



An outdoor classroom at the water quality wetland.



Sediment removal from the forebay of the water quality wetland in 2008.



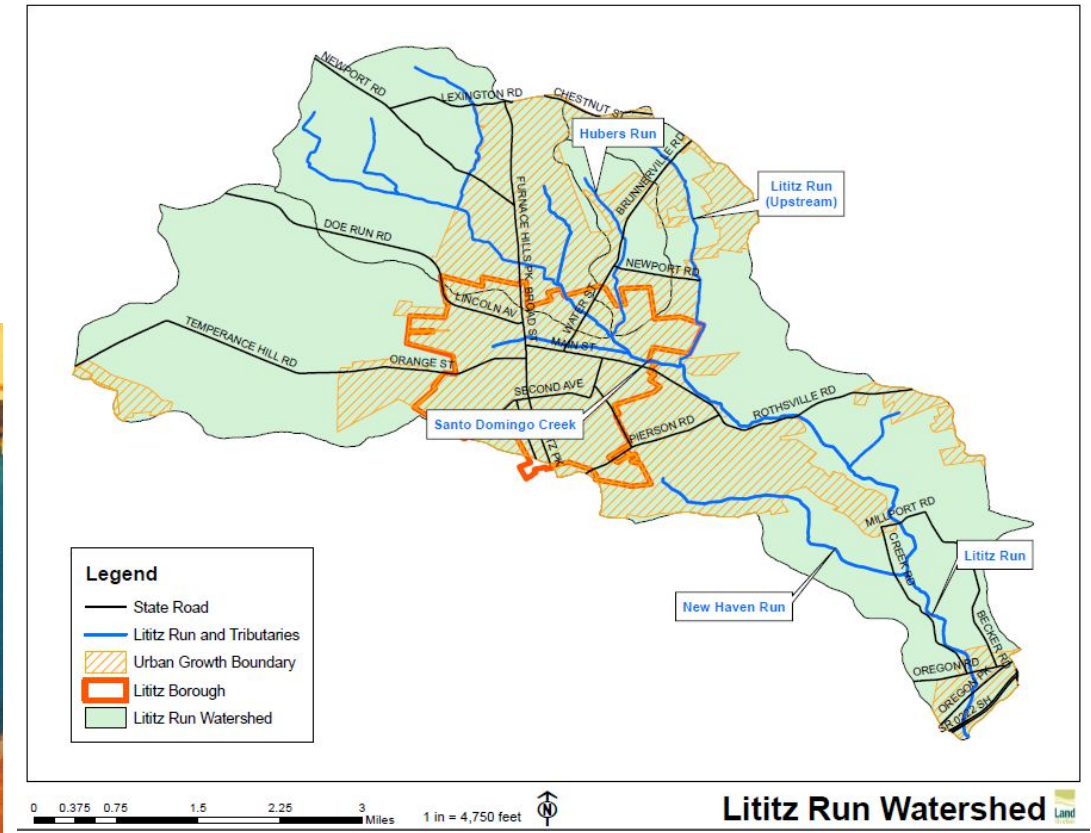
Cross vane stream feature part of the Water Street reach restoration.



This created wetland, constructed in 1995, continues to provide water quality benefits and a thriving native plant community.



Original watershed maps used for presentations before GIS was available.



Lititz Run Watershed



Watershed Awareness Days began in 1995 and continues annually as an educational event for elementary students in the Warwick School District.



Floodplain restoration constructed in 2005 includes 1,800 linear feet of stream, wetland creation, riparian planting, and significant flood and deposition storage.



Banta Site Floodplain Restoration

Measurable Results

- Re-designated in 2008 a Cold Water Fisher (CWF), upgraded from its previous designation as a Warm Water Fishery (WWF).
- First Critical Aquifer Recharge Area (CARA) restoration in Pennsylvania.
- First regional water quality facility in Pennsylvania.
- Over 5 miles of stream and riparian corridor restored.
- Over 9 acres of wetlands have been created to reduce flooding and improve water quality.
- Hundreds of community residents have volunteered their time and contributed money to help in the restoration effort.
- Warwick School District and Millersville University integrated education curriculum related to the watershed.

Awards

- US EPA National Showcase Watershed – 1999
- Governor’s Award for Environmental Excellence - 1999
- Pennsylvania Planning Association – Outstanding Planning Award 1999
- PA/Del Chapter American Society of Landscape Architects - Merit Award 1999

Project Description:

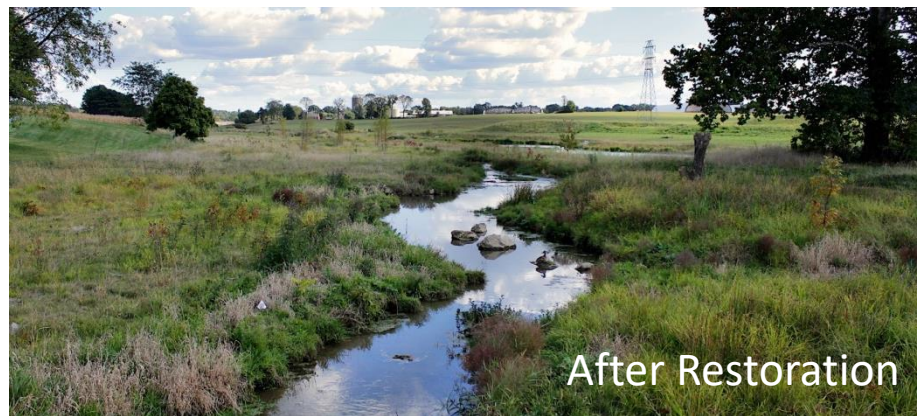
Working with local partners and stakeholders, LandStudies, Inc. developed an **award winning watershed based planning model** implemented over the past 20 years for the Lititz Run Watershed Alliance (LRWA), Lancaster County, PA. Key to this project’s success was the identification of target locations along with prioritized projects based on water quality benefits and availability of the sites. A timeline of restoration and project milestones can be found at www.warwicktownship.org , LRWA page.

Approach

Community based planning brings together a diverse group of local citizens who actively participate in the planning process. The planning approach includes four components: community organization, public outreach and education, management and planning, and project implementation.

This site demonstrates the following sustainable design elements:

- Stormwater BMPs
- Nutrient and Sediment Reductions
- Streambank Stabilization
- Water Quality Improvement
- Ecological Vegetation Management
- Wildlife/Aquatic Habitat



Quantifiable Results:

- Approximately 2,600 linear feet of stream restoration
- Approximately 6.5 acres of created wetlands
- Meets peak rate and volume control requirements for land development activity
- Planting
 - > 25,000 native herbaceous plugs
 - > 700 trees and shrubs
- Estimated annual pollutant load removal:
 - 800 lb. Nitrogen
 - 130 lb. Phosphorus
 - 150,000 lb. Sediment

Peak Runoff Rate Analysis*

*considering full build-out of Landis Homes campus

| Return Period | Existing @ Conestoga R. (cfs) | Existing On-site (cfs) | Post Devel. @ Conestoga R. (cfs) | % Reduction (Site) | % Reduction (Total) |
|---------------|-------------------------------|------------------------|----------------------------------|--------------------|---------------------|
| 2-yr | 363.69 | 63.38 | 349.87 | 22% | 4% |
| 5-yr | 894.56 | 133.73 | 868.95 | 19% | 3% |
| 10-yr | 1512.24 | 207.62 | 1475.43 | 18% | 2% |
| 25-yr | 1895.01 | 251.41 | 1853.75 | 16% | 2% |
| 50-yr | 2460.88 | 315.19 | 2419.10 | 13% | 2% |
| 100-yr | 3155.77 | 390.83 | 3110.27 | 12% | 1% |

Estimated 2-yr runoff volume reduction:

302,785 cf (floodplain), 343,364 cf (total of all BMPs)

Project Description:

Expansion of the Landis Homes Retirement Community required additional stormwater management. The client's goals were to improve stream function and the aesthetics of the community while minimizing the space devoted to stormwater management and increasing the space available to construct resident housing.

The floodplain restoration project removed legacy sediment from the floodplain and increased floodwater storage potential in accordance with the PA Stormwater Best Management Practices Manual (BMP 6.7.1). The stormwater storage capacity of the project reduced the amount of useable space devoted to traditional stormwater basins and increased buildable acreage allowing for 11 additional residential units. In addition, the project reduced stream bank erosion and created wetland pockets resulting in the infiltration and filtration of runoff and water quality benefits. The floodplain has been planted with colorful native vegetation which will become an aesthetic asset to the community. The project also resulted in the improvement of aquatic and terrestrial wildlife habitat.

Construction date: July 2012 – October 2012

Services: Engineering, design, permitting, construction management, plant installation, post-construction monitoring and maintenance

Contract Amount: \$800,000

Awards: 2012 LEED (Leadership in Energy and Environmental Design) Project of the Year by the U.S. Green Building Council (USGBC) Central PA Chapter

Lessons Learned:

- A design/build approach proved very successful to address all site and project challenges while completing the project within the proposed budget and schedule.
- Include language in design drawings that allows flexibility for field modifications during construction. Keep agencies apprised of these design changes.
- The custom “toe wood” fish structures were by far the most effective and functional fish habitat structures installed.
- Excavating and converting the pond area to floodplain/wetland/stream was the most difficult & challenging part of the project. A more thorough evaluation of existing conditions would have been helpful.



Monitoring site visit



After



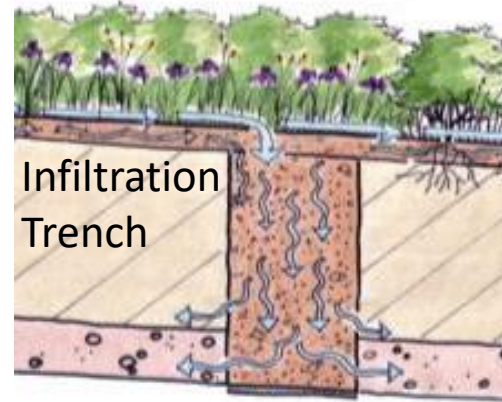
After



After



Before



Infiltration Trench

This site demonstrates the following sustainable design elements:
 Critical Aquifer Recharge Area Restoration
 Groundwater Recharge
 Natural Landscaping
 Ecological Vegetation Management
 Recreation
 Education



During Construction



Infiltration Trench



After



After



After – During Storm Event

Plant List:

- | | |
|-------------------|--------------------|
| Sedges | Coreopsis |
| New England Aster | Blue vervain |
| Smooth blue aster | Swamp milkweed |
| Tickseed | Bur marigold |
| Soft rush | Native grasses |
| Violet | Chokeberry |
| Cardinal flower | Red osier dogwood |
| Blue lobelia | Arrowwood viburnum |
| Golden ragwort | River birch |
| Goldenrod | Bald cypress |

Quantifiable Results:

- 2,250 linear feet of drainage channel restored
- 2.85 acres of native plant bio-swale seeding
- 135 trees planted

Construction dates:

- Phase 1 – 2006
- Phase 2 – 2007
- Phase 3 – 2008
- Phase 4 – 2010

Services: Engineering, design, permitting, construction management, plant installation, and post-construction monitoring

Project Cost: \$400,000

Awards:

Recipient of a **2011 Smart Growth Leadership Award** from the Lancaster County Planning Commission

Lessons Learned:

- The infiltration techniques used have been successful
- Annual maintenance has been performed since project completion which has helped ensure optimal project performance and a vibrant native plant community.

Project Description:

A drainage swale running through the Butterfly Acres development was degraded. The swale had significant erosion, was dominated by invasive plant species, and was not infiltrating and filtering run-off. The site was identified as a Dry Stream Valley, one of four types of Critical Aquifer Recharge areas (CARAs) designated by the Susquehanna River Basin Commission as part of the Northern Lancaster County Groundwater Study completed in 2005.

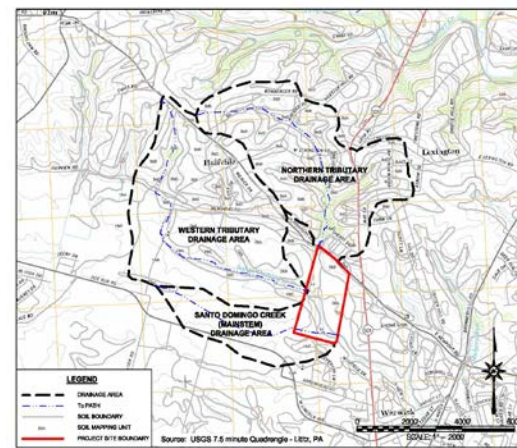
Magnetic logging studies, used to check for susceptibility of sinkhole formation, geoprobes, and field surveys were used to develop a four-phase master plan that would allow the site to once again function as an aquifer recharge area, provide a healthy native plant and wildlife habitat, and improve the aesthetics of the site for people who utilize the adjacent walking trail. Four phases of the restoration have been constructed over the past three years and monitoring continues to provide data in support of the effort to infiltrate and recharge the groundwater supply. Signs have been installed to educate the public about the function and importance of the project.



Before

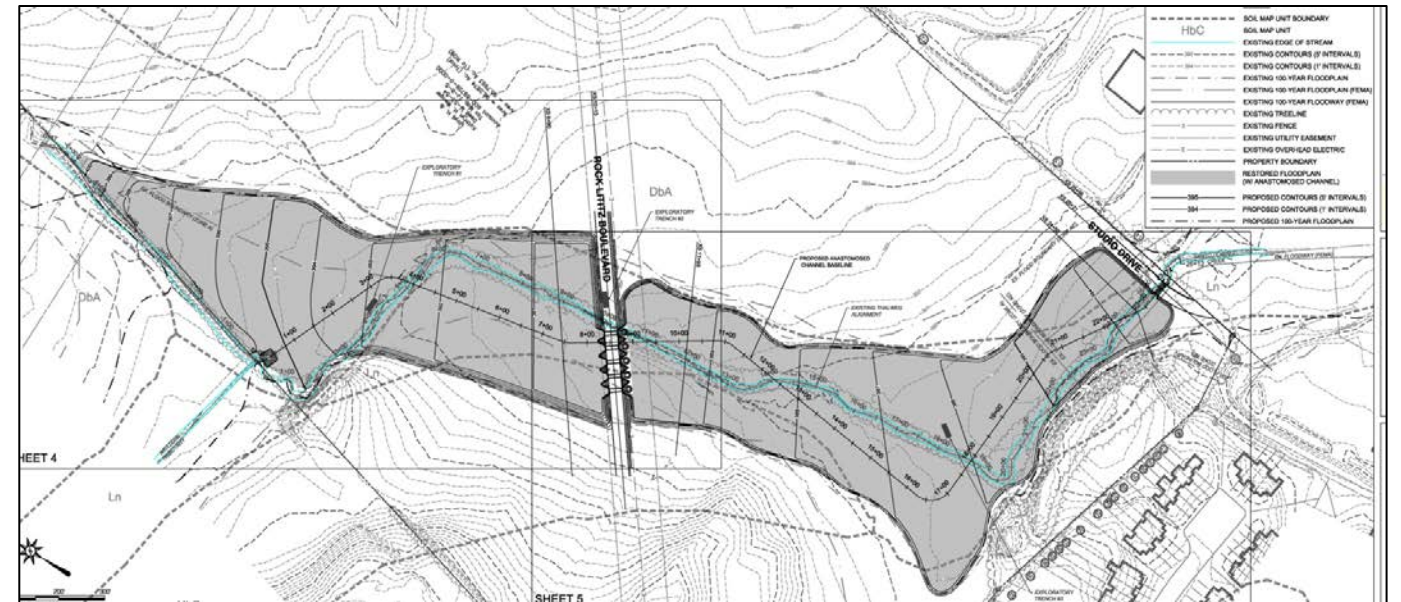


Preliminary Master Plan



Trench Evaluation

- This site demonstrates the following sustainable design elements:**
- Alternative Stormwater Management
 - Stormwater BMPs
 - Nutrient and Sediment Reductions
 - Legacy Sediment Removal
 - Enhanced Infiltration
 - Streambank Stabilization
 - Water Quality Improvement
 - Ecological Vegetation Management
 - Wildlife/Aquatic Habitat



Rock Lititz - Santo Domingo Floodplain Restoration

Preliminary Peak Rate Summary Considering Full Masterplan Build-Out

| Return Period | Existing @ Property Line (cfs) | Existing On-site (cfs) | Post Devel. @ Property Line (cfs) | % Reduction (Site) | % Reduction (Total) |
|---------------|--------------------------------|------------------------|-----------------------------------|--------------------|---------------------|
| 2-yr | 49.78 | 7.01 | 8.57 | 588% | 83% |
| 5-yr | 170.51 | 34.43 | 129.07 | 120% | 24% |
| 10-yr | 342.48 | 72.35 | 309.29 | 46% | 10% |
| 25-yr | 463.29 | 97.74 | 435.57 | 28% | 6% |
| 50-yr | 657.70 | 136.60 | 638.65 | 14% | 3% |
| 100-yr | 910.72 | 184.57 | 903.42 | 4% | 1% |

Benefits:

- Additional buildable area where detention basins would have otherwise been needed (Increased opportunities for economic development and targeted development density)
- Significant sediment and nutrient load reductions (TMDL and MS4 considerations)
- Significant aquifer recharge enhancement
- Long-term stream stability
- Wildlife habitat improvement
- Increased recreational opportunities (Walking trails, wildlife observation)

Annual Pollutant Reductions:

- 248,600 lb. of sediment; 1,007 lb. of nitrogen; 155 lb. of phosphorus

Rock Lititz – Volume BMP Summary

| Volume Retained (cf) | |
|--|----------------|
| Note: This Volume is only for Phase 1A; Additional upland BMPS will be included with future phases | |
| Total Recharge Volume Outside of Floodplain | 12,800 |
| Floodplain Restoration 2-yr Infiltration (from Hydrograph Diversion) | 970,725 |
| Grand Total Recharge Volume | 983,525 |

| | |
|---------------------------------------|----------------|
| CG-1 Required Volume Reduction | 529,362 |
|---------------------------------------|----------------|

Quantifiable Results:

- 17-acre floodplain restoration
- 3,136 l.f. stream restoration
- 70,000 tons of sediment/legacy sediment removed

Design:

LandStudies designed the 17-acre floodplain restoration project to address the many needs of the campus. This project will restore ~3,136 linear ft. of the Santo Domingo Creek by removing legacy sediment from the valley bottom and increasing floodwater storage potential. This increase of flood storage, and the resulting peak rate reduction will reduce the need for traditional stormwater basins and increase the amount of usable space for development. If traditional stormwater facilities were used, at least 2 of the proposed 10 parcels would have been significantly compromised and all would have had less buildable area. Diverse native vegetation and walking trails will become an aesthetic asset to the employees of the Rock Lititz campus as well as the local community. The project will also reduce stream bank erosion and promote the infiltration/filtration of runoff resulting in improved water quality benefits.

Project Description:

Rock Lititz Properties, comprised of Clair Global and Tait Towers proposed to construct a new campus facility on a 96-acre farm within the urban growth boundary. The Santo Domingo Creek, a tributary to Lititz Run, had been significantly altered by historical human activities. The channel had been realigned by farming operations and legacy sediment had deposited in the flat valley bottom following extensive land clearing in the upslope watershed. Streambank erosion and stream bed degradation had resulted in nutrient-rich sediment affecting downstream water quality.

Project Goals:

Project goals included restoring the degraded riparian corridor while meeting site stormwater management requirements, reducing pollutant loads, enhancing infiltration and maximizing buildable area.

Construction date: 2014

Services:

Engineering, design, permitting, construction management, plant installation, and post-construction monitoring



Green Master Plan



Section of Rife Run in Logan Park



Erosion from stormwater discharge along Rife Run

This site demonstrates the following sustainable design elements:

- Stormwater BMPs
- Nutrient and Sediment Reductions
- Streambank Stabilization
- Water Quality Improvement
- Ecological Vegetation Management
- Wildlife/Aquatic Habitat



Post Construction



Quantifiable Results:

- Nitrogen: 757 lb/yr
- Phosphorus: 293 lb/yr
- Sediment: 118 Ton/yr

Construction date: July 2015 - October 2015

Services: Green Master Planning, Landscape Design, Engineering, Permitting, Construction, Monitoring, Maintenance

Partner: Chiques Creek Watershed Alliance, Manheim Borough, Manheim Soccer Club, PA DEP Growing Greener, National Fish and Wildlife Foundation

Plant List:

- | | |
|-------------------|--------------------|
| Red Chokeberry | Winterberry |
| Serviceberry | Spicebush |
| River Birch | Sweetbay Magnolia |
| Hornbeam | American Sycamore |
| Buttonbush | Swamp White Oak |
| Sweet Pepperbush | Pin Oak |
| Silky Dogwood | Highbush Blueberry |
| Red Osier Dogwood | Arrowwood |

Project Description:

In 2005, the Chiques Creek Watershed Alliance and LandStudies, Inc. completed a stream and floodplain restoration of Rife Run, a tributary to Chiques Creek that runs through Mummau Park in Manheim, PA. This restoration project proved to be a great success, and in 2011 the watershed alliance received a Growing Greener Grant that would allow them to fund the development of a green master plan for Logan Park. Logan Park is located downstream of Mummau Park at the confluence of Rife Run and Chiques Creek. The primary goal of the project was to develop a plan for a restoration that would build on the Mummau Park restoration and extend to the confluence at Chiques Creek. The green master plan also addressed the extension of a greenway trail, water quality, stormwater BMPs, additional parking, and athletic field improvements.

LandStudies completed a master plan for Logan Park which included the re-alignment of Rife Run to provide more available upland area for athletic fields, stream and floodplain restoration, wetland creation to improve water quality and wildlife habitat, and the implementation of stormwater BMPs. The floodplain restoration was constructed in 2015.