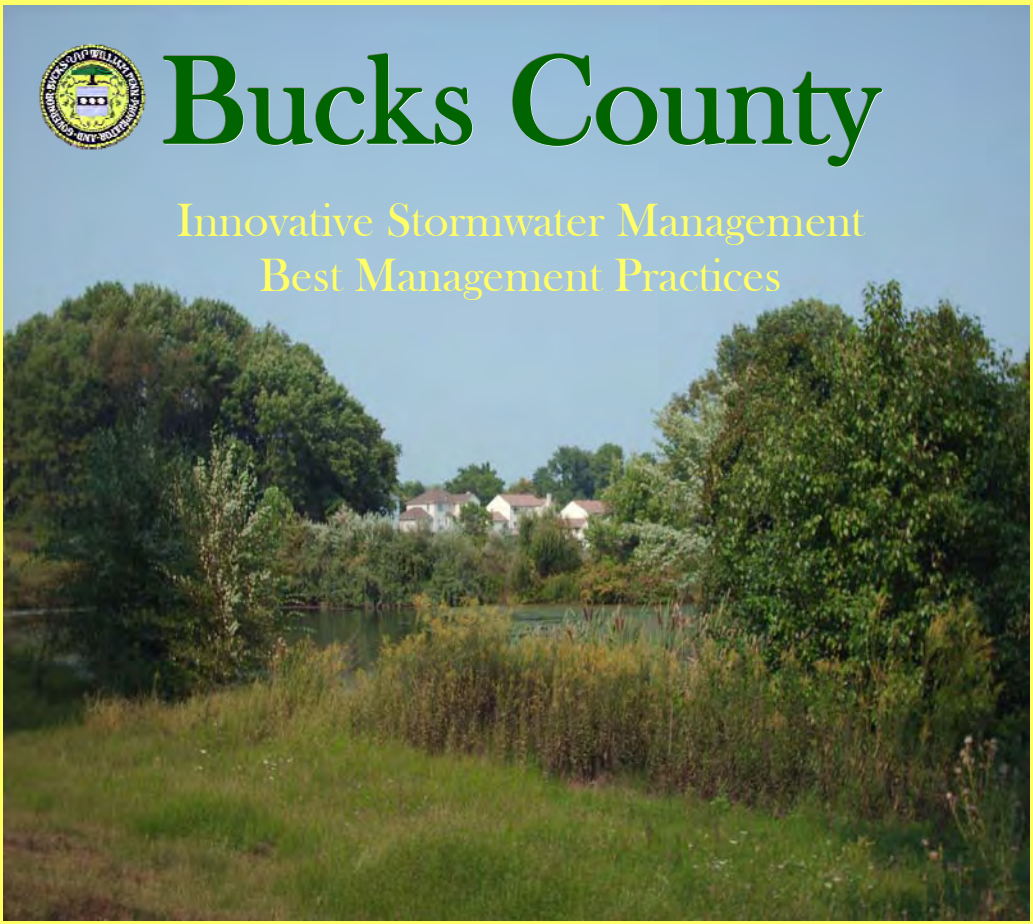
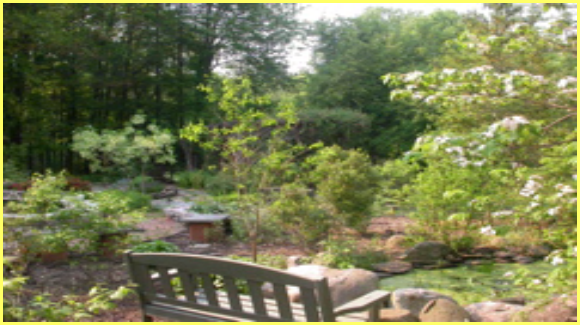
Bucks County

Innovative Stormwater Management Best Management Practices





Bucks County Planning Commission

Table of Contents

	Page
Introduction	3
Map of BMP Locations	4
BMP Locations	5
Bowman's Hill Wildflower Preserve	6
Brayton Gardens	8
Brownsburg Park	10
Buckingham Township Administration Building	12
Buckingham Township Water and Wastewater Department	16
Churchville Nature Center	20
Doylestown Commerce Center	22
None Such Farm	23
Pennswood Village	26
Pine Run Meadow	32
Plumstead Township Building	33
Sweetwater Farm	34
Pennsylvania Stormwater Management BMP Manual	37
Stormwater Management Basics	38
Stormwater Management Glossary	39
Reference Websites	42
Acknowledgments and Contact Information	43
Sponsors	47

Introduction

The goal of this project is to provide municipal and elected officials, board and committee members, planners, engineers, planning commission members, students, and the general public with information that will enable them to preserve water resources and better manage stormwater runoff within their community.

The Bucks County Planning Commission, in partnership with the Bucks County Conservation District, hosted a guided bus tour, which showcased six Bucks County properties utilizing innovative stormwater management Best Management Practices (BMPs) designed to protect Bucks County's watersheds from the impacts of nonpoint source (NPS) pollution. The tour also featured a presentation about green roofs while en route. At each stop, tour attendees heard presentations given by landscape managers, engineers, conservationists, and others directly involved with the design, implementation, maintenance, stewardship, and educational outreach associated with each facility.

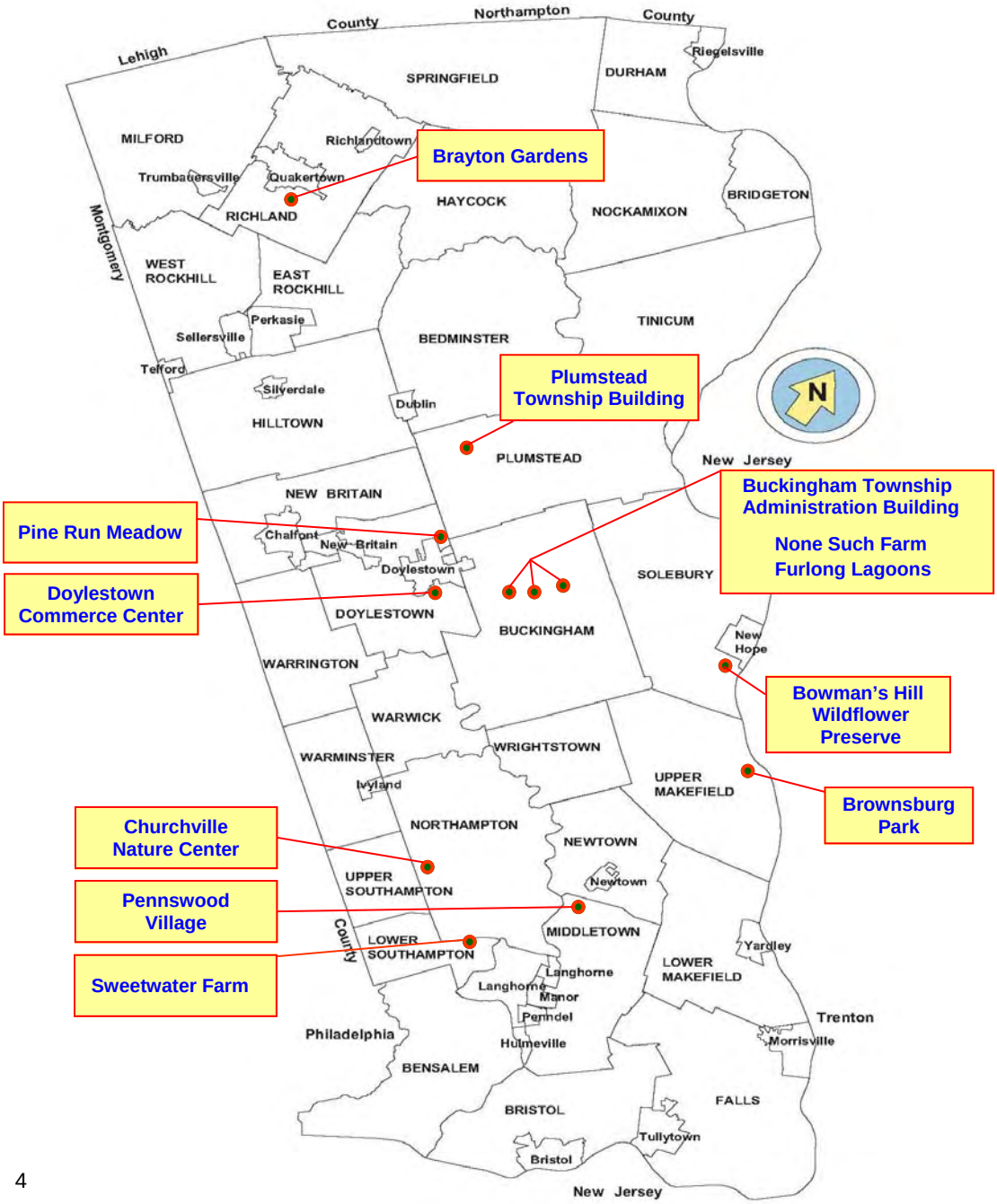
The bus tour was open to Bucks County municipal and elected officials, planners, engineers, board and committee members, planning commission members, and developers. By distributing this brochure to each municipality within Bucks County, we can also provide the public with information about what some municipalities and organizations are doing to improve the environment and quality of life for their communities.

Our goal is to educate the public about the importance of watershed protection and how to improve or remediate a watershed from the impacts of nonpoint source (NPS) pollution. We hope our efforts will prompt people to action with regard to natural resources protection.

A copy of this brochure is also available online for viewing and download at http://www.buckscounty.org/government/departments/CommunityServices/PlanningCommission/index.aspx, www.bucksccd.org and at pennridgepacc.webs.com

Thank you for your interest in protecting our water resources.

Map of BMP Locations



BMP Locations

- **Bowman's Hill Wildflower Preserve—Solebury Township**
  Native Plants, TreeVitalize, Conservation, and Education
- **Brayton Gardens—Richland Township**
  Wetland Area, Retention Basins and, Riparian Areas
- **Brownsburg Park—Upper Makefield Township**
  Master Plan Design to Include Various Stormwater Management BMPs
- **Buckingham Township Administration Building—Buckingham Township**
  Ecological Restoration, Wetland Creation, and Education
- **Buckingham Township Water and Wastewater Department—Buckingham Township**
  Innovative Wastewater Treatment and Reuse—Furlong Lagoons and Spray Irrigation
- **Churchville Nature Center—Northampton Township**
  Green Building Campaign, Education and Environmental Stewardship
- **Doylestown Commerce Center—Doylestown Township**
  Porous Paving
- **None Such Farm—Buckingham Township**
  Various Agricultural BMPs
- **Pennswood Village—Middletown Township**
  Wetland Stormwater System and Riparian Stream Corridor
- **Pine Run Reservoir Meadow—Doylestown Township**
  Meadow Restoration Project
- **Plumstead Township Building—Plumstead Township**
  Rain Garden
- **Sweetwater Farm—Lower Southampton Township**
  Wetlands and Riparian Buffers

Bowman's Hill Wildflower Preserve

Native Plants, TreeVitalize, Conservation, and Education

The 134-acre Preserve was founded in 1934 and is home to nearly 1,000 species of wildflowers, trees, shrubs, vines and ferns native to Pennsylvania and the Delaware Valley Region, remarkably about 50 percent of the total number of native species in Pennsylvania. The collection includes about 80 species designated as Plants of Special Concern in Pennsylvania, including rare, endangered, or threatened plants. Trails wind through picturesque woodlands and meadows and along a pond and Pidcock Creek allowing visitors to experience a variety of habitats along with native birds, butterflies, and other wildlife that have co-evolved with the native plants.

Numerous educational programs for adults and children are available throughout the year. The Preserve also hosts special events, including the Spring Garden Gala, Spring and Fall Native Plant Sales, Earth Day, and Discovery Day.

For the past two years, the Preserve has been working on a conservation tool, the ***Plant Stewardship Index (PSI),*** which assesses the vitality of native plant communities. The PSI enables land stewards and municipalities to survey the health of the native populations on the properties they preserve and manage.

As a quantitative measure of the floristic quality and botanical integrity of a site, the *PSI* offers a method for monitoring and evaluating land management practices and affords granting agencies the ability to track those results over time. In this way, the Plant Stewardship Index can provide land stewards with the information they need to establish priorities and set goals for the management of these public trusts. The database and PSI calculator, which will automatically calculate the Index values for any site plant list entered onto the website, are available to the public at no charge on the Preserve's website at www.bhwp.org/db/

On Arbor Day 2004, Governor Rendell launched TreeVitalize, a partnership to restore tree cover in the five-county Southeastern Pennsylvania region. The partnership, led by the Pennsylvania Department of Conservation and Natural Resources (DCNR), brought together leaders from public and private sectors to include all levels of government, regional nonprofits, institutions, and corporate entities. Working together, the partners seek to increase tree planting and encourage better tree care.

Bowman's Hill Wildflower Preserve

Bowman's Hill Wildflower Preserve recognizes the importance of riparian buffers to protect water resources from nonpoint source pollution and provide bank stabilization and aquatic and wildlife habitat.

TreeVitalize project utilizing DEP and DCNR funding, to complete a riparian buffer restoration project on the Bowman's Hill Wildflower Preserve, included the planting of 835 native trees of various sizes and 32 species (e.g., red maple (*Acer rubrum*), river birch (*Carpinus caroliniana*), and sweetbay magnolia (*Magnolia virginiana*)).

TreeVitalize evolved in response to a 2003 study by American Forests (see complete report posted at www.treevitalize.net). Using satellite imagery taken between 1985 and 2001, researchers estimated that 34,000 acres (-8 percent) of heavy tree cover was lost in urban, suburban and rural areas in that time period. Tree cover refers to the percentage of land covered or shaded by trees.

This same study recommends that metropolitan areas in the northeastern portion of the United States have, at a minimum, 40 percent tree cover but tree cover in Southeastern Pennsylvania averages only 27 percent. Tree cover in riparian areas, which is land adjacent to streams and creeks, is critical to the health of a watershed. Forest buffers provide the best protection and the most benefits, yet many of our region's stream miles are in need of forested buffers.

Brayton Gardens

Wetland Area, Retention Basins, and Riparian Areas

Brayton Gardens, a residential community located in Richland Township, utilizes several best management practices for stormwater, which are recommended by the PA DEP.

An existing wooded area, which is bordered by Beaver Run, was maintained and enhanced by adding a constructed wetland. Several retention basins were also installed, and riparian areas were enhanced or created for stormwater management.

Forebay areas are situated in several locations along the wetland area which runs next to Beaver Run. These forebay areas act as energy dissipaters which work to slow down the flow of stormwater and allow pollutants and sediment to drop out. Positive overflow structures were installed in several places along the wetland to handle excess water during periods of high water flow.

To enhance habitat value and visual aesthetics, 25-foot and in some cases 50-foot buffer areas were added to the existing woodlands along the wetland and alongside the installed walking path which separates the wetland from Beaver Run.

Above: A walking trail that winds through the residential community of Brayton Gardens is adjacent to the constructed wetland.

Brayton Gardens

Above: The walking trail continues through the existing woodlands and runs between the constructed wetland and Beaver Run, which encourages residents of Brayton Gardens to enjoy the outdoors.

Left: Beaver Run leaves Brayton Gardens at Trumbauersville Road, its flow relatively unaffected by stormwater due to the effective use of BMPs in this development.

Brownsburg Park

Master Plan Design to Include Various BMPs

Following a 1998 update of the Township Park and Recreation Comprehensive Plan, Upper Makefield Township received a grant from the Department of Conservation and Natural Resources (DCNR) to develop a master site plan for Brownsburg Park. Working with the Township Board of Supervisors and the Park and Recreation Board, Pickering, Corts & Summerson, Inc. (PC&S), led a community-wide effort to create a public consensus for the new park design. Incorporating input from numerous community meetings and workshops, PC&S created a design which reflected the public's desires. PC&S designed a master plan for the park which considered the needs of both organized sports programs and the community at large.

Brownsburg Park's location in the Delaware River valley offered excellent soil and geologic opportunities for aquifer recharge and the incorporation of best management practices for stormwater management. Nontraditional stormwater management techniques achieved 100 percent infiltration and employed native vegetative practices for aquifer recharge. In addition, all roadways and pathways were constructed of porous bituminous pavements.

Future phases of the design will include two tennis courts, two basketball courts, a playground area, volleyball courts, a facilities building, and an extensive walking trail.

Below: Brownsburg Park Master Plan rendering prepared by: **Pickering, Corts & Summerson, Inc.**

Brownsburg Park

Above: View across a river stone bottom stormwater infiltration basin, surrounded by wet tolerant, native trees, shrubs, and meadow grasses. ***Below Left:*** View looking West into park from entrance off River Road. In the foreground is the river stone bottom of a stormwater infiltration basin planted with wet tolerant, native meadow grasses, trees, and shrubs.
Below Right: River stone lined stormwater infiltration trench that parallels the edge of the park's driveway in key areas. Native meadow plantings are in the background along the woodline.

Buckingham Township Administration Building

Ecological Restoration, Wetland Creation, and Education

For over a decade, Buckingham Township had been interested in creating an outdoor ecological education center behind the municipal administration building in the area of an existing detention basin. The municipality's administration building was constructed in the mid 1980s with an appurtenant stormwater basin adjacent to an unnamed tributary of the Lahaska Creek. The basin was designed and constructed in accordance with existing stormwater regulations that did not address water quality treatment. The basin mitigated peak runoff flows from a 2-acre parking lot in the municipal complex. Land adjacent to the creek was maintained as lawn. The township wanted to reconstruct the existing basin as a wet meadow and restore the riparian corridor, adjacent to the creek, to a forested wetland.

As part of a development agreement with the township, Orleans Construction Company was required to create one acre of wetlands within the township in order to offset wetlands being filled to create the Devonshire Estates housing subdivision on Swamp Road. The township's engineer recommended Orleans utilize the township land adjacent to the Lahaska Creek. Orleans agreed and hired Princeton Hydro, LLC, to design the stormwater basin reconstruction and wetlands mitigation. Working with the township's landscape consultants, a layout for the detention basin was developed. Orleans recontoured the existing detention basin and created the pool into which stormwater from the old basin now flows. The pool's first function is to trap stormwater-borne sediment and contaminants before they reach the small stream that winds through the swale. The pool is also designed to serve as a wildlife habitat.

Prior to initiating the design, an existing topographic and property boundary survey was completed and stormwater and groundwater hydrology data were obtained. The groundwater hydrology was determined from the excavation of test pits, which allowed visual inspection of the existing groundwater regime and optimal depth for the basin and created wetlands. The detention basin was designed to attenuate the 100-year storm runoff peak flow and discharge 100 percent of runoff generated from the 1-year storm over a minimum of 24 hours, incorporating the expected stormwater runoff from the parking lot and flooding from Lahaska Creek. The basin was constructed of two cells: an inundated sediment forebay (6-12 inches of water) and a main detention cell.

The use of a gravel filter at the basin outlet ensured success in meeting water quality treatment requirements. The gravel filter was chosen over a standard low flow orifice due to the small volume of runoff generated by the 1-year storm and the relatively long detention time of 24-hours. Hydraulic characteristics of a gravel media allow for an extremely small discharge flow without the potential for clogging, which would be the case with a small diameter orifice (less than 3' in diameter). The final filter design included an at-grade 12'x20'x18" thick gravel layer, underlain by six-inch diameter, perforated PVC pipes embedded in pea-gravel. To aid maintenance of the filter, clean-outs were installed with a sump constructed within the main discharge control structure.

Buckingham Township Administration Building

The detention basin was specified to include native wetland herbaceous species to assist in the uptake of nutrients such as nitrogen and phosphorous. The created wetland was established at an elevation that would intercept both a 24-inch thick gravel layer encountered during the subsurface investigation and backwater from the unnamed tributary of Lahaska Creek. To enhance the hydrology of the mitigation, the outlet of the detention basin was discharged directly into the created wetland.

Construction of the basin and wetland began in July 2001, with all planting completed by November 2001. The construction included innovative soil erosion and sediment control practices, such as use of an outflow control device, which can provide up to 45 percent reduction in the mass of suspended sediment discharged from a sediment basin over conventional perforated risers.

Prior to construction, the existing basin did not hold the volume generated by the water quality storm (1-year frequency) for a substantial amount of time (less than 1 hour). Additionally, the lack of infiltration devices and vegetation did not allow for groundwater recharge or the uptake of nutrients. Although no monitoring data was collected before and after construction, following construction, the basin was able to detain and release the water quality storm for over 24 hours, allowing adequate suspended solids (SS) settling time, with a theoretical 80 percent reduction in pre-treatment SS quantities. The gravel filter at the outlet structure provides groundwater infiltration and the wetland vegetation provides a substantial amount of nutrient uptake.

Despite drought conditions, the basin and wetlands were fully established by October 2002.

Source*: Intelligencer, Project a Win for Wetlands.*

Left and Above: Project site during initial construction of the ecological restoration and wetland area.

Buckingham Township Administration Building

Buckingham Township Wetlands Park

History of Project:

Buckingham Township had always hoped to retrofit the basin on the property to improve the stormwater management system and make use of the naturally occurring wetland area. When the Orleans Corporation, a developer in the Township obligated to mitigate by the PA DEP was unable to find a suitable place for mitigation on their site; the Township approached them in hopes to partner with them and realize their dream for the basin area. The Orleans Corporation accepted and along with their consultant Princeton Hydro provided engineering and labor for the project well beyond their initial obligation. As the planning progressed the Township felt that the location situated between the Township building and Buckingham Elementary School provided a wonderful opportunity to provide an outdoor classroom for the students and the public.

Project Goals and Funding:

Buckingham Township obtained a Growing Greener Grant from the Pennsylvania Department of Environmental Protection for the Buckingham Township and Buckingham Elementary School Stormwater Restoration and Education Project. Our grant project had two primary goals; environmental and educational. Our environmental goals included redesigning an existing stormwater basin, creating wetlands, installing native vegetation and creating a stormwater treatment chain. Our educational goal included creation, purchase of supplies and implementation of a wetlands curriculum for the students at Buckingham Elementary School, and demonstration of the use of best management practices.

Project Results:

1. Redesign and retrofit of existing basin to retain water longer, treat stormwater runoff and take advantage of wetlands already on site.

2. Creation of one (1) acre of wetlands along with upland and wet meadows surrounding the wetland area.

3. Plantings of upland meadow, hedgerow, shrubs, trees, wet meadow, and emergent wetland plants totaling over three thousand plugs and hundreds of container plants.

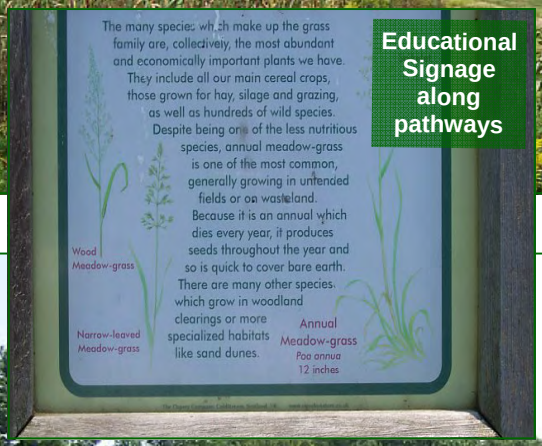
4. Creation and implementation of a wetlands curriculum for kindergarten through sixth grade at the Buckingham Elementary School.

5. Provide for an outdoor classroom where students and the public can come to see a functioning wetland system and its inhabitants and learn through educational signage.

6. Educate the public about watershed planning, use of best management practices and site design.

7. Demonstrate a successful wetland mitigation project as an example to other developers that are required to mitigate wetlands.

Buckingham Township Administration Building



Educational Signage along pathways

Above: Project site with the Buckingham Township Administration Building in the background.

Below: View looking toward Buckingham Elementary School.

Buckingham Township Water and Wastewater Department

Innovative Wastewater Treatment and Reuse

Spray irrigation began as a method of disposing and recycling treated wastewater from municipal systems.

From a public health and environmental health perspective, spray irrigation is one of the most beneficial ways of dealing with all aspects of wastewater.

When properly designed, spray irrigation places effluent where plants can take up nutrients; sunlight can provide some disinfection; soil microbes can consume remaining organic matter; groundwater resources are recharged; and point source discharges are eliminated.

Once the wastewater is treated and disinfected to remove harmful substances, what remains are valuable nutrients such as nitrogen and phosphorus.

The treated wastewater can then be sprayed onto agricultural crops, golf courses and forested areas. The nutrients are also used by the plant material as fertilizer. The water is continually treated as it passes through the layers of soil and eventually returns to the groundwater, ready to begin the cycle again.

The land is irrigated at a rate based on the ability of the plants to use the nutrients and the ground to accept the water. This process prevents groundwater contamination and runoff.

Properly designed and operated, spray irrigation is cost effective, beneficial and is not a nuisance.

Source: Community Wastewater Systems Lagoon/Spray Irrigation brochure. Castle Valley Consultants

Left: Aerial views of the Furlong lagoons in Buckingham Township.

Benefits of Spray Irrigation

- Capable of producing the highest quality of treated water of all land disposal methods;
- Significantly reduces the potential of surface water and groundwater degradation;
- Serves as a means for recharging the groundwater aquifers, thereby reducing the risk of saltwater intrusion into freshwater supplies in coastal areas;
- Provides an alternative source of water for irrigation purposes, thereby eliminating the need to tap freshwater supplies;
- Promotes preservation of open space and recreational areas;
- Promotes preservation of agriculturally productive lands;
- Economic return from use of water and nutrients to produce marketable crops;
- Long-term savings in operation and maintenance particularly when used in conjunction with a lagoon treatment system;
- Leasable irrigated lands available to farmers or nurserymen;
- Cost savings realized from the reduction in the amount of commercial fertilizers needed when crops are irrigated with treated wastewater;
- Potential enhancement of property values of surrounding properties with the assurance that irrigated lands will never be developed.

Source: Community Wastewater Systems Lagoon/Spray Irrigation brochure. Castle Valley Consultants

Buckingham Township
Water and Wastewater Department

Stage one Lagoon was installed in 1989. Raw sewage enters this holding area where solids settle out before the water is released into lagoon two, which is the second stage of the process.

Treated wastewater is sprayed via an irrigation system, which is located in the lawn area to the left of the lagoon.

Wastewater Recycling System

Treatment Process

When a lagoon treatment/spray irrigation system is used, the wastewater is continually treated from the time it enters the lagoon until it filters through the soil. In many of the 50 states, wastewater must be subjected to secondary treatment before spray irrigation is undertaken. In a secondary treatment process, wastewater is first run through a coarse screen or comminutor to break apart the solids. The wastewater is then subjected to a biological treatment process followed by disinfection before reaching the spray field.

This biological process is accomplished by using a series of lagoons that combine natural sunlight and air with mechanical devices that introduce air (oxygen) into the wastewater to obtain the required treatment level. These lagoons have the built-in ability to treat and store the wastewater for a period of up to 90 days without any discharge to the spray irrigation system.

It is recommended that a lagoon treatment system be used in conjunction with spray irrigation to maximize the environmental and economic benefits of each technology. In place of expending vast amounts of energy to remove the nitrates and phosphates, these nutrients remain suspended in the wastewater and are used by the plants as fertilizer as the water is irrigated onto crops.

Wide variations in flow and the introduction of toxic substances into a system are common problems encountered in the day-to-day operation of most conventional wastewater systems. While a lagoon treatment system cannot prevent these events from occurring, it can eliminate or substantially reduce the negative environmental impacts that are inevitable in a conventional stream discharge plant.

A lagoon can also substantially reduce sludge handling and eliminate the need to periodically upgrade the process to meet increased discharge requirements found in conventional discharge systems. Both storage and treatment time are items built into the design of a lagoon treatment system, which minimizes these environmental and economic impacts.

Above: The proximity of the lagoons and spray irrigation system has not been an impediment to the construction or sale of new homes. A housing development, located just beyond the wastewater treatment system, is visible in this picture.

Churchville Nature Center

Education, Environmental Stewardship, and Green Building Campaign

Green Building Expansion

Green buildings avoid or minimize negative impacts on the environment by conserving and using natural resources efficiently. A green building facilitates ecological harmony and respect for biodiversity in relation to buildings and architecture. Churchville Nature Center's new green building will incorporate green and sustainable design features, which will allow it to become LEED certified. LEED stands for Leadership in Energy & Environmental Design and is a nationally recognized green building rating system formulated by the U.S. Green Building Council to provide a national standard for what constitutes a green building.

Key Green Features of Churchville's New Nature Center

Geo-thermal (Exchange) Heating and Cooling Geo-thermal systems use the earth's constant temperature both to heat the building in the winter and to cool it down in the summer. A geoexchange series of underground pipes circulate liquid that absorbs the constant temperature of the earth. This liquid is then circulated into the building. In winter, a compression process transfers and amplifies the heat energy from the earth so the 50 degree ground temperature is warmed to the inside temperature of 70 degrees. Air ducts distribute the warmth throughout the building. In the summer, the process is reversed: the warmer temperature inside the building is then dissipated back into the earth.

Natural Daylighting and Solar Panels Natural daylighting reduces use of electricity, thereby reducing maintenance costs and operating expenses. It has been shown to improve the learning environment and reduce eye fatigue. Solar panels will provide some of the electricity needs for the Center during sunny days. These panels will also absorb sunlight and convert it into energy.

Earth Sheltering and Native Landscaping The new building will utilize the ground as a natural shelter by grading a portion of the soil to cover part of the building. This will help save energy costs, as it provides added insulation and helps to blend the building with the natural environment. Native plants in the landscape will help increase wildlife habitat and provide a natural food supply for native animals. Native plants are able to adapt better to local environmental conditions, thereby lessening the need for watering, which helps to save our natural resources.

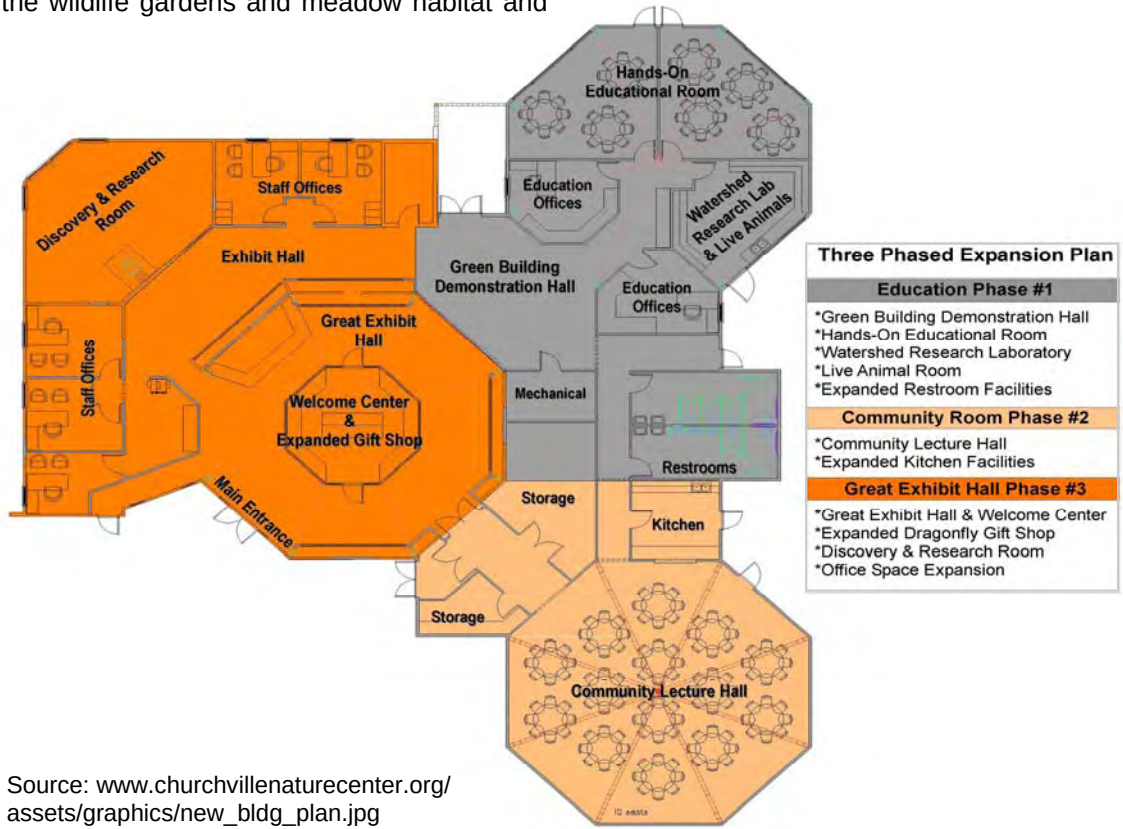
Green Vegetated Roof Green roofs lower energy costs; extend roof life; improve roof water management; serve as added sound insulation; help reduce ambient temperature; and provide an attractive natural aesthetic to the building.

Grey Water Use and Water Efficient Fixtures Water from the bath, shower, washing machine and bathroom sink are all sources of grey water. Grey water and rainwater, which can be collected from the roof, can be used to supply many of the water needs of the facility such as landscape irrigation, toilet flushing and mechanical systems and custodial uses. This minimizes the use of dwindling potable water resources

while decreasing stormwater runoff. In addition, by utilizing high efficiency fixtures, water-saving faucets with occupant sensors, and waterless urinals, the overuse of valuable clean water supply can be minimized.

Reduced Building Footprint The area of land beneath the building is called its footprint. In order to minimize impact on existing natural habitat around the building, Churchville will build up, instead of out, utilizing an area on the east side of the current building. The footprint will be kept to a minimal size to reduce negative impacts to the wildlife gardens and meadow habitat and to blend in with the aesthetics of the current building.

Environmentally Friendly Products Other environmentally friendly products that will be incorporated into the building include low Volatile Organic Compounds (VOC) paints and adhesives to avoid unhealthy organic compounds; the use of rapidly renewable materials such as cotton batt or straw insulation; and bamboo or wheatgrass cabinetry; utilizing re-claimed or salvaged lumber; and striving to use materials with 100 percent recycled content, such as homosote.



Source: www.churchvillenaturecenter.org/assets/graphics/new_bldg_plan.jpg

Doylestown Commerce Center

Porous Paving

Using porous pavement for driveways, walkways and patios has numerous benefits for the environment. It helps to recharge groundwater by allowing rain and snowmelt from paved surfaces to percolate into the soil. Porous pavement also reduces stormwater runoff and the contaminants that runoff carries. In addition, the water that is absorbed into the soil is of a higher quality because porous pavement systems filter some pollutants out of the water before it is absorbed.

Builders and homeowners can benefit from using porous pavement. Builders can realize cost savings because porous pavement systems integrate a subsurface base reservoir to store and transmit water, reducing runoff.

Homeowners benefit because porous pavement provides an attractive, cost-effective, and green alternative for the home's outdoor hardscape surfaces.

Keys to the long-term success of porous pavement systems are correct design, successful installation and proper maintenance.

For more information visit: www.forester.net/sw_0305_porous.html

Above: Porous pavement shown at left and conventional pavement to the right in the parking facility at the Doylestown Commerce Center.

Left: Aerial view of the Doylestown Commerce Center.

Source: www.hgtvpro.com/hpro/bp_green_building/article/0,3140,HPRO_29336_5500035,00.html

None Such Farm

Various Agricultural BMPs

None Such Farm has implemented numerous conservation strategies. The Farm has begun to switch some crops over to a 'No-Till' planting method, which involves planting into a cover crop or crop residue from the previous year. Not all of the crops the Farm grows can be grown this way, so the Farm uses other methods to promote soil retention. Staff makes use of water ways, which are sections of a field that are prone to soil loss. These areas are planted with grass and clover to keep the soil from eroding and require constant maintenance to keep them working properly. Another form of soil retention is the use of terraces. Terraces can be used in big fields having drainage problems, which are broken down into smaller fields and water ways are then incorporated into each terrace.

Cover crops are also a beneficial way to prevent soil erosion. After the harvest of a crop, such as sweet corn, a winter cover crop is planted. The cover crop is predominantly a rye, wheat, or barley. These crops can also be planted in the fall for spring/summer harvest. The cover crop prevents erosion, builds up organic material and nutrients in the soil, and breaks up the compacted soil.

None Such Farm has two creeks running through the middle of the property (i.e., Watson and Lahaska). The creeks come together to form Mill Creek, in the pasture where the cattle spend the majority of their time. Up until 2001, the cattle were able to walk into both creeks. This action caused deterioration of the creek banks and widening of the creek beds. The Bucks County Conservation District and Ducks Unlimited helped the Farm fence in the creeks and put in cattle crossings so the cattle could cross without harming either creek. The health of the Watson, Lahaska, and Mill creeks has improved where they pass through the Farm.

The majority of vegetables the Farm raises are planted using plasticulture. This process involves the placement of 5-foot-wide plastic film laid in rows across the field. Underneath the plastic, trickle tape is placed, which is used to irrigate and fertilize the crop. This process saves on water consumption and the use of fertilizers by putting them at the plants' roots. This process also boosts crop productivity. A problem experienced with this method is water runoff from heavy rain. The Farm has remedied this by seeding between the rows of plastic with a grass mix to hold the soil and prevent eroding.

Above: Cement walkway continues across the stream to prevent animals from stirring up sediments in the stream while crossing.

None Such Farm

Two people are responsible for handling the chemicals and pesticides used on the Farm and both are certified by the state and have a pesticide applicator's license. To maintain the license, a specific number of course credits must be completed each year. Attending meetings hosted by the Penn State Cooperative Extension and other agencies accumulates credits. The classes provide training on effective use and proper handling practices. The Farm also follows Integrated Pest Management (IPM) techniques.

Stream Bank Fencing

A sizable portion of sediment pollution comes from unprotected stream banks caused by livestock grazing and trampling. Fencing stream banks and limiting livestock access with crossings promotes the establishment of a healthy vegetative cover. Vegetation binds soil particles together and creates a stable bank that reduces erosion and collapse. Stream bank vegetation also helps trap sediment and pesticides and absorbs some nutrients that may run off of adjacent cultivated fields and feedlots. A vegetative buffer consisting of a mixture of trees, shrubs, grasses, or wildflowers also enhances the beauty of the farm landscape.

Stream bank fencing is a simple, cost-effective way for farmers to improve water quality in the streams flowing through their farms and into larger water bodies and watersheds. Construction of stabilized crossings is regulated by the Pennsylvania Department of Environmental Protection (DEP). The DEP or county conservation district staff can help landowners obtain a free general permit for agricultural crossings and ramps. Financial and technical assistance for developing alternative water sources may be available through the county conservation district, United States Department of Agriculture (USDA) Farm Services Agency, or the USDA Natural Resources Conservation Service.

Stream bank fencing is a low-cost strategy that benefits waterfowl, fish and other wildlife; protects herd health; and helps to restore water quality by preventing sediments and nutrients from entering waterways.

Source:http://nonesuchfarms.com/

Below: Lower left area shows a culvert for stream flow, which allows for vehicle and farm machinery crossing without degrading the stream.

None Such Farm

Ducks Unlimited

Due to poor agricultural practices, many streams in Pennsylvania are no longer able to support a year-round or wild trout population. Pastureland streams tend to suffer the most. Overgrazing and repeated livestock use initiates the streambank erosion process.

As the streambanks erode, the stream channel tends to widen and become shallower. Silt bars and islands choke and divide the flow. A blanket of fine sediment eliminates habitat for aquatic insects and does not allow successful reproduction of many fish species. The absence of streamside vegetation lets the sun warm the water beyond the tolerance of many aquatic organisms. It also allows excess nutrients, pesticides, bacteria and other runoff to enter the stream system easily.

Ducks Unlimited is a North American leader in waterfowl and wetlands conservation. For over six decades, staff and volunteers have been successful in conserving over 11 million acres of habitat.

Ducks Unlimited became involved in the None Such Farm project in order to conserve riparian wetlands and upland buffers to aid in the reduction of nonpoint source (NPS) pollution. The funding to accomplish the agricultural BMPs and stream clean-up on None Such Farm was part of a Growing Greener project termed Clean Water Pennsylvania.

With the restoration and enhancement of wetland and riparian areas, Ducks Unlimited and its partners can move forward in improving water quality and the health of the wetlands for wildlife to use throughout their lifecycle.

Source: www.ducks.org/conservation/

Above: Location of created, enhanced, or restored Ducks Unlimited projects in Bucks County. October 2004.

Pennswood Village

Wetland Stormwater System and Riparian Stream Corridor

Pennswood Village is a retirement community built in the early 1980s and was guided by Quaker values such as respect for the individual, simple and functional design, and environmental stewardship. Pennswood Village is located adjacent to the George School and Newtown Friends, both Quaker schools.

In the late 1990s, Pennswood Village was preparing to expand and implement a stormwater management plan developed in the wake of a major flood in 1996. Much of the expansion was to take place over land adjacent to the community's entrance road, which Pennswood Village had leased to a local farmer. Runoff from Route 413 and nearby buildings traveled quickly across this area, often overflowing the existing detention basin and causing flooding in the residential neighborhoods downstream.

Over the course of ten years, Pennswood Village Executive Director, Nancy Spears, staff members and residents, the George School and Newtown Friends School, PennDOT and Middletown Township collaborated to create the stormwater management plan.

Pennswood Village then hired Philadelphia-based landscape architecture firm Wells Appel Land Strategies to work on the expansion project. Wells Appel President Stuart Appel, ASLA, whose practice is based on restoring and preserving the ecological and historical context of landscapes, recognized several problems with the proposed project. In addition to depleting open space, the plan would have sited new buildings on the former farmland, demolished an old stone barn on the site, and would have expanded the existing 17-foot-deep detention basin near the southwest corner of the property.

Wells Appel worked closely on the project with Princeton Hydro, a New Jersey firm with wide-ranging expertise in water and wetlands management and the civil engineering firm Pickering, Corts & Summerson.

The project's objectives and features were presented to Middletown Township and the residents of Pennswood Village. The final design would include a riparian stream corridor channel and meadow plantings.

***Above*:** Detention/recharge area in the initial stages of creating the wetland stormwater system.

Pennswood Village

Features of the stormwater system include a large sedimentation basin with a smaller offshoot nearby, a series of bioretention basins, grassy swales and a created treatment wetland. After a storm, a network of pipes directs runoff from the watershed and the road to an outfall structure in the form of a semicircular wall made of local brownstone that houses the main sedimentation basin. The water's flow out of this basin is slowed by boulders that also filter out large particulates and debris and a stone weir regulates the runoff's flow into a second sedimentation basin. Both basins are accessible for cleaning and maintenance.

Stormwater then continues to move through a broad, flat swale, planted with grasses and sculpted to mimic a floodplain, which runs along Pennswood Village's entry road to an infiltration basin designed to manage the first flush runoff volume of storms. When stormwater flows exceed the capacity of this basin, they are then discharged over a stone weir into another planted swale that connects a series of bioretention basins and crisscrosses either side of the entrance road. Bridges constructed of local brownstone support the road at points where the swale crosses underneath.

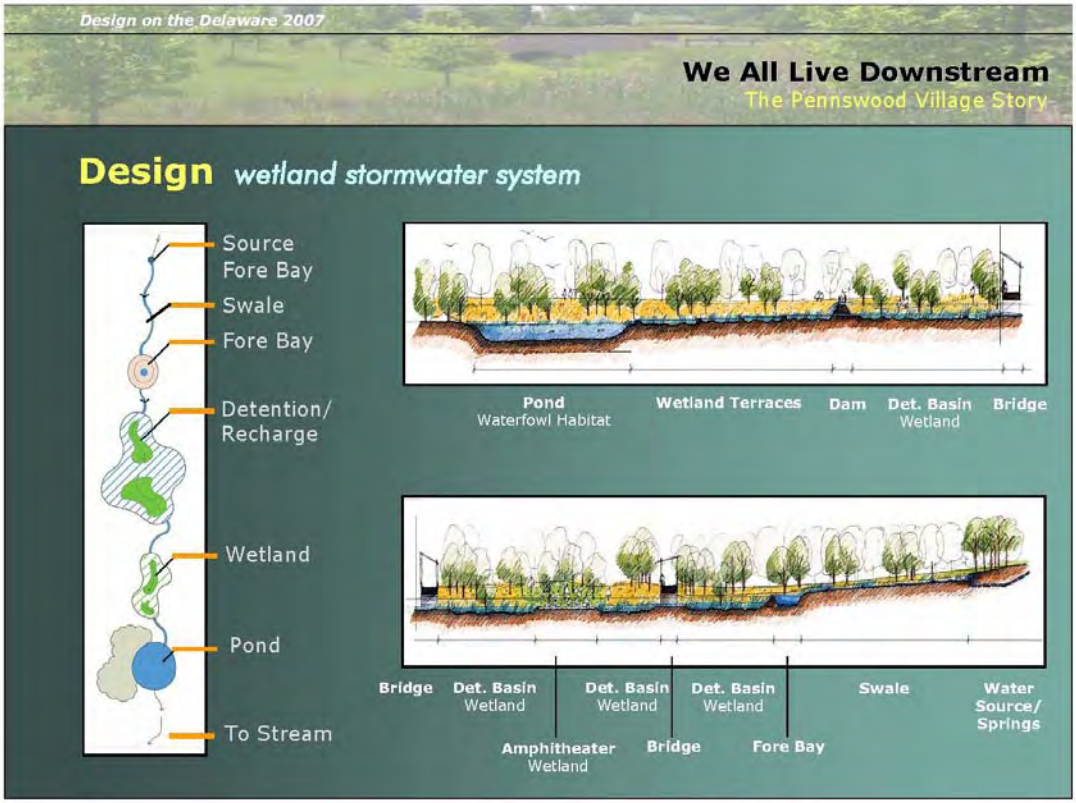
During severe storms, runoff moves from the wetland to the final basin by means of a swale, but the outlet control structure on that basin allows water to flow, during a 100-year storm or other major storm event, back into the wetland. If necessary, water will flow further to a swale along the north side of the site and through three more bioretention basins into Neshaminy Creek. However, according to Pennswood Village Landscape Manager Drew Mason, since the system was built, no water from the community has run into the Neshaminy Creek, even after heavy rain events.

Above: Pond area after installation.

Above: Trails wind next to the stormwater system and throughout Pennswood Village.

Only native plants were used in the design, which creates a balance in terms of function and aesthetics. The wetland is fed by groundwater and collects enough runoff that it remains in a true wetland state year-round and is therefore able to function as a wetlands habitat for many animal species. Pennswood Village also sits in the path of a natural wildlife corridor and the project has encouraged animals to come back to the area.

Pennswood Village



Source Attributes
- Waterfall
- Aeration
- Sound

Swale Attributes
- Sediment removal
- Phosphates
- Removes metals
- Floodplain infiltration

Wetland Attributes
- Sediment removal
- Removes nutrients
- Removes metals

Forebay Attributes
- Dissipates velocity
- Removes large litter
- Drops sediments

Detention/Recharge Attributes
- Detains water
- Releases slowly
- Runoff storage
- Removes sediments
- Captures nutrients
- Groundwater recharge

Pond Attributes
- Water quality
- Habitat
- Irrigation and fire protection
- Aesthetics
- Removes solids

Pennswood Village

Water flow is slowed by boulders that also filter out particulates and debris.

Stormwater moves through a swale, planted with grasses and sculpted to mimic a flood-plain, which runs along Pennswood Village's entry road to an infiltration basin.

Above Left: When stormwater flows exceed the capacity of this basin, they are discharged over a stone weir into another planted swale that connects a series of bioretention basins and crisscrosses either side of the entrance road. Bridges constructed of local brownstone support the road at points where the swale crosses underneath it.

Shown: Lower wet pond/wetland area. The year-round wetland area provides habitat for many animal species.

Native plants create a balance in terms of both function and aesthetics. A variety of cool season grasses, flowers and shrubs attract birds and butterflies.

Pennswood Turning Green

What is Green Design?

Design and construction practices that significantly reduce or eliminate the negative impact of buildings on the environment and occupants, and that support and improve the health of systems that sustain life.

Impact Buildings Have on the Environment

Buildings in the U.S consume more than 30 percent of our total energy and 60 percent of our electricity annually. Five billion gallons of potable water are used to flush toilets daily. A typical North American construction project generates 2.8 pounds of solid waste per square foot of floor space. Buildings produce 35 percent of the country's carbon dioxide emissions and account for 40 percent (3 billion tons annually) of raw material used globally.

These are just a few examples of the environmental impacts associated with the construction and operation of buildings.

One of the many organizations today to join in the fight against the destruction of our environment is the U.S Green Building Council (USGBC). Established in 1994, USGBC is an 8,500-member organization with a network of 75 regional chapters, which work together to improve sustainability in the building industry.

The USGBC has established a whole building approach, which encourages and guides a collaborative, integrated design and construction process. A rating system has been developed to determine the requirements a building needs to be termed "green." This rating system is called LEED, which stands for Leadership in Environmental and Energy Design. The rating system is organized into five environmental categories: Sustainable Site, Water Efficiency, Energy & Atmosphere, Materials & Resources, and Indoor Environmental Quality.

Benefits of Green Building

- ⇒ *Environmental benefits* - reduce the impacts of natural resource consumption
- ⇒ *Economic benefits* - improve the bottom line and reduce operating costs significantly
- ⇒ *Health and safety benefits* - enhance occupant comfort and health
- ⇒ *Community benefits* - minimize strain on local infrastructures and improve quality of life

Pennswood Village

Pennswood Site Redevelopment and Green Expansion Plans

– Stormwater system	1999
– Removal of all underground storage tanks	2001
– Installation of new Energy Management System	2002
– Including all HVAC units and lighting	
– New construction of Mott & Newman buildings and Passmore Center	2003
> Installation of four energy recovery units	
> Four-pipe system	
> Installation of dual fuel burners	
> High efficiency windows	
– Replacement and upgrade of fire alarm systems	2004
– Jointing USGBC, DVGBC, and certified LEED AP	2005
– Removal and replacement of underground electrical system and transformer upgrades	2006
– Implementation of green cleaning program	2006
– Green specification on new capital project	2006
– Implementation of green label paints & carpets lowering VOCs	2006
– Installation of the Geothermal HVAC system	2007
– Installation of waterless urinals	2007
– Purchase of rainwater barrels and solar trash containers	2007
– Registration of the new Barclay Assistant living building as a LEED project	2007
– Recycling kitchen grease and working with the George School on making bio-fuel	2007
– Installation of recyclable sidewalks	2008
– Installation of full-site generator	2008

Pine Run Meadow

Meadow Restoration Project

The Pine Run Reservoir, located in Doylestown Township, includes a 39-acre flood-control lake and approximately 74 acres of adjoining lands owned and maintained by the Bucks County Department of Parks and Recreation. The reservoir is listed as a Priority Four site in the *Natural Areas Inventory of Bucks County.* Priority Four sites are locally significant and in some cases harbor small remnant populations of rare species or ecosystems that provide the basis for future restoration efforts.

Heritage Conservancy, in partnership with the North Branch Watershed Association, Bucks County Conservation District, and Bucks County Department of Parks and Recreation initiated the Pine Run Meadow Restoration pilot project in 2004 with a grant from the National Fish & Wildlife Foundation.

A 10-acre demonstration site was planted with native warm season grasses along the shores of the Pine Run Reservoir. The goal was to replace the nonnative cold season grass fields with native warm season grass meadows and to educate the public about the benefits of native vegetation and reduced mowing schedules for water quality and wildlife habitat. The emergency spillway, approximately 65 acres located on the Southeast corner of the lake, is maintained as mowed fields to prevent the growth of woody vegetation. This mowed area of open fields is used extensively for hiking, dog walking and bird watching.

Volunteers monitor use of the area by breeding birds and identify rare and unusual bird species that utilize the restoration site. The reduced mowing schedule will benefit water quality as tall meadow grasses will discourage use by resident Canada Geese and act as an effective filter of stormwater runoff.

The project partners believe that the reduced mowing schedule and habitat restoration will provide critical nesting habitat for declining species and will enhance regional habitat available for species utilizing the Peace Valley Nature Center (a National Audubon Important Bird Area) located two miles away.

Source*: Palms* Summer Newsletter Issue June 2006

Top: View looking forward, over the lake and Meadow.
Below: View looking right and across the fields.

Plumstead Township Building

Rain Garden

Bucks County Conservation District, working with Plumstead Township and the Plumstead Environmental Advisory Committee, planted a rain garden at the Plumstead Township Building on Stump Road. The project involved the production of a brochure and a PowerPoint presentation to introduce this BMP, geared toward homeowners, local garden clubs, and area residents. The planting of the demonstration rain garden will act as an educational tool for homeowners wishing to make a contribution toward the reduction of nonpoint source pollution.

Rain gardens help hold stormwater and allow it to soak into the ground where many of the pollutants can be filtered out by the soil. Stormwater is responsible for up to 70 percent of the pollution found in our streams, lakes, and rivers. Rain gardens can reduce the amount of water and pollutants that enter our streams by up to 30 percent.

Financial and other support for this project was provided by the Pennsylvania Association of Conservation Districts, Inc. through a grant with the U.S. Environmental Protection Agency's (EPA) Section 319 Program.

Above Left: Site in summer 2006, prior to construction of the rain garden.

Bottom Left: Rain garden in August 2006.

Above Right: Rain garden in October 2006.

Sweetwater Farm

Wetlands and Riparian Buffers

Wetlands and riparian buffers (streamside vegetation zones) have a crucial role in the health of the environment. They provide critical natural flood control by slowing down stormwater and by helping to recharge groundwater. Both purify runoff by trapping sediment, fertilizer, heavy metals and chemicals and preventing concentrations of these pollutants from entering the water cycle. Without these ecological safeguards for protection, rivers, streams and flood basins become polluted. Wildlife in Pennsylvania, including threatened and endangered species, use wetland habitat during all or some of their lifespan.

Thousands of miles of riparian buffers along Pennsylvania's streams and rivers have been lost or degraded because of rampant development. Buffers are important because they help to shade streams and rivers, stabilize banks, and provide food for aquatic organisms.

Deforestation destroys the buffer and its effectiveness in preventing flooding and erosion by removing tree canopies and plant roots that normally intercept rainfall and slow the rate at which it enters streams. In southeastern Pennsylvania, rapid development has replaced routes of natural water flow with culverts and detention basins, making buffer retention a critical local problem. Wetlands and buffers are crucial to the health of an ecosystem and can also reduce costs associated with floods, generate income from recreational use, and add property value.

Wildflowers and other native plants thrive in the basin

The Sweetwater Farm project began when residents of the Sweetwater Farm residential development, located in Lower Southampton, approached the township to inquire if they could help with the geese population problem along Turkey Run Creek, behind their homes, where there was a large, maintained turf grass area covering the open space between property lines and the Turkey Run Creek.

Farther downstream, an outdated detention basin aided in the bank erosion of the Neshaminy Creek at nearby Playwicki Park, which caused severe flooding at the township's premier open space park. Three dams, which were also part of the old technology to create the basin, served to trap stormwater, which was polluted with household runoff.

Using a Pennsylvania Department of Environmental Protection Coastal Zone Management grant, township staff, Nancy Minich, Principal of NAM Planning and Design, LLCA, project Engineer Kirk Horstman, and the Bucks County Conservation District promoted community outreach efforts to garner awareness and volunteer support.

Sweetwater Farm

Above: Riparian buffer with meandering path throughout the site.

The riparian buffer on the Turkey Run Creek is now in its fifth season. Meandering paths of low grass encourage neighbors to walk through and explore the site on their way to Playwicki Park. Bird activity is increasing; more sightings of Great Blue Heron, Red-winged Blackbirds, American Goldfinches, and Eastern Bluebirds have been recorded.

The banks have been stabilized and wildflowers and other native plants are thriving and increasing biodiversity. Lower Southampton's commitment to proper stormwater management and the site serve as a model to other communities.

Source: www.lowersouthamptontownship.org and www.audubon.org/bird/at_home/pdf/AAHPA-33-42-Wetland.pdf

Top to bottom: Infiltration trench to decrease nonpoint source pollution and reduce downstream velocity and flooding during installation, two weeks after, and two months after.

Sweetwater Farm

Clockwise: Detention basin reengineered to create a riparian buffer along Turkey Run Creek and restore it to its pre-development natural state — one week, two months, one year, and two years after implementation of the final management plan.

Pennsylvania Stormwater Management BMP Manual

Stormwater runoff and flooding are natural events that have helped shape our watersheds and rivers. Our activities on the landscape routinely alter natural drainage patterns. If not managed, these changes increase localized flooding, streambank erosion and loss of groundwater recharge. In addition to its physical impact on the environment, stormwater may carry a variety of pollutants. Stormwater runoff impacts can be minimized through planning and properly constructed and maintained best management practices (BMPs). By managing stormwater runoff as a resource, rather than as a waste, a host of opportunities are available to protect the environment and complement new development.

The Pennsylvania Stormwater Best Management Practices Manual identifies opportunities to manage stormwater as a resource, defines performance guidelines and standards, provides an inventory of proven BMPs, and describes a process for planning and applying them to construction sites. It is a technical reference of planning concepts and design standards that will satisfy Pennsylvania's stormwater management requirements when properly tailored and applied to local conditions.

Legal Framework

Land development activities that change the surface features of the land also alter stormwater runoff characteristics. Unmanaged changes in stormwater runoff volume, rate, and water quality that alter the chemical, physical, or biological properties of receiving waters can constitute pollution regulated under the federal Clean Water Act, as well as the Pennsylvania Stormwater Management Act and Clean Streams Law.

Postconstruction stormwater management is addressed under several programs administered by the Department of Environmental Protection including the National Pollutant Discharge Elimination System Permit for Discharges Associated with Construction Activities (NPDES Construction) and the National Pollutant Discharge Elimination System Permit for Municipal Small and Large Separate Storm Sewer System (NPDES MS4) programs, as well as under the Pennsylvania Stormwater Management Act requirements (Act 167).

These programs identify BMPs for stormwater control. BMPs used to manage postconstruction stormwater runoff must ultimately meet antidegradation requirements of Chapter 93 Water Quality Standards to protect the water quality of special protection waters (high quality and exceptional value) and protect, maintain, and restore water uses for all surface waters (25 Pa. Section 93.4a).

The manual is a tool to help achieve stormwater discharge compliance with water resource protection requirements. It includes information on resource planning, techniques for land development and BMPs for managing stormwater for quantity and quality. When properly planned, designed, installed, operated and maintained, these BMPs should generally meet water resource protection requirements.

Though the manual in itself is not regulation, it is provided as a guideline to assist permit applicants in meeting the regulatory requirements. Alternate BMPs or control strategies, not listed in this manual, or variations of the BMPs included that meet water resource protection requirements, may also be used. Proposals to use alternative BMPs or deviate from the control guidelines must demonstrate their effectiveness with appropriate supporting analysis, calculations, test results, or other documentation.

Source: www.dep.state.pa.us/dep/deputate/watermgt/wc/Subjects/StormwaterManagement/BMP%20Manual/BMP%20Manual.htm

Stormwater Management Basics

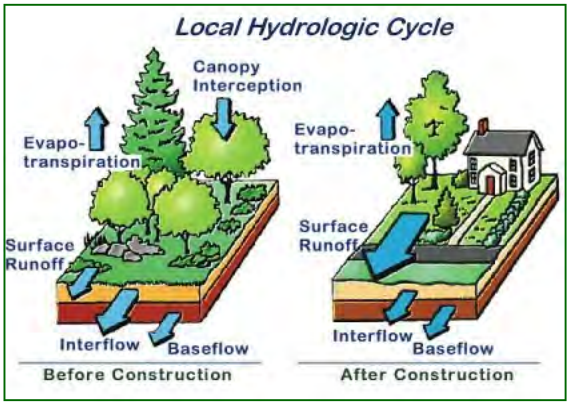
Stormwater Runoff and storm sewer discharges are the second most significant cause of water pollution in the nation's estuaries. Stormwater runoff is increased by human activities through construction, paving, soil compaction, or changes in the vegetation growing on the land. As runoff increases, flooding often follows and can cause streambank erosion and degradation to stream channels and aquatic habitats. Runoff moving across the ground after a rainfall carries pollutants, excess nutrients, and soil to nearby streams, rivers, lakes and estuaries. These substances degrade water quality and can have serious impacts on drinking water and aquatic life.

Increased stormwater runoff is also related to reduced groundwater infiltration. Some portion of annual rainfall needs to infiltrate into the ground to replenish water that humans have drawn out of the ground. Without this recharge, groundwater supplies will continue to decrease, creating potential shortages for individual drinking water wells and other public supplies that rely on public wells.

Current stormwater regulations in Pennsylvania are aimed at reducing the impacts of stormwater runoff, increasing recharge to public and private water supplies, improving stream corridor habitats, and restoring the overall environmental integrity of the watershed.

Stormwater is part of the natural hydrologic cycle of precipitation, infiltration, evaporation and groundwater discharge. In undisturbed landscapes, the natural environment maintains an equilibrium by accepting and absorbing rainfall. Healthy vegetation and soil, with its organic matter, porosity, and micro-organisms, use and absorb rainwater in their living processes. Excess water infiltrates into groundwater to discharge slowly and steadily into streams and wetlands, supporting essential aquatic ecosystems during dry weather.

Development radically alters the natural hydrologic patterns generating excessive amounts of surface runoff through vegetation removal, soil compaction, impervious paving surfaces, and structures. Impervious pavement collects and concentrates runoff. The pollutants that accumulate on these surfaces are collected in the runoff that is directed into streams and estuaries. Uncontrolled urban runoff also contributes to hydrologic and habitat modification, two important sources of river impairment identified by the EPA.



Above Left: Under natural (pre-development) conditions, rain infiltrates through soils and percolates downward to the underlying water table, where it recharges the groundwater.
Above Right: Conventional development creates large areas of impervious surfaces which prevent the infiltration of rainwater.
Source: www.fosc.org/Images/LandscapingCoop/HydroChart.jpg

Stormwater Management Glossary

Aquifer—A geologic formation that is water bearing. A geological formation or structure that stores and/or transmits water, such as to wells and springs. Use of the term is usually restricted to those water-bearing formations capable of yielding water in sufficient quantity to constitute a usable supply for human use.

Base Flow—Sustained flow of a stream in the absence of direct runoff. It includes natural and human-induced streamflows. Natural base flow is sustained largely by groundwater discharges.

Condensation—The process of water vapor in the air turning into liquid water. Water drops on the outside of a cold glass of water are condensed water. Condensation is the opposite process of evaporation.

Discharge—The volume of water that passes a given location within a given period of time. Usually expressed in cubic feet per second.

Evaporation—The process of liquid water becoming water vapor, including vaporization from water surfaces, land surfaces, and snow fields, but not from leaf surfaces. See transpiration.

Evapotranspiration—The sum of evaporation and transpiration.

Flood—An overflow of water onto lands that are used or usable by man and not normally covered by water. Floods have two characteristics: the inundation of land is temporary; and the land is adjacent to and inundated by overflow from a river, stream, lake, or ocean.

Flood, 100-year—A 100-year flood does not refer to a flood that occurs once every 100 years, but to a flood level with a 1 percent chance of being equaled or exceeded in any given year.

Floodplain—A strip of relatively flat and normally dry land alongside a stream, river, or lake covered by water during a flood.

Groundwater—(1) Water that flows or seeps downward and saturates soil or rock, supplying springs and wells. The upper surface of the saturated zone is called the water table. (2) Water stored underground in rock crevices and in the pores of geologic materials that make up the Earth's crust.

Groundwater Recharge—(1) Inflow of water to a groundwater reservoir from the surface. Infiltration of precipitation and its movement to the water table is one form of natural recharge. (2) Volume of water added by this process.

Hydrologic Cycle—The cyclic transfer of water vapor from the Earth's surface via evapotranspiration into the atmosphere, from the atmosphere via precipitation back to Earth, and through runoff into streams, rivers, and lakes, and ultimately into the oceans.

Infiltration—Flow of water from the land surface into the subsurface.

Continued on next page

Stormwater Management Glossary

Million Gallons Per Day (MGD)—A rate of flow of water equal to 133,680.56 cubic feet per day, or 1.5472 cubic feet per second, or 3.0689 acre feet per day. A flow of one million gallons per day for one year equals 1,120 acre feet (365 million gallons).

Nonpoint Source (NPS) Pollution—Pollution discharged over a wide land area, not from one specific location. These are forms of diffuse pollution caused by sediment, nutrients, organic and toxic substances originating from land-use activities, which are carried to lakes and streams by surface runoff. Nonpoint source pollution is contamination that occurs when rainwater, snowmelt, or irrigation washes off plowed fields, city streets, or suburban backyards. As this runoff moves across the land surface, it picks up soil particles and pollutants, such as nutrients and pesticides.

Percolation—(1) The movement of water through the openings in rock or soil. (2) The entrance of a portion of the streamflow into the channel materials, to contribute to groundwater replenishment.

Permeability—The ability of a material to allow the passage of a liquid such as water through rocks. Permeable materials, such as gravel and sand, allow water to move quickly through them, whereas impermeable material, such as clay, do not allow water to flow freely.

Point-source Pollution—Water pollution coming from a single point, such as a sewage-outflow pipe.

Precipitation—Rain, snow, hail, sleet, dew, and frost.

River—A natural stream of water of considerable volume, larger than a brook or creek.

Runoff—(1) That part of the precipitation, snow melt, or irrigation water that appears in uncontrolled surface streams, rivers, drains or sewers. Runoff may be classified according to speed of appearance after rainfall or melting snow as direct runoff or base runoff, and according to source as surface runoff, storm interflow, or groundwater runoff. (2) The total discharge described in (1), above, during a specified period of time. (3) Also defined as the depth to which a drainage area would be covered if all of the runoff for a given period of time were uniformly distributed over it.

Sediment—Usually applied to material in suspension in water or recently deposited from suspension. In the plural the word is applied to all kinds of deposits from the waters of streams, lakes, or seas.

Storm sewer—A sewer that carries only surface runoff, street wash, and snow melt from the land. In a separate sewer system, storm sewers are completely separate from those that carry domestic and commercial wastewater (sanitary sewers).

Stormwater—A term used to describe water that originates during precipitation events. It may also be used to apply to water that originates with snowmelt or runoff water from overwatering that enters the

Stormwater Management Glossary

stormwater system. Stormwater that does not soak into the ground becomes surface runoff, which either flows into surface waterways or is channeled into storm sewers. Stormwater is of concern for two main issues: one related to the volume and timing of runoff water (flood control and water supplies) and the other related to potential contaminants that the water is carrying, i.e. water pollution.

Stream—A general term for a body of flowing water; natural water course containing water at least part of the year. In hydrology, it is generally applied to the water flowing in a natural channel as distinct from a canal.

Streamflow—The water discharge that occurs in a natural channel. A more general term than runoff, streamflow may be applied to discharge whether or not it is affected by diversion or regulation.

Subsidence—A dropping of the land surface as a result of groundwater being withdrawn in large amounts.

Surface Water—Water that is on the Earth's surface, such as in a stream, river, lake, or reservoir.

Transpiration—Process by which water that is absorbed by plants, usually through the roots, is evaporated into the atmosphere from the plant surface, such as leaf pores. See evapotranspiration.

Water Cycle—The circuit of water movement from the oceans to the atmosphere and to the Earth and returning to the atmosphere through various stages or processes such as precipitation, interception, runoff, infiltration, percolation, storage, evaporation, and transpiration.

Water Table—The top of the water surface in the saturated part of an aquifer.

Watershed—The land area that drains water to a particular stream, river, or lake. It is a land feature that can be identified by tracing a line along the highest elevations between two areas on a map, often a ridge. Large watersheds, like the Delaware River basin contain many smaller watersheds.

Source: http://mainegov-images.informe.org/dep/blwq/docstand/stormwater/stormwaterbmps/vol1/chapter3.pdf

Reference Websites

Water Resources Education Network:
www.wren.palwv.org/

Department of Environmental Protection Watershed Management:
www.depweb.state.pa.us/watershedmgmt/cwp/view.asp?a=1437&Q=518682&PM=1

Environmental Protection Agency Nonpoint Source Tool Outreach Toolbox:
www.epa.gov/nps/toolbox/index.html

PA's NPS Management Homepage:
www.dep.state.pa.us/dep/deputate/watermgt/wc/Subjects/Nonpointsourcepollution/defaultnew.html

Chesapeake Bay and Other Nonpoint Source Pollution Educational Resources:
www.pacd.org/resources/default.htm

What is Nonpoint Source Pollution?:
www.epa.gov/owow/nps/qa.html

Nonpoint Source News-Notes:
www.epa.gov/OWOW/info/NewsNotes/

Photographs of Best Management Practices (BMP's):
www.epa.gov/owowwtr1/NPS/ex-bmps.html

Wastewater Education Materials:
www.cfpub.epa.gov/npdes/wastewatermonth.cfm#other

Delaware's Green Technology Manual:
www.dnrec.state.de.us/DNREC2000/Divisions/Soil/Stormwater/New/DURMMTechnicalManual01-04.pdf

Nonpoint Education for Municipal Officials (NEMO):
www.nemo.uconn.edu/

National Management Measures to Control Nonpoint Source Pollution from Urban Areas:
www.epa.gov/owow/nps/urbanmm/

Chester County Water Resources Authority:
www.dsf.chesco.org/water/

Stream-A-Syst: A Tool to Help You Examine Stream Conditions on Your Property:
www.eesc.orst.edu/agcomwebfile/edmat/html/em/em8761/em8761.html

NPS Unified Watershed Assessment:
www.dep.state.pa.us/dep/deputate/watermgt/WC/Subjects/NonpointSourcePollution/Initiatives/WRASLISTINFO/UniWshed-Tbl-A.htm#Table-1

Perkiomen Watershed Conservancy Stormwater Management Glossary:
www.perkiomenwatershed.org/Stormwater/stormwater_management_glossary.aspx

Psychology and the control of NPS:
www.law.utoledo.edu/LIGL/psychologyandthecontrolofno.htm#ednref27

Stormwater Manager's Resource Center:
www.stormwatercenter.net/

Environmental Guidelines for Responsible Lawn Care and Landscaping: www.epa.gov/pesticides/grants/lei/draft_guidelines.pdf

Rain Gardens A How-to Manual for Homeowners:
www.dnr.wi.gov/runoff/rg/rgmanual.pdf

A Homeowner's Guide to Stormwater Management:
www.greentreks.org/eacnetwork/pdf/PWDFinalHomeownerBMPManual11006.pdf

Landowner Guide to Buffer Success:
www.creppa.org/pdf/landowner%20guide%20revised%2030oct07.pdf

Using Natural Landscaping for Water Quality & Esthetics: www.clean-water.uwex.edu/pubs/pdf/storm.basins.pdf

Acknowledgments and Contact Information

Bowman's Hill Wildflower Preserve

1635 River Road (PA Route 32)
P.O. Box 685
New Hope, PA 18938

Miles Arnott, Executive Director
Nancy Beaubaire, Director of Communications
Joyce Burian, Business Manager

Contact information: 215-862-2924 to schedule a school or group tour. Daily-guided tours April-October 2:00 P.M. Self-guided tours year round. Please visit the Preserve's website at www.bhwp.org for additional information.

Hours of Operation: Daily 9:00 A.M. - 5:00 P.M. year round excluding some holidays.

Brayton Gardens

Richland Township Administration
1328 California Road, Suite A
Quakertown, PA 18951

Stephen Sechriest, Manager, Richland Township

Contact Information: Call Richland Township Administration at 215-536-4066 to arrange a walking tour of the site. Main entrance is located at the intersection of Trumbauersville Road and Route 309. Please visit the township's website at www.richlandtownship.org/ for additional information.

Hours of Operation: Monday-Friday 8:30 A.M. - 5:00 P.M.

Brownsburg Park

Upper Makefield Township
1076 Eagle Road
Newtown, PA 18940

Stephanie Teoli, Manager
Upper Makefield Township

Contact Information: Upper Makefield Township Administration, 215-968-3340. Please visit the township's website at www.upper-makefield.com/ for additional information.

Hours of Operation: Monday-Friday 8:30 A.M. - 4:30 P.M.

Pickering, Corts & Summerson, Inc.
Wayne R. Johnson, ASLA, RLA
828 B Newtown-Yardley Road
Newtown, PA 18940

Contact Information: Call Pickering, Corts & Summerson, Inc., 215-968-9300 ext. 226 for project information. Please visit the company's website at www.pcs-civil.com for additional information.

Acknowledgments and Contact Information

Buckingham Township Administration Building

4613 Hughesian Drive
P.O. Box 413
Buckingham, PA 18912

Dana Cozza, Acting Township Manager
Thomas Kelso, President, Castle Valley Consultants
Graham Orton, Director of Water and Wastewater Operations

Contact Information: Administration Building, 215-794-8834, or Water and Wastewater Department, 215-794-8854. Please visit the township's website at www.buckinghampa.org/ for additional information.

Hours of Operation: Monday-Friday 7:30 A.M. - 4:30 P.M.

Churchville Nature Center

501 Churchville Lane
Churchville, PA 18966

Chris Stieber, Director
Kirsten Becker, Assistant Director

Contact Information: 215-357-4005 or visit the Churchville Nature Center's website at www.churchvillenaturecenter.org for additional information.

Hours of Operation: Tuesday-Sunday 10:00 A.M. - 5:00 P.M. Closed Mondays.

Doylestown Commerce Center

2003-2005 South Easton Road
Doylestown, PA 18901

Steven D. Gilmore, P.E., President, Gilmore & Associates

Contact Information: Gilmore & Associates, 350 E. Butler Avenue, New Britain, PA 18901-5106, 215-345-4330. Please visit the company's website at www.gilmore-assoc.com/projects/case_doylestown.asp for additional information.

None Such Farm

4493 York Road
Buckingham, PA 18912

Scott Yerkes, Owner/Operator
Scott Smith, Farm Manager

Contact Information: Market - 215-794-5201. The Market is located across the street from the Farm. Call the Farm Office at 215-794-7742 to schedule a tour of the farm. Visit their website at www.nonesuchfarms.com for additional information.

Hours of Operation: Spring and Summer Monday-Friday 8:00 A.M.-6:30 P.M. Saturday and Sunday 8:00 A.M.-6:00 P.M. Fall and Winter Monday-Friday 8:00 A.M.-6:00 P.M. Saturday and Sunday 8:00 A.M.-6:00 P.M.

Acknowledgments and Contact Information

Pennswood Village

1382 Newtown-Langhorne Road
Newtown, PA 18940

Contact Information: Contact Drew Mason, 215-504-1159 or via email at grounds@pennswood.org, to schedule a tour of the stormwater management system. Please visit the Pennswood Village website at www.pennswood.org for additional information.

Linda Krause, Executive Assistant
Drew Mason, Landscape Manager
Pete McBrien, FMA, LEED AP, Facilities Director
Nancy Spears, Executive Director

Wells Appel
1516 Locust Street
Philadelphia, PA 19102

Stuart Appel, Principal

Contact Information: Contact Stuart Appel, RLA, PP Principal, 215-731-1577, 215-205-2116 (cell), or email sappel@wellsappel.com, who provided master planning and landscape architectural design services. Please visit the Wells Appel website at www.wellsappel.com for additional information.

Stephen Souza, Ph.D., President, and Mark Gallagher, Vice President, Princeton Hydro, provided water resources engineering services. Please visit the Princeton Hydro, LLC website at http://www.princetonhydro.com/ for additional information.

Pine Run Meadow Restoration Project

Bucks County Parks and Recreation Department
901 E. Bridgetown Pike
Langhorne, PA 19047-1597

Contact Information: Contact the Bucks County Parks and Recreation Department at 215-348-6114 for additional information. Pine Run Meadow park entrance is located off of Sandy Ridge Road, Doylestown Township. Please visit the Heritage Conservancy's website at www.heritageconservancy.org for specific information about the project.

Acknowledgments and Contact Information

Plumstead Township

5186 Stump Road
P.O. Box 387
Plumsteadville, PA 18949-0387

Louis Fineberg, Director of Land Use and Planning

Contact Information: Plumstead Township Building, 215-766-8914. Please visit the Township's website at www.plumstead.org for additional information.

Hours of Operation: Monday-Friday 8:00 A.M.- 4:30 P.M.

Sweetwater Farm

Lower Southampton Township Administration
1500 Desire Avenue
Feasterville, PA 19053

Contact Information: Contact Randy Behmke, Director Public Works and Sewer Department, Lower Southampton Township at 215-357-7300 to arrange a tour of the site. Please visit the following websites for additional information: www.lowersouthamptontownship.org
www.audubon.org/bird/at_home/pdf/AAHPA-33-42-Wetland.pdf
www.landscapearchitects.org/awards05/sweetwater.html

Hours of Operation: Monday-Friday 9:00 A.M.- 5:00 P.M.

Sponsors

Bucks County Commissioners

James F. Cawley, Esq., *Chairman*

Charles H. Martin, *Vice Chairman*

Diane M. Ellis-Marseglia, LCSW

David M. Sanko, *Chief Operating Officer*

Bucks County Planning Commission

Edward Kisselback, *Chairman*
Darrin Hoffman, *Vice Chairman*
Kathleen M. Babb, *Secretary*
H. Paul Kester
David R. Nyman
Carol A. Pierce
David H. Platt
James J. Stoeckhert
Walter S. Wydro

Lynn T. Bush, *Executive Director*

Water Resources Education Network (WREN)

This project has been funded in part by the League of Women Voters of Pennsylvania Citizen Education Fund through a Section 319 Federal Clean Water Act grant from the United States Environmental Protection Agency (EPA) administered by the Pennsylvania Department of Environmental Protection (PADEP). Please visit the WREN website at www.wren.palwv.org

Bucks County Planning Commission
1260 Almshouse Road
Doylestown, PA 18901
215-345-3400
bcpc@co.bucks.pa.us
www.buckscounty.org/

Bucks County Conservation District
1456 Ferry Road
Doylestown, PA 18901
215-345-7577
www.bucksccd.org