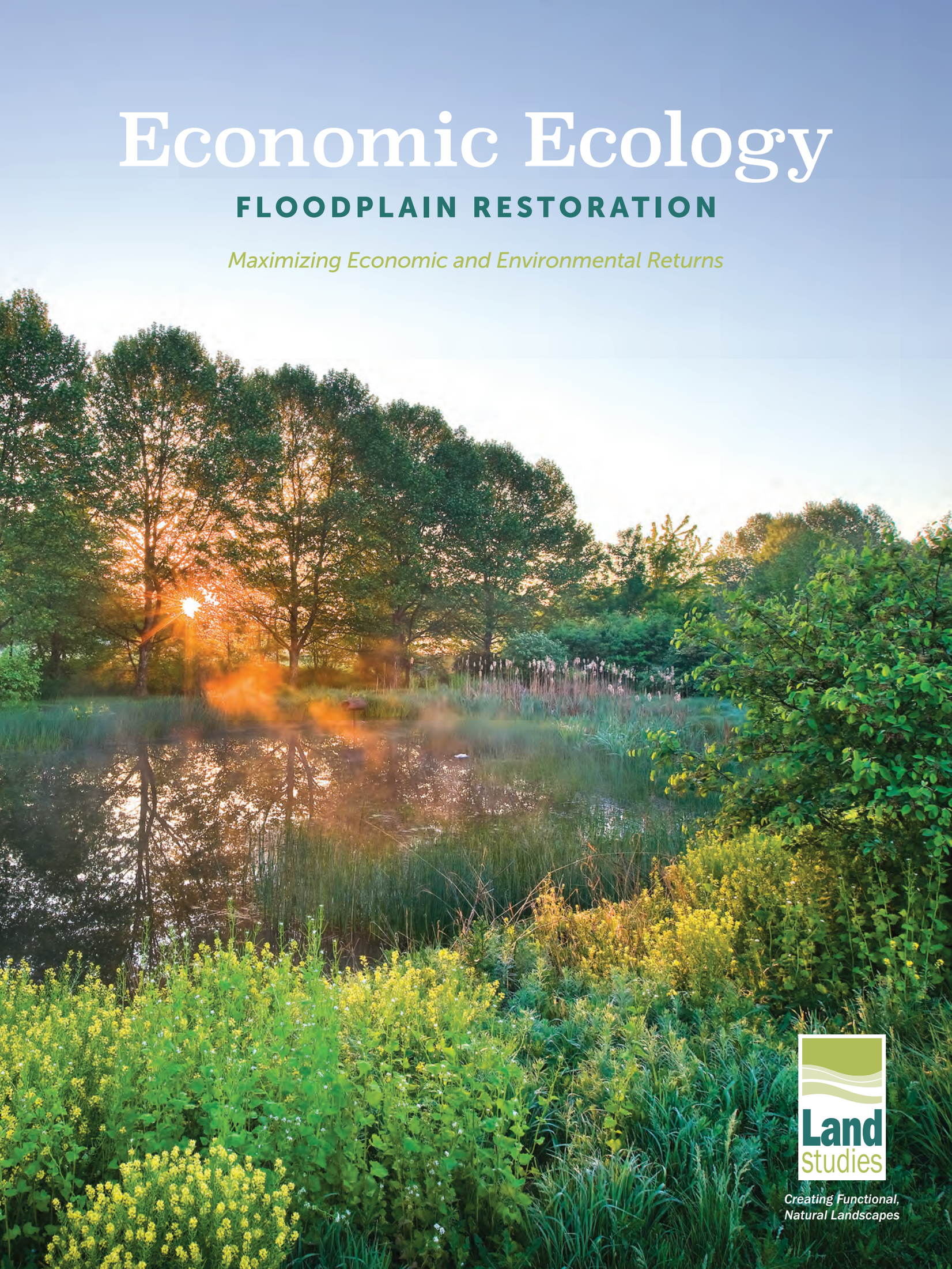
Economic Ecology

FLOODPLAIN RESTORATION

Maximizing Economic and Environmental Returns



Land Studies

Creating Functional, Natural Landscapes

Photo: Bob Ingraham

Letter

FROM THE FOUNDER & VICE PRESIDENT

Since the publication of *Floodplain Restoration* in 2007, greater attention and concern from state and federal regulatory agencies has focused on water quality and quantity issues. As an applied ecological restoration professional, I have observed, over the last 30 years, efforts to address pollutant removal, flood reduction, and habitat restoration in the mid-Atlantic region, particularly in Pennsylvania and Maryland.

Solving these issues isn't easy. It requires significant resources of time and money to provide the long-term, quantifiable data that regulators use to validate water-quality improvements. And these improvements are measured against performance standards that are based on computer modeling assumptions about the relationship between water, soil, and land. However, the hard numbers need to be blended with qualitative visual observations.

Ideally, we want natural, functional landscapes because they support biodiversity, manage stormwater, filter pollutants, and more. They also work not as independent project sites, but rather as part of a greater regional whole, connected to a larger freshwater system — a watershed.

Conventional methods of addressing water-resource issues are frequently land-intensive and cost-prohibitive. We need landscapes that actually work and that provide economic as well as ecological benefits.

If your town is flooding, or you're struggling to comply with water-quality regulations in a cost-effective manner, or your county or state is trying to meet Chesapeake Bay cleanup requirements, *Economic Ecology: Floodplain Restoration* is for you. It's intended for community leaders, municipal officials, corporations, real estate managers, economic and land developers, campus managers, sustainable-community planners, policy-makers, and watershed groups.

With 12 case studies, it shows how Economic Ecology, an innovative, regional approach to solving water issues, can maximize both economic and environmental returns on investment. LandStudies has designed, constructed, maintained, and monitored these projects. With up to 15 years of monitoring data on these projects, we can demonstrate their long-term success.

You'll read about cost-benefit analysis, opportunity cost, value proposition, water-quality trading and offsetting, risk management, and mitigation banking — in addition to the compelling ecological benefits of a comprehensive science-based solution.

With *Economic Ecology: Floodplain Restoration*, I hope, as you work to solve water-resource issues, you are encouraged and challenged to leverage green-infrastructure projects that encourage private and public-private partnerships and that advance economic and environmental benefits to you and the region.

Mark Gutshall,
Founder & Vice President

Introduction

Few can dispute the merits of undertaking projects to repair or prevent environmental damage. The hard truth, though, is that some projects with the best long-term results require a significant initial investment of time and financial resources. Consequently, some view the environmental improvements from these projects as not worth the investment.

LandStudies demonstrates how and why that point of view is changing. Twelve case studies are included to demonstrate the economic rewards of tackling environmental issues on a regional scale, specifically through floodplain restoration. Also included are cost-benefit analyses revealing the true value proposition of an approach we call Economic Ecology that maximizes economic and environmental returns to solve water issues on a regional scale. Understanding Economic Ecology is especially important for those who influence the economic development and vitality of our communities. Decision-makers who can benefit from reading this publication include officials at all levels of government, bankers, real-estate brokers, developers, land planners, and lawmakers.

Economic Ecology requires that decision-makers depart from more traditional approaches to planning, permitting, and implementation, and it requires some or all of the following to succeed:

- Land planning on a regional rather than local scale.
- Understanding both immediate and long-term costs and benefits.
- Promoting collaboration among diverse stakeholders.
- Public-private partnerships.
- Private sector collaborators (e.g., land developers and commercial and residential builders).

Banta Property Floodplain Restoration
Photo: Larry LeFever

What Is Economic Ecology?

LandStudies has been a pioneer in advancing floodplain restoration to solve multiple water-resource challenges. Because we have helped restore and protect stream systems for nearly two decades, we have been able to monitor and analyze project results over time. We have discovered that, although floodplain restoration may appear to cost more than certain traditional solutions, it is often the most cost-effective way to achieve a multitude of environmental and economic benefits both immediately and in the long term.

In 2007, LandStudies published *Floodplain Restoration*,* a 30-page booklet which explains the history of mid-Atlantic and Northeast stream systems; how land-use practices destabilized most of those systems; how today we are living with the consequences; and the multiple benefits derived from restoration. The booklet also explains the theory behind floodplain restoration, which entails returning an entire system — both stream and floodplain — as closely as possible to its historical, more stable configuration.

The theory, developed and verified in conjunction with leading universities, including Franklin & Marshall College and the University of Louisville, says that when streambed, stream channel, and historical floodplain are restored, so too are numerous ecological functions. They interact to provide cleaner surface and groundwater, effective stormwater management through increased flood storage and infiltration, and improved plant and animal habitat. The system returns to a more stable and functional state.

By employing a holistic approach that takes the regional watershed into account, LandStudies' method of floodplain restoration addresses the root causes of stream system problems rather than focusing on the symptoms. A multitude of problems are corrected simultaneously, symptoms disappear, and diverse stakeholders benefit from lasting results that require minimal maintenance.

This approach, which optimizes both the environmental and economic benefits of ecological repair and restoration on a regional scale, is appropriately referred to as **Economic Ecology**. It requires that we look beyond traditional, site-bound solutions to discover a better way that offers a higher value proposition.

** Floodplain Restoration is available as a free download on the LandStudies website: www.landstudies.com.*

What Are the Benefits?

ONE FLOODPLAIN RESTORATION PROJECT CAN POTENTIALLY ADDRESS THE FOLLOWING:

Water quality
Removes pollutants.

Water quantity
Provides natural stormwater management and flood control.

Wetland creation and restoration
Improves interaction between surface flow and groundwater, which increases infiltration and purification of stormwater.

Water supply
Increases groundwater recharge and purification.

Biodiversity
Improves native plant and animal habitat.

Infrastructure protection
Prevents flood damage to bridges, roads, and buildings.

Regulatory compliance
Meets state and federal requirements.

Smart growth
Enables higher density development and fulfills open-space requirements.

More developable space
Stormwater is managed within the floodplain instead of in detention/retention basins that use up land that might otherwise be used for development.

Comprehensive planning
Municipal and regional.

Mitigation banking
Creates or restores wetlands.

Education
Introduces students and residents to environmental education and stewardship.

Recreation
Creates open space and trails.

Aesthetic improvement
Creates biologically diverse, naturalized open space.

Increased property values
For the benefits listed above.

Stream restoration alone does not restore the integrated functions of the entire system. The initial investment of time and money may be less for a partial restoration, or other more traditional approaches, but such techniques often don't work, don't last, or require ongoing and sometimes costly maintenance. When floodplain is part of the restoration, benefits are greater and longer lasting.

Common sense tells us that maximum stability is achieved through restoring the integrated system of channel and floodplain. Therefore, the initial cost of a complete floodplain restoration, which can be higher or lower than traditional restoration methods, is a wise and cost-effective investment due to the wide array of long-term and stable benefits for a broad spectrum of people.

Who Benefits?

A SURPRISING NUMBER OF CONSTITUENCIES

In theory, every time a stream system is improved or restored, we all benefit because, as the saying goes, "We all live downstream." In practice, a surprising number of constituencies can reap the benefits of one floodplain restoration project:

- **Municipal officials**
- **Communities both around and downstream of the project site**
- **Individual property owners who live nearby or downstream**
- **Developers**
- **Commercial enterprises**
- **State government**
- **Financiers**
- **Farmers**
- **Sportsmen**
- **Watershed groups**

Economic Advantages

FLOOD REDUCTION

If floodplain restoration did nothing more than reduce flood damage, it still would be a wise investment. According to the April 2007 issue of *Pennsylvania Township News*, published by the Pennsylvania State Association of Township Supervisors, "Pennsylvania led the nation with an average of $682 million in flood losses each year between 1955 and 1999."

Photo: Lancaster Liederkranz

A Pennsylvania golf course official cited replacement costs of $45,000 to $60,000 to rebuild a green and $5,000 to rebuild a bunker. A floodplain restoration project on the property may potentially save the course owners several hundred thousand dollars over the long term.

In 1990, the Federal Emergency Management Agency (FEMA) implemented a voluntary and financially beneficial Community Rating System (CRS) through its National Flood Insurance Program (NFIP). Under the program, flood insurance premiums are discounted to reward *community* actions that reduce property damage from flooding and develop a comprehensive approach to floodplain management. Floodplain restoration achieves exactly that, especially when targeted to problem areas throughout a watershed.

Discounts for complying communities begin at five percent. As a participating community's CRS rating improves, its premium discount grows by five percent for each rating class.

As of March 2014, according to the FEMA fact sheet on CRS, "Nearly 3.8 million policyholders in 1,296 communities participate in the CRS by implementing local mitigation, floodplain management, and outreach activities that exceed the minimum NFIP requirements."

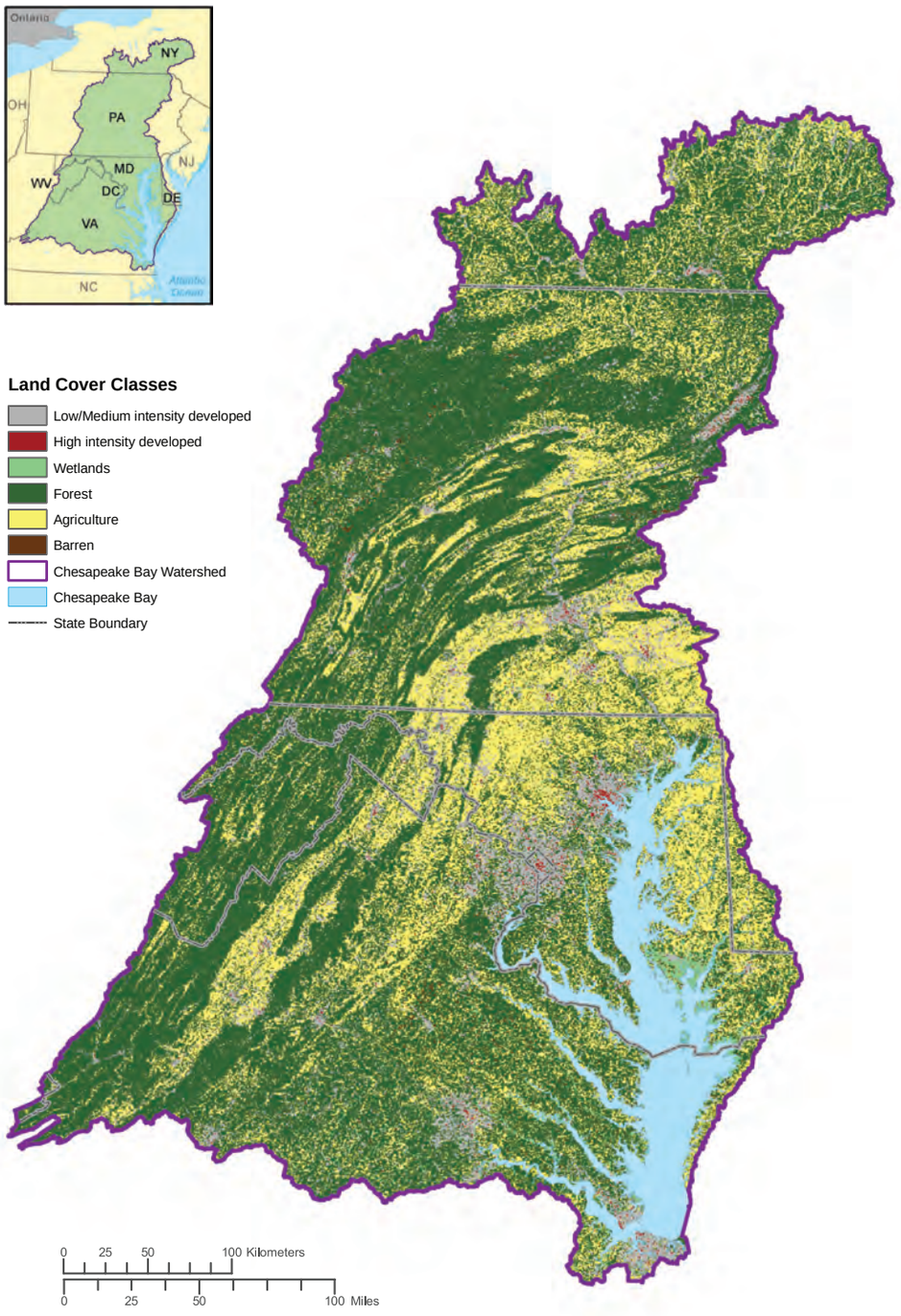
WATER-POLLUTION REDUCTION

The previously mentioned publication, *Floodplain Restoration*, explains in detail how floodplain restoration reduces sediments and nutrients from channel flow immediately upon removal of the legacy sediments that were deposited on top of the historical floodplain. Floodplain restoration also helps capture much of the sediment and nutrients washed from upstream during high flows.

Nitrogen, which is particularly difficult to capture through other techniques, is reduced through the creation of an anaerobic environment in the saturated soils of functional wetlands. Bacteria that thrive in that environment use the oxygen from nitrates (NO_3) for metabolism. The resultant harmless nitrogen gas is released into the air, and nitrates are removed from groundwater.

That's good news for Pennsylvania, which has until 2017 to implement best management practices (BMPs) that reduce nitrogen loads in its streams and rivers by 10 million pounds and sediment loads by 212 million pounds. The Commonwealth fell short of meeting the 2013 milestones for nitrogen and sediment reductions, according to the U.S. Environmental Protection Agency (EPA). If the 2017 milestones aren't met, EPA can impose additional reduction requirements directly on wastewater-treatment plants and controls on farmland and stormwater runoff. These wastewater-treatment plant upgrades and stormwater BMPs cost more per pound of sediment and nutrients removed than floodplain restoration.

The Chesapeake Bay Watershed



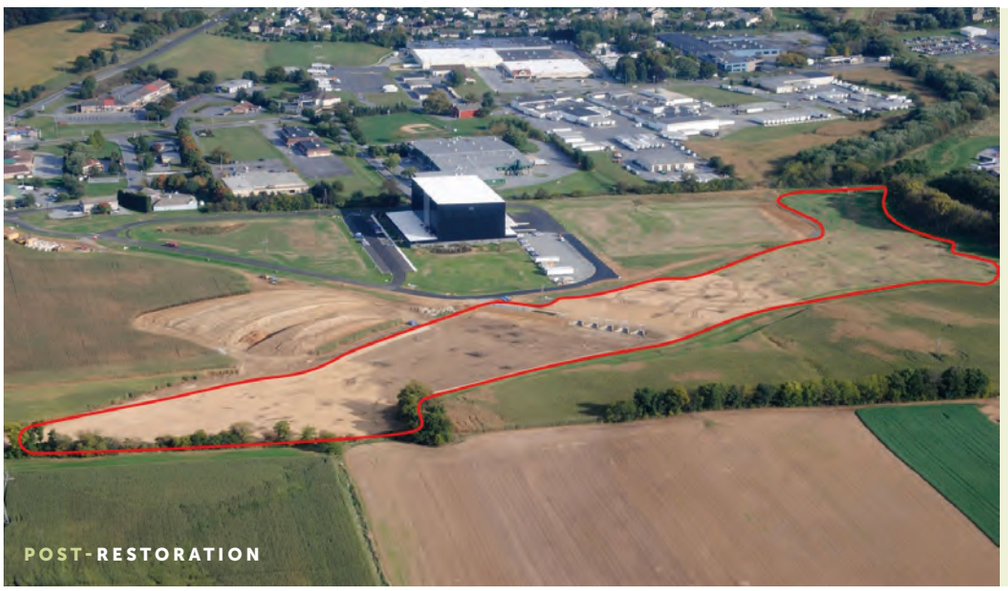
Map: Land Cover: Chesapeake Bay Watershed (2008). Author: Emma Andrews. Accessed May 5, 2015 from http://www.chesapeakebay.net/maps/map/land_cover_chesapeake_bay_watershed.

Because pollutant removal and flood reduction (only on sites where flooding is a problem and given specific site constraints) are the overriding benefits that result from virtually all floodplain restoration projects, Pennsylvania can improve water quality and meet its Chesapeake Bay milestones with this innovative, cost-effective BMP.

OPPORTUNITY-COST RECOVERY

Strict regulations against encroaching on the floodplain as well as into wetlands prevent floodplain acreage from being developed. Regulatory requirements for stormwater management and open-space areas traditionally have rendered even more acreage undevelopable.

Since 2006, the Pennsylvania Department of Environmental Protection (DEP) has recognized floodplain restoration as a stormwater best management practice. In 2014, Rock Lititz* was the first floodplain restoration project to be accepted by DEP to satisfy the overwhelming majority of the site's stormwater management requirements.



Rock Lititz: Economic Ecology By the Numbers

9
MORE ACRES OF DEVELOPABLE LAND

182%
RETURN ON INVESTMENT**

$3.1 Million
VALUE OF RECAPTURED LAND

By managing stormwater and meeting open-space requirements within the restored floodplain instead of on developable acres, commercial and residential developers can recover a substantial opportunity cost. Opportunity-cost recovery can be worth millions of dollars.

** View the full Rock Lititz case study on page 15*
*** Based on implementation of floodplain restoration and value of recaptured land.*

ECONOMIC SUMMARY

A floodplain restoration project saves money in numerous ways:

- The completed restoration reduces the risks of flooding and water pollution, improves the appearance of the riparian zone, and potentially increases property values nearby and downstream through the addition of improved recreational open space.
- Private landowners, commercial developers, municipalities, and state governments can satisfy numerous regulatory requirements within the scope of one floodplain restoration project.
- Property owners gain more developable land by using floodplain restoration for stormwater management, recovering what would otherwise be a significant opportunity cost.
- The newly naturalized area requires reduced maintenance, and the documented stability of the restoration over time reduces or eliminates the need for further financial investment.

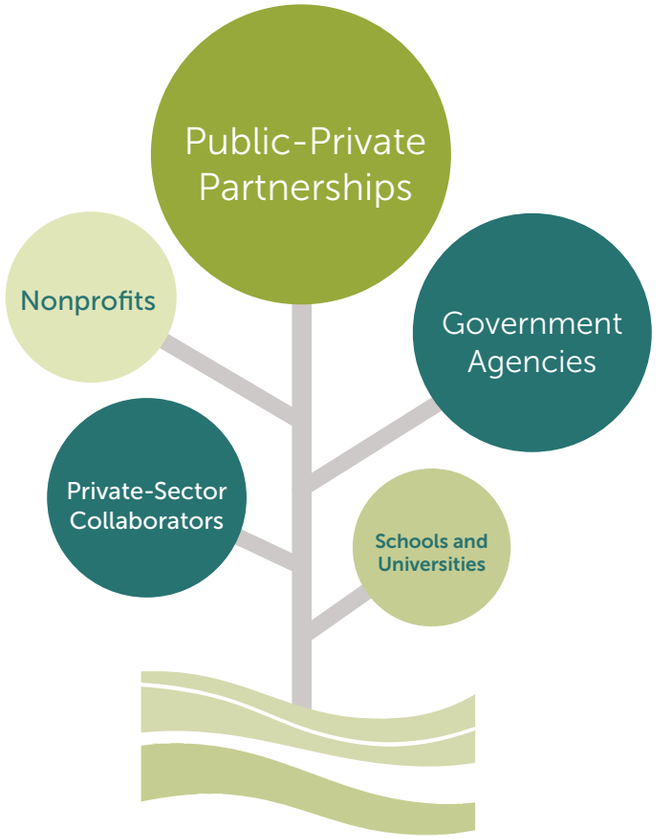

Photo: RGS Associates

ADVANTAGES OF COLLABORATION

Because floodplain restoration benefits numerous groups and individuals for both economic and environmental reasons, it lends itself readily to collaborative efforts. Collaboration among stakeholders, especially when it involves public-private partnerships, encourages its own economic advantage.

Cooperative Efforts From Diverse Stakeholders Creates Opportunities and Divides Costs

Collaborative efforts typically are viewed favorably by funding sources, especially when the resultant project benefits are numerous, widespread, and relatively permanent and when cooperating stakeholders are diverse. Not only are funding opportunities increased, but also any remaining costs can be divided among the stakeholders.



See Economic Ecology in Action

ATTEND A HEALTHY WATERSHEDS TOUR

As part of LandStudies' commitment to applied learning and spreading the word about Economic Ecology and floodplain restoration, those who are interested can sign up to attend a Healthy Watersheds Tour. The tour includes some of the projects featured in *Economic Ecology: Floodplain Restoration*.

To learn more, go to http://www.landstudies.com/healthy-watersheds-tour

CASE STUDY 1

Lititz Run Watershed

(OVERVIEW)

POST-RESTORATION

PROJECT HIGHLIGHTS

Challenge

A variety of man-made changes to the landscape had led to flooding and water-quality issues in the Lititz Run watershed.

Economic Ecology Solution

- Regional, watershed-based solutions featuring floodplain and stream restoration implemented at several sites
- Reduced flooding, improved water quality along 5 miles of stream and floodplain corridor
- 15 acres of native wetland habitat created

Collaborators

- Donegal Chapter of Trout Unlimited
- Lititz Run Watershed Alliance
- Warwick Township
- Lititz Borough

Awards

- EPA National Showcase Watershed
- Governor's Award for Environmental Excellence
- Outstanding Planning Award, Pennsylvania Planning Association
- Merit Award, Pa./Del. Chapter of the American Society of Landscape Architects
- Platinum Certified Sustainable Municipality, Sustainable Pennsylvania Community Certification program

Benefits

More than 20 years ago, Lititz Borough and Warwick Township began implementing a regional planning model to improve water quality and reduce flooding in the Lititz Run watershed. Community involvement was encouraged and nurtured from the beginning. The restored health and public enjoyment of the watershed has become a source of pride for local residents; hundreds have volunteered their time and donated money to help improve their watershed.

The regional effort quickly gained national attention. In 1999, it won various national and state awards and distinctions. It is one of only 12 watersheds in the country chosen to be part of EPA's National Showcase Watershed. A high point came in 2009, when the stream's designation was elevated from a Warm Water Fishery to a Cold Water Fishery, indicating its improved water quality.

Cooperating partners in the municipal projects have included the local watershed association and the Donegal Chapter of Trout Unlimited. Warwick School District, as well as other districts, has used floodplain restoration areas in their curriculum for middle school and high school students. Millersville University also has used the watershed in its science curriculum.

To date, floodplain restoration projects have helped reduce flooding and improve water quality along five miles of stream and floodplain corridor and created 15 acres of wetlands. Funding has come through state and federal grants as well as through private donations. Five projects in the Lititz Run Watershed are described in greater detail in the following pages.

NATIONAL SHOWCASE WATERSHED
U.S. ENVIRONMENTAL PROTECTION AGENCY

OUTSTANDING PLANNING AWARD
PENNSYLVANIA PLANNING ASSOCIATION

GOVERNOR'S AWARD ENVIRONMENTAL EXCELLENCE
PA DEPARTMENT OF ENVIRONMENTAL PROTECTION

MERIT AWARD PA/DE CHAPTER
THE AMERICAN SOCIETY OF LANDSCAPE ARCHITECTS

PLATINUM CERTIFIED SUSTAINABLE MUNICIPALITY
SUSTAINABLE PENNSYLVANIA COMMUNITY CERTIFICATION PROGRAM

Letter From Warwick Township, Lititz, PA

ECONOMIC ECOLOGY IN PRACTICE FOR OVER 20 YEARS

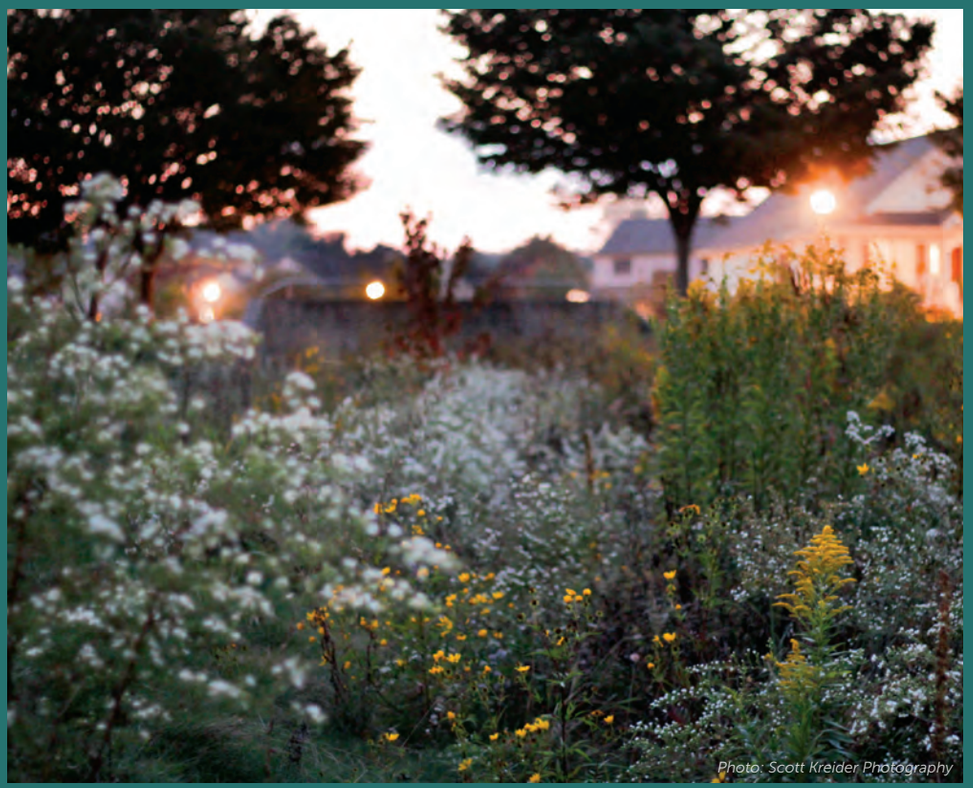


Photo: Scott Kreider Photography

There is often a desire to be green and make environmental improvements, but the knowledge of how to go about it and limited financial resources can be a challenge.

Warwick Township's goal is to address those challenges and guide development and other kinds of projects in a direction that provides long-term sustainability. For projects that are close to Lititz Run or one of its tributaries, we look to see if we can incorporate watershed improvements. By doing that, we're able to provide greater benefits to our community and to the larger region.

We've worked with LandStudies on a number of sites, both residential and commercial. Many of these projects have exceeded regulatory requirements. But they also promote development, economic growth, and jobs. Lititz Run is much cleaner today than it was 15 years ago. We do the monitoring and have the data to show that. Yet our community has grown substantially. Warwick Township is living proof that environmental benefits and economic benefits don't have to be mutually exclusive. It's possible to have both.

"Lititz Run is much cleaner today than it was 15 years ago. We do the monitoring and have the data to show that. Yet our community has grown substantially. Warwick Township is living proof that environmental benefits and economic benefits don't have to be mutually exclusive. It's possible to have both."

Daniel L. Zimmerman
Township Manager
Warwick Township

CASE STUDY 2

Photo: Larry LeFever

New Street Park Nutrient Trading Pilot Project

(LITITZ RUN WATERSHED)

PROJECT HIGHLIGHTS

Challenge

A pilot project was needed to help establish nutrient-pollution trading parameters in the Conestoga watershed. The New Street Park ecological restoration provided additional flood storage, improved water quality, and protection of downstream bridges from flood damage.

Economic Ecology Solution

- 750-foot straightened section of stream restored to 950-foot section of meandering stream channel
- 15.6 million pounds of sediment removed
- ~ 8,900 pounds of phosphorus removed
- ~ 26,000 pounds of nitrogen removed
- 1.5 acres of wetlands created

Collaborators

- Pfizer
- Lititz Borough

Award

- Governor's Award for Environmental Excellence

Benefits

The New Street Park ecological restoration in Lititz Borough was a cost-effective way to rejuvenate an existing community park, and at the same time, provide additional flood storage, improve water quality, and protect downstream bridges from flood damage and debris.

Excavation during the floodplain restoration removed 15.6 million pounds of sediment, about 8,900 pounds of phosphorus, and about 26,000 pounds of nitrogen.

The New Street Park ecological restoration helped to pilot nutrient-pollution trading parameters in the Conestoga watershed (in which Lititz Run is a subwatershed) in Lancaster County, Pennsylvania.

Photo: LSI

Fully functional created wetland areas incorporated plantings of native plants, shrubs, and trees.

In addition to removing a substantial amount of sediment and nutrients from the stream system, the New Street Ecological Restoration also created fully functional wetland areas and incorporated plantings of native plants, shrubs, and trees along the length of the restored corridor.

The New Street Ecological Restoration project won the coveted Governor's Award for Environmental Excellence. It remains a model of floodplain restoration through a heavily populated residential area, and the restoration area has become a favorite feature for local residents who use the park.

CASE STUDY 3

Banta Property Floodplain Restoration

(LITITZ RUN WATERSHED)

At the Banta property in Warwick Township, the Lititz Run channel had been moved to the side of the deep, narrow valley, straightened, and dammed for a historical mill operation. Because of its artificial configuration, the channel and banks were unstable, eroding both laterally and downward, creating a channel that was too deep and too wide.

The floodplain restoration involved 2,250 linear feet of stream and floodplain. The channel was moved back to the lowest and most stable elevation in the valley. Cross vanes and rock vanes were installed in the channel specifically to improve trout habitat. Sediments in the floodplain were removed and wetlands were created along the length of the restoration area. The stream, floodplain, and wetlands now interact with groundwater and each other.

The restoration site was planted with native species, and they are flourishing. Trees were planted as young seedlings and have grown to heights ranging 25-30 feet. More interesting, perhaps, was the discovery that other native wetland plants were sprouting and thriving in abundance during the first growing season after the restoration was completed. The historical floodplain seed bank, buried for centuries, had been uncovered with the excavation, and the long-dormant seeds began to grow.

Reproducing trout have been observed through electrofishing, and macroinvertebrate and trout surveys indicate these communities are healthy and increasing in number.

A monitoring study conducted several years after the project was completed revealed that, in spite of enduring a number of severe flood events and high-flow periods, the channel and floodplain have remained stable.

PROJECT HIGHLIGHTS

Challenge

A historical mill dam had altered the section of Lititz Run that flows through the Banta property, leading to streambank erosion and stream-channel instability.

Economic Ecology Solution

- 2,250 linear feet of stream and floodplain restored
- Native wetland habitat created
- Sediments in floodplain removed

Collaborators

- DEP Growing Greener
- Warwick Township, Pa.

Benefits

Photo: Landscape Architecture Magazine

CASE STUDY 4

Santo Domingo Water Quality Facility

(LITITZ RUN WATERSHED)

PROJECT HIGHLIGHTS

Challenge

Lititz Run and its tributaries, including the Santo Domingo Creek, were listed by DEP as impaired due to high sediment loads. The Lititz Run Watershed Alliance and Warwick Township sought innovative ways to reduce the sediment load in this watershed.

Economic Ecology Solution

A settling basin and constructed wetland were created to divert sediment-laden storm flow from the Santo Domingo Creek, slow the water down and filter it through wetland vegetation, and return cleaner water to the stream.

Collaborators

- Warwick Township
- Lititz Run Watershed Alliance

Benefits

The Santo Domingo Water Quality Facility, the first of its kind in Pennsylvania, demonstrates a regional alternative to traditional on-site stormwater management.

As Santo Domingo Creek, a Lititz Run tributary, flows into Warwick Township's Linear Park, excess stormwater is diverted into a forebay pond, a water pretreatment settling basin, where stream flow velocity is slowed and sediment settles out. The reduced-sediment stormwater flow then moves through a three-acre wetland where even more sediment settles out and nutrients can be absorbed through the metabolic processes of thousands of wetland plants. Then, the clean, filtered water is discharged downstream.

Created in 1998, the Santo Domingo Water Quality Facility demonstrates a biologically sound solution to riparian management on a regional scale, as well as the community's willingness to think outside the box, and their ability to recognize the worth of a nontraditional approach. Residents in the surrounding development consider the open-space facility a highly valued asset, and the lots adjacent to the site sold at a premium.

Water in the pretreatment settling basin (circled area) is brown with sediment. In the wetland above it, the water is noticeably cleaner.

Photo: Larry LeFever

CASE STUDY 5

Butterfly Acres

(LITITZ RUN WATERSHED)

POST-RESTORATION

The Butterfly Acres site is a stormwater drainage swale that flows through a development in Lititz Borough, Pennsylvania, that had become severely degraded. There had been significant erosion, and undesirable invasive plants had dominated the site. When the Susquehanna River Basin Commission, during the course of their 2005 Northern Lancaster County Groundwater Study, identified Butterfly Acres as a Critical Aquifer Recharge Area (CARA), it became especially important to find a way to restore the site.

Photo: Scott Kreider Photography

Educational signage along the walking trail helps inform the public about how the regional bioswale works and why it is so important.

Results from field surveys, geoprobes, and electromagnetic logging studies to check for susceptibility to sinkhole formation evolved into a four-phase Master Plan to restore the site's function as an aquifer recharge area. Because the site runs through a residential development and features a walking trail, the plan included the establishment of a healthy native plant community to improve the aesthetics and to increase enjoyment for the residents and others who use the site.

All four phases were completed over four subsequent years on behalf of the borough and through the generous contributions of private community businesses. Monitoring is ongoing, and visual observations indicate that the goal of restoring the infiltration and groundwater recharge function has been realized in this critical area. Educational signage on the site helps inform the public about how the regional bioswale works and why it is so important.

PROJECT HIGHLIGHTS

Challenge

A degraded drainage swale running through the Butterfly Acres development had significant erosion, was dominated by invasive plant species, and was not infiltrating and filtering stormwater runoff.

Economic Ecology Solution

- Native plant and wildlife habitat created
- Function of aquifer recharge area restored through enhanced infiltration
- Recreational opportunities (e.g., walking trail) and aesthetics enhanced
- Stormwater conveyance improved and localized flooding and infrastructure damage reduced

Results

Over the years, in spite of enduring a number of severe flood events and high-flow periods, the channel and floodplain have remained stable. Trout communities are thriving and long dormant native wetland plant seeds were excavated and now growing.

Collaborators

- Lititz Borough
- Private Community Businesses

Award

- Smart Growth Leadership Award

Benefits

CASE STUDY 6

Rock Lititz

(LITITZ RUN WATERSHED)

PRE-RESTORATION

RESTORATION IN PROGRESS

PROJECT HIGHLIGHTS

Challenge

The Santo Domingto Creek, a tributary to Lititz Run located on the Rock Lititz site, had been significantly altered by historical human activities, leading to streambank erosion and streambed degradation that caused nutrient-rich sediment to affect downstream water quality.

Economic Ecology Solution

- 3,136 linear feet of stream restored by removing legacy sediment from the valley bottom and increasing floodwater storage potential
- Stormwater managed within the floodplain, increasing available land for development by 9 acres

Collaborators

- Warwick Township
- Clair Global
- TAIT Towers
- Atomic Design
- Derck & Edson Associates

Benefits

The central green area in the plan above and red outlined area in the photo on the facing page indicates the floodplain restoration project now in progress, Image: Derck & Edson

Rock Lititz is a landmark floodplain restoration project. It is the first time DEP has permitted floodplain restoration to provide the overwhelming majority of stormwater management for a large commercial site. This designation is economically important for a number of reasons.

Rock Lititz is one of Lancaster County's newest and most far-reaching and important enterprises. The company provides facilities for the training, preparation, coordination, and rehearsals needed for musical acts from all over the world.

Santo Domingo Creek, a Lititz Run tributary, flows through the Rock Lititz property. The channel and floodplain occupy 17 of the 96 acres and cannot be developed. Conventional approaches to land development would have set aside additional acreage for stormwater management, open space, and building setbacks — as required by local land development, stormwater management and zoning ordinances, and state stormwater management requirements. The traditional approach would have allowed only 47 of the 96 acres to be developed — less than half the site.

An alternative option that would maximize land use was needed. After careful consideration, Rock Lititz chose to fund a floodplain restoration on the portion of Santo Domingo Creek that runs through its property.

The restoration project is expected to provide *annual* pollutant reductions of 248,000 pounds of sediment, 1,010 pounds of nitrogen, and 173 pounds of phosphorus.

The Rock Lititz floodplain restoration project, more than any other to date, was thoroughly researched in terms of its economic value to Rock Lititz. A detailed cost-benefit analysis is available from LandStudies.

The results of that analysis provided an eye-opening picture of both direct and indirect benefits to Rock Lititz and the surrounding communities, which further reveals why the greater up-front investment for floodplain restoration pays off financially and environmentally.

With floodplain restoration, Rock Lititz regains **nine** acres of land for development that could have been lost to conventional stormwater-management systems and detention basins, resulting in a **182%** return on investment based on implementation of floodplain restoration and a $3.1 million value of the recaptured nine acres. The developable portion of the site went from 47 to 56 acres.

The floodplain restoration is helping Warwick Township to meet MS4 and total maximum daily load (TMDL) requirements, and it's helping Lancaster County to meet Chesapeake Bay cleanup obligations. By looking beyond traditional ways of developing and permitting, the Rock Lititz floodplain restoration project has set a new standard for cost-effective development.

Economic Ecology By the Numbers

9
MORE ACRES OF DEVELOPABLE LAND

182%
RETURN ON INVESTMENT*

$3.1 Million
VALUE OF RECAPTURED LAND

* *Based on implementation of floodplain restoration and value of recaptured land.*

CASE STUDY 7


Photo: Melody McFarland Photography


Photo: Scott Kreider Photography

Landis Homes

PRE-RESTORATION

PROJECT HIGHLIGHTS

Challenge

An expansion to the Landis Homes Retirement Community required additional stormwater management. The client's goals were to improve stream function of Kurtz Run and the aesthetics of the community while minimizing the space devoted to stormwater management so that space available to construct resident housing could be maximized.

Economic Ecology Solution

- 11 additional residential units will be added upon permit approval as a result of the land-use savings from the floodplain restoration
- The floodplain restoration approach was more cost-effective for Landis Homes compared to other approaches relying on conventional detention basins. It achieved all of the following results for a single design, build, and monitoring cost of $800,000:
  - Annual sediment removal: 150,000 pounds per year.
    - Cost for the same result using rain gardens, requiring 121 acres: $7.6 million.
    - Cost for the same result using urban forested riparian buffer, requiring 518 acres: $6.4 million.
  - Annual nitrogen removal: 800 pounds per year.
    - Cost for the same result using rain gardens, requiring 42 acres: $1.1 million.
    - Cost for the same result using urban reforested riparian buffer, requiring 94 acres: $1.1 million.
  - Annual phosphorus removal: 130 pounds per year.
    - Cost for the same result using rain gardens, requiring 50 acres: $1.3 million.
    - Cost for the same result using urban reforested riparian buffer, requiring 148 acres: $1.8 million.
  - Significant aquifer recharge: Runoff volume reduction is nearly four times greater than required by the NPDES permit.

Collaborator

- Landis Homes Retirement Community

Benefits

Additional stormwater management facilities were a requirement for a residential expansion at Landis Homes Retirement Community. Because stewardship is an important component of Landis Homes' mission, management wanted to find a sustainable yet financially astute way to increase housing while environmentally and aesthetically improving the site. Floodplain restoration along Kurtz Run, which flows through their property, provided the solution.

Kurtz Run, like so many other streams in the area, had been a source of sediment and nutrients due to streambank erosion. A floodplain restoration project met management's


Photo: Scott Kreider Photography

Native wetlands increase biodiversity.

high standards for appearance and functionality, managing stormwater, removing pollutants, and capturing and filtering stormwater naturally.

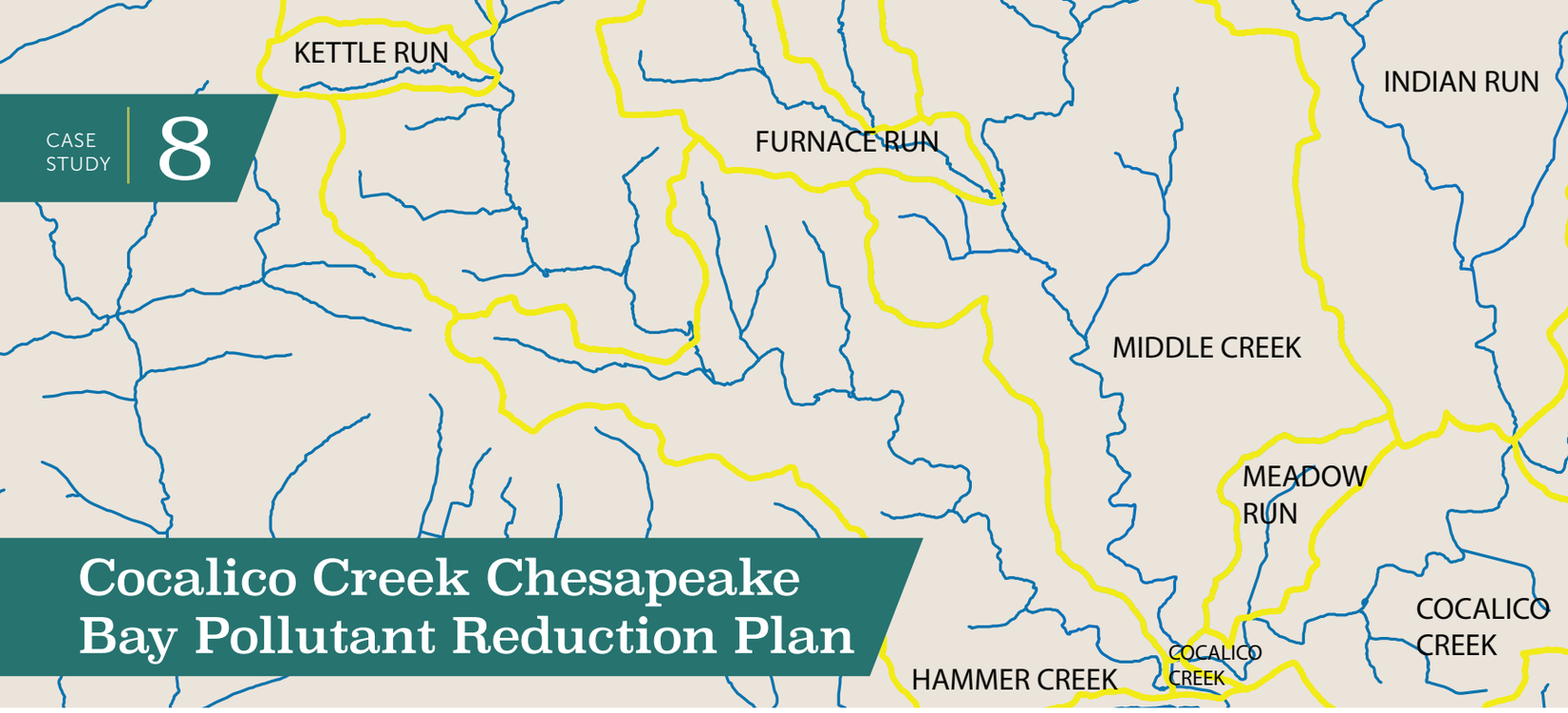
The return on investment for the project was significant. The floodplain restoration provided the additional stormwater management required and freed up enough space on the 114-acre parcel to seek permitting for building 11 more cottages— on acreage that otherwise would have been used for traditional stormwater management structures. Landis Homes is awaiting final approval of the permit, which is in its final stages with DEP.

Approximately 27,500 cubic yards of sediment were removed from the floodplain and spread on adjacent fields or stockpiled for future use.

A pond was restored to a wetland full of native plants and now attracts wildlife and helps filter water during storm events.

Applying a holistic ecosystem approach has paid off in many ways for Landis Homes and for the environment both on site and downstream. Management has more than met their obligation to control stormwater rate, quantity, and quality. The community has been able to maximize its utilization of limited land area and at the same time, decrease outdoor maintenance. Residents are enjoying the natural beauty of more plants, color, wildlife, and walkable areas.

Kurtz Run now features a winding stream channel.



CASE STUDY 8

Cocalico Creek Chesapeake Bay Pollutant Reduction Plan

PROJECT HIGHLIGHTS

Challenge

Twelve municipalities in the Cocalico Creek watershed needed a Chesapeake Bay Pollution Reduction Plan to address nutrient and sediment loads to streams.

Economic Ecology Solution

- 3 primary sources of pollutants identified
- Each municipality saved 80% on cost of producing a CBPRP by combining efforts on a regional plan
- Cost-benefit analysis conducted to compare multiple approaches; floodplain restoration identified as most cost-effective option

Collaborators

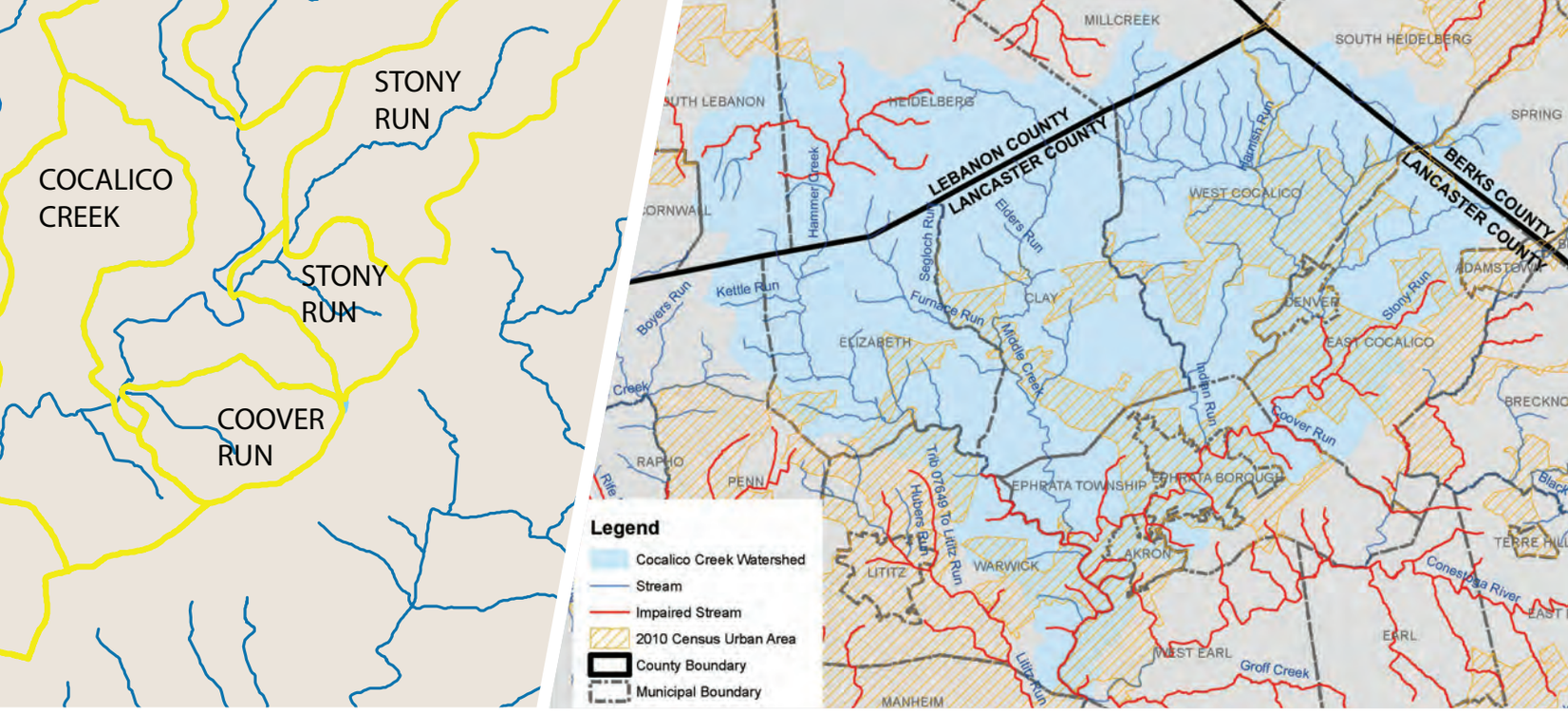
- Cocalico Creek Watershed Association
- 12 municipalities in Lancaster County

Benefits

Twelve municipalities within the Cocalico Creek watershed in Lancaster County, Pennsylvania, joined together to develop a regional Chesapeake Bay Pollution Reduction Plan (CBPRP). Their efforts are a classic example of the exponential benefits that come from collaborating to meet local, state, and federal requirements concerning flooding and water quality.

The development of a CBPRP is a new regulation imposed on many municipalities in the Chesapeake Bay watershed as part of their Municipal Separate Storm Sewer System (MS4) permits — at a cost to be borne by the municipality. The CBPRP must address nutrient and sediment loadings to streams from the regulated MS4 discharges in the Chesapeake Bay watershed. Ultimately, municipalities are required to implement BMPs that will reduce stream pollutants, and for many it can be a serious financial strain.

Under the aegis of the Cocalico Creek Watershed Association, the 12 municipalities collaborated on developing one CBPRP that addresses nearly the entire watershed. In turn, each of them saved 80 percent on the cost of developing the plan.



This approach also satisfied MS4 permit requirements associated with public participation and involvement.

To get the best return on every dollar invested in the CBPRP, the approach was to do the following:

1. Identify the major sources of the pollutants of greatest concern: sediment, nitrogen, and phosphorus.
2. Focus on reducing pollutants from those sources.
3. Decide how to get the best results for each dollar spent.

MapShed, a modeling program developed by Penn State, identified annual pollutant-loading rates in the watershed. The major sources for the pollutants of concern in the watershed are as follows:

- Sediment from stream bank erosion: 28,438 pounds per year.
- Nitrogen from groundwater (stream baseflow): 1,148,660 pounds per year.
- Phosphorus from livestock: 639,368 pounds per year.

Streambank erosion, the model showed, accounts for a full 79 percent of the sediment loading in the urban area (UA) of the watershed. Most of the nitrogen pollution comes from groundwater, which is likely a result of historical manure-management practices.

This kind of information is invaluable for determining where to focus financial resources to get the best return on investment. The next step was to identify which methods would be the most cost-effective in these areas. The results are eye-opening.

To reduce sediment loads by 100,000 pounds in the Cocalico Creek watershed, it would cost about $329,000 using floodplain restoration. To achieve the same result using basin retrofit, rain gardens, or riparian buffers, the cost rises sharply: $5.25 million, $5.09 million, and $4.24 million respectively. Floodplain restoration proved to be the most cost-effective solution.

CASE STUDY 9

Bedford Springs Resort

PROJECT HIGHLIGHTS

Challenge

A Bedford Springs Resort golf course was being threatened along Shober's Run by flooding and erosion, and it was contributing to nonpoint source pollution.

Economic Ecology Solution

- 6,800 linear feet of stream and floodplain restored
- In-stream structures installed for grade control, bank protection, and improved aquatic habitat
- 12 acres of wetlands created

Collaborators

- Bedford Springs Resort
- Forse Design (www.forsedesign.net)

Awards

- Affinity Award for Best Environmental Project, Golf Course Industry Magazine
- Renovation of the Year, Golf, Inc.

Benefits

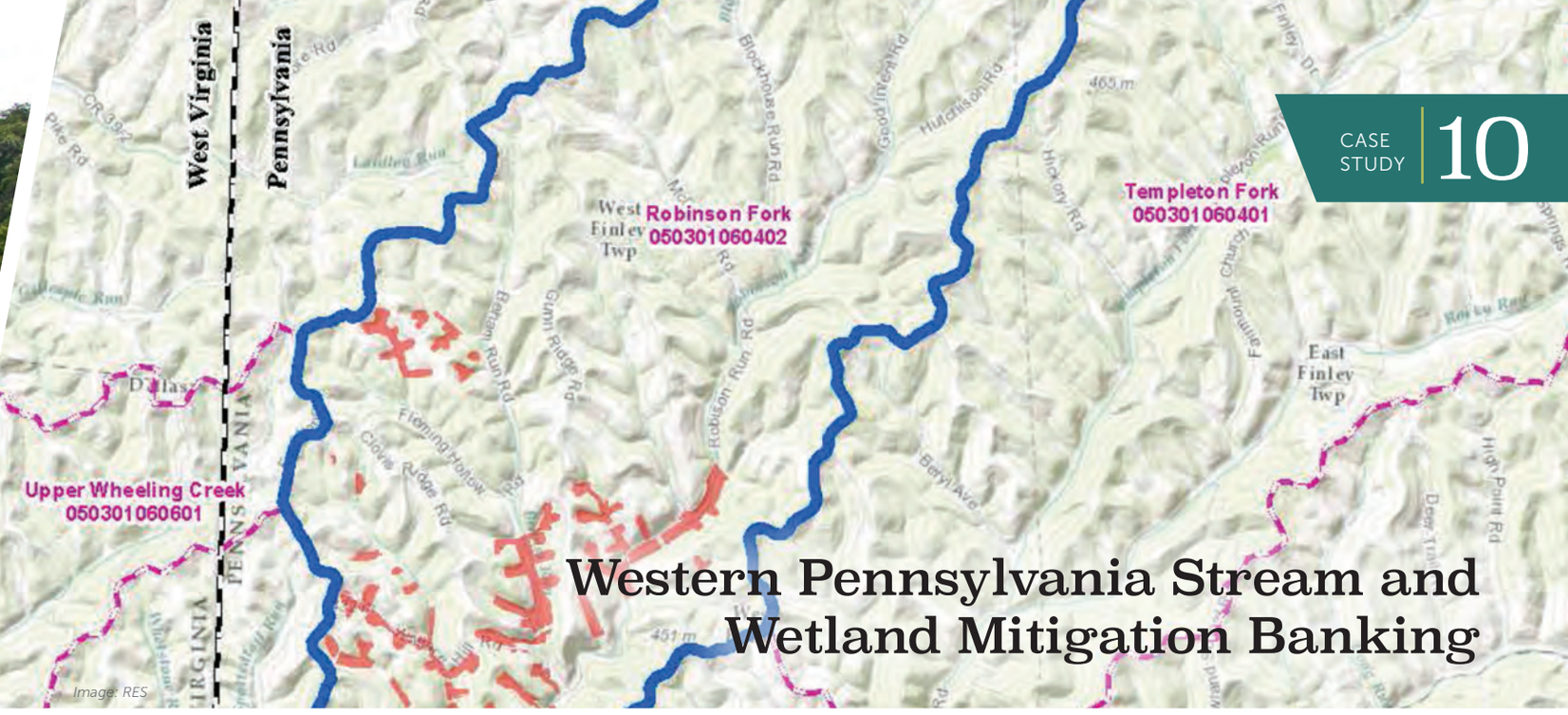
The golf course at the historic Bedford Springs Resort in Bedford, Pennsylvania, was still being used, but many of the course features were being threatened or damaged by flooding and erosion along Shober's Run, which runs through the property. A new golf course was planned for the site, which was being restored in its entirety. However, something had to be done to prevent the stream from causing costly damage to the new course.

The solution was a floodplain restoration along 6,800 feet of Shober's Run. The floodplain was excavated to its historical elevations. A floodplain corridor at least 80 feet wide was created to accept and diminish the forces of high flows and to provide flood storage and infiltration. In-stream structures further stabilized the channel through grade control and bank stabilization and improved the aquatic habitat. Twelve acres of wetlands were created along the length of the restoration site, including several acres to mitigate wetlands disturbed during the restoration of the Victorian era Bedford Springs Hotel.

Post-construction monitoring, which ended seven years after project completion, indicated that the entire project — channel, floodplain, new wetlands, and mitigation wetlands — is functioning as DEP required and is remaining stable over the long term.

Flood reduction and pollutant removal, as well as improved aesthetics and wildlife habitat, are among the valuable assets of the newly renovated resort and golf course and downstream town of Bedford.

Upon completion of the project, the floodplain restoration of Shober's Run received two awards from the golfing industry: the Affinity Award for Best Environmental Project and Renovation of the Year.



CASE STUDY 10

Western Pennsylvania Stream and Wetland Mitigation Banking

A watershed-scale stream-restoration project in Washington County, Pennsylvania, will become Pennsylvania's largest mitigation bank associated with a stream and floodplain restoration. The project represents a cost-effective approach to meeting local, state, and federal regulatory requirements for the energy industry and other economic development in western Pennsylvania while improving regional environmental and ecological functions that will benefit many people.

As with most other floodplain restoration projects that address the root causes of environmental problems on a regional scale, the direct benefit (in this case, creating a permitted mitigation bank) is accompanied by numerous other indirect benefits — stormwater storage and infiltration, groundwater recharge and filtration, and reduced damaging flood flows, all of which can affect the region both ecologically and financially.

The restoration will take place across 552 acres in West Finley Township, in the Robinson Fork watershed, where land was undermined, deforested, and farmed. The project is designed to restore nearly 47,500 linear feet of stream, enhance 41,890 linear feet, and preserve another 53,508 linear feet. Legacy sediments in the stream valley will be removed, and the entire channel will be relocated to its historical elevations, creating a functional, stable, and healthy stream and wetland complex while providing suitable compensatory mitigation for unavoidable disturbances to streams and wetlands as a result of activities authorized by local, state, and federal levels of government.

Along with developing a re-integrated stream and wetland complex, the project will restore local groundwater aquifers, greatly improve both plant and animal habitat, and create a riparian system that will remove pollutants from the stream and reduce damaging flood flows both on site and downstream.

Restoring a regional riparian system to its historical, most stable configuration to reconnect stream flow, wetlands, and groundwater is, in the long term, the most cost-effective approach. The area's energy industry and everyone in the surrounding municipalities will reap both direct and indirect benefits through the re-establishment of a historically degraded system to a long-term stable system that will essentially maintain itself.

PROJECT HIGHLIGHTS

Challenge

Mined, deforested, and farmed land in what will be a large mitigation bank suffers from legacy sediments and an altered floodplain and stream channel.

Economic Ecology Solution

- Detailed plan to feature stream and floodplain restoration and wetland creation

Collaborators

- TRC

Benefits

CASE STUDY 11

Big Spring Run

PROJECT HIGHLIGHTS

Challenge

Big Spring Run was characterized by severe streambank erosion and streambed degradation, resulting in the release of nutrient-rich sediment that impacted downstream water quality.

Economic Ecology Solution

- Wetland-meadow valley bottom complex created
- 22,000 cubic yards of legacy sediment removed
- 1,500 linear feet of valley restoration
- 3,100 linear feet of stream restoration
- Five years of monitoring

Collaborators

- Pennsylvania Environmental Council
- Franklin & Marshall College
- U.S. Geological Survey
- The Friends School, Baltimore
- Elizabethtown College
- Millersville University
- EPA
- DEP

Benefits

Under the auspices of the Pennsylvania Environmental Council, the Big Spring Run floodplain restoration project in southern Lancaster County, Pennsylvania, helped establish Chesapeake Bay protocols for defining reductions in pollutant loads through individual floodplain restoration projects.

Big Spring Run is a headwater tributary of the Conestoga River. Historical land-use practices and the imposition of 19th century milldams on the stream system generated a nutrient-rich sediment load that, over time, had filled in the stream valley. Analysis indicated that streambank erosion in Big Spring Run under pre-restoration conditions accounted for 63 percent of nutrient-laden sediments suspended in the stream flow.

The restoration, which is part of a research project led by Franklin & Marshall College scientists Robert Walter, Ph.D., and Dorothy Merritts, Ph.D., was designed to return the bottom of the stream valley to its historical condition, creating a

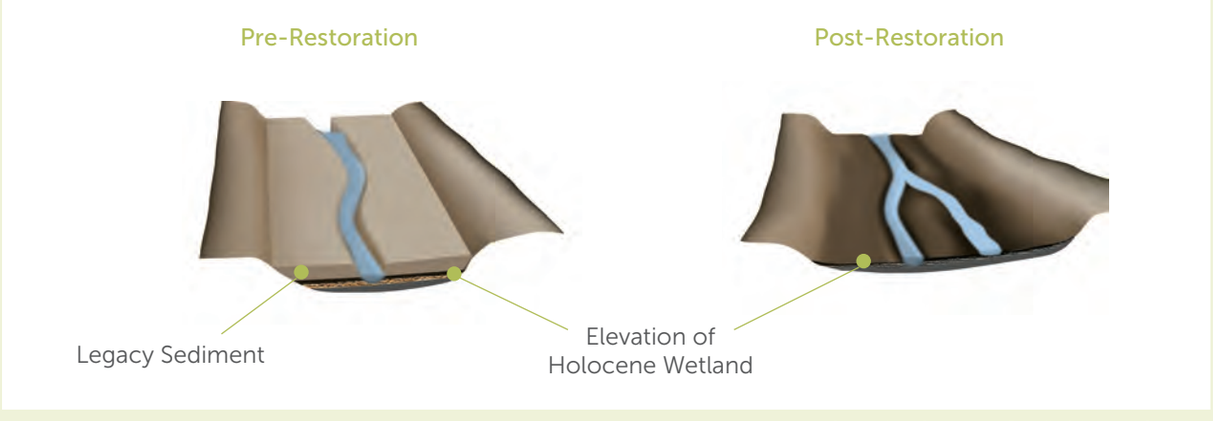
wetland-meadow valley bottom complex. Restoration construction activity removed approximately 22,000 cubic yards of legacy sediment. Included in the restoration were 3,100 linear feet of stream channel and 1,500 linear feet of stream valley.

The restoration has improved water quality on site and for downstream portions of the watershed, created additional storage capacity for flood waters, increased groundwater-recharge capabilities, and restored and improved both aquatic and terrestrial wildlife habitat.

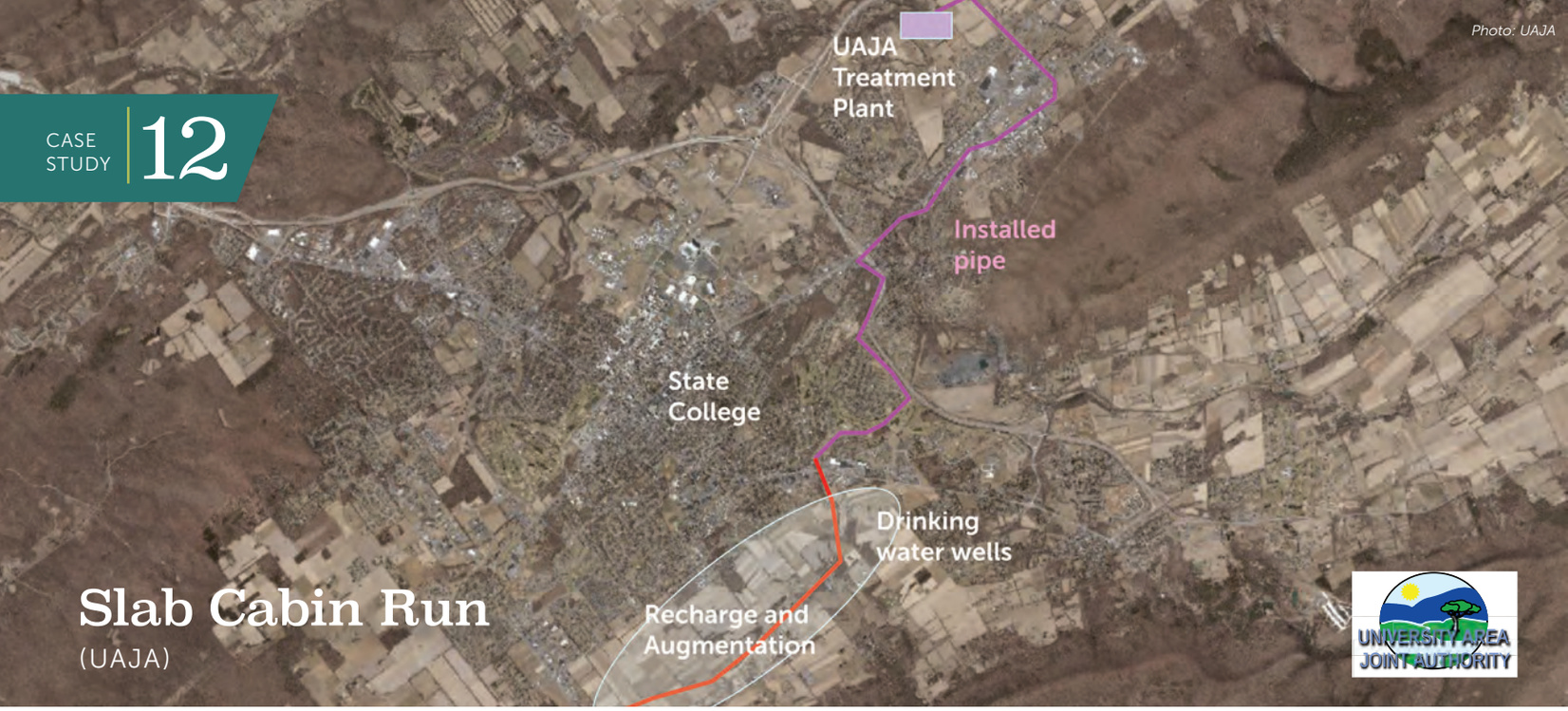
Several videos of the project are available on YouTube: https://www.youtube.com/channel/UCorgwKIsH03jLRuTSF3Wxzg. Detailed information on the restoration project is available at www.bsr-project.org.

Floodplain Restoration Method

Legacy sediments were excavated and removed, reestablishing the valley bottom at the elevation of the pre-settlement floodplain, much of which remained intact beneath the historic millpond deposits. The channel and floodplain were designed to allow for both wet and dry zones depending on precipitation and fluctuating groundwater levels.



Credit: Kayla Schulte and Franklin & Marshall College



CASE STUDY 12

Slab Cabin Run

(UAJA)

PROJECT HIGHLIGHTS

Challenge

The University Area Joint Authority seeks to improve brook trout habitat in Slab Cabin Run and improve water quality and groundwater recharge, promoting ecological enhancement and economic development.

Economic Ecology Solution

- Detailed plan to feature floodplain restoration

Collaborator

- University Area Joint Authority

Benefits

UAJA Beneficial Reuse Project purifies wastewater through micro-filtration and reverse osmosis used to augment Slab Cabin Run and recharge the drinking water aquifer.

Economic growth in any region is closely tied to water quality and availability. One of the greatest examples of how the principles of Economic Ecology can be implemented to advance economic and environmental prosperity is the Slab Cabin Run floodplain restoration and flow augmentation project. Slab Cabin Run is a tributary of Spring Creek in Centre County, Pennsylvania. The University Area Joint Authority (UAJA), which provides wastewater treatment to the six municipalities of the Centre Region in Centre County, is advancing the project.

Instead of releasing treated wastewater where it's treated — downstream — UAJA is recycling it for beneficial reuse. Wastewater is collected, treated using reverse osmosis, and piped back to the headwater aquifer of Slab Cabin Run, where water is pumped out of the ground for use by the Centre Region municipalities. Along the route, commercial and industrial customers can use the recycled water in place of water from the region's drinking-water suppliers. Additionally, heat can be extracted from the water to provide energy-efficient heating to some customers, and the cooled water can then be used for groundwater recharge and stream augmentation.

A restored floodplain will contribute to beneficial water reuse through groundwater recharge. Furthermore, it will support UAJA's mission to enhance the environment, quality of life, and economy of the region by doing the following:

- Restoring native brook trout and other aquatic-species habitat (thus encouraging fishing and recreational use).
- Removing pollutants to achieve reductions in phosphorus, nitrogen, and sediment.
- Reducing flooding on the upstream project site.
- Providing a valuable commodity — high-purity reuse water — to benefit the region's economy.

This project will clearly demonstrate that it is possible to have economic growth while improving and restoring the watershed.

Further Reading

The following resources provide more information about floodplain restoration, economic ecology, and the case studies in this book.

BSR Project. Acquatic Ecosystems Restoration Research. Big Spring Run, Lancaster, PA. http://bsr-project.com/

Chesapeake Bay Foundation. "The Economic Benefits of Cleaning Up the Chesapeake." CBF Reports. http://www.cbf.org/EconomicBenefits

Delaware Valley Regional Planning Commission and the GreenSpace Alliance. "Economic Value of Open Space." http://www.dvrpc.org/openspace/value/

EPA. "Cost-Benefit Resources." Water: Green Infrastructure. http://water.epa.gov/infrastructure/greeninfrastructure/gi_costbenefits.cfm

Gutshall, Mark, LandStudies, and Diane Huskinson. "The Future of Watershed Restoration: Landis Homes Expansion Project Meets Needs of Business, Community and Environment." *Catalyst*, Spring 2014. http://landstudies.com/images/pdfs/Landis_Homes_Catalyst.pdf

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Economic Ecology

Economic Ecology maximizes both economic and environmental returns to solve water issues, such as pollutant removal and flood reduction, at a regional scale. It is defined by ecological principles that are validated by engineering measurement and performance standards. It is proactive rather than reactive, addressing the causes of problems and not merely symptoms. By employing the principles of Economic Ecology, planners and decision-makers can reduce wasteful spending and more effectively meet regulatory requirements for stormwater, flooding, and more. Economic Ecology also involves the formation of partnerships with government, public, nonprofit, and private organizations to share costs and increase benefits throughout an entire region or watershed.

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Lititz Run Watershed. Photo: Larry LeFever