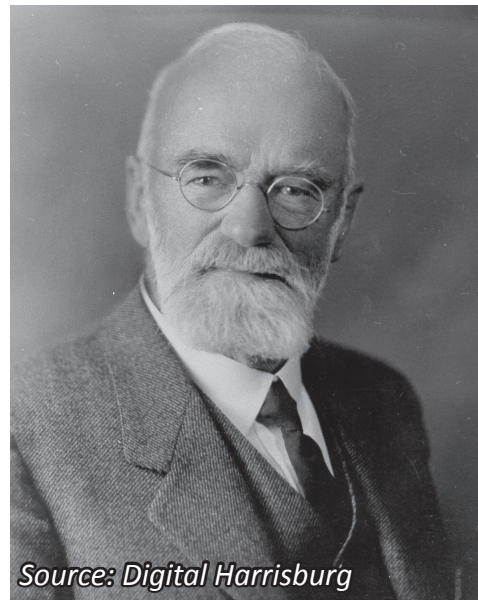


Figure 6: Original Harrisburg, Pennsylvania Park Scheme [Manning Brothers Plan No. 322-30-33, September 1901]

The continued degradation of the entire Paxton Creek Watershed over the past 200 years has permanently changed the ecosystem of the creek. In addition to development, pollution, and stormwater impacts, non-native species have proliferated throughout the watershed. Remaining natural habitats and ecosystems are fragmented and largely isolated from one another.



Source: Digital Harrisburg

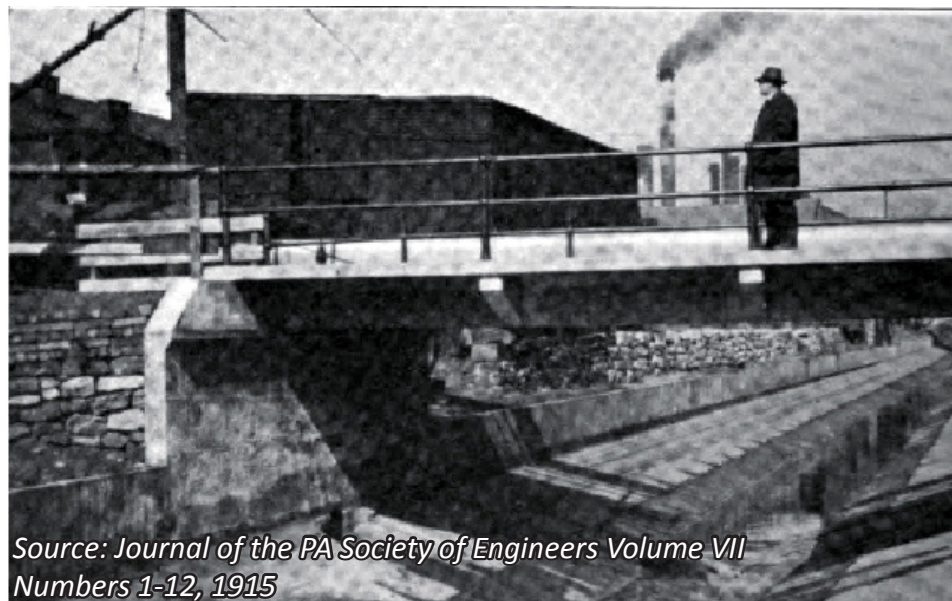
Warren Manning

“Where the stream passes through the city it receives the discharges from several large sewers, which, during dry weather, pollute the water and foul the shores and bottom of the creek to a very objectionable extent.”

-- Proposed Municipal Improvements for Harrisburg, PA, 1901



Paxton Creet at Walnut Street Before Channelization, 1913



Paxton Creek at Walnut Street After Channelization, circa 1914



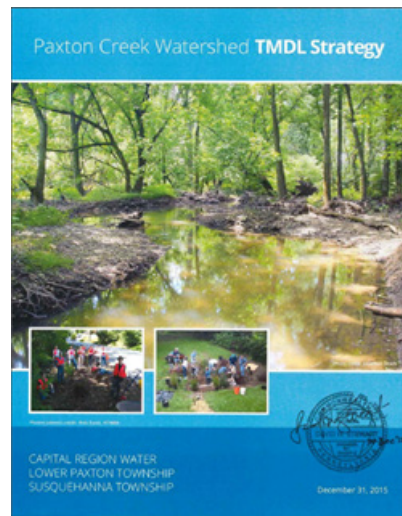
Paxton Creek at Walnut Street, 2017



Paxton Creek Restoration Movement

Growing concern over the Paxton Creek Watershed’s deteriorated ecological condition led to the formation of the Paxton Creek Watershed & Educational Association (PCWEA) in 2000 to begin developing watershed-wide initiatives focusing on education, stream assessments, and monitoring. **The PCWEA’s efforts culminated into the creation of the Paxton Creek River Conservation Plan (RCP) in 2006, and it provides background, strategies, and tactics for reaching the goals and objectives of rehabilitating and enhancing Paxton Creek.**

More recently, the **Paxton Creek Watershed TMDL Strategy** (December 2015)⁴ developed by CRW in collaboration with Susquehanna Township and Lower Paxton Township, developed a single, comprehensive watershed-wide TMDL approach to solve the stream’s erosion, sediment load, and resulting habitat degradation. These were identified in the TMDL as a major source of water quality impairment in Paxton Creek.



Previous Paxton Creek Plans and Studies Covers

4. Paxton Creek Watershed TMDL Strategy. Capital Region Water. Retrieved online at <https://capitalregionwater.com/wp-content/uploads/2015/11/Paxton-Creek-Watershed-TMDL-Strategy-Final-123115.pdf>.

Other complementary restoration efforts included the following:

- **The City as a Park – A Strategic Initiative Adopted by City Beautiful 2.0 (CB2 “City as a Park” Working Group, March 2016):** This document presents a plan based on the concept “City as a Park” from the City Beautiful Movement that flourished in Harrisburg in the early 1900s.
- **Paxton Creek Stormwater Project (Susquehanna River Basin Commission, 2010):** This presentation discusses the approach for stormwater issues for Paxton Creek Watershed using education/outreach, demonstration projects, and management studies.

Figure 7 illustrates a timeline of Paxton Creek’s evolution characterizing major events contributing to its degradation and rehabilitation.

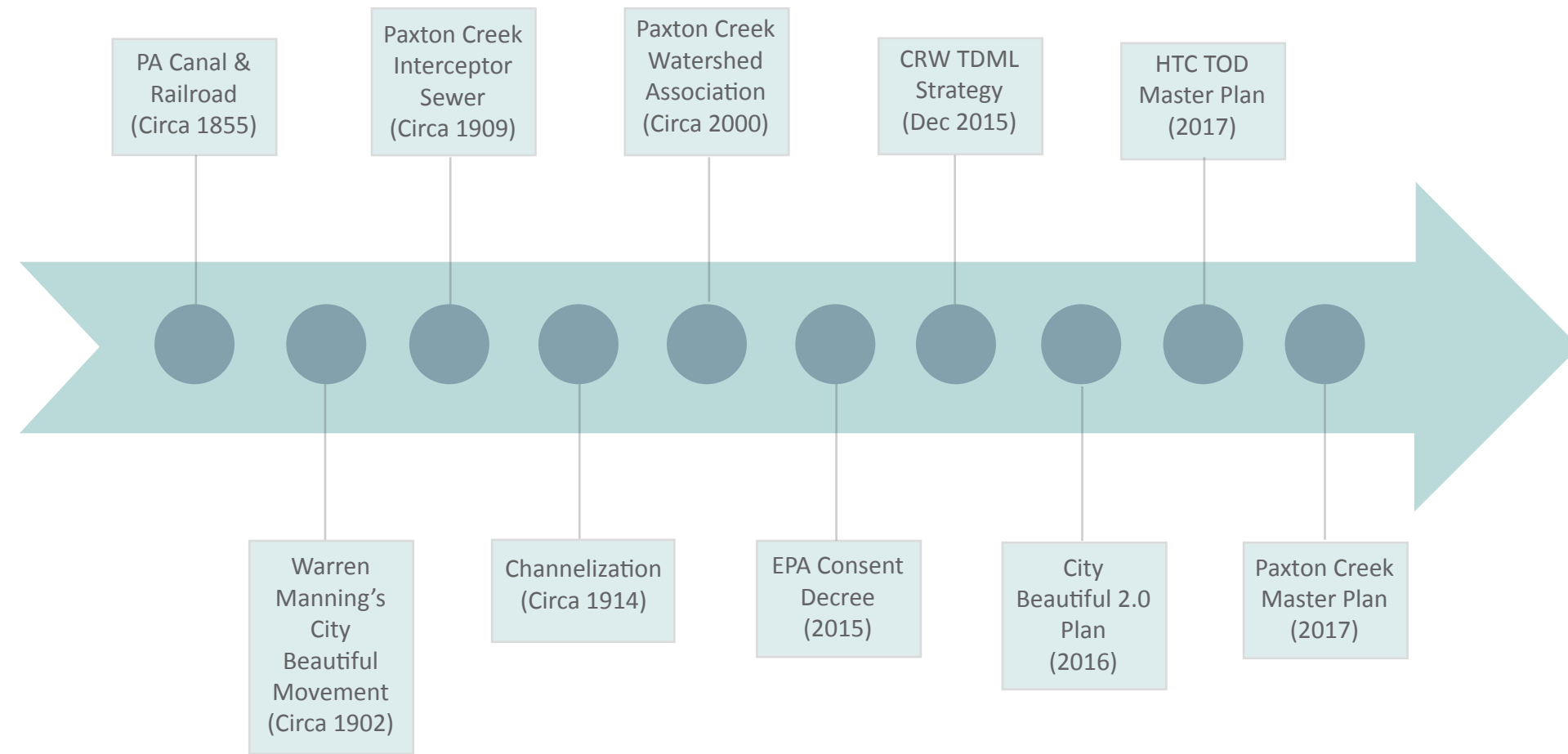


Figure 7: Paxton Creek Evolution Timeline



Paxton Creek Restoration Design

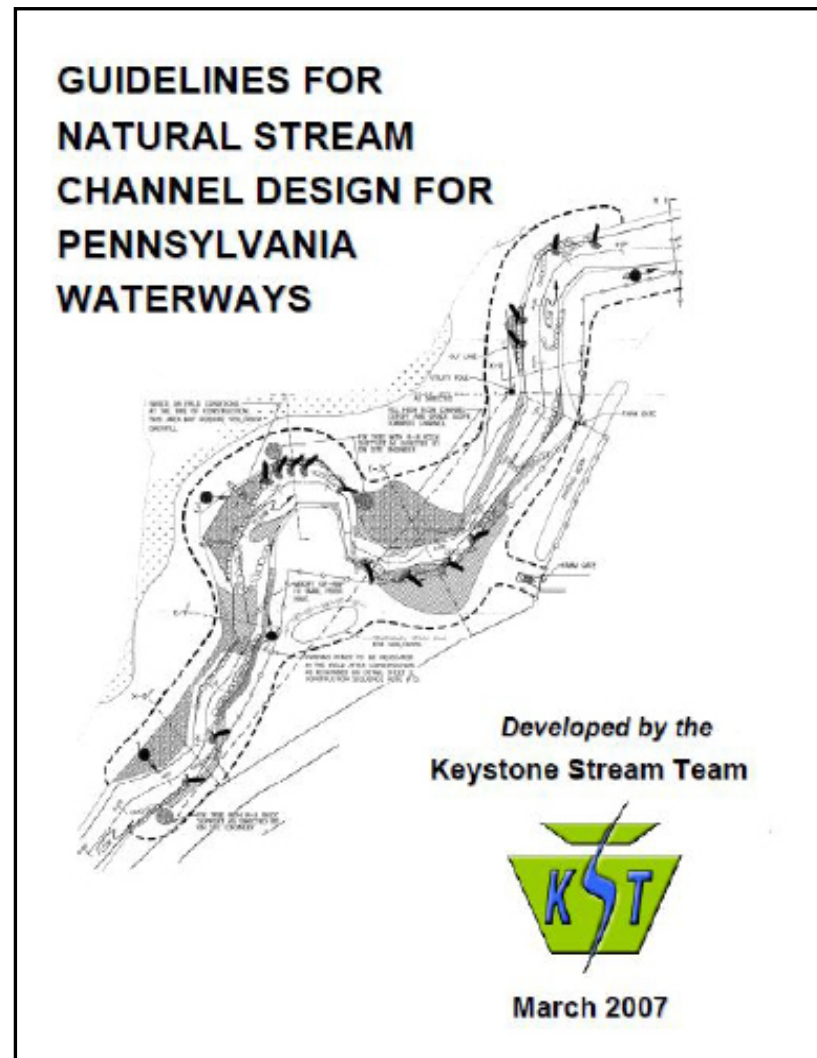
Natural Stream Channel Design Approach

During the Paxton Creek Flood Control Reduction Study process, PennDOT and Michael Baker International staff, along with representatives from the City, CRW, and Susquehanna and Lower Paxton Townships, held preliminary coordination meetings with regulatory agency representatives from PADEP and the U.S. Army Corps of Engineers to discuss the study's objectives and preliminary findings and to determine the necessary regulatory requirements for the permitting process. **These meetings placed significant emphasis on the value and opportunity for the project to holistically address the creek's USS by restoring the creek's ecosystem and reestablishing the creek's natural functions and services, including its aquatic connection to the Susquehanna River.**

The project's proposed multi-use pedestrian and bicycle pathway connecting the HTC TOD area with the Capital Area Greenbelt (CAG) Trail would serve as a critical stormwater Best Management Practice (BMP) by providing pre-treatment to runoff and outfall point sources from adjacent commercial and industrial properties. **Figures 8 – 9** illustrate typical cross-sections of the proposed creek channel restoration designs that include the multi-use path and adjacent pre-treatment BMP swale.

The Paxton Creek Restoration Master Plan establishes a conceptual Natural Stream Channel Design (NSCD) approach to holistically improve the biological and morphological function of Paxton Creek. The NSCD approach is based on fluvial geomorphology (FGM), which is the study of a stream's interactions with the local climate, geology, topography, vegetation, and land use. **The restoration project will reduce sedimentation pollution and improve water quality (temperature, Dissolved Oxygen (DO) and pH).**

The NSCD approach will ultimately improve water quality to support a more diverse macroinvertebrate community and greatly improve the quality of life for habitat and residents alike.



Guidelines for Natural Stream Channel Design Cover

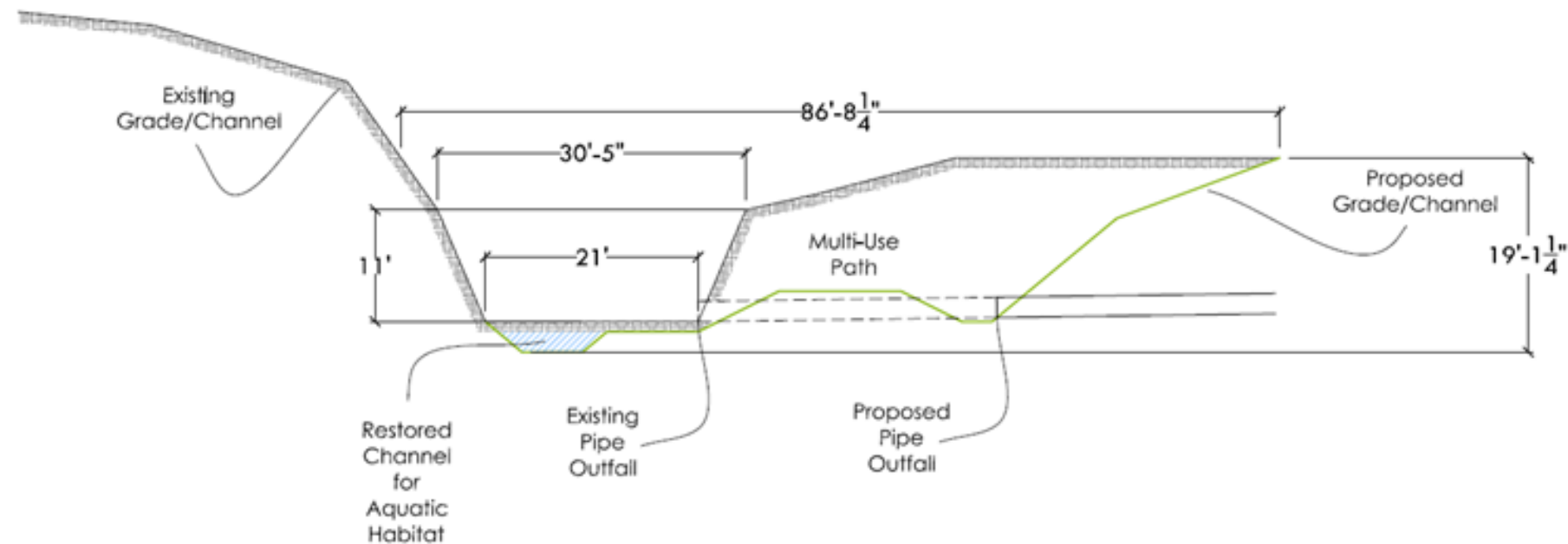


Figure 8: Paxton Creek Typical Channel Design and Multi-use Path Cross-Section

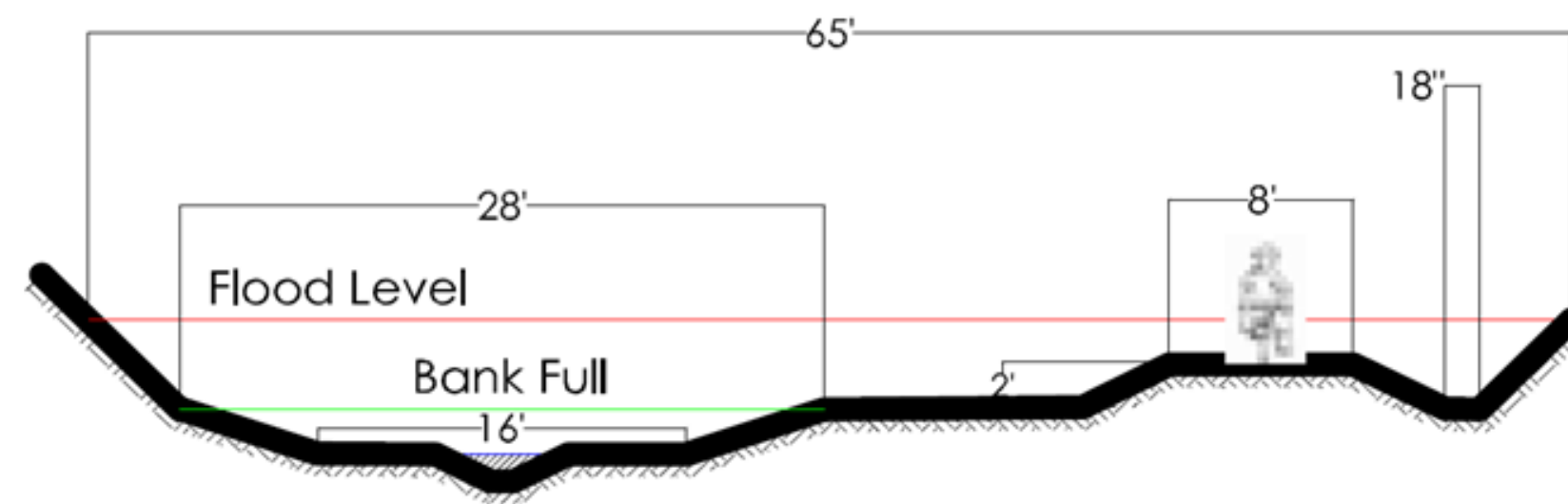


Figure 9: Paxton Creek Design Cross-sections: Channel Section | Maclay St. to Herr St.

The NSCD approach for improving the natural function and stability of Paxton Creek primarily consists of the following:

1. Establishing a multi-stage channel – A major component of restoring Paxton Creek will be to reestablish a natural multi-stage channel, which is a channel cross section consisting of a base flow, bankfull, and floodplain hydraulic stages (**Figure 10 - 11**). Through these multiple stages, Paxton's flow will be collected within an appropriately-sized channel that will increase velocity and sediment transport power. This will aid in eliminating the heavy siltation and the following of stagnant water prominent throughout the creek. Another advantage of a multi-stage channel is that it allows for a more natural distribution of flood flows through additional floodplain area and increasing floodplain connectivity.

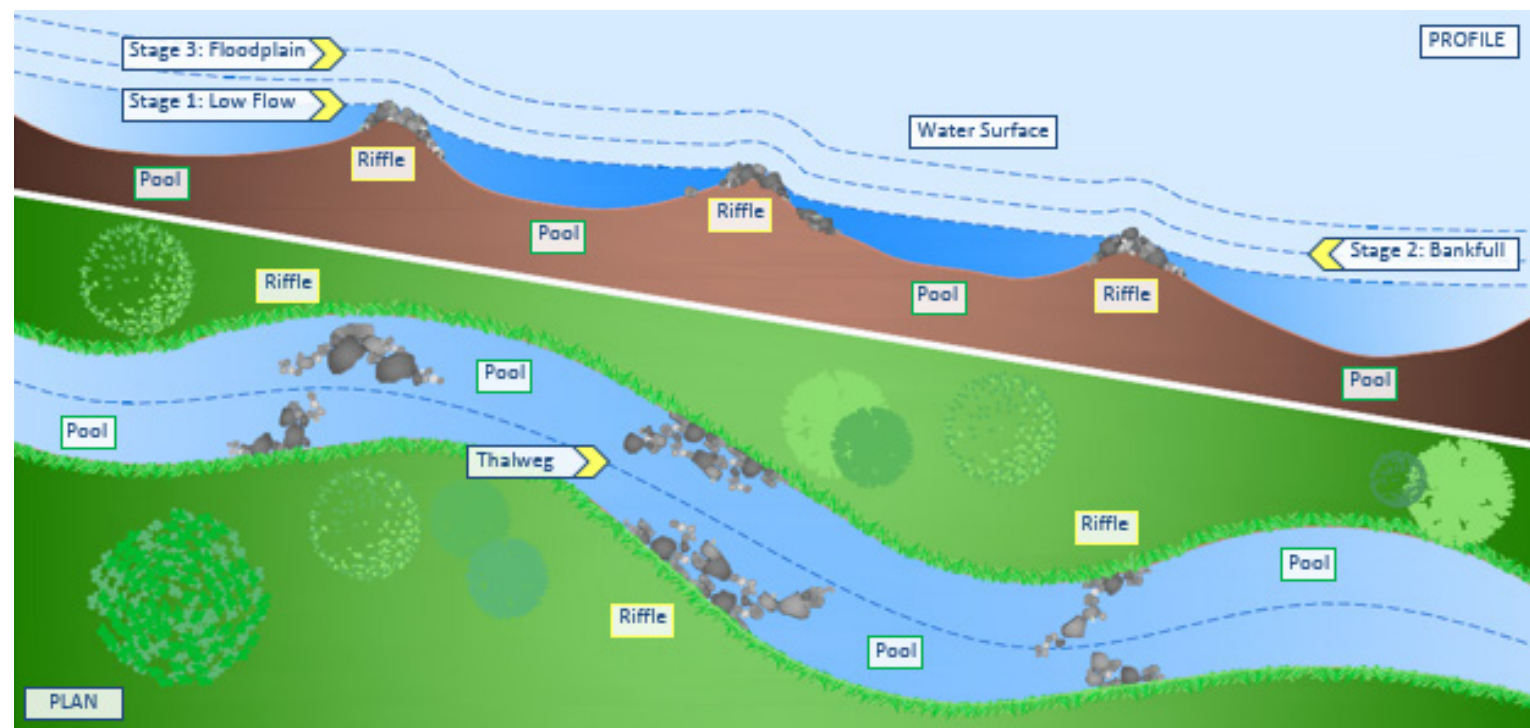


Figure 10: Typical Multi-stage Creek Channel Design

The establishment of a larger, more natural floodplain will allow for an overall increase in hydraulic capacity of the channel and decrease the flooding impacts to adjacent properties.

2. Creating a pool-riffle sequence – Pools and riffles develop as a stream's hydrological flow structure alternates from areas of deep to relatively shallow water. Riffles are formed in shallow areas by coarser materials, such as gravel deposits, over which water flows. Pools are deeper, calmer areas whose bed load (in general) is made up of finer material such as silt. Pools and riffles are not only critical elements to sediment transport and distribution of velocities, but they also play a critical role in chemical biological process, particularly pertaining to fish passage and oxygenation.

3. Establishing a natural sinuosity – Equally critical as and related to the pool-riffle sequence is stream sinuosity, which is a stream's tendency to bend and meander in an S-shaped pattern across its floodplain. The meander geometry and spacing of riffles and pools increase a stream's ability to equalize the transport of sediment while reducing scour along the channel banks.

4. Implementing in-stream structures – The application of in-stream structures will enhance channel stability and the riparian habitat. Natural stream design structures like rock/log vanes, cross rock vanes, cover boulders, and rootwads reduce bank erosion and can create habitat pools and fish cover. Riparian vegetation provides shade, habitat, and detritus material. The proposed bedload will be comprised of several source materials including natural aggregate sourced from the existing stream,

borrowed aggregate from other adjacent projects, and quarried stone. Suitable bed stone material creates habitat for macroinvertebrates and fish passage.

5. Establishing naturalness and native plantings - A stream's riparian zone forms the 'land-water' connection and is an important buffer with a high ecological function and value. There should be a variety of native species that include different heights, shapes, and ground cover along with flowering species to attract birds and pollinators. In addition to riparian plantings, the proposed project will have multiple habitats including wetlands, meadows, and tended green spaces. The UGS should have a diverse, layering of native species utilized by wildlife as a food source and nesting/resting areas.

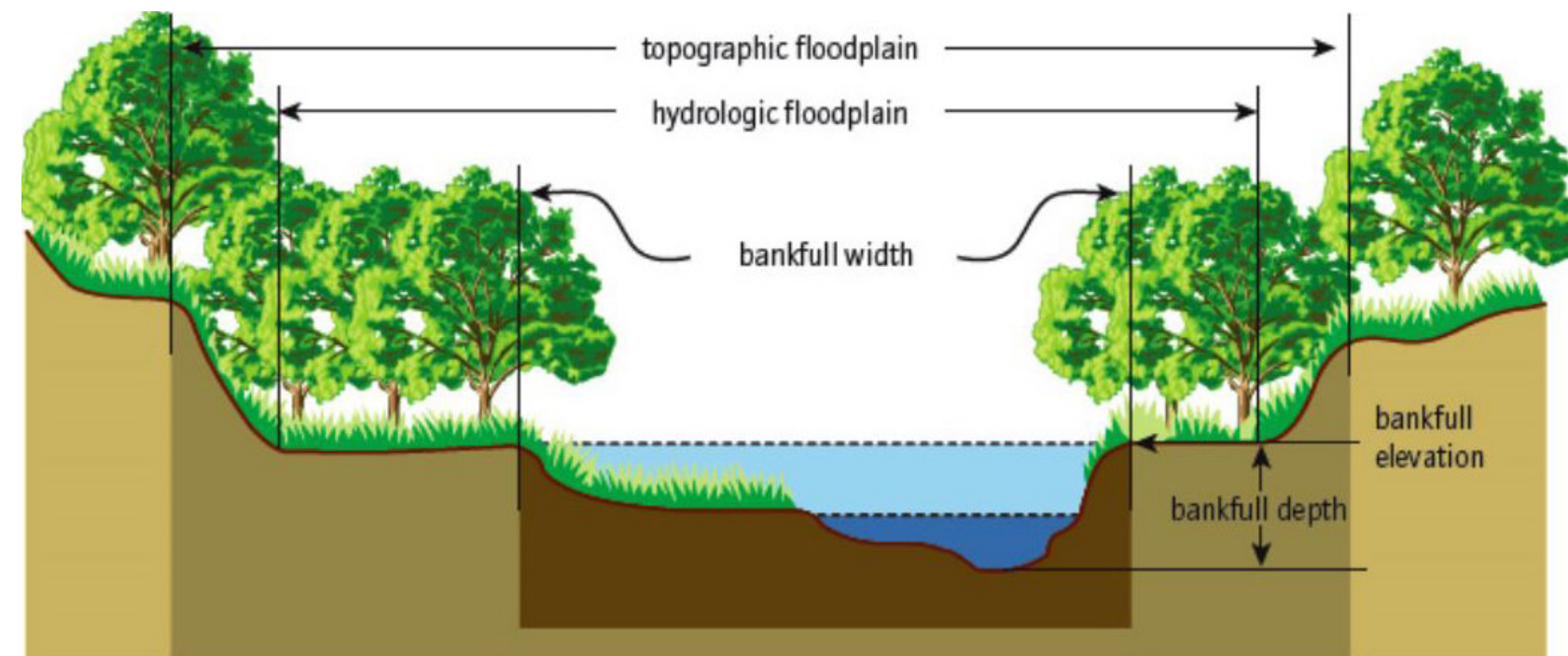


Figure 11: Section of Typical Multi-stage Creek Channel Design [Stream corridor restoration: Principles, processes, and practices. October 1998]

6. Creating habitat for wildlife – Consideration of potential wildlife use in a UGS plan is also critically important. This Master Plan considers five specific native species to help propose habitat niches within the proposed concept plan. The species include a few fairly common species whose habitat can be established in the proposed plan. The list also includes scarce or declining species in the region with ecological connections that need help in order to survive and flourish. Such species include Great Egret, Eastern Bluebird, Bumblebee, Monarch butterflies, Dragonflies, and various fish (e.g., Darters, American Shad, Rock Bass, Redbreast Sunfish, Pumpkin Seed, Smallmouth Bass).

Urban Green Space

As previously discussed, the Paxton Creek is envisioned as an UGS corridor that will include recreational benefits, community connectivity, and redevelopment opportunities with improved ecological function. More specifically, **the Paxton Creek UGS will act as a linear north-south corridor combining both a naturalized stream channel and a multi-use pathway for wildlife and human movement and also add ecological value creating feeding, breeding, nesting, and resting areas between Wildwood Lake and the Susquehanna River.**

Maintaining functional connections between patches of similar habitat allows free movement of species from one area to another. The surrounding environment in Harrisburg is predominantly urban



Source: All About Birds

Species of Wildlife in the Paxton Creek Area



Source: French Tribune



Source: flicker



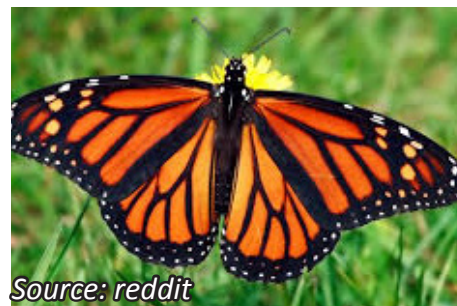
Source: HD Wallpapers



Source: AP



Source: Audubon



Source: reddit



Source: Nature Museum



Source: Wikipedia

development; however, the existing parks and streams create habitat patches and corridors that ultimately connect to the Susquehanna River. Creating a UGS that becomes a habitat corridor between Wildwood Lake and the Susquehanna River could mimic a natural area where there are genetic exchanges and biodiversity among flora and fauna species. As illustrated in **Figure 12**, the Paxton Creek UGS adds additional green space connection with a pattern that mimics a remnant of the river's back channel.

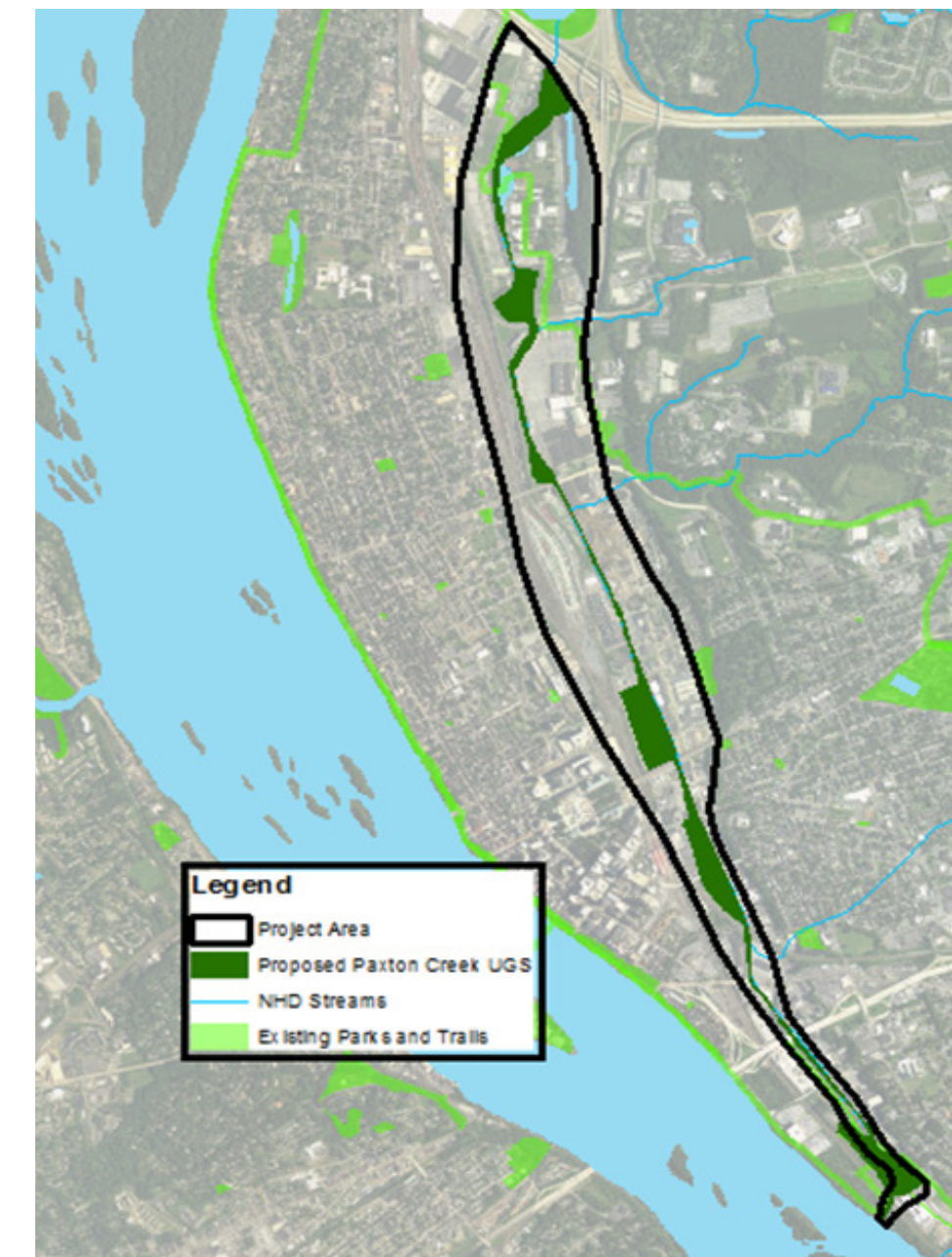


Figure 12: Paxton Creek Corridor Greening

Concept Plans

Using the Paxton Creek Restoration Master Plan as the basis, a series of concept plans were developed to illustrate the NSCD and UGS design elements for the following creek segments as delineated in **Figure 13**.

- **North Paxton Greenway:** Wildwood Park Dr. to Herr Street [7,600 Linear Feet (1.4 miles)]
- **Paxton Creek Park:** Herr Street to Berryhill Street [5,300 Linear Feet (1 mile)]
- **South Paxton Greenway:** Berryhill Street to Susquehanna River [5,400 Linear Feet (1.02 miles)]

As illustrated in **Figures 14 – 17**, the NSCD and UGS design elements include a naturalized channel, a vegetated riparian zone, larger natural park areas, and the multi-use path that provides a linear north-south connection with the CAG. The naturalized channel utilizes natural pool and riffle sequence, along with the use of in-stream structures to create a structurally complex system that can support multiple species and a range of habitat types.

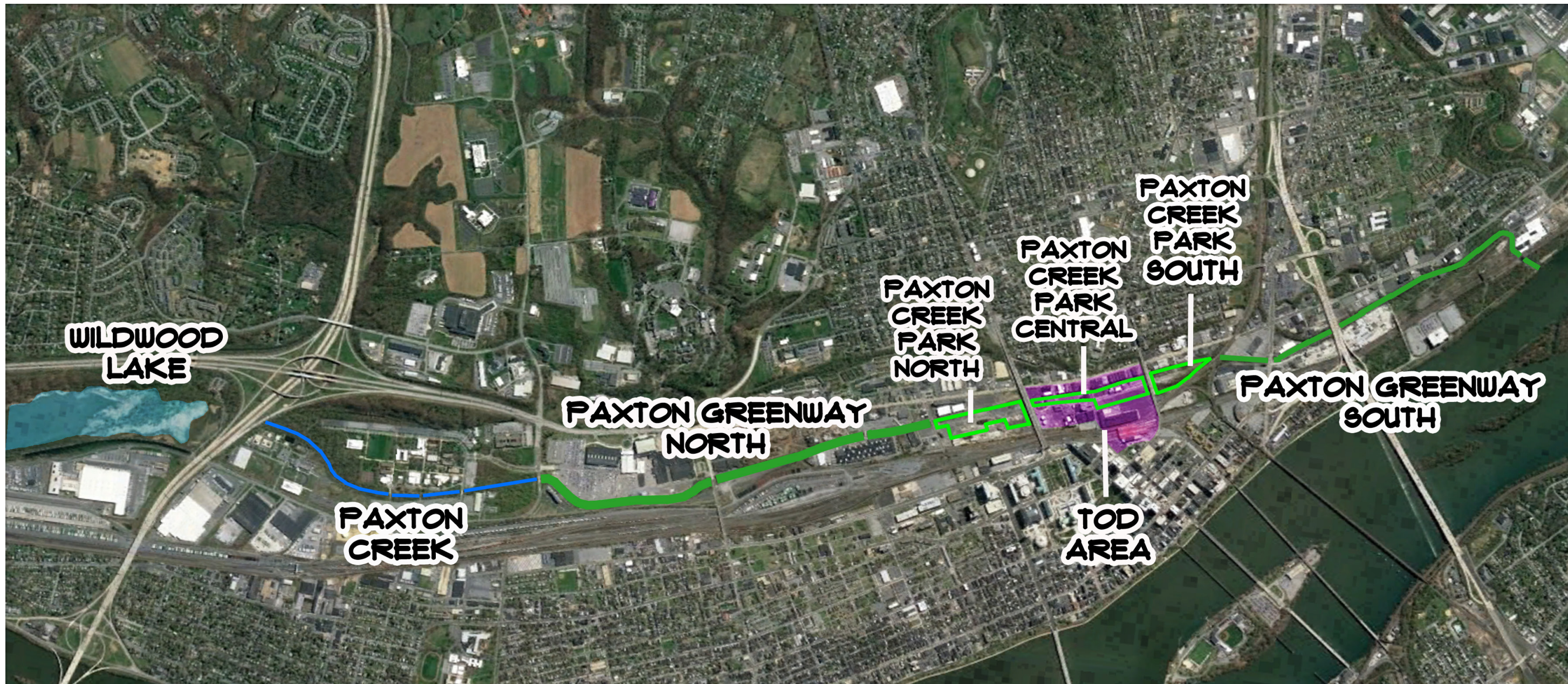


Figure 13: Paxton Creek Concept Plan Segments

Paxton Greenway Concept - North and South Sections

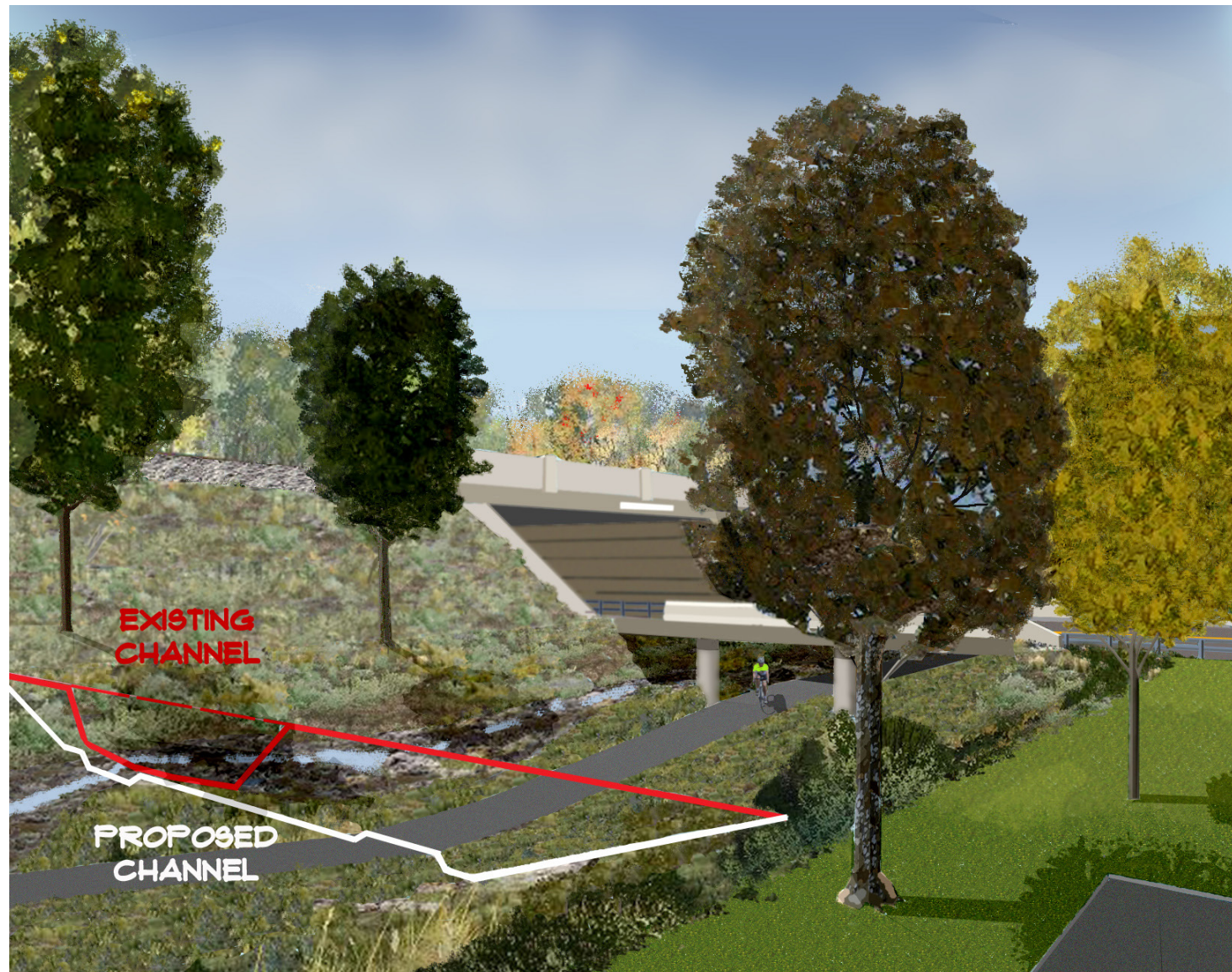


Figure 14: Paxton Greenway Concept



Ararat River Greenway and adjacent River restoration in Mount Airy, North Carolina



Source: San Antonio River Authority



Source: San Antonio River Authority

Alazan Creek and adjacent bike paths in San Antonio, Texas

Paxton Creek Park Concept - North Section



Paxton Creek Park (North Section)

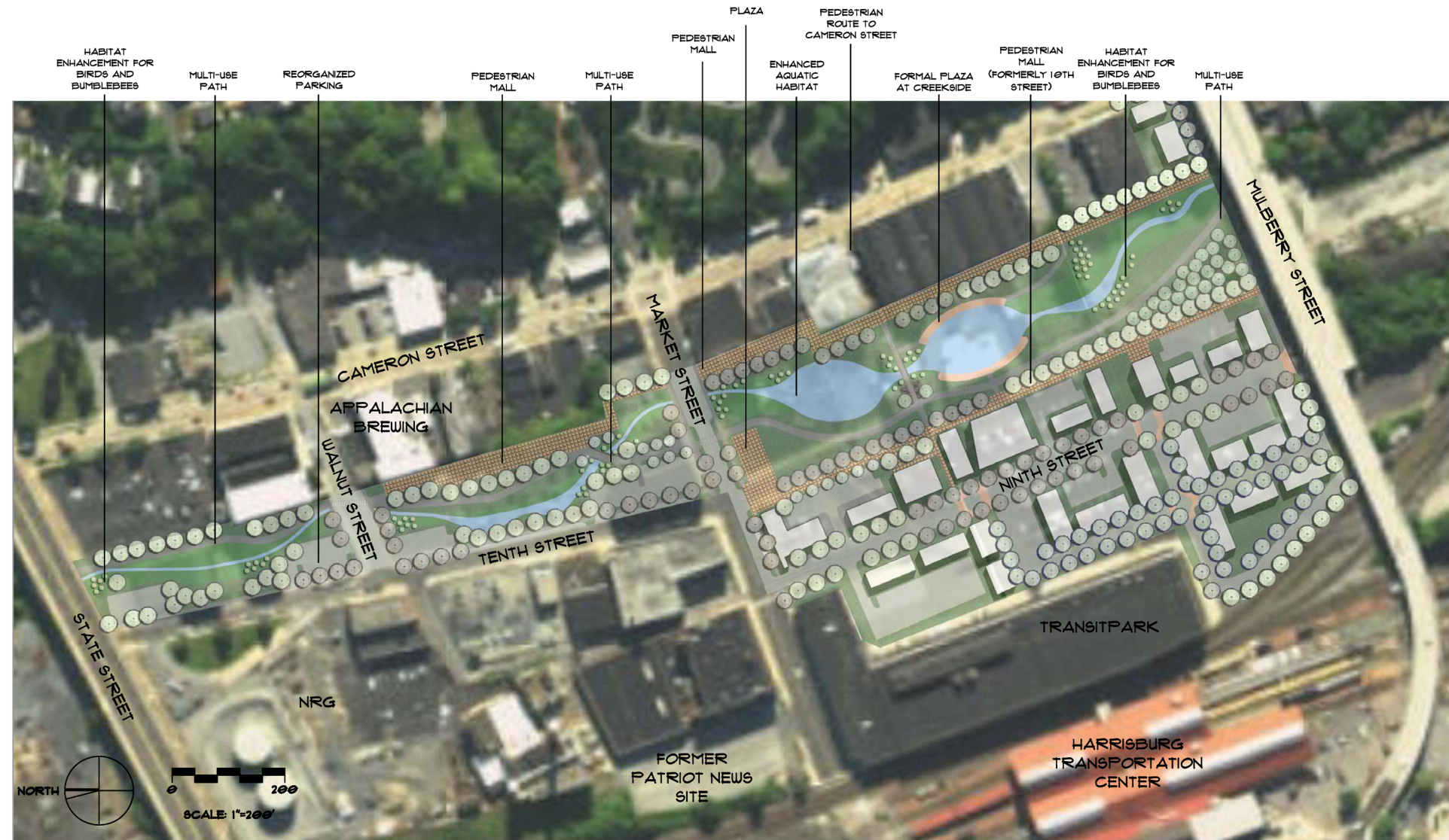
Figure 15: Paxton Creek Park (North Section)

Paxton Creek Park Elements - North Section

This park is intended to provide habitat types that require more area than is afforded in Paxton Greenway North and a transition from active, intensive uses in the TOD area park segment.



Paxton Creek Park Concept - Central Section (TOD Area)



Paxton Creek Park
(Central Section and TOD Area)

Figure 16: Paxton Creek Park (Central Section)

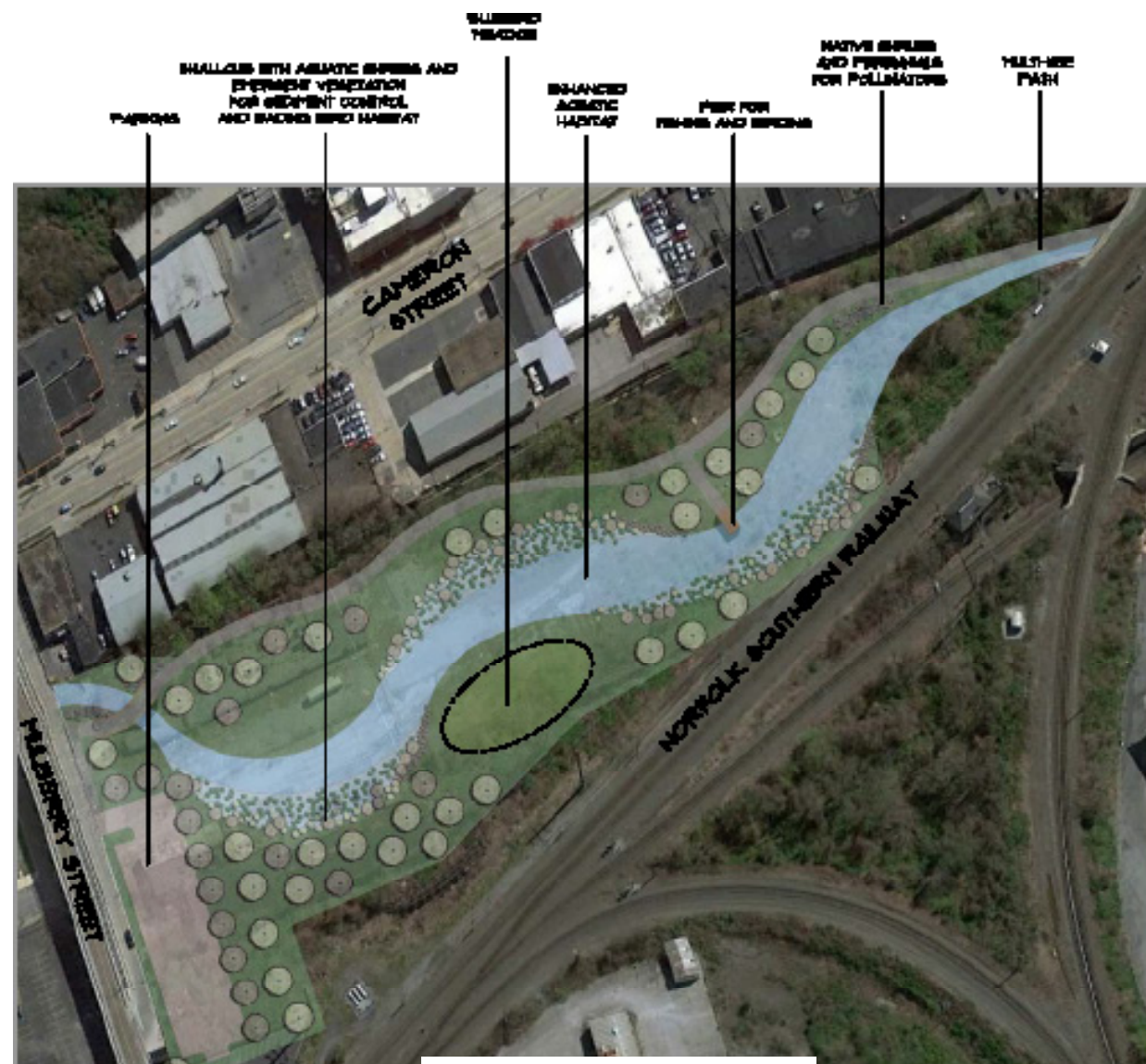
Paxton Creek Park Elements - Central Section (TOD Area)

This park is to provide for intensive uses of an urban waterfront park, expanding the utility of the west side of businesses that face onto Cameron Street and creating more public open space and connections from east of Camon Street to the HTC.



Possible location of bier garden for Appalachian Brewing, illustrating how businesses on Cameron could expand facing Paxton Creek Park and the pedestrian mall. Concept Only. Parking considerations will need to be addressed in the design phase.

Paxton Creek Park Concept - South Section



**Paxton Creek Park
South Section**

Figure 17: Paxton Creek Park (South Section)

Paxton Creek Park Elements - South Section (South of Mulberry Street)

This park segment is intended to provide a natural habitat environment similar to Wildwood Lake and significantly contribute to reducing the impacts of urban runoff into the Susquehanna River. The park's primary uses are centered on nature study and wildlife observation.



Image of the viewing platform in the photosimulation associated with Paxton Park South used by permission. The authors express gratitude to The Wild Deck Company Limited trading as Flights of Fantasy Creative Play Limited for this generous gesture.



Implementation Strategy

The Paxton Creek Restoration Master Plan represents a significant milestone effort culminating years of technical studies, education, and advocacy by the City of Harrisburg, CRW, PCWEA, Dauphin County, and other Paxton Creek Watershed stakeholders to address the creek's impaired condition and restore and maintain its natural ecological functions and services. This Implementation Strategy provides a blueprint to advance the restoration plan and includes a series of recommended action strategies as summarized in **Table 1**, a Probable Cost Estimate and Phasing Plan, and a summary of the applicable permitting needs.

Action Steps

Table 1 outlines a series of action strategies that are necessary to begin implementing the Paxton Creek Restoration Master Plan. Along with each action strategy, the table also defines a responsible Lead Entity and supporting Partners who serve as champions for the project's success, and a timeframe for execution.

Table 1: Action Strategies

Action Strategy	Lead Entity(ies)	Partners	Timeframe
AS.1 – Create a formal partnership, 'Development Authority' to execute a Memorandum of Understanding (MUO) between the proposed Lead Entities and Partners outlining the roles and responsibilities, and commitments to ensure the successful implementation and continued management of the Paxton Creek Riparian Corridor Restoration.	Capital Region Water (CRW) Harrisburg Redevelopment Authority (HRA)	City of Harrisburg Dauphin County Board of Commissioners PCWEA PennDOT	January – March 2018
AS.2 – Conduct a detailed field survey and prepare a stream restoration design plan (30%) to support the FEMA Conditional Letter of Map Revision (CLOMR).	PennDOT	Capital Region Water (CRW) City of Harrisburg HRA PCWEA	Begin winter of 2017-2018; submit for review spring of 2020 (see AS.9)
AS.3 – Identify disturbance extent and secure land and right-of-way/easements as required pursuant to applicable local, state, and federal regulations.	CRW HRA	City of Harrisburg PennDOT PCWEA	January – December 2018
AS.4 – Conduct a pre-permit application meeting and field view with United States Army Corps of Engineers (USACoE) and other permitting agencies.	PennDOT	City of Harrisburg HRA USACoE PADEP US Fish and Wildlife Service Dauphin County Conservation District PCWEA	January 2018

Action Strategy	Lead Entity(ies)	Partners	Timeframe
AS.5 – Prepare a FEMA Conditional Letter of Map Revision (CLOMR) per the requirements specified in NFIP Regulation 44 (CFR) Ch. 1 Parts 60, 65, and 72.	PennDOT	CRW City of Harrisburg HRA	January 2018 - June 2019
AS.6 – Proceed with Preliminary Engineering and Design	CRW	City of Harrisburg HRA PennDOT PCWEA	July 2019 - February 2020
AS.7 – Obtain National Environmental Protection Act (NEPA) Clearances as required.	CRW	City of Harrisburg	March 2019 - December 2019
AS.8 – Utilize Preliminary Engineering and Design cost estimates to identify and secure necessary funding for Final Engineering and Design, and Construction.	CRW	City of Harrisburg HRA PennDOT PCWEA	January 2017 - December 2020
AS.9 – Prepare and submit the necessary applications to obtain the required permits.	CRW	City of Harrisburg HRA PennDOT	January 2020 - December 2020

Action Strategy	Lead Entity(ies)	Partners	Timeframe
AS.10 – Proceed with Final Design and completion of Plan, Specifications, and Estimates (PS&E) for Project Bid Package.	CRW	City of Harrisburg HRA PennDOT	January 2021 - December 2021
AS.11 – Secure contractor, commence construction, and perform appropriate Project Management Oversight.	CRW	City of Harrisburg HRA PennDOT	TBD
AS.12 – Develop and maintain a Monitoring and Maintenance Plan consistent with the USACoE Invasive Species Control/Management Plan (ISCP) Guidance. Ensure the plan addresses water quality and includes a strategy to minimize invasive species colonization	Pursuant to the proposed MOU as recommended in AS.1.	Pursuant to the proposed MOU as recommended in AS.1.	Following Construction and Ongoing
AS.13 - Prepare and maintain a Capital and Operating Budget to finance the continued maintenance and future capital improvements of the restoration improvements.	Pursuant to the proposed MOU as recommended in AS.1.	Pursuant to the proposed MOU as recommended in AS.1.	Ongoing

Probable Cost Estimates and Phasing Strategy

The conceptual level design performed through the Paxton Creek Restoration Master Plan provides a solid foundation for determining a rough order of magnitude (ROM) cost for the recommended restoration for Paxton Creek.

As previously illustrated in Figure 13, the stream channel restoration has been segmented into three main sections: North Paxton Greenway, Paxton Creek Park, and South Paxton Greenway. These sections serve as the basis for a phased implementation strategy beginning with the Paxton Creek Park and South Paxton Greenway sections that extend from Herr St. south to the confluence with the Susquehanna River. These sections serve as the critical first step to the revitalization process based on the following:

1. The Paxton Creek Park restoration is critical to support the implementation of the HTC TOD Master Plan and the revitalization opportunities envisioned therein. The success of the HTC TOD is dependent upon the successful reduction of the Paxton Creek flood elevation to 314 feet, which as previously discussed is a crucial flood mitigation measure.
2. The NSCD restoration approach is dependent upon connecting the Paxton Creek and Susquehanna waterway ecosystems.

The Paxton Creek Park and South Paxton Greenway sections represent approximately half of the project area and includes a considerable amount of infrastructure replacement and rehabilitation needs to achieve the flood elevation reduction objective. Thus, partnerships among public and private entities will be imperative to secure the funding. Total project cost (ROM) is estimated to be \$60 million - \$90 million and includes engineering, design, right-of-way acquisition, and construction, including bridge structure replacements.

The project’s final phase will focus on the North Paxton Greenway section that extends north of Herr St. to Wildwood Park Drive. This section requires additional coordination among property owners and further evaluation of flooding issues. Large portions of the Pennsylvania Farm Show property are below flood elevation 314 and while this project will not eliminate future flooding it should reduce the frequency of floods.

Regulatory and Permitting

Stream restoration and design activities are subject to various federal, state, and local regulatory programs. Most of these regulations are aimed at protecting natural resources and the integrity of the Nation’s water resources. Designers of the Paxton Creek Restoration project should have an in-depth familiarity and understanding of the project permitting regulations and requirements as outlined in **Table 2**. Moving forward, the federal, state, and local permitting agencies should be consulted as soon as preliminary plans are developed and before permit applications are prepared and submitted for their respective regulatory review. The following materials and information provide a general list of information that should be prepared for the pre-application consultation meetings:

- Site map
- Description of existing environmental conditions (written and maps, photos, drawings)
- Description of the proposed work (written and drawings)
- Property ownership
- Access and staging information
- Preferred times of implementation

Table 2: Permit Summary Table

Water Obstruction and Encroachment
PADEP Joint Permit Application/US Army Corps of Engineers Section 404
General Permits
Transfer of Permit and Submerged Lands License
National Pollutant Discharge Elimination System
General Permit
Individual Permit
Municipal Separate Storm Sewer Systems (MS4s)
Stormwater Construction Activities
Erosion and Sediment Control
Rare Threatened and Endangered Species
Pennsylvania Natural Heritage Program – Pennsylvania Natural Diversity Inventory
Other Related Resources
Pennsylvania Historical & Archaeological Resource Protection – PA Historical & Museum Commission – Bureau of Historic Preservation
Other Program Potential Requirements*
Pennsylvania Storm Water Management Act (Act 167)
Water Quality Management Permit
Water Quality Management General Permit for Small Flow Treatment Facilities
General Permit for Sewer Extensions and Pump Stations
Water Quality Management Post Construction Certification
Water Allocation
Safe Drinking Water
Pennsylvania Act 537 – Municipal Sewage
Pennsylvania Act 2 Land Recycling Program – Voluntary Cleanup Program
National Environmental Protection Act (NEPA)
Federal (EPA) – Resource Conservation and Recovery Act (RCRA)
*related to redevelopment, existing infrastructure/systems and water use and discharge allocations (e.g., wastewater)

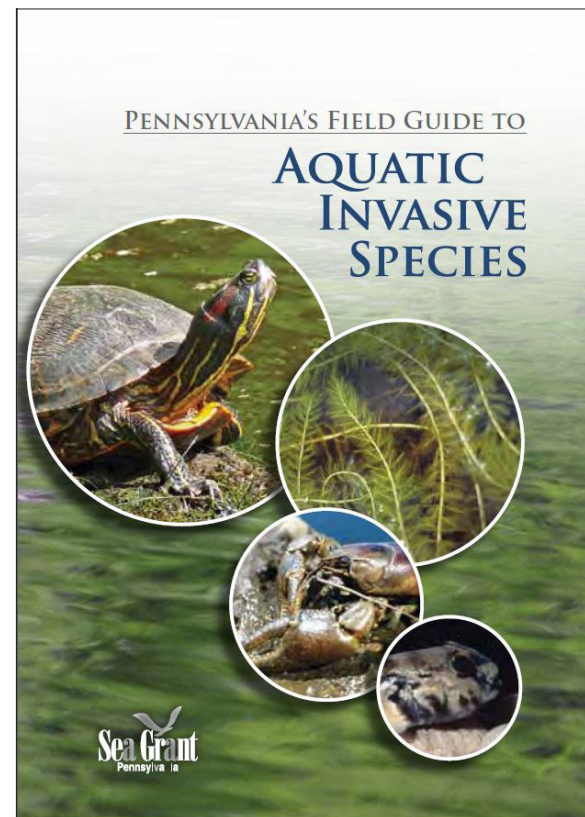
Restoration Maintenance and Monitoring Strategy

Continued performance of the Paxton Creek Corridor Restoration project's NSCD and USG design elements is dependent upon appropriate maintenance and monitoring of the system. Maintenance and monitoring are actions intended to ensure that the objectives of the stream restoration project are met over time. **Maintenance is the collection of actions taken to ensure that the stream restoration project performs as designed and to attain project objectives. Monitoring is the process of measuring or assessing specific physical, chemical, and/or biological parameters of a project.** Although projects should be designed to require minimal maintenance, uncontrolled factors such as extreme flow events, changes in land use, introduction of non-native species must be considered to ensure the system's intended performance is being achieved.

The monitoring and maintenance plan for Paxton Creek will need to consider required regulatory maintenance standards, the UGS, and managing unwanted wildlife. These are further explained as follows:

Required Regulatory Maintenance – Regulatory monitoring required for the project includes biannual monitoring reports for the first two years, followed by annual reports for an additional three years (five years total if not released early). Additional monitoring is required after a bankfull event for the five-year monitoring period. These reports will be prepared based on current guidance presented in the USACoE's *April 10, 2008 Final Rule; Compensatory Mitigation for Losses of Aquatic Resources*. As-built surveys should be done within 60 days of post construction and include field changes, cross sections, profiles, structure elevation, and a photograph log.

UGS Monitoring and Maintenance – Long time monitoring of the channel stability and functionality is critical. Annual assessments of channel and bank stability, riparian survey, habitat assessment, and water chemistry parameters could be conducted by local volunteers and advocacy groups such as the PCWEA. Problematic areas could be noted for further investigation for remedial action including bank erosion, structure failure, invasive vegetation, and water chemistry issues. It is expected that the City of Harrisburg would be responsible for trash and debris pick-up. The ultimate Paxton Creek Corridor Restoration plan should include recommended landscape directions where required.



PA's Field Guide to Aquatic Invasive Species Cover

Managing Unwanted Wildlife – The spread of invasive species is recognized as one of the major factors contributing to ecosystem change and instability throughout the world. Invasive species are “a non-native species whose introduction does, or is likely to cause, economic or environmental harm or harm to human, animal, or plant health” (Executive Order 13112, 1999). The most effective way to reduce the amount of invasive plants is to monitor and detect species before they become an infestation. An important resource to consider in the monitoring and detection process is the *The Pennsylvania Field Guide to Aquatic Invasive Species*. This field guide is specifically designed to aid natural resource professionals and other interested individuals in aquatic invasive species (AIS) early detection and reporting in Pennsylvania's waters.

Funding Resources

The Paxton Creek Restoration Master Plan's complexity will require a diverse set of funding resources to advance the project through engineering, design, and construction. Moreover, the plan calls for trails, waterways, redevelopment, and public spaces that provide opportunities for various public and private sector interests to participate in the project's success through their respective financial resources. To that end, no single funding source can accomplish the project's entire menu of improvements and the following outlines potential sources of funding to consider at the federal, state, and local government level, and from the private sector and community support.

Federal Resources

Army Corps of Engineers

Federal funding for authorized U.S. Army Corps of Engineers (USACoE) activities is provided in annual Energy and Water Development appropriations acts or supplemental appropriations acts. Annual USACoE appropriations for its water resource activities have ranged from \$4.5 billion to nearly \$6.0 billion during the last decade. An

increasing share of the agency's appropriations has been used for operations and maintenance. In recent years, some new studies, new construction projects, and new programs have been funded using enacted appropriations.

Environmental Protection Agency – Chesapeake Bay Program

The Chesapeake Bay Program (CBP) is a unique regional, state, federal, and local partnership that has been directing and conducting the restoration of the Chesapeake Bay since the signing of the historic 1983 Chesapeake Bay Agreement. In November 2000, President Clinton signed the Estuaries and Clean Waters Act of 2000, which included Title II-Chesapeake Bay Restoration. This Act amended Section 117 of the Federal Water Pollution Control Act (commonly known as the Clean Water Act or CWA) and established new authorities for the CBP. These new legal authorities specify the type of work that can be performed with the funds appropriated for the CBP, the type of funding vehicles (e.g., assistance agreement) that can be used, and the types of governments and organizations eligible to receive funding.

CWA Section 117(d) Technical Assistance and General Assistance Grants

USEPA awards these grants competitively to nonprofit organizations, state and local governments, colleges, universities, and interstate agencies through an RFP process. These grants are used by recipients to implement the goals of the Chesapeake Bay agreements through activities that support:

- Sustainable Fisheries
- Vital Habitats
- Water Quality
- Toxic Contaminants
- Healthy Watersheds
- Stewardship
- Land Conservation
- Public Access
- Environmental Literacy
- Climate Resiliency

CWA Section 117(g)(2) Small Watershed Grants (SWG)

The Small Watershed Grants Program was established under Section 117(g)(2), which provides that grants can be awarded under Section 117(d) to local governments, nonprofit organizations, and individuals in the Chesapeake Bay region working at a local level to protect and improve watersheds while building citizen-based resource stewardship. The purpose of this grant program is to demonstrate effective partnership-building techniques to achieve CBP objectives at the small-watershed scale. The SWG Program has been designed to encourage the sharing of innovative ideas among the many organizations wishing to be involved in watershed protection activities.

Economic Development Administration Public Works

The Economic Development Administration's (EDA) mission is to lead the Federal economic development agenda by promoting innovation and competitiveness, preparing American regions for economic growth and success in the worldwide economy. EDA fulfills this mission through strategic investments and partnerships that create the regional economic ecosystems required to foster globally competitive regions throughout the United States. EDA supports development in economically distressed areas of the U.S. by fostering job creation and attracting private investment. EDA will make construction, non-construction, and revolving loan fund investments under its Public Works and Economic Adjustment Assistance (EAA) Programs.

Fish and Wildlife Service

The Fish and Wildlife Service works with others to conserve, protect and enhance fish, wildlife and plants and their habitats for the continuing benefit of the American people. The Division of Bird Habitat Conservation provides matching grants to organizations and individuals who have developed partnerships to carry out wetlands conservation projects in the United States, Canada, and Mexico for the benefit of wetlands-associated migratory birds and other wildlife. The Partners for

Fish and Wildlife program provides technical and financial assistance to private landowners and tribes who work with partners to help meet the habitat needs of Federal Trust Species.

Department of Housing and Urban Development

Community Development activities include many different programs that provide assistance to a wide variety of grantees. The Community Development Block Grant (CDBG) program provides annual grants on a formula basis to eligible cities, urban counties and states to develop viable urban communities by providing decent housing and a suitable living environment, and by expanding economic opportunities, principally for low- and moderate-income persons.

Land and Water Conservation Trust Fund

The Land and Water Conservation Fund has historically been a primary funding source of the U.S. Department of the Interior for outdoor recreation development and land acquisition by local governments and state agencies. The Land and Water Conservation Fund Act of 1965 was enacted to help preserve, develop, and assure access to outdoor recreation facilities to strengthen the health of U.S. citizens. It created the Land and Water Conservation Fund in the U.S. Treasury as a funding source to implement the outdoor recreation goals in the law.

State Resources

Redevelopment Assistance Capital Program (RACP)

The Redevelopment Assistance Capital Program (RACP) is a Commonwealth of Pennsylvania grant program administered by the Office of the Budget for the acquisition and construction of regional economic, cultural, civic, recreational, and historical improvement projects. RACP projects are authorized in the Redevelopment Assistance section of a Capital Budget Itemization Act, have a regional or multi-jurisdictional impact, and generate substantial increases or maintain current levels of

tax revenues, or other measures of economic activity. RACP projects are state-funded projects that cannot obtain primary funding under other state programs.

Multimodal Transportation Fund

The Multimodal Transportation Fund provides grants to encourage economic development and ensure that a safe and reliable system of transportation is available to the residents of this Commonwealth. The program is intended to provide financial assistance to municipalities, councils of governments, businesses, economic development organizations, public transportation agencies, and rail and freight ports to improve transportation assets to enhance communities, pedestrian safety and transit revitalization. The program is jointly administered by the Department of Community and Economic Development (DCED) and the Pennsylvania Department of Transportation (PennDOT).

Growing Greener Program

The Growing Greener program (The Environmental Stewardship and Watershed Protection Act) remains the largest single investment of state funds in Pennsylvania's history to address critical environmental concerns of the 21st century. The funds are distributed among five state agencies: the Department of Agriculture to administer farmland preservation projects; the Department of Conservation and Natural Resources for state park renovations and improvements; the Department of Environmental Protection; and the Pennsylvania Infrastructure Investment Authority for water and sewer system upgrades. DEP's portion of Growing Greener more than doubled to \$547.7 million over the life of the program, from \$241.5 million in the original five-year program. DEP is authorized to allocate these funds in grants for: watershed restoration and protection, abandoned mine reclamation, and abandoned oil and gas well plugging projects.

Private and Non-Profit Resources

National Fish and Wildlife Foundation

The National Fish and Wildlife Foundation (NFWF) is a private, nonprofit, tax-exempt organization chartered by Congress in 1984. The NFWF sustains, restores, and enhances the nation's fish, wildlife, plants, and habitats. The Foundation awards matching grants under its Keystone Initiatives to achieve measurable outcomes in the conservation of fish, wildlife, plants, and the habitats on which they depend. Awards are made on a competitive basis to eligible grant recipients, including federal, tribal, state, and local governments, educational institutions, and non-profit conservation organizations. Project proposals are received on a year-round, revolving basis with two decision cycles per year. Grants generally range from \$50,000-\$300,000 and typically require a minimum 2:1 non-federal match.

Blue Moon Fund

The Blue Moon Fund makes grants to nonprofit organizations that have developed innovative, holistic approaches to improving human quality of life in harmony with the natural world. The Balancing Human and Natural Ecosystems initiative promotes new economic and culture approaches to reducing resource pressure and preserving biodiversity. The Blue Moon Fund is primarily concerned with the value of diverse ecosystems for human quality of life. The fund seeks economically sustainable development models that do not displace humans and that take advantage of market forces.

A special thanks to the following project partners:



Michael Baker
INTERNATIONAL

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