

Using Vegetative Systems to Manage Stormwater Runoff: 10 Case Studies

A “Green” Approach to Stormwater Management

1. Philadelphia, Pennsylvania

Stormwater Management Approaches that Utilize Trees

2. Regenerative Stormwater Conveyance Systems
3. Staten Island Bluebelt
4. Foresting Stormwater Ponds in Virginia and Pennsylvania

Green Streets

5. Portland, Oregon 12th Avenue Green Street Project
6. Seattle, Washington Street Edge Alternatives
7. New York City Greenstreets Program

Community Greening

8. Philadelphia Green Vacant Land Stabilization Program
9. Frederick County, Maryland Public Schools Greening Initiative
10. Chicago’s Green Roof Program

A “Green” Approach to Stormwater Management

Philadelphia, Pennsylvania

Philadelphia has a long history of environmental planning and natural resource protection and boasts the nation’s first water treatment facility and one of the first urban parks. Like many historic cities, a major portion of Philadelphia’s stormwater system is combined sewer. In 1996, the Philadelphia Water Department (PWD) undertook an effort to evaluate the infrastructure needs associated with controlling the 16 billion gallons of combined sewer overflows per year. Costs were expected to run into the billions of dollars. PWD questioned whether, after expending the time and money necessary to implement conventional solutions, local waterways and streams would be healthy. The answer was no: they would still have eroded banks, exposed infrastructure, poor aquatic life, impaired fish passage, and poor aquatic habitat.

PWD decided to integrate their stormwater program with other water resource protection and regulatory programs to improve synergy and develop a holistic approach. The idea was to simultaneously address a number of regulations, including combined sewer overflows, a Phase I NPDES stormwater permit, and Clean Drinking Water Act requirements, while preserving and maintaining the health of the watershed. This was the birth of the Office of Watersheds. Philadelphia is one of few communities in U.S. that has an office specifically dedicated to watershed protection.

PDW's approach to water management has evolved as the regulatory landscape has evolved. Much of the success of the PDW has been attributed to Philadelphia's Commissioners and Deputy Commissioners’ openness to new, progressive ideas. Also, in the past few years there have been a number of large flood events that have helped raise awareness with the public and at the political level that something must be done to prevent catastrophic flooding. This has allowed the City to continue moving forward with water-related initiatives with a broad base of support.

Specific City programs and initiatives that make it a good example of a ‘green’ approach to stormwater management include:

- Performance-based stormwater ordinance: Philadelphia has developed a revised stormwater ordinance that goes beyond traditional stormwater management and encourages a return to pre-development conditions. The new ordinance focuses on a performance-based approach, requiring developers to manage the first inch of stormwater on-site. It does not dictate how developers should meet this requirement, but provides guidance on a variety of innovative BMPs that can be used. Also, redevelopment projects are exempted from certain stormwater requirements if they can reduce impervious cover by 20%. This provides a huge incentive for developers to pursue redevelopment and infill projects over greenfield development. In addition, the 20% reduction is typically met using green infrastructure BMPs.
- Demonstration projects: The City has installed a number of demonstration facilities on public lands, including green roofs, porous pavement and tree trenches and other innovative BMPs that reduce stormwater runoff. These facilities provide educational opportunities and let people experience the practices directly.

- Philadelphia Green ® Initiative: A program of the Pennsylvania Horticultural Society, Philadelphia Green® is the nation's most comprehensive urban greening program. The program supports the development and ongoing care of community gardens, neighborhood parks and high-profile public green spaces in Philadelphia. Working in partnership with neighborhood residents, community organizations and city agencies, the program uses greening as a community building tool, empowering people to make the city a more attractive and livable place through horticulture. One of Philadelphia Green's initiatives, the Vacant Land Stabilization Program, converts vacant lands to greener spaces that provide stormwater management benefits.
- Watershed management: the City actively addresses existing stormwater runoff issues through watershed-scale planning. The Office of Watersheds (OOW) is developing integrated watershed management plans for the five major tributary streams of the Schuylkill and Delaware Rivers within the City limits. Designed to meet the goals and objectives of numerous water-resources related regulations and programs, integrated watershed management plans recommend the use of adaptive management approaches to implement recommendations watershed-wide. Specific projects being implemented include stormwater wetlands and active restoration of degraded streams and wetlands. The end goal of these restoration projects is to create new habitat and re-colonize them with aquatic wildlife to bring them back to a healthy status.
- Stormwater utility: Philadelphia is revising its stormwater billing system to create a more equitable fee structure that more closely reflects the costs of managing stormwater from each property. Rather than charging a single flat rate for all metered customers, new fees will be determined based on the amount of impervious cover on a given property. A 50% discount will be available to residents and businesses who have implemented green infrastructure BMPs.
- Various community greening efforts: To date, the City has planted more than 500 trees through a regional planting program called TreeVitalize and has plans to plant up to 84 acres of riparian buffers throughout the City's park system. The City also has a Campus Park Initiative and a Green Roof Program for the School District of Philadelphia that focus on integration of stormwater BMPs and vegetation into school sites.

For more information on the City's green stormwater programs, see:

<http://www.phillyriverinfo.org/>

<http://www.phila.gov/water/>

Stormwater Management Approaches that Utilize Trees

Regenerative Stormwater Conveyance Systems

Underwood and Associates, an Annapolis-area restoration firm, has developed a holistic ecosystem restoration approach to address stormwater problems. One specific design variant is the Regenerative Stormwater Conveyance (RSC) system, which replaces traditional pipe outfalls and re-establishes stream valley ecosystems. Conveyance through these systems replicates a forested wetland system with seepage and involves construction of a system of step pools, weirs, and plantings that are able to control the 100-year storm. The RSC utilizes proprietary riffle weir grade control structures, constructed of native materials, and shallow aquatic beds, underlain

with a seam of sand, to reduce runoff velocity, remove pollutants and recharge groundwater, essentially restoring spring heads to stream and wetland ecosystems. They provide a host of benefits beyond just stormwater, such as creation of high quality plant and wildlife habitat, and minimal site disturbance, and result in aesthetically pleasing, self-sustaining systems.

RSCs have been utilized primarily in the Coastal Plain of Anne Arundel County, Maryland, with a focus on restoration of Atlantic White Cedar habitat. However, they can be implemented in almost any region with some minor adaptations. Some practical applications include treatment of runoff from road or surface drainage, channel protection downstream of stormwater management facility outfalls, and collection and conveyance of stormwater. For more information, see Underwood and Associates webpage: www.ecosystemrestoration.com.



Photo courtesy of Underwood and Associates

Staten Island Bluebelt

The Staten Island Bluebelt program was initiated in the late 1980s by New York City's Department of Environmental Protection and is one of the Northeast's most ambitious stormwater management efforts. The overall goal is to provide the necessary stormwater drainage infrastructure for a 12,000-acre region on the southern end of the island while at the same time preserving the last great stand of freshwater wetlands in New York City. The bluebelt uses a series of carefully placed best management practices (BMPs) at the storm sewer/wetland interface to reduce flooding and improve water quality. Creation of a self-regulating ecosystem that is native to the Staten Island region is of primary importance to the program.

BMPs used in the bluebelt include stormwater wetlands, stream restoration, outlet stilling basins, and sand filters. Ninety-two stormwater wetlands are planned for the project (many of which incorporate trees), about half of which have been constructed to date. In order to integrate the wetlands into the natural ecology, the construction process is advised by restoration specialists

since general contractors are typically not trained in proper plant selection and installation. The planting design focuses on quick establishment of the preferred successional communities that will complement the surrounding landscape, before invasive species take over the site.

http://www.nyc.gov/html/dep/html/dep_projects/bluebelt.shtml

Forestry Stormwater Ponds in Virginia and Pennsylvania

Stormwater dry ponds are a BMP that was frequently used in the 1990's primarily for stormwater quantity control. They are prolific in the suburban landscape yet researchers now know they provide little in the way of pollutant removal benefits. Several communities have developed programs or initiatives to plant trees in their existing dry ponds as a way to improve the water quality treatment provided and to meet community greening goals, such as urban tree canopy targets. Reforesting dry ponds also improves the aesthetic quality of these common neighborhood features.

Fairfax County, Virginia developed an interim policy in 1999 regarding planting trees in new and existing stormwater ponds. The intent of the policy is to encourage tree preservation and replanting in and around stormwater ponds. The County provides sketches of dry and wet ponds to illustrate where trees can/cannot be planted, along with recommended species lists, on their website:

<http://www.fairfaxcounty.gov/dpwes/utilities/pondtreepolicy.htm>



The Town of Leesburg, Virginia is currently exploring a similar type of initiative and has developed a brochure for HOAs about planting trees in dry ponds. Several pond retrofits and plantings are currently being planned with HOAs in the Town.

The Perkiomen Watershed Conservancy in Montgomery County, Pennsylvania has developed a guidebook on creating and maintaining “naturalized” stormwater basins, i.e., retrofitting dry ponds to incorporate native trees, shrubs and herbaceous vegetation. Using this guidance, several sites in Montgomery County have been naturalized by volunteer groups and are part of the Montgomery County Conservation District BMP Tour:

<http://www.montgomeryconservation.org/bmptour.htm>

- *Improving Stormwater Basins, Naturally. Creating and Maintaining Naturalized Stormwater Management Basins* by the Perkiomen Watershed Conservancy. Online: www.perkiomenwatershed.org/Stormwater/stormwater_management_improvement.aspx

Green Streets

Portland, Oregon SW 12th Avenue Green Street Project

The SW 12th Avenue Green Street project, located adjacent to Portland State University in downtown Portland, is unique to Portland and the U.S. in the way the pedestrian zone of this street has been transformed to sustainably manage street stormwater runoff. As part of the City of Portland's commitment to promote a more natural approach to urban stormwater management, this "green street" project converts the previously underutilized landscape area between the sidewalk and street curb into a series of landscaped stormwater planters designed to capture, slow, cleanse, and infiltrate street runoff. Each stormwater planter is allowed to collect runoff to a depth of 6 inches until it flows back out into the street and is collected in the next downhill planter. Built in the summer of 2005, this street retrofit project demonstrates how both new and existing streets in



downtown or highly urbanized areas can be designed to provide direct environmental benefits and be aesthetically integrated into the urban streetscape. The City is dedicated to sustainable stormwater management practices and has installed many other green street projects over the years, as detailed in their Green Streets brochure: <http://www.portlandonline.com/shared/cfm/image.cfm?id=209683>

Seattle, Washington Street Edge Alternatives

Seattle's pilot Street Edge Alternatives Project (SEA Streets) was completed in the spring of 2001. It is designed to provide drainage that more closely mimics the natural landscape prior to development than traditional piped systems. To accomplish this, impervious surfaces were reduced to 11 percent less than a traditional street, surface detention was provided in swales, and over 100 evergreen trees and 1100 shrubs were added. One of the primary drainage goals was to use surface retention or detention to reduce 2-year, 24-hour storm event peak



runoff rate and volume to pre-developed conditions. The method used for achieving this goal was to maximize the stormwater time of concentration and the site's detention volume, without compromising homeowner access and parking needs on the street.

The landscape elements serve an important role in both providing an aesthetic benefit as well as contributing to the management of rainfall. Trees will help to restore more of the evaporation and transpiration that was present before development. The other vegetation in the drainage swales will also help to filter and slow the flow of storm water. Two years of monitoring show that SEA Street has reduced the total volume of stormwater leaving the street by 99 percent. The project is located on 2nd Ave NW, between NW 117th and 120th Streets in Seattle. For more information, see the City of Seattle's SEA Streets website:

http://www.seattle.gov/UTIL/About_SPU/Drainage_&_Sewer_System/Natural_Drainage_Systems/Street_Edge_Alternatives/SPU_001805.asp

New York City Greenstreets Program

New York City's Greenstreets program is a partnership between the Department of Parks & Recreation and the Department of Transportation. Launched in 1996, Greenstreets is a citywide program to convert paved, vacant traffic islands and medians into green spaces filled with shade trees, flowering trees, shrubs, and groundcover. In April 2007, Mayor Bloomberg announced PlaNYC, a blueprint for New York City to attain sustainable growth and improve the quality of life in the face of escalating population projections. PlaNYC includes a number of groundbreaking greening initiatives, including planting street trees in all possible locations, creating 800 new greenstreets, and reforesting 2,000 acres of parkland. Mayor Bloomberg has dedicated \$391 million in funds, plus additional staff and maintenance funds to support these greening efforts over the next ten years. The City's website provides more information on the Greenstreets program:

http://www.nycgovparks.org/sub_your_park/trees_greenstreets.html

Community Greening

Philadelphia Green Vacant Land Stabilization Program

A program of the Pennsylvania Horticultural Society (PHS), Philadelphia Green® is the nation's most comprehensive urban greening program. Working in partnership with neighborhood residents, community organizations and city agencies, the program uses greening as a community building tool. It educates and empowers people to make the city a more attractive and livable place through horticulture. Philadelphia Green works hand-in-hand with community-based organizations and the City to transform vacant land into an asset for the community. One way the City contracts with Philadelphia Green to revitalize vacant spaces is through the Vacant Land Stabilization Program. Philadelphia Green begins stabilization by cleaning and mowing the grounds, laying topsoil, planting seeds, and adorning the area with new trees and fencing. Presently, more 6 million square feet of land have undergone this treatment and continue to receive care. PHS produces a manual on how to green vacant lots:

<http://www.pennsylvaniahorticulturalsociety.org/garden/vacantmanual.html>



Photo sources: Philadelphia Green

Frederick County, Maryland Public Schools Greening Initiative

While many schools across the country are making an effort to become more ‘green’ in the sense of using green building materials, recycling and conservation water use in the buildings, fewer schools have taken the initiative to green their properties by increasing tree cover. In Frederick County, Maryland, the Potomac Conservancy and Frederick County Public Schools (FCPS) have begun an initiative to increase tree canopy at public schools to help meet Chesapeake Bay urban tree canopy goals, which focus on reducing stormwater runoff. The Conservancy’s goal for this project is to work with the school district to establish an achievable tree canopy cover goal for all FCPS sites. The aim is to then have this goal supported by FCPS and incorporated into policy by the Board of Education for maintaining and increasing tree canopy cover on FCPS sites.

The Conservancy completed a land cover assessment of public schools in the County (using 2005 aerial imagery) in partnership with the USDA Forest Service. Based on the assessment, Potomac Conservancy estimates that cumulatively FCPS school sites contain approximately 12% tree canopy cover and approximately 38% of land open and available for tree canopy increase. Based on this analysis, the school district has committed to increase its tree canopy to 20%.



Since Fall 2007, over 1,400 students, teachers and volunteers planted more than 500 native trees and shrubs on FCPS school grounds in an effort to demonstrate the great opportunity that exists to increase tree canopy on FCPS campuses. Many of the selected school sites are located in wellhead protection areas. More than 1,000 additional trees and shrubs will be planted in 2008/2009.

Tree plantings were supported by FCPS Facilities Division and Schoolyard Habitat Program, Maryland DNR Forest Service, and the Monocacy & Catoctin Watershed Alliance. Funders included the USDA Forest Service, Chesapeake Bay Trust, Home Depot Foundation and Potomac Watershed Partnership. The Potomac Conservancy's website provide more information about this project: <http://www.potomac.org/site/urban-tree-canopy/>

Chicago's Green Roof Program

The City of Chicago is furthering the cause of making Chicago the greenest city in the country with a new grant program for green roofs. Owners of residential and small commercial buildings will have an opportunity to get a \$5,000 grant to help with the planning and installation of a green roof. A written commitment is required to maintain the green roof project for at least 5 years. In addition to supporting residential and business owners with green roof costs, the City hopes the grants will increase public awareness of green roofs.

Because it believes so strongly in the benefits of green roofs, the City of Chicago recently adopted a policy that encourages and, in some cases, requires green roofs in developments undergoing Department of Planning and Development review. These include private, not-for-profit and public developments receiving financial or other types of public assistance from the City, as well as Planned Developments and Lakefront Protection Ordinance Developments.

The City has installed a number of green roofs on its own buildings. The first municipal green roof in the country, the City Hall rooftop garden, is probably the best-known green roof in Chicago. There are more than 250 public and private green roofs totaling more than 1 million square feet that are under design or construction in Chicago.

As part of its ongoing interest in green roof technology, the City Department of Environment hired a consultant to carry out an experimental program that compared temperature and stormwater runoff characteristics of a variety of green roofs to conventional roofs. This research will help to inform green roof design and provide data to support the use of green roofs over conventional roofs. For more information on the City's green roof programs, see:

<http://egov.cityofchicago.org/city/webportal/home.do>

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MD 21043

