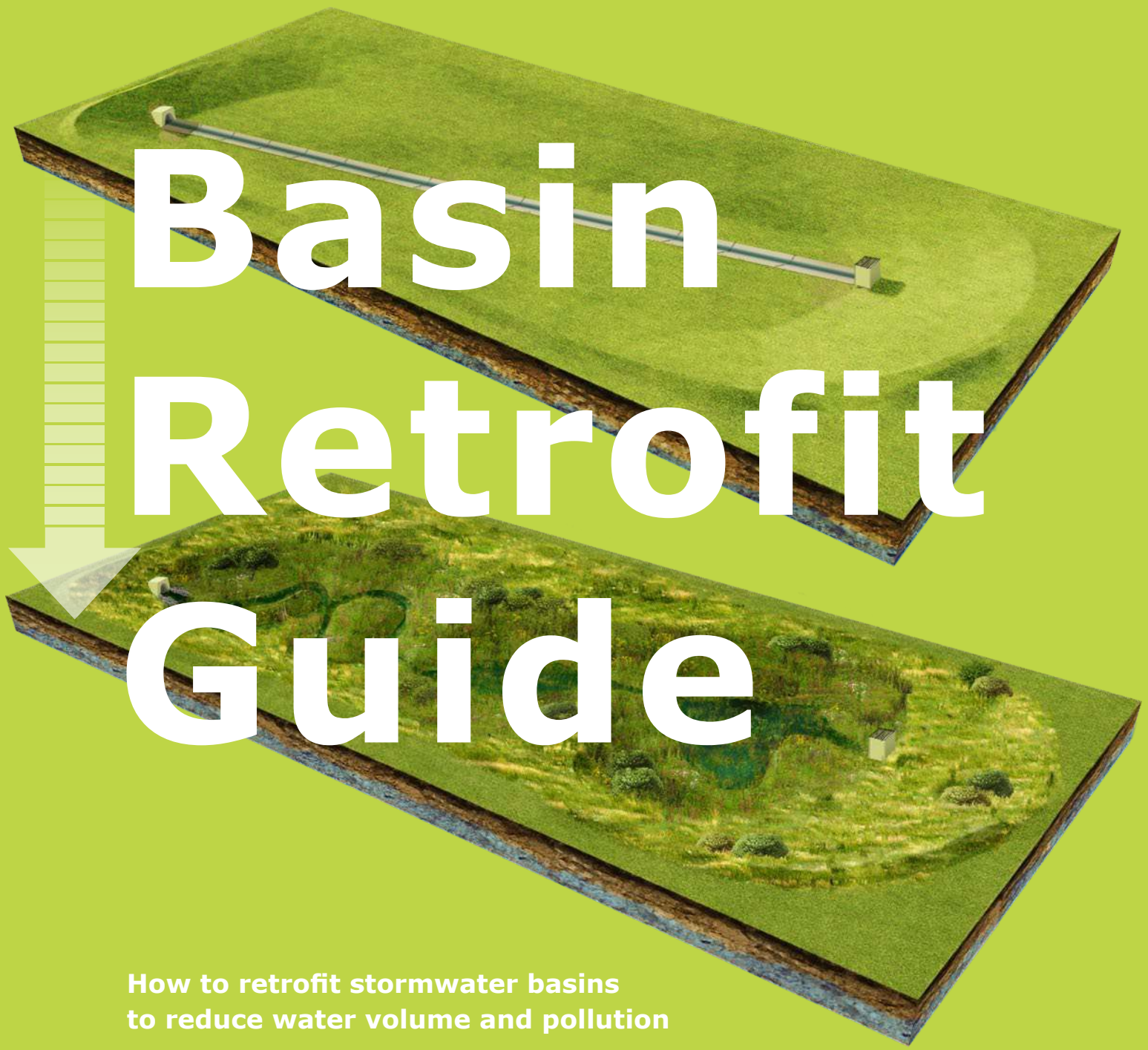
pennsylvania environmental council
stormwater solutions



Basin Retrofit Guide

How to retrofit stormwater basins to reduce water volume and pollution

Acknowledgements

The Pennsylvania Environmental Council (PEC) protects and restores the natural and built environments through innovation, collaboration, education and advocacy. PEC believes in the value of partnerships with the private sector, government, communities and individuals to improve the quality of life for all Pennsylvanians.

PEC recently facilitated a basin retrofit implementation team, which consisted of engineers, landscape architects, contractors and others experienced with basin retrofit projects. The team's purpose was to examine barriers to more widespread adoption of basin retrofit projects, given that only a small percentage of the many hundreds of stormwater basins in southeastern Pennsylvania have been retrofitted. This guide is a result of these meetings to identify a path to retrofitting basins for a variety of audiences from municipal officials, EAC members, private landowners, HOAs, corporate parks, and school districts. Anybody who has a traditional stormwater basin can benefit from the information presented in the guide.

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Introduction

01 Stormwater and basins
02 How does a retrofit work?
03 Motivators for basin retrofits

Hundreds of stormwater basins have been constructed in Southeastern Pennsylvania to manage runoff from development. Many basins were designed to manage larger storm events. A range of modifications can be made to make basins more efficient in managing runoff from the smaller more frequent storms. This guide will demonstrate how to select, install and maintain basin retrofit projects for slowing down and infiltrating runoff from most storms, thereby reducing flooding, erosion, and water pollution.

01 Stormwater and basins

Stormwater is a problem in Pennsylvania causing flooding, erosion, loss of steam habitat and water pollution. But these problems are relatively new. Southeastern Pennsylvania used to be a forest, capable of soaking up rain where it fell. Only in larger storms did water run off into area streams. With human development over the past century, most of the forests were replaced with roads, buildings, parking lots and other ground surfaces that do not allow water to soak into the ground. When the rain falls today, large quantities of water run off into area streams and rivers. The streams and river were never meant to handle that volume of water so they are flooding more often, even in small storms. The flooding can lead to property damage and dangerous conditions.

Top: A typical grass basin allows water to quickly flow from inlet to outlet. Bottom: A retrofitted naturalized basin allows water to slow, soak and be filtered as it passes through.

In addition to flooding, runoff can also pollute our streams, many of which are the source of our drinking water. When rain falls and travels over the ground it picks up surface contamination along the way, trash, oil grease, loose sediment, excess fertilizers, pesticides, chemicals, deicers, and animal waste. All of these pollutants are carried by the water into the streams and rivers, causing problems of contamination, habitat loss, poor water quality.

It is not possible to reverse the trend of development, and existing water treatment alone does not solve the issues so we need to look for opportunities to slow down, stop and clean the water before it reaches the streams. Existing stormwater basins are a relatively low cost way to do just that. Stormwater detention basins were installed starting in the 1960s and 1970s to reduce flooding in large storm events. As flood control measures they worked well, but had little affect on the water from small storms, as most basins are designed similarly to bath tubs, if the faucet was at the opposite end from the drain. Basins have inlets that allow water to enter quickly during storms, water flows through the basin, to the outlet situated at the lowest point in the basin. In small storms the water passes through the basin quickly, in a direct line from inlet to outlet, often in a concrete channel or low-flow channel.

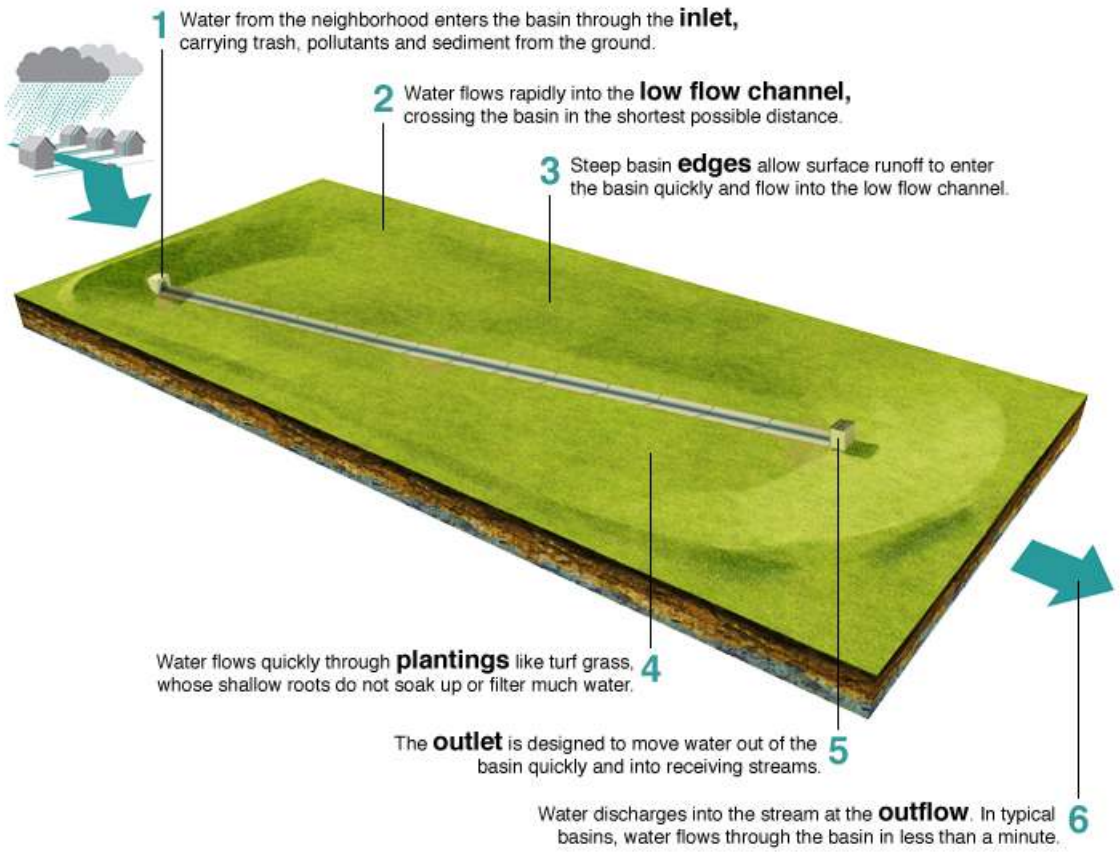
Introduction

Basins are plentiful and the land is already devoted to stormwater management. Simple changes can result in profound results.

Small storms are much more frequent than large storms. In order to improve water quality and reduce volume, small storms must be managed by the basins as well. Also the runoff from the very beginning of the storm, picking up all of the surface contamination, is much more polluted than runoff from later in the storm. This is called the 'first flush.' In traditional basins, this initial water passes through the basin very quickly.

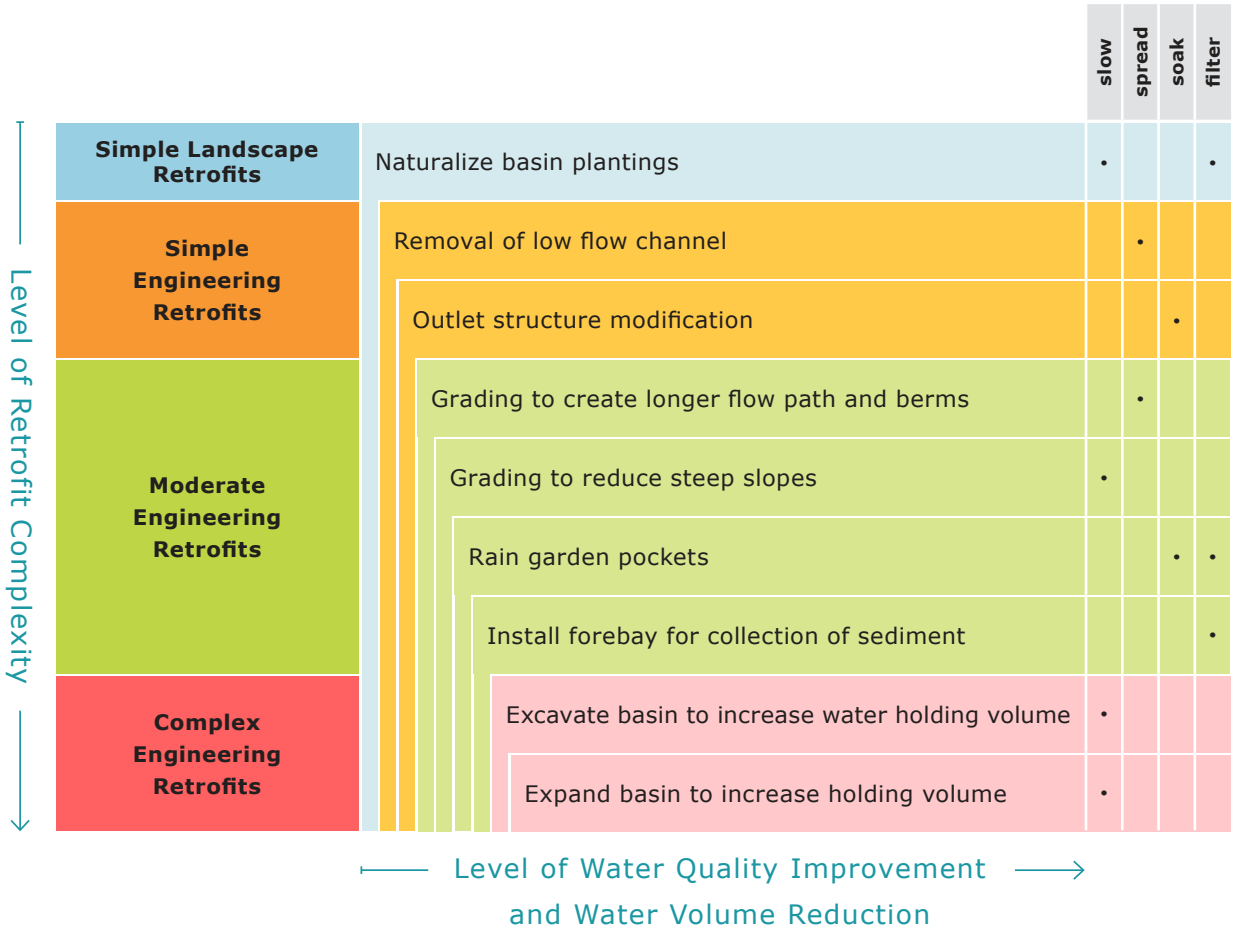
Basins are plentiful and the land is already devoted to stormwater management. Simple changes can result in profound results. Some basin retrofits lead to small storm volumes being completely contained within the basin and soaking into the ground. If retrofits can be done on a large scale within the region, we will start to see positive effects on flooding issues and pollution problems.

What Happens to Stormwater in a *Typical* Detention Basin?



02 How does a retrofit work?

The goals of basin retrofits are to **slow**, **spread**, **soak** and **filter** water before it leaves the basin, resulting in better water quality leaving the basins in all storms. It is important to keep in mind that any of these improvements will improve water quality incrementally. Here are the modifications to existing basins that allow these changes to occur.

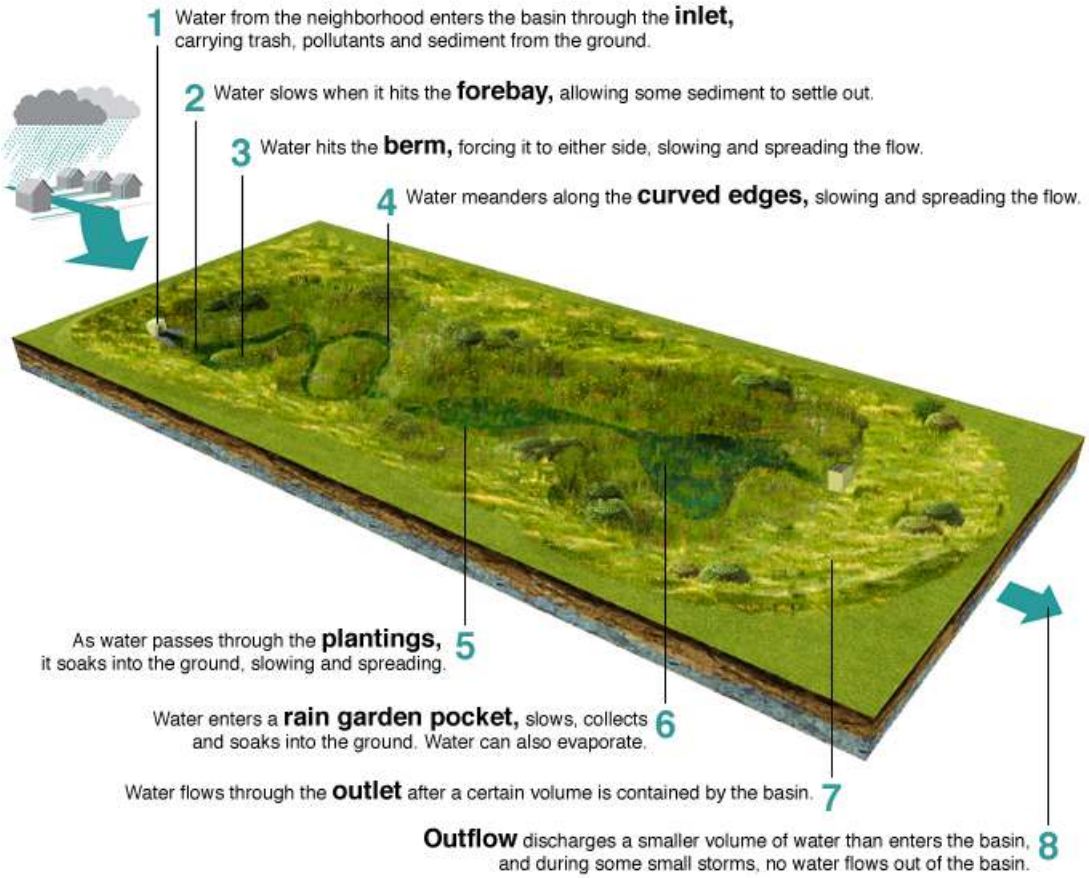


PEC has developed information about basin retrofits that can be found on stormwaterPA.org. See the reference section at the end of the guide for more information.

03 Motivators for basin retrofits

- Regulatory Compliance for new stormwater regulations. Basin retrofits can help communities required to limit non-point source pollution discharges reach their new goals by filtering and holding water in basin retrofits.
- Maintenance compliance as the Pennsylvania Department of Environmental Protection (PADEP) is enforcing maintenance of facilities more often. Owners need to maintain basins today but some owners may not know their maintenance requirements.
- Reduction of flooding and erosion. Both can lead to high cost solutions downstream and complaints from neighbors. Repairs will cost more than using preventive measures like retrofits.
- Retrofits can reduce maintenance costs over time. Some partners have seen an immediate reduction of mowing costs through less man hours, less gas and reduced equipment wear and tear.
- Naturalized basin landscapes can hide unsightly concrete structures in the basin.
- Naturalized basin landscapes have habitat benefits that attract birds, butterflies and beneficial insects while also deterring geese.

What Happens to Stormwater in a *Retrofitted* Detention Basin?



Plan & Prioritize

01 Develop a strategy
02 Create an inventory and prioritize
03 Project costs and funding

This section will look at how to get started with assessing the potential for basin retrofit projects. It will show the planning steps to identify, inventory and prioritize potential basin retrofit projects.

01 Develop a strategy

In order to understand the extent of the opportunities for retrofitting basins, to effectively communicate the ideas to other stakeholders and to generate support for the project, it is a good idea to begin the planning process by creating a written strategy about the project. This strategy document will include the following information:

1. Identify the project area that includes all possible basins to be retrofitted (watershed, municipality, private development, private property)
2. Outline the goals of the project which may include: improving water quality, reducing flooding, controlling sediment, aesthetic benefit, reduced maintenance, regulatory compliance, or others.
3. Consider the budget in general terms. Although it is difficult to understand a project budget prior to the design phase, it is helpful to understand the capacity of the overall budget by classifying the projects generally into four budget categories per 20,000 sq. ft. basin retrofit:
    - Simple Landscape Retrofit: $500+
    - Simple Engineering retrofits: less than $15,000
    - Moderate Engineering retrofits: $15,000 - $50,000
    - Complex Engineering retrofits: $50,000+

    A breakdown of these cost ranges will be looked at more closely later in the guide.
4. Consider existing resources – the easiest way to reduce retrofitting costs is identify and use existing resources. Resources can range from using municipal labor and machinery, to using free municipal compost/soil materials, to volunteer planting crews, and any other quantifiable options. Other resources that should be identified in this section of the plan are secured or potential funding sources.
5. Schedule for completion

Depending on the size and complexity of the project area, this strategy may be a simple one page document or it may be an extensive report. Regardless of the level of detail, the document will be essential to prioritize the basins, communicate the information, apply for funding, and maintain a clear path forward.

02 Create an inventory and prioritize

Once you have a statement that identifies the project area and goals it is time gather information about the basins within the project area. The information collected will be the basis for prioritizing projects if there are multiple retrofit possibilities, providing the consultant with background material or simply understanding the basins in the project area better. How to organize the basin inventory depends on how many basins are in the project area. To simplify the paths for different users of the

guide, it is divided into two paths in this section. The first is for users with less than 10 basins in their project area and the second path guides users with more than ten basins to inventory and prioritize.

How to organize the basin inventory depends on how many basins are in the project area.

Although most stormwater basins function similarly, no two basins are identical so it is important to collect the unique information for each basin within the project area. It is important to gather as much information about each basin before trying to prioritize the projects if the project area contains multiple basins. However, this step is valuable for a project of only one or few basins, too, as it is an organized way to list available information about the basins which will be important for the design phase.

! 1-10 basins

Private development and homeowner scale inventory (1-10 basins):

Audience: homeowners, school districts, HOAs, corporate parks, parks departments, small municipalities

1. Gather information about the basins

Public and private landowners should first contact the persons responsible for managing their facility, institution or homeowner's association. Then talk to the township manager for more comprehensive stormwater system maps if possible. Gather critical information about ownership, responsibility, size, structural features, historic design plans, current field conditions, visibility, access and note unique conditions of the basin. Some of this information can be gathered though research of construction or as-built plans, historical aerial photos, public records, etc. However a site visit to each basin is critical to gather the current condition information. Number or name all of the basins within the project area.

2. Create matrix to organize information

A matrix in spreadsheet format is a great way to record information gathered about each basin. It can be used to compare the sites and can be sorted by goal based approach for smaller facilities. Some of the information that will be important to gather is: physical features of the basin and the conditions (inlets, outlets, low-flow channel, spillway), square footage, visibility, access, existing issues, existing maintenance cost, etc. A good example of a matrix was developed by Philadelphia Water Department (PWD) for the Wissahickon inventory and can be found in the reference section at the end of the guide. Once the matrix is personalized to the project area, you can then go to visit the basins and collect the visual information to fill out the matrix.

3. Prioritize basins based on goals

Once all of the specific basin information is gathered for the project area, it is time to prioritize the projects and determine which basin to retrofit first. Look at the goals written in the strategy and sort the data in the matrix according to the goals. If visibility is a big concern for the basin projects (people within the community may not want the basin behind their home to be altered first, for fear of it looking unkempt) sort the basins according to how visible they are, choosing the first retrofit as the least visible basin. If reducing maintenance costs is the top goal, often choosing the largest size basin to start with makes the most sense. At the smaller scale, the most important step to retrofitting the basins is to make any improvement at all as even small, incremental change will improve water quality.

! 10+ basins

Watershed/Municipal Scale inventory (10+ basins):

Audience: municipalities, watershed associations, large developments or property owners

1. Gather information about the basins

If possible, obtain a copy of the stormwater system map or plan that shows not only the location of the basin itself but also the inlets, ditches, pipes and other conveyance systems that direct water into the basin. For moderate and complex engineering basin retrofits projects the size of the land area that drains into the basin will also need to be determined (the catchment area). Municipalities in Pennsylvania regulated under a Pennsylvania Department of Environmental Protection (PADEP) Municipal Separate Storm Sewer System (MS4) permit are required to develop maps of their storm-water systems. When considering a basin retrofit, first check with the township engineer or Township Manager to determine the status of basin and stormwater system mapping. To see a good example of a stormwater map, see the reference section at the end of the guide.

Gather critical information about ownership, responsibility, size, structural features, historic design plans, current field conditions, visibility, access and note unique conditions of the basin. Some of this information can be gathered through research of construction or as-built plans, historical aerial photos, public records, etc. However, a site visit to each basin is critical to gather the current condition information.

2. Create inventory and prioritize basins

For a detailed analysis of many basins within a watershed, it is often necessary to seek the services of a professional engineer. The engineer will be able to analyze the existing basins in the project area and gather the critical information necessary to make decisions about retrofitting. In the next section of this guide there is information about how to select a consultant or using an in-house resource like a municipal engineer is a potential way to realize cost savings.

PWD and Temple University have created resources for more detailed information on basin retrofit prioritization criteria and are good examples of large scale inventories and prioritizations of basins. If the project are is in the Wissahickon or Pennypack water sheds, where these inventories were focused, the priorities may be identified already. The methodology for these inventories is clearly explained in the reports and worth replicating in other watersheds. See the reference section at the end of this guide for links to these extensive reports.

3. Prioritize basins based on goals

Once all of the specific basin information is gathered for the project area, it is time to prioritize the projects and determine which basin to retrofit first. Look at the goals written in the strategy and sort the data in the matrix according to the goals. The two inventory methods references above give extensive prioritization criteria. The following table is a generalized summary of questions/ criteria that were used to prioritize basins for those inventories when the goal was to improve water quality within the watershed. The most important step to retrofitting the basins is to make any improvement at all as each incremental change will improve water quality.

- Who directly controls the basin/property and has the authority to apply retrofit techniques? Having site control makes it a higher priority candidate for a retrofit.
- Does the basin have an impervious (e.g. concrete) low flow channel that conveys water directly through the basin? If so, this is a high priority candidate for a retrofit that includes removal of the low flow channel.
- Is there an opportunity to lengthen the flow path between the inlet and outlet structure so that water has an opportunity to stay in the basin longer? Basins with greater opportunities to lengthen the flow path are higher priority candidates. The larger basins are likely to provide more opportunities to implement retrofit features within the existing footprint.
- Is the vegetation in the basin mowed turf grass or mix of grasses and woody plants? Mowed turf grass basins are higher priority basin retrofit candidates that those with more diverse vegetation.
- Was the basin constructed more than ten years ago? Many older basins require maintenance such as removal of sedimentation to recover lost volume, so they can be considered higher priority retrofit candidates.
- Is the basin in a highly visible area where negative public perception could be an issue? In this situation, initiating retrofit activities at less visually sensitive basins is a better place to start. The residents may need to adjust to the change in landscape aesthetic from highly manicured lawn to more naturalized plantings by seeing successful installations in lower visibility areas first.
- Does the basin have the capacity to infiltrate water? Standing water in a basin is a sign that the bottom of the basin does not infiltrate water well. This can be due to many reasons from compaction during construction, sedimentation of basin over time, high water table, bedrock close to the surface, high clay content soils. Fixing a basin with standing water may be costly or difficult to construct and therefore makes the basin a lower priority for retrofitting.

- What are the conditions adjacent to the basin? If there is adjacent land onto which the basin can be expanded to manage more water, this is a positive condition for a retrofit. If there are properties close to the basin that could create/increase drainage or flood risks by grading to increase berm height, this is a negative factor for such a retrofit.

03 Project costs and funding

Cost is typically a major consideration when considering a basin retrofit project. You need to consider the budget you have on hand now and what funding you may be able to obtain via grants, loans, or internal financing. Lower cost, easier to implement retrofit techniques can improve water quality, increase infiltration, and fit your budget.

Understanding cost components

Although it is difficult to understand a specific project cost prior to the design phase, the guide begins to outline the components by classifying the projects generally into four budget categories per 20,000 sq. ft. basin retrofit. This cost information is summarized from a variety of sources and simplified to provide order of magnitude costs. There are many unique factors to each basin retrofit that unlike conventional construction, it is not easy to generalize cost data for the projects. The engineering costs can vary widely due to the lack of reliable, existing information about the basins. To examine more specific cost data, refer to the reference section for links to project costs and methodologies.

Site assessment:	
Soil testing	$50-$200
Percolation/Infiltration testing	$120 - $1200
Survey	$2000
Design and permit:	**(15-35% of construction cost)**
Construction:	
Naturalization of basin vegetation (slow, filter)	$500+
Simple landscape/engineering retrofits:	<$15,000
Naturalize basin plantings (slow, filter)	$0-$2000+
Removal of low flow channel (spread)	$2500+
Outlet structure modification (soak)	$2000+
Moderate engineering retrofits:	$15,000 - $50,000
Grading to create longer flow path and berms (spread)	
Grading to reduce steep slopes (slow)	
Rain garden pockets (soak, filter)	
Install forebay for collection of sediment (filter)	
Complex engineering retrofits:	$50,000+
Excavate basin to increase water holding volume (slow)	
Expand basin to increase holding volume (slow)	

Funding the project

Finding a way to fund a retrofit project is a common challenge. Right now there are few funding sources available for retrofitting existing structures and little motivation to do so. With new regulations in the works and enforcement of maintenance for existing structures, costs for non-compliance may drive spending for retrofits. Here are some resources for identify cost-saving measures and funding sources for your project.

Identify existing resources to reduce overall cost

Review the strategy document for information about available resources and then talk to engineers, landscape architects, and other professionals regarding project costs. Consider starting with conceptual designs that include a range of retrofit options and associated costs so that elements can be added or removed based on available funds. Once a general cost estimate is completed, consider any available low cost resources there may be to do any of the work. This may include:

- Municipal engineer support for outlet structure modification calculations and design.
- Support from public works or maintenance staff for small grading projects, removing a low flow channel, installing a plate on the outlet structure, or for vegetation management tasks.
- In-kind labor for planting tasks drawn from local volunteer groups or environmental advisory committees.
- In-house stormwater management budgets for hiring design and construction consultants.
- Calculate the maintenance costs for the basins currently, especially if mowed turf. Then calculate the proposed maintenance costs for the basin. Often there is significant cost savings over time for reducing mowing of basins. For more complex retrofit projects, it may take a few years to see the savings. These savings will only increase as gas prices rise.

Apply for grant funds

The following list of grantors may fund basin retrofit projects:

- Growing Greener (Pennsylvania Department of Environmental Protection). Annual grants typically due in September. See www.depweb.state.pa.us/portal/server.pt/community/growing_greener/13958
- Exelon Schuylkill River Heritage Area Grant Program. Annual grants with letter of intent due in March. See www.schuylkillriver.org/Grant_Information.aspx
- TreeVitalize (primarily for trees, but shrubs and plugs can also be purchased). See www.treevitalize.net/index.aspx
- PENNVEST may also provide funding for non-point source pollution projects including stormwater BMP projects. PENNVEST program assistance is being offered through the Pennsylvania Association of Conservation Districts. They are offering application assistance to local conservation districts, small municipalities, farmers, and other non-profit organizations. See http://pacd.org/2011/05/pennvest-grant-and-loan-application-help-now-available.

Outreach

Basin retrofits generally involve a transition from more manicured, turf grass basins to more natural looking meadow grass and shrub basins. If the basin is in a highly visible location there may be questions about the project from these neighbors. The public may be sensitive to projects in a municipal park or open space lands. Homeowners may have questions about projects on neighbor's property or within a development with an association. And business clients may be critical of projects within a corporate industrial park. Consider the following community outreach steps during the design and construction phase of the basin retrofit project.

Initiate community outreach to landowners and community leaders

First consider visibility and public access in and around basin retrofit project. More proactive outreach will be necessary for basins that are in high use public areas or in direct line of sight of homeowners or business clients.

Send letters or hold an informational meeting to explain the proposed project and gather comments. Explain the purpose, goals, and benefits of project, and what the impacts will be to area residents such as changes in visual aesthetics and site use/access. Example language from a letter sent to residents in the area around a recent basin retrofit can be viewed in the resource section at the end of the guide.

Be prepared to address questions about the basin retrofit

Most questions will fall within the following two categories and can be easily addressed before the project begins. It is important to emphasize the benefits of the project and address the concerns with the understanding that not all citizens realize that stormwater is an issue that can be addressed by retrofitting existing basins. There are several good resources for educational materials about stormwater in the resources section at the end of the guide to help convey these messages.

Health and Safety Concerns

The two most common concerns people have with naturalized landscapes involve the perception of increased populations of mosquitos and ticks. The following information is useful to answer questions related to these pests. For more information, see the reference section at the end of the guide.

West Nile Virus (WNV) is a mosquito-borne disease that can cause encephalitis, a brain inflammation. Mosquitoes need at least four days of larval development to reach adulthood during the summer (PA DEP). Dry detention basins are designed to completely drain within 2 to 3 days after a storm. Existing and retrofitted basins should be maintained to prevent standing water which over time can create mosquito breeding grounds. Clogged basins require maintenance cleaning to prevent standing water. Infiltration testing should be conducted during the design phase to assure that the

water retained in the retrofitted basin will infiltrate into the ground before mosquito breeding can occur. Some partners point out that a retrofitted basin may actually reduce mosquito populations by creating a habitat with insects, birds and other animals which eat the mosquito larvae.

Lyme disease is caused by the bacterium *Borrelia burgdorferi* and is transmitted to humans through the bite of infected blacklegged ticks. Typical symptoms include fever, headache, fatigue, and a characteristic red expanded "bull's eye" skin rash (CDC). To avoid contact with ticks, regularly mowed paths can be established in areas in and around stormwater basins used by the public and/or maintenance workers.

The two most common concerns people have with naturalized landscapes involve the perception of increased populations of mosquitos and ticks.

Aesthetic Concerns

In order to manage the expectations of the public, basin owners should demonstrate that the naturalized basin is being maintained. Simple measures to indicate that the naturalized basin is intentional and not neglected may include: fencing, mowing the edge of a naturalized basin, providing other mowed trails where necessary, installing interpretative signage, and removing invasive plants. Basin designers should understand the level of naturalization that the public will accept, and use education and outreach to increase public acceptance of more naturalized basins. The goal over time is to see well managed naturalized basins become the new landscaping norm, with the benefits of cleaner water, healthier streams, less pollution and improved bird and butterfly habitat.

Design & Construct

01 Determine permit requirements
02 Conduct site assessment
03 Find a design consultant
04 Design and construct

This section of the guide will discuss the options for designing, bidding, constructing basin retrofit projects. Since each basin in unique, understanding the permitting requirements and conducting an accurate site assessment prior to design is important to understand the scope of the project. Reviewing the scope of the project and available resources will determine whether a design/engineering consultant is necessary and what the steps in the design process will be. Finally, finding a qualified contractor and overseeing construction is critical to the success of the project.

Design & Construct

01 Determine permit requirements

All earth disturbance activities in Pennsylvania are regulated by the Pennsylvania Code. Depending on the area of the ground surface the project will disturb, the requirements may range from implementing erosion and sediment control best management practices (BMPs) to having a plan for erosion and sediment control during and after construction to requiring a permit for the construction activities. This is because when the ground surface is disturbed, loose soils can be carried into the waterways during storm events as pollution called sediment. The regulations define what precautions to take while the soil is exposed in order to prevent that soil from travelling off-site during construction and cause pollution problems. It is best to contact your municipality and your local county conservation district about plan and permit requirements prior to starting the project. See the resources at the end of the guide for more information about erosion and sediment regulations and contact information for the conservation districts.

For a basic overview of requirements for sites over one acre, reference the diagram in Appendix B on page 34 by Montgomery County Conservation District to determine permit requirements.

If your site is less than one acre, a permit may not be necessary but a plan to prevent erosion during and after construction will be necessary. Here are examples of simple retrofit features that may require notification or plans:

- Naturalized plantings: typically no permit, although a plan may be necessary if there is exposed soil over area greater than 5,000 sq. ft. Contact municipality about installation method for plantings and to understand existing weed ordinances.
- Modify Outlet structure: Some municipalities allow a certain amount of modification without approval (raising the orifice between 6”-12”.) Contact your municipality to confirm.
- Removing the low flow channel may require a plan or permit depending on the amount of disturbed area.

02 Conduct site assessment

If the scope of your project goes beyond simply letting the existing vegetation grow up within the basin, there are a few more site assessments that need to be conducted prior to design. These tests will help to determine what design is best suited for the basin and reduce the probability of problems during the construction phase if conducted correctly.

Soil Test and Percolation/Infiltration Test

A key consideration for retrofitting a basin is how quickly will water infiltrate into the ground if it is detained within the basin. Water in a dry detention basin should drain within 48 to 72 hours. Check available records for information on the types of soil present and whether soil testing has been

conducted. You may already know via observation that runoff collecting in your basin readily drains. Overall, we recommend that you conduct soil testing to determine infiltration rates. A good rule of thumb is to confirm that rates of one-half inch or more per hour are occurring.

A key consideration for retrofitting a basin is how quickly water will infiltrate into the ground if it is detained within the basin.

Infiltration will be impeded if bed rock or the water table are at a shallow depth (e.g. 3 feet or less below the bottom of the basin) or if there is compaction or hard layers of soil. Dig a test pit with a small back hoe to observe if subsurface materials (e.g. soil layers, bedrock, water table) are amendable to infiltration. For example, the presence of thick clay layers can impede infiltration. If there is enough depth for infiltration, conduct infiltration tests at several locations in the basin to determine the infiltration rate. See the reference section at the end of the guide for soil and infiltration test methods.

Survey

Unless the basin was constructed within the last 10 years, it may be necessary to collect survey information to verify the elevations of basin features such as berms, spill way, and basin floor. This will provide the designer with an accurate site picture on which to design the retrofit. Often basins will accumulate sediment over time, which can lead to changes in their holding capacity and it is important for the designer to account for the changes. The cost of the survey cost will vary depending on size of basin. Note that PWD estimated a cost of $2,000 for a topographic survey of a 15,000 square foot basin.

Inspection and maintenance records combined with survey information can tell you what the current size of the basin, how much sedimentation has occurred since the basin was constructed, how much sediment can be removed via maintenance to achieve original design conditions, and what the potential is to gain additional volume via a retrofit expansion.

03 Find a design consultant

Depending on the scope of the project and the available resources, you may need an engineer or design consultant. Find a consultant with experience in basin retrofits to design the project. A good place to begin is by asking your municipality for recommendations, or a watershed partnership. Also he list of contributors for this guide is a local group of professionals experienced with basin retrofits. Ask any potential consultants for examples of their work, associated costs and references.

04 Design and construct

Since the complexity of a retrofit can cause the design process to vary widely, the guide is split into three sections according to the project scope. The simplest form of retrofit may require no outside consultants to achieve, while complex retrofits can engage a group of professionals in the process. The sections below are divided into the same scope definitions as seen in the chart on page six, except the moderate and complex engineering retrofits have been combined here as the design and construction process for those retrofits are similar.

Simple landscape retrofits

Naturalization of Basin Vegetation

No permits, no plans or calculations

Typically a basin naturalization retrofit involves converting the vegetation within a basin from mowed grass basin to a more diverse mix of plant species. The plants chosen for the basin will cause the design process to be quite different depending on complexity of planting design and installation techniques.

The simplest conversion is to allow the existing vegetation in the basin to grow. This is achieved by changing the frequency of the mowing schedule. These 'let it grow' basins may only be mowed once or twice per year and seasonally inspected for invasive plant species. This naturalization method does not require any design or construction process but rather a revision to the maintenance schedule and maintenance person skilled at plant identification. The main advantage of this retrofit method is it is very low-cost, often realizing cost-saving quite soon after the conversion is made. The drawbacks include: little control over the plant species and aesthetic look of the basin as it depends on what is already growing there and the existing seed bank, and the retrofit does not reduce volume although it will increase infiltration of the basin as deeper rooted species establish.

The 'let it grow' basins can also be supplemented with planting additional species among the existing plants. This may require a consultant with knowledge of plants to recommend species for the site conditions. The plants can be installed as seed, plugs, shrubs or trees. Keep in mind how the basin will be maintained when considering the addition of plant material.

If the existing vegetation in a basin is eradicated prior to planting, plans and permits may be required depending on how much soil is disturbed. A skilled contractor or a landscape design consultant may be necessary to determine the best plants for the basin and how to install the new landscape. There are several options for installation of vegetation within the basin and the specific

site conditions should be evaluated prior to creating a planting design. The main advantage of this retrofit method is the control over the plant species within the basin, plants can be selected specifically to survive in the basin conditions and to filter certain pollutants. The basin can also be designed to have a specific aesthetic quality, with plant textures and colors. Depending on the size and species of plants chosen for the installation, costs can vary widely.

Simple engineering retrofits

Simple Landscape/Engineering Retrofit

No permits, plans and calculations may be required

The next step for making improvements to water quality beyond naturalizing the basin with longer rooted native plants that is to slow the water in the basin down and retain some of it for longer periods of time. These small engineering changes are what can be considered a simple engineering retrofit. Depending on the specific site conditions of the basin, an engineer may or may not be required to calculate the volume changes for the basin. It is good to consult an engineer to understand whether it is required for your project.

The components for the simple retrofit involve removing a low flow channel if present and modifying the outlet opening with a steel plate. A construction contractor should be able to do this fairly easily, depending on site access.

Moderate and complex engineering retrofits

Moderate Engineering Retrofit

Permits may be required, plans and calculations required

Complex Engineering Retrofit

Permits required, plans and calculations required

For retrofits that involve more advanced changes to the hydrology of the basin, an engineer will be necessary to design and test the retrofit features. Meliora Environmental Design's and Viridian Landscape Studio's Basin Retrofit O & M Summary recommends eleven items to consider when planning a basin retrofit. See Appendix E on page 44. Some of the considerations include:

- Estimate basin drainage area from construction drawing or GIS map.
- Calculate small storm volume (i.e. volume from 0.5 to 1.5 inch storms) to set target capture volumes from drainage area.

Design & Construct

- Modify outlet structure to hold small storm volumes to meet target capture volume established above.
- Evaluate inlet/outlet location for short-circuited conditions (i.e. where water flow path between inlet and outlet can be lengthened by retentive grading or check dams).
- Consider soil restoration by amendment with compost, air spade, etc.
- Design to maintain access to control structures for maintenance and inspection (e.g. include mowed paths through naturalized vegetation to access structures).
- Consider invasive seed bank adjacent to site. Re-vegetate with plants considered to be generalist. Keep planting palette simple.

Cost estimate and bid process

Depending on the scope of retrofit activities and the project budget, grant funders, municipalities, and other organizations may require that a basin retrofit project be put out to bid in order to obtain a qualified contractor at the best cost. Check with grant administrators, solicitors, and financial managers to determine bid requirements. For projects going to bid you will need to craft a request for proposal (RPF) that clearly defines project work tasks, schedule, and bidding requirements. You can consider the following outline for preparing a bid, but be sure to check in with the bidding requirements of your organization:

- General information for bidders such as when bid is due, who and where to submit, how to submit (e.g. hard copies, electronic), number of copies both originals and copies, who must sign the bid, how the bid should be labeled, how long the bid is good for, what information should be in the bid, who the bidder needs to notify, and who to contact for more information.
- Description of basin retrofit project
- Activities that bidder will need to perform (general specifications, technical specifications, design plans for construction projects).
- Be sure to include follow-up activities such as requirements to maintain vegetation or replace vegetation that dies in first 1 or 2 years.
- Bid submission requirements such as qualifications and background, resumes, key staff and their time committed to project, descriptions of representative projects demonstrating bidder's ability to complete the retrofit project along with references, detailed project schedule, total project fee, and other documentation required by your organization.

For suggestions of contractors, experienced with basin retrofits, again ask your design consultant, municipality or a watershed partnership for more recommendations.

Construction

Once you have selected a contractor and are initiating the construction phase of the project, it is recommended that you conduct the following types of oversight activities:

- Hold pre-construction meetings to confirm expectations of designers, construction contractors, landowners, funders, and other key stakeholders.
- Conduct construction oversight to ensure work is done properly. You may need to assign or hire a construction management professional who has the expertise to assess the contractors work activities and confirm that all tasks are completed according to your specifications.

Outreach

You should continue to communicate to stakeholders during this active phase of project. You can invite landowners, the selected contractor, and other key stakeholders to a pre-construction meeting. Explain the degree of site disturbance that will occur during construction, the types of activities and equipment that will be on the site, and the duration of the construction activity. Address concerns that may arise about safety, schedule, appearance, and overall purpose of project.

Once the construction phase is completed, you can plan a ribbon cutting with neighborhood representatives, key funders, and elected officials that have supported the project. Use this as an opportunity to explain project benefits and identify key maintenance and management issues as you move forward.

You also can use both temporary and permanent signage that explains project features and benefits. Educational signage was developed for the Aiden Lair Park basin retrofit project in Upper Dublin and the Center Street homeowner project in North Wales. The templates used for these sign can be adapted to other basin retrofit projects. See the reference information at the end of the guide for a link to the signage templates.

Maintain & Monitor

01 Adaptive management
02 Monitor long-term performance

This section provides guidance about maintaining and monitoring the new landscape once the retrofit is complete. Maintaining the basin properly is important for three reasons: regulatory compliance, engineering functionality and public perception.

Maintain & Monitor

01 Adaptive management

Whether constructed traditionally or retrofitted, a stormwater basin needs to be maintained using adaptive management techniques. This requires maintenance consisting of regular inspections and a plan of maintenance resulting from decisions based on the inspections. This allows for flexibility of handling unforeseen issues that often arise with natural systems and insures the functionality of the basins over time. Maintenance responsibilities may fall on a municipality, a business, or home-owner's association. Whoever is responsible will need to assign maintenance responsibilities to staff, contractors, or private landowners/volunteers. Clear, easy to follow instructions should be created that guide those responsible for and performing maintenance activities.

Design with maintenance in mind

If possible engage maintenance personnel during basin retrofit design and construction tasks so that they understand what must be done to maintain the project. The availability (or non-availability) of tools should be considered. For example, if you are recommending that a meadow grass be cut to a certain height, be sure that the mowing equipment is available to meet the desired specification. Overall, simplify the maintenance as much as possible, and adopt planting plans that match the skills and abilities of maintenance staff. Avoid designs that result in a lot of edges that need to be maintained, or overly diverse planting plans that require a lot of maintenance. Be aware that more intensive landscape management (e.g. watering and weeding) will be required during the first couple years that it takes for native vegetation to get established.

Vegetation establishment and weed tolerance

It is important to water and weed during first few growing seasons, depending on the type of planting installation and weather. Good establishment of vegetation is essential to the success of the retrofit and the eventual reduction of maintenance costs.

When basins are naturalized with native plants, efforts must be undertaken to remove invasive plants that encroach on the basin. If you have a maintenance crew for the basin already, it is good to understand whether they have the skills necessary to ID and eradicate weed species. Check for pesticide licenses from all contractors, as proper training is required to handle the chemicals so that humans and the environment are notexposed to risks. Many contractors will schedule seasonal visits to scout specifically for weed invasions and address any issues. Better to address invasive species often as it may only take a fraction of a season for the baisn to be overrun with invasive species, depending on the surrounding vegetation in the area. See the resource section at the end of the guide for invasive plant identification and control guidance.

Maintenance schedules

There are maintenance requirements that occur at different time periods with retrofitted basins. Often the maintenance is more time consuming for the first few growing seasons, while plants get

established then is reduced in subsequent years. Understanding when to inspect the basin for maintenance is the first step in adaptive management. The inspections are generally divided into three categories: Annually, seasonally and per storm event. Regular inspections and maintenance result in better functionality and overall reduced maintenance costs as the problems are addressed when they occur. See the resources section at the end of the guide for more maintenance resources.

PEC's 2008 guide to maintaining stormwater basins recommends the following general maintenance activities. The full report can be found in Appendix D beginning on page 36.

- Prevent sediment and litter accumulation
- Control erosion by stabilizing erosion prone areas, and dispersing and slowing runoff (these recommendations can be integrated into a basin retrofit design).
- Ensure basins drain/dry properly by removing sediment build up and keeping outlet structures clear of debris and blockages.
- Regular inspect basins (twice a year and after major storms of over two inches of rain.

Additional maintenance schedule details as developed by Meliora Environmental Design and Viridian Landscape Studios are listed below.

- Inspect and vacuum clean the inlet structure and overflow outlet structure at least two times per year (fall and spring).
- Inspect overflow spillway for erosion or signs of undermining two times per year. Repair as needed.
- Inspect for signs of erosion a minimum of two times per year or following extreme storm events. Restore any areas showing signs of erosion and re-vegetate with specified plant species.
- Periodically check plant health, provide pruning and other care, and replant if needed.

02 Monitor long-term performance

Basin performance standards can be established for the retrofit during the design process such as how much stormwater volume the basin retrofit is able to infiltration, target quality for water exiting the basin or other benchmarks for performance. Properly designed, constructed, and maintained basin retrofits should continue over time to maintain target infiltration and pollutant reduction goals. Monitoring the actual pollutant reduction performance of the basin can be costly but as regulations require it, may be necessary. There are some good resources at the end of the guide for monitoring basin retrofits for water quality improvement.

Outreach during this phase

Continue to manage expectations with stakeholders. Depending on the visibility of the basin and the degree of community involvement to date, you will need to communicate how the basin will mature over time. It will take a couple of years for a meadow to mature and shrubs/trees to establish. Plant mortality may occur that will require replacement. Let the community know that a major and more visual appealing basin retrofit project will emerge over a several year period. You may have been able to involve community members during the planting phase of the project. If possible and if relevant to the site (e.g. a homeowner association basin), you may be able to involve community members in monitoring and maintaining the basin. Be clear about what activities they can be involved with. There may be a targeted invasive plant specifies that they can look out for and remove when observed following appropriate directions.

If possible, include a way for the community to interact with the basin. For example, a mowed path around the edge of the basin may provide an opportunity for walking, bird watching, or nature contemplation. Adding bird boxes to naturalized basins can make a positive impression on public perception, as it engages the community to interact with nature.

References & Resources

References

Stormwater PA

The StormwaterPA website, http://stormwaterpa.org, is an initiative of GreenTreks Network, Inc., a Philadelphia-based non-profit communications organization whose mission is moving people towards a more sustainable world.

Stormwater map

A good example of a municipal stormwater system map is Whitpain Township.
www.whitpaintownship.net/pages/gov_deptengineering_storm.php

Sample matrix for prioritization

PWD's Office of Watersheds has identified criteria for prioritizing basin retrofit projects. You can download their *Final Report: Inventory of Existing Stormwater Management Facilities With Retrofit Potential Within the Wissahickon Creek Watershed* at www.phillywatersheds.org/Wiss_basins/basininventory.html. Table 1 of this report lists the full 15 criteria used to prioritize basins in the Wissahickon. Appendix E is a good spreadsheet for a sample matrix.

The criteria used by Temple University's Center for Sustainable Communities to prioritized basin retrofit sites in the Pennypack Watershed are presented in Section 6.1 of Temple's *Pennypack Creek Watershed Act 167 Plan* (see www.csc.temple.edu/research/Act167.htm.) Overall, they focused on sites where increasing the berm height or lowering the basin floor is feasible in order to increase the volume that can be managed in the basin. You can also consult their *Appendix C Detention Spreadsheet* in the same document to view additional ranking factors they used for project prioritization.

Cost information about retrofits

PWD's Office of Watersheds has cost information in the *Final Report: Inventory of Existing Stormwater Management Facilities With Retrofit Potential Within the Wissahickon Creek Watershed* [1] at www.phillywatersheds.org/Wiss_basins/basininventory.html.

Temple University's Center for Sustainable Communities contains cost information for basin retrofit sites in the *Pennypack Creek Watershed Act 167 Plan* (see www.csc.temple.edu/research/Act167.htm.) The plan only includes sites where increasing the berm height or lowering the basin floor is feasible in order to increase the volume that can be managed in the basin. This makes all of the projects complex engineering retrofits with the higher costs associated.

References & Resources

Pest information

Stormwater Management and West Nile Virus, Pennsylvania Department of Environmental Protection, Publication Number 4700-FS-DEP3058, Revised May 2005.

Lyme Disease website for Center for Disease Control and Prevention, www.cdc.gov/lyme

Soil/infiltration test info

The PA DEP Stormwater Best Management Practices manual3 includes recommendations (in Appendix C) on how to conduct soil testing for infiltration rates. They recommend a double ring infiltrometer test for infiltration basins
(see www.elibrary.dep.state.pa.us/dsweb/Get/Version-48483/13_Appendix_C.pdf).

PWD also recommends an infiltration test that can be conducted by homeowners
(see www.phillywatersheds.org/whats_in_it_for_you/residents/infiltration-test).

Basin educational signage templates

See www.StormwaterPA.org—search for basin retrofit resources

Plant information

Model weed ordinances website: www.for-wild.org/weedlaws/weedlaw.html.

Controlling invasive plants

Pennsylvania Field Guide: Common Invasive Plants in Riparian Areas for photos and control strategies for common invasive plants at
www.acb-online.org/pubs/projects/deliverables-145-1-2004.pdf.

Controlling Backyard Invasives part of the *Plants for a Liveable Delaware* at
http://ag.udel.edu/extension/horticulture/pdf/backyardinvaders.pdf.

Plant Conservation Alliance's Alien Plant Working Group *Least Wanted: Alien Plant Invaders of Natural Areas Fact Sheets* at www.nps.gov/plants/alien/fact.htm.

The Global Invasive Species Team by the Nature Conservancy at www.invasive.org/gist/index.html.

Maintenance information

A detailed evaluation form that addresses how well vegetation is growing in rain garden and bioswale BMPs can be found at the City of Seattle's *Natural Drainage Systems Landscape Maintenance Categories (LMC) and Characteristics Checklist*
www.seattle.gov/UTIL/groups/public/@spu/@usm/documents/webcontent/spu02_020019.pdf.

References & Resources

Monitoring information

A report comparing the benefits of a retrofit against a conventional basin southeastern PA. It contains some maintenance cost information about potential savings over time for retrofits and some monitoring information. www.fxbrowne.com/html/Montgomerybasins-finalreport.pdf

Other resources on basins and stormwater

Temple/Villanova site for case studies of basin projects:
www.temple.edu/ambler/csc/t-vssi/bmpsurvey/project_profile_type.htm#No-Mow

Manuals that outline several retrofit techiniques, specifically in manual 2 there is information on basin retrofits: www.cwp.org/categoryblog/92-urban-subwatershed-restoration-manual-series.html

Fact sheet about construction activities and permit requirements: www.epa.gov/npdes/pubs/fact3-0.pdf

The Pennsylvania Association of Conservation Districts at www.pacd.org provides E&S, BMP, and educational resources.

The Bucks County Conservation District: www.bucksccd.org

The Chester County Conservation District: www.chesco.org/conservation

The Delaware County Conservation District: www.delcocd.org

The Montgomery County Conservation District: www.montgomeryconservation.org (includes a virtual BMP tour)

The Brandywine Valley Association: www.brandywinewatershed.org

The White Clay Creek Watershed Association: http://home.ccil.org/~wcwa/

The White Clay Creek Watershed Management Committee: http://mercury.ccil.org/%7ewcc_ws (visit "Useful Information" for info on rain gardens, bio-retention, and recommended native plants).

The Chester, Ridley, Crum Watersheds Association: www.crcwatersheds.org

The Darby Creek Valley Association: www.dcva.org

The Green Valleys Association: www.greenvalleys.org

The Perkiomen Watershed Conservancy: www.perkiomenwatershed.org

The Wissahickon Valley Watershed Association: www.wvwa.org

References & Resources

Appendix A

Stormwater Management Basin Retrofit Area Maintenance/Easement Agreement, between North Wales Borough and the Esterles, March 11, 2011. North Wales Borough developed an O/M check list for the resident-owned basin retrofit project on Center Street, considering tasks that should be performed by the Borough and tasks that should be performed by the homeowner.

MAINTENANCE & INSPECTION PLAN - Stormwater Management Basin	Responsible Party	
FIRST YEAR MAINTENANCE	**Borough**	**Owner**
Turf Grass		
1. Mow turf grass areas as soon as top growth is tall enough to cut. Mow grass to roughly 3 inches high. Repeat mowing to maintain specified height without cutting more than 40 percent of grass height. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet.		Owner
2. Water or supplement natural rainfall to provide a minimum rate of 1 inch per week until a healthy, dense, close stand of grass has been established.		Owner
Meadow Areas		
1. Mow meadow areas to a height of 10 inches	Borough	
Rain Garden Pockets and Tree/Shrub Groves		
1. Weed as necessary to remove invasive species.	Borough	Owner
2. Water or supplement natural rainfall to provide a minimum rate of 1 inch per week.		Owner
SECOND YEAR & BEYOND MAINTENANCE		
Turf Grass		
1. Mow turf grass areas as soon as top growth is tall enough to cut. Mow grass to 3 inches high. Repeat mowing to maintain specified height without cutting more than 40 percent of grass height. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet.		Owner
Meadow Areas		
1. Mow meadow areas at least once per year to a height of 8 inches. Mowing in early spring is preferred, but if the area is too wet then mow in late fall. Evenly distribute mowing.	Borough	
2. Inspect 1-2 times annually for invasive species. Cut biennial weeds to a height of 12 inches or less, do not allow weeds to go to seed.	Borough	Owner
Rain Garden Pockets and Tree/Shrub Groves		
1. Weed as necessary to remove invasive species.	Borough	Owner
2. Mulch with composted shredded leaf litter to a depth of three inches if necessary to suppress weed growth.	Borough	
GENERAL MAINTENANCE		
1. Do not mow or use weed whackers near trees and shrubs	Borough	Owner
2. Do not mow to less than recommended mowing height.	Borough	Owner
3. Inspect all seeded areas for bare spots (greater than 1 sq ft) in late summer. Reseed bare spots with appropriate seed mixes during the fall seeding window (August 15 to September 30) or spring seeding window (April 15 to June 15).	Borough	
4. Replenish mulch around trees and shrubs each spring to suppress weeds.	Borough	
5. Monitor for deer damage during establishment years and use repellent as needed.	Borough	Owner
6. Establish an emergency drought watering plan for the first and second years. Replace trees, shrubs, and reseed if loss is 20 percent or greater.	Borough	
7. Monitor and remove invasive species in all areas.	Borough	Owner
8. Keep photo records following installation and each year thereafter to document changes.	Borough	
9. During the threes years of establishment, coordinate maintenance and training of Borough staff and owner with Municipal Engineer.	Borough	Owner
10. To prevent clogging and maintain system capacity, inlet and outlet structures should be inspected and cleaned if necessary a minimum of two times each year. Regular inspection should be conducted.	Borough	
11. Inlets should be inspected for signs of erosion and if present, will be regraded and repaired.	Borough	

References & Resources

Appendix B

Basin Retrofit Permitting Guidance, June 8, 2011, Montgomery County Conservation District

MONTGOMERY COUNTY CONSERVATION DISTRICT

Basin Retrofit Permitting Guidance
6/08/2011

Basin Retrofit Guidance

This document is intended to provide an explanation of terms and potential permits associated with basin retrofit projects. A pre-design meeting is recommended to bring regulatory agencies into design concept and determine permitting requirements.

Basin Retrofit – Modification to an existing stormwater basin to improve water quality and promote groundwater recharge. Modifications could include; reconstruction of the basin floor to extend the flow path, installation of sediment forebays, modification of the outlet structure to provide extended detention, and/or changes to the vegetation.

Chapter 105 – The rules and regulations regarding water obstruction and encroachment applicable to design, construction, operation, monitoring, maintenance, modification, repair and removal of structures which impact Waters of the Commonwealth.

Dam Safety Permit – Permit authorizing water obstruction and encroachment activities to protect the health, safety, welfare, and property of the people.

Earth Disturbance Activity – Any human activity which would tend to increase the potential for accelerated erosion.

Erosion and Sediment (E&S) Control Plan – A site specific plan for earth disturbance projects identifying BMPs which will be used to minimize accelerated erosion and sedimentation. A plan which meets the requirements of the Chapter 102 regulations must be properly designed, implemented, and available on site for all earth disturbance activities over 5000 sq. ft. Projects less than 5,000 sq. ft should implement BMPs on-site. Check with County Conservation District for requirements.

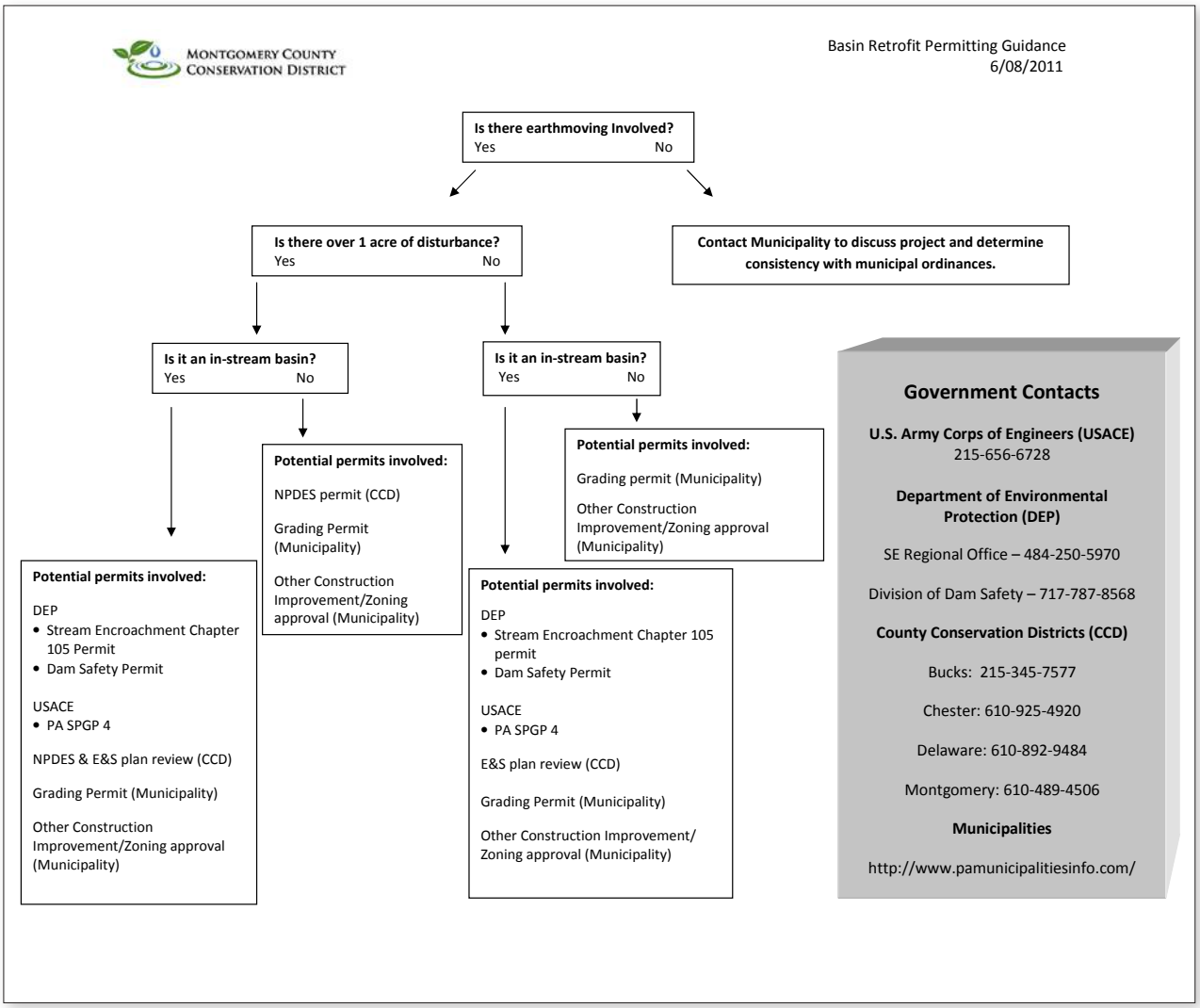
In-stream basin – Stormwater basin located on Waters of the Commonwealth.

National Pollutant Discharge Elimination System (NPDES) - All construction activities proposing to disturb greater than one acre of land must be authorized by a National Pollutant Discharge Elimination System (NPDES) permit.

State Programmatic General Permit (SPGP) – Federal permit under the Clean Water Act that authorizes the discharge of dredge and fill materials into Waters of the United States.

Waters of the Commonwealth - rivers, streams, creeks, rivulets, impoundments, ditches, water courses, storm sewers, lakes, dammed water, ponds, springs, wetlands and all other bodies or channels of conveyance of surface water, or parts thereof, whether natural or artificial, within or on the boundaries of this Commonwealth.

References & Resources



References & Resources

Appendix C

Text from Upper Dublin Letter to Homeowners Around Basin Retrofit

Have you noticed the changes at Aidenn Lair Park over the past year?

The Township, with funding from Pennsylvania Environmental Council's Exelon Schuylkill River Heritage Grant and the Montgomery County's Treevitalize Program, has made design improvements to the Aidenn Lair's stormwater basins to better control neighborhood stormwater runoff. (Runoff entering these basins from the adjoining drainage area flows into Pine Run and on to the Wissahickon Creek.)

This project aims to slow the flow of stormwater in the basin to help keep new plants irrigated. As the stormwater flows more slowly, sediment will drop out and other non-point stormwater pollutants, like nutrients from lawn fertilizer, will be absorbed by plants; this means stormwater entering Pine Run will get cleansed naturally by basin plants and soils. The plants, including tall grasses, flowering meadow plants, and native shrubs and trees will also cool stormwater runoff helping to lower water temperature entering the creek. The basin will take on the appearance of a *rain garden;* it will still manage stormwater, but will look less industrial and more natural. Once plants are established, this project will enhance the park landscape, better control stormwater, and even attract butterflies and dragonflies.

During the first two growing seasons, neighbors and patrons are asked to help with their care and protection. We're enlisting your help:

- **We Need Volunteers Planters**: Please sign up to participate in Volunteer Planting Day, **Saturday, September 18** (weather permitting). This is your park, even an hour will be helpful (wear garden gloves, tools and instruction provided).
- Limit access into the basins, particularly in locations where grading and planting have occurred and treat the young plants gently.
- Report any problems observed to the township.

Andy Fowler is managing the project for the Township. He and the project team are available to answer questions and share more information. Contact **Mr. Fowler** to volunteer and with any questions.

References & Resources

Appendix D

Maintaining Stormwater Basins on Your Property, Fall 2008, Pennsylvania Environmental Council.

pennsylvania environmental council

MAINTAINING STORMWATER BASINS on Your Property – Fall 2008

This basin was recently converted from a mowed-turf grass dry detention basin into a naturalized basin. The result: an attractive wildflower and tall grass meadow with reduced mowing and maintenance requirements for the basin owner. (See ideas for basin naturalization in Tips for Improving Your Basin, Page5).

Why Maintain Your Basin?

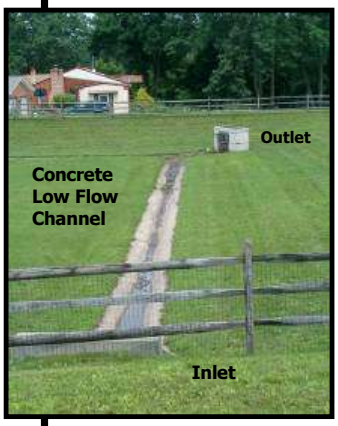
- To ensure the basin controls stormwater runoff and contribrutes to the reduction of flooding problems.
- Basins that are not properly maintained will eventually malfunction. When basins fail, very serious hazards can occur, including severe flooding and damage that can be difficult and costly to repair and cleanup.
- Lack of proper operation and maintenance is often cited as the number one reason for failure of stormwater facilities.
- Malfunctioning or improperly installed basins can cause **non-point source pollution** and degrade water quality in our streams and rivers.
- The Federal Clean Water Act requires that stormwater runoff be controlled to protect streams and rivers. In Pennsylvania, the Department of Environmental Protection requires that municipalities ensure stormwater facilities are properly inspected and maintained.

What is a Dry Detention Basin?

Most basins in Pennsylvania were designed as "dry detention basins". Dry detention basins are intended to temporarily hold stormwater during and immediately after storms, and drain in between storms. Dry detention basins are large earthen depressions constructed to receive stormwater runoff from roads during storms, and to allow that water to drain away at a controlled rate. Every basin is designed to capture a certain volume of stormwater from streets, rooftops and other impervious surfaces in a specific drainage area. In general, dry detention basins are designed to drain within 24 hours after a storm. NOTE: basins designed for *extended detention* or as *wet ponds* retain stormwater for an extended period (in some cases up to 72 hours); wet stormwater ponds are designed to remain wet year round.

"An ounce of prevention is worth a pound of cure."
It is easy and inexpensive to inspect and clean out a stormwater basin compared to the high cost of repairing a neglected basin and cleaning up flood damage and water pollution caused when basins malfunction.

References & Resources



These two images show two typical dry detention basins. All **dry detention basins** have: 1) an *inlet structure*, typically metal or concrete pipe, that conveys runoff into the basin from a developed area; 2) a primary *outlet structure* through which stormwater from most storms exits the basin; and 3) an *outfall structure (typically a pipe) that* discharges stormwater from the basin onto land or into a waterway. Basins also have a secondary spillway to divert water from large storms. Some basins have a concrete **low flow channel** to quickly route stormwater from the inlet in a straight path directly to the outlet.

THE BASICS OF BASIN MAINTENANCE:

(1) Prevent Sediment and Litter Accumulation

Stormwater basins naturally collect sediment, including gravel, sand, and mud, as well as other debris like litter. Any materials that can be transported by stormwater runoff will be carried into a basin, and can accumulate there. To maintain its capacity and function, a basin should be kept free of excessive debris, litter and sediment. Here are some tips for controlling sediment and litter accumulation in your basin:

- **Institute a litter prevention program**. Institute litter programs to help prevent litter from entering storm drains and being carried into basins and waterways. For example, stencil storm drains with "no dumping" message as a reminder that storm drains are not for dumping; prohibit uncontrolled trash from collecting curbside; require trash cans be covered with securely fitting lids; institute a street cleaning program in your neighborhood.

- **Ensure Compliance with Local and State Earth Disturbance and Erosion Control Laws**. Any person or site engaged in excavation or grading that temporarily or permanently exposes soil to rain and runoff, including construction and farming activities, must control the dirt and prevent it from migrating off site. (Sites 1 acre or more must obtain a permit prior to earthwork.) Anyone in the neighborhood who fails to control erosion on their property could be allowing their dirt to accumulate in your basin!

(2) Control Erosion

Erosion can occur on gradual slopes as well as steep slopes both within and outside our basins. When erosion occurs, it can result in soil, rock or other material being transported by stormwater runoff to down slope properties, roads and waterways where it is a source of sediment pollution. When erosion occurs up slope in a drainage area or within the basin itself, it can result in excess sediment accumulation and can hinder basin performance. Excessive accumulation of sediment and other eroded debris can rapidly clog basin inlet and outlet structures and contribute to basin failure. Some basins can trap a certain amount of sediment; close monitoring is needed, however, to ensure basins do not discharge sediment pollution into our waterways.

- **Stabilize areas subject to erosion.** Preventing erosion can often be achieved using well-selected vegetation or rock. Grass and other vegetation when established help the earth to withstand erosive forces of stormwater runoff. Rock, sometimes called **rip rap**, can also be used to control erosion in a basin; rock helps hold soil in place and also helps control erosive velocities of runoff. Stabilization can also be achieved using man-made products. For example, turf reinforcement matting is a woven matting material that be installed along with vegetation to provide stabilization in hard-to-control areas. (See *PA Stormwater Best Management Practices Manual (PA BMP Manual)* for more information.)

- **Modify slope in areas subject to erosion**. Erosion is often caused by fast flowing stormwater runoff, which is a function of the slope of land, type of land cover (including

References & Resources

plants, soil or rock), and the volume of water. Re-grade land to reduce slopes that are erosion prone, including areas inside and outside the basin. Provide more stable ground cover such as deep-rooted and water-tolerant plants, rock or other material to hold the soil in place.

- **Divert runoff.** Divert runoff into a more gradual and stable area. Stormwater can be diverted or re-routed within a basin using earthen berms or rock berms. Materials used to establish a permanent diversion should be strong and stable and not subject to erosion, migration or premature deterioration.

- **Disperse runoff.** Disperse runoff using a **level spreader** (See *PA BMP Manual*) or modified grade downslope of outfall pipe to diffuse or spread water over a larger level area. Create sheet flow conditions to help prevent channelization, gully formation and erosion.

- **Slow flows on steep slopes**. All erosion caused by stormwater flowing on steep slopes should be controlled. Slopes can be recontoured, cut back or extended to reduce steepness and grade in erosion-prone areas. **Retentive grading** and **check dams** can be used to control flows on slopes (see *Tips for Improving Basin Performance* below.) **Rip rap** is often relied upon to control erosion; however, its use generally is only a temporary solution, can be unsightly and doesn't necessarily solve the erosion problem at its source. It is recommended that an engineer be consulted to identify the best long-term control practice to manage steep slopes.

(3) Ensure Basins Drain Properly

In general, "dry" detention basins should completely drain within 24 hours and dry out between storms. Each basin is designed to drain within a certain time period; however, sometimes basins aren't installed properly or conditions within the basin hinder proper drainage. One common problem with basins is the outlet structures malfunction and impede drainage.

- **Identify the cause of improper drainage (i.e., drainage that isn't consistent with basin design).** Excess sedimentation or siltation in the basin can alter the bottom grade and hinder stormwater flow through the basin, which can hinder proper drainage. Clogged outlet control structures are often the cause of drainage problems. Poorly installed outlet structures are also a cause of outlet malfunction. Activities during site development and construction (i.e., excessive compaction of basin soils) can severely limit stormwater from soaking into basin soils. If it appears that that your basin was not installed consistent with its design, consult the responsible design firm or your municipality.

- **Clean-out clogged pipes and basin structures.** Clogs caused by excessive litter, leaf matter, tree debris/dead branches, soil or grass clippings should be addressed immediately by removing material causing the clog and properly disposing of materials off site.

- **Repair or replace corroded, rusted, cracked pipes and structures.** If any conveyance structure, including an inlet or outlet, appears damaged or deteriorating, consult a water resource expert or an engineer to determine the extent of damage and identify needed repairs.

(4) Overall Conditions

Basic conditions all basin owners should be aware:

- **Keep basin drainage area (i.e., streets and land that drain to the basin) clean and free of debris and litter**. Every basin receives stormwater runoff from a specific upslope "drainage area" where precipitation hits the earth and flows into the basin either as overland flow

The accumulated leaf, litter and sediment debris in front of basin inlet and outlet structure is restricting flow through these basin structures.

Cleaning out debris and sediment will easily correct this maintenance problem.

References & Resources

Definitions for terms used in this publication

Berm: An elevated mound, or rise, constructed of compacted earth, rock or other material, installed to contain, divert or direct stormwater flow and accumulation. In many basins earthen berms comprise the outside basin walls; berms can be constructed within a basin to direct or extend a stormwater flow path.

Check Dam: A relatively small embankment constructed across the slope (or parallel to the slope) to control the flows down a slope including the flow of stormwater down a channel or swale. Multiple check dams are often used in series to create terraces to control flows and mitigate erosion on a slope. Check dams generally are not found in older dry detention basins, but their use is increasing.

Conveyance: In this context, a structure such as a pipe or earthen channel that conveys or directs stormwater in a specific path.

Invasive Plant: Undesirable non-native plant that tends to overtake other plants and can readily out-compete native plants and even damage existing mature trees and plants. Invasive plants are undesirable because they limit the growth of more diverse plants, including natives, and overtime adversely impact a diverse landscape and native plant habitat.

Low Flow Channel: A narrow pathway that directs stormwater in a straight line through a basin from the inlet to the basin outlet.

Non-Point Source Pollution: Unlike pollution that enters our waterways through a discreet pipe from an industrial or sewage plant, non-point pollution originates from many diffuse sources and activities. Non-point source pollution is caused when rainwater flows over land and picks up pollutants in its path, such as oil, grease, fertilizers, and even soil, and then discharges pollutants into a creek or river.

Retentive Grading: A stormwater management practice that involves modifying an earthen slope to create terraced or plateau-like steps to convey runoff gradually down a slope to control erosion.

Rip rap: Large rock installed to slow the flow of stormwater and control erosion. Rip rap is often used as a temporary measure; with a more permanent long-term erosion control solution to include more thoughtful and comprehensive basin repair, redesign or retrofit.

Stabilization: Practices that control soil erosion in areas prone to erosive action of stormwater runoff. Stabilization methods include seeding and mulching in areas of disturbed earth, construction, gardening or tilling that has left soil or earth loose (i.e., uncompacted) and exposed such that it readily erodes, or washes away when exposed to rain or runoff. Other stabilization practices include planting deep-rooted vegetation, rip rap, and erosion control turf matting.

Trash Rack: A metal device installed in front of an outlet pipe opening that traps and screens out debris to prevent it from entering the pipe. Trash racks require regular cleaning to ensure they are not restricting flows.

or through underground storm pipes. When littered streets; bare ground, exposed soil or other evidence of erosion; and piled grass clippings, leaves or debris are exposed to rain or located in the flow path of stormwater runoff materials can be readily conveyed into your basin. Accumulation of this material in pipes and basins can cause premature clogs and over time will impact basin function.

- **Maintain proper grade.** The bottom of the basin generally should be graded consistent with the design. In general, dry detention basins should appear level, but should be moderately sloped in the direction of the outlet.

- **Stabilize your basin.** In general, basins should be "stabilized" with vegetation such as grasses or other plants to hold the soil in place and prevent erosion of basin soils. Use of rock, **rip rap** or other turf protection materials in the basin is an option for stabilizing soil when vegetation alone is ineffective. **Invasive plants** should be removed from the basin. Chemical fertilizers and pesticides should not be used within basins. See *Tips for Improving Basin Performance* (below) which suggest basin planting options for the basin.

- **Ensure basin berms and structures are sound**. All basin structures including basin berms or walls, inlets/outlets, pipes should be stable and sound with soil compacted in a level and secure manner where the structure's outside surface contacts the earth. Cracked or rusted pipes, signs of erosion, hollowed areas, caving in or slumping berms, are all indications that basin structures may be unstable and not sound, and in need of an in-depth inspection by an engineer.

- **Ensure basin overflow spillway is unimpeded**. The overflow spillway is the area designed to safely carry water out of the basin in major storms. The overflow, or emergency, spillways located along the basin's outside wall should be clearly visible and free of obstructions. The spillway should be level side-to-side to evenly convey water out of the basin in high flow conditions and prevent erosion. There should be no signs of channelization or preferential flow paths on spillways.

(5) Regularly Inspect Your Basin

- It is recommended that basins be inspected at least twice a year and after major storms of more than 2" of precipitation. Conduct inspections in early spring early in the growing season and mid-way through the growing season or in the fall. Inspections mainly consist of looking at basin structures to determine whether basin clean out is needed or if other maintenance or repair may be necessary. Sediment removal should only occur when sediment and soils are dry.

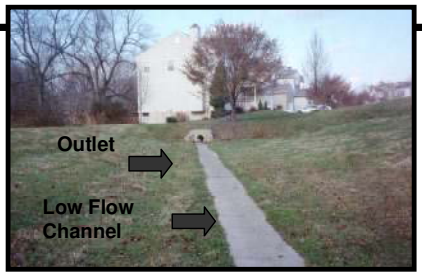
References & Resources

TIPS FOR IMPROVING BASIN PERFORMANCE

Conventionally designed dry detention basins are one of the many culprits contributing to damage and erosion observed in many urban and suburban streams today. As such, efforts are underway to modify the design and function of these basins to better control stormwater runoff, improve water quality by reducing non-point pollution, and enhance basin appearance. Contact your municipality prior to undertaking basin improvements and check local ordinances and permit requirements; your municipality may recommend ways to improve your basin.

♦ Replace mowed turf grass with native meadow plantings including perennial native grasses and wild flowers to reduce mowing needs and enhance basin aesthetics. Plant selected native shrubs and trees to shade meadow plants and help prevent unwanted **invasive plant** growth. Refer to PA Native Plant Society for guidance on plants (www.pawildflower.org) and/or consult a landscape architect. Prior to preparing a design for converting a mowed turf grass basin into a native landscape, obtain okay from your municipality.

♦ If basin repair is needed consult an engineer for technical assistance and consider a basin retrofit to improve function, performance, and appearance. This can be a good opportunity to create an attractive naturalized basin with flowering native plants and shrubs. Consult the Conservation District office in your County and their Website for engineering firms experienced with stormwater management and specifically stormwater best management practices (BMPs) and basin retrofitting.



The concrete low flow channel visible in the center of this basin quickly transports stormwater to the basin outlet limiting the extent to which stormwater soaks into basin soils. This basin can be retrofitted by removing the low flow channel and adjusting bottom grade to disperse water across the entire basin. This type of retrofit would filter non-point source pollutants, replenish ground water, irrigate vegetation, and better protect receiving streams from impacts of fast moving unfiltered stormwater runoff.

♦ Amend and improve basin soils that are over compacted and limit percolation of stormwater into the ground within basins. The soil can be tilled and amended with sand or leaf mulch, then revegetated to enhance basin performance and increase infiltration of stormwater into the ground.

♦ Extend the flow path of stormwater and remove concrete low flow channels within basin to increase stormwater contact with basin soils and vegetation. This retrofit will improve opportunities for filtering out non-point source pollutants, replenish groundwater and irrigate plants. Contact your municipality to verify this retrofit is allowed in your community.

♦ Modify outfall location to slow flows, reduce erosion and protect down slope land, vegetation and streams. Repair and retrofit practices employed at outfall areas to protect land and water can include level spreaders, retentive grading, check dams. The *PA BMP Manual* describes practices.

♦ Install additional stormwater BMPs upslope in the drainage area to capture, divert and infiltrate stormwater and reduce reliance on large basins and help restore watershed health. Some BMPs include rain barrels, rain gardens, and vegetative roofs.

A naturalized basin, like this one, enhances basin performance by filtering non-point pollutants and slowing stormwater flows through the basin; is an attractive native landscape; and is less costly to maintain since mowing is virtually eliminated.

References & Resources

Dry Detention Stormwater Basin Inspection Checklist for use by Basin Owners

Name(s) of Person Inspecting the Basin: _____ Basin:_____

Date of Inspection: _____

	No	Yes *	Notes / Follow-up items
Overall Observations			
1) Any reports of basin not functioning?			
2) Does stormwater remain in the basin more than 72 hours after a storm?			
3) Are there any structures in the basin used during site construction no longer in use?			
4) Is water entering the basin "short-circuiting" by directly exiting the basin outlet without coming in contact the basin bottom soil and vegetation?			
Inlet: A structure within the basin designed to convey runoff from the drainage area into the basin, typically concrete and/ or a metal pipe.			
1) Signs of breakage, damage or corrosion or rusting of inlet structure/pipe?			
2) Excess debris or sediment accumulation in or around the inlet potentially clogging the inlet opening/pipe?			
3) Signs of erosion, scour or gullies; undermined or undercut earth/embankment; exposed dirt; worn vegetation; "fresh" soil; washed out, disturbed, or damaged soils, rock or vegetation above or around the basin inlet structure?			
4) Tree roots, woody vegetation growing close to or through the inlet structure or a situation impacting structure's integrity?			
5) If the inlet has a pretreatment structure, such as a trash rack or forebay, is it filled with debris or sediment?			
Basin: The basin includes interior side slopes and bottom, vegetation, rock, or berms, inlets and outlets, and exterior side slopes.			
1) Accumulation of debris or litter within basin?			
2) Exposed dirt or earth visible, are there areas of ground without vegetation or where grass is worn or dead?			
3) Excess sediment accumulation in the basin (i.e., is sediment covering vegetation, covering/blocking inlet or outlet pipes)?			
4) Basin walls/embankment eroded, slumping, caved in or being undermined?			
Outlet: The primary structure within a basin that conveys stormwater from within the basin to a location outside the basin. Most basins have a single primary outlet that conveys stormwater from typical storms and a secondary spillway to divert water during large storms. A typical outlet is made of metal or concrete pipe.			
1) Breakage, damage or corrosion or rusting to outlet pipe or conveyance?			
2) Erosion, scour or gullies; undermined or undercut earth/embankment; exposed dirt; worn vegetation; "fresh" soil; washed out, disturbed, or damaged soils, rock or vegetation on or around the outlet structure?			
3) Debris or sediment accumulation in or around the outlet pipe (i.e., is outlet orifice covered with debris/sediment)?			
4) Accumulation of debris or litter in or around outlet?			
5) Tree roots or woody vegetation encroaching or impacting the outlet or causing potential damage to the structure?			
Secondary Overflow Spillway or Emergency Spillway: The location within the basin that conveys high flows safely out of the basin once the basin has reached capacity during large storms or in the event the primary outlet structure is malfunctioning.			
1) Are pipes, conduits, or conveyances free of debris, clogs and in sound condition (i.e., no visible cracks, breakage, slumping, undermined or undercut earth/embankments)			
2) Large tree or root growth close to pipes or conveyances with the potential to crack structure or impede flow?			
3) Erosion, scour or gullies; undermined or undercut earth/embankment; exposed dirt; worn vegetation; "fresh" soil; washed out, disturbed, or damaged soils, rock or vegetation on or around the spillway?			
Basin Outfall Area. The location outside the basin where stormwater is supposed to exit or discharge from the basin including the area in the vicinity of the outfall pipe/conveyance and immediately down slope including but not limited to receiving waterways.			
1) Signs of stormwater exiting the basin in an uncontrolled manner over or through basin outside wall?			
2) Erosion, scour or gullies, undermined or undercut earth/embankment; exposed dirt; worn vegetation; "fresh" soil; washed out, disturbed, or damaged soils, rock or vegetation at or down slope of the outfall?			

*** Items to which inspector responded "yes" require follow-up prior to next inspection.**

References & Resources

FOR MORE INFORMATION

PA Stormwater Best Management Practices Manual (***PA BMP Manual***) published December 30, 2006 by the PA Department of Environmental Protection. Website: **www.depweb.state.pa.us**. (Navigate: "southeast region", choose "stormwater information")

Center for Watershed Protection Ellicott City, MD. Website: **www.cwp.org**.

PA Association of Conservation Districts provides information and contact information for your County Conservation District Office. Website: **www.pacd.org/districts/directory**.

PA Native Plant Society provides information on native plants. Website: **www.pawildflower.org**.

About this Publication

The Pennsylvania Environmental Council is providing this information to help property owners manage stormwater facilities; information provided is intended for the non-engineer and should not be construed as law or legal. Consult with the Conservation District Office or water resource agency in your County and your municipality for more information.

Disclaimer: This publication is intended to educate basin owners and operators to assist with oversight and inspection of stormwater basins. More in-depth technical site assessment information, repair and remediation actions, and input should be sought from municipal officials, County Conservation District staff where basin is located or from the engineer and contractor responsible for basin design and construction. Earthwork (e.g., grading), as well as other repair and retrofit activities in and around your basin may require prior approval or permit from your municipal engineer or the Conservation District.

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References & Resources

pennsylvania environmental council

MAINTAINING STORMWATER BASINS on Your Property – Fall 2008

A Guide for Stormwater Basin Owners

This pamphlet will help residents, businesses, and other individuals perform routine inspection and maintenance activities to ensure stormwater management basins on private property are in good shape and functioning properly. If there is a stormwater basin on a residential or commercial property you own, either individually or under common ownership, it may be your responsibility, as the property owner, to regularly inspect the basin and perform periodic maintenance. When basins are not maintained, they will fall into disrepair, which can lead to severe flooding and pollution of creeks and streams. This publication is provided to help the non-engineer understand basic inspection procedures, and includes tips for improving basin performance and appearance. Most stormwater basins in Pennsylvania are privately owned; as such, individual property owners are responsible for operation and maintenance. If there is uncertainty about the ownership of a basin on or near your property, contact your municipality to verify ownership and maintenance obligations. If there is uncertainty about basin design or function, if damage or malfunctions are observed, or in the event a more in-depth inspection or assessment is needed, the owner should secure the professional services of a licensed professional engineer. Most stormwater basins in Pennsylvania were designed as **dry detention basins.** This publication focuses on inspection and maintenance only of dry detention basins, or "dry ponds."

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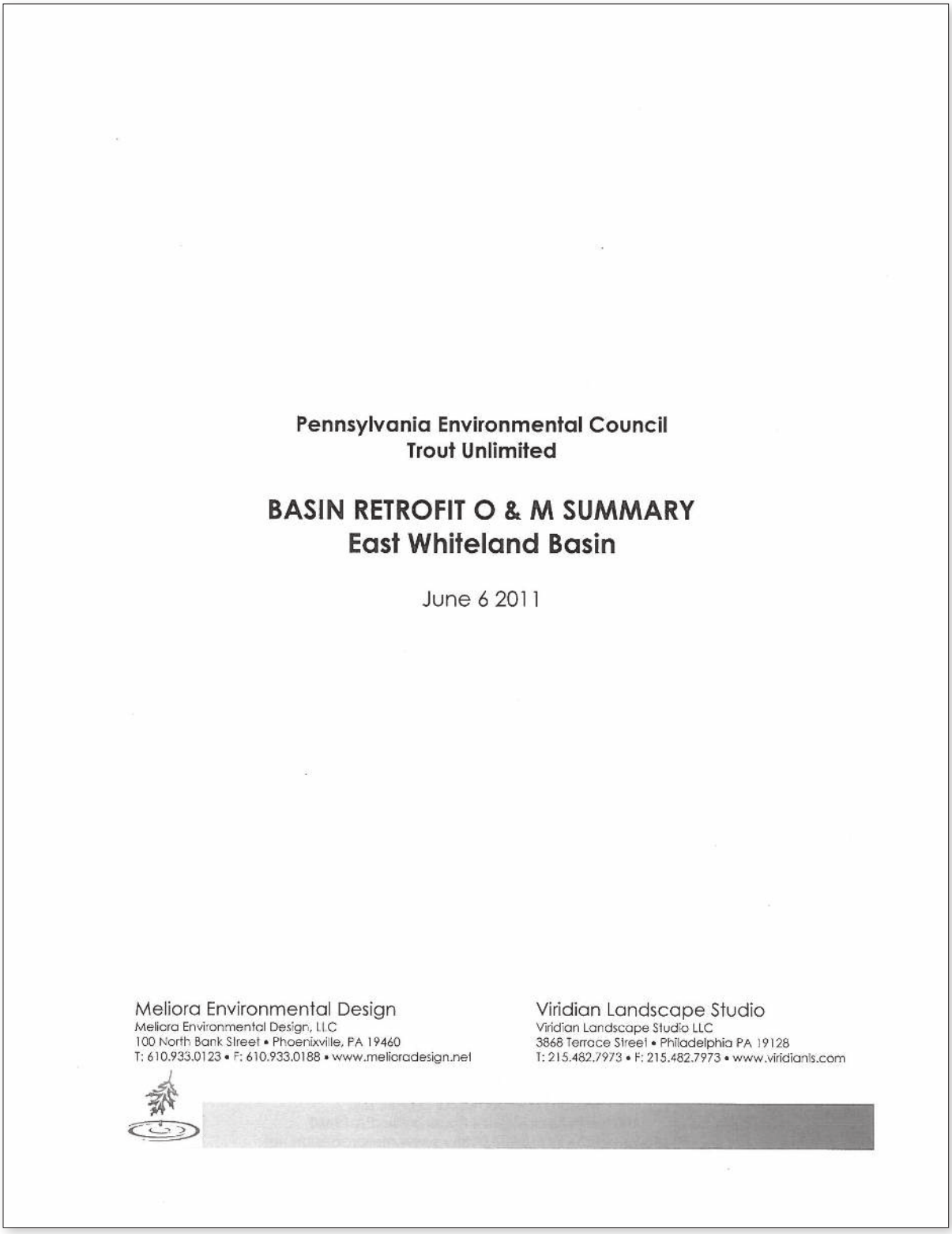
References & Resources

Appendix E

Basin Retrofit O & M Summary, East Whiteland Basin, Meliora Environmental Design for Pennsylvania Environmental Council and Trout Unlimited, June 6, 2011.



Pennsylvania Environmental Council
Trout Unlimited

BASIN RETROFIT O & M SUMMARY
East Whiteland Basin

June 6 2011

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Meliora Environmental Design

Pennsylvania Environmental Council
BASIN RETROFIT O & M SUMMARY

General Maintenance

- Inspect and vacuum clean the Inlet Structure and Overflow Outlet Structure at least two times per year (Fall and Spring).
- Inspect overflow spillway for erosion or signs of undermining two times per year. Repair as needed.
- Inspect for signs of erosion a minimum of two times per year or following extreme storm events. Restore any areas showing signs of erosion and revegetate with specified plant species
- Periodically check plant health, provide pruning and other care, and replant if needed

Retrofit Considerations

- Estimate basin drainage area from construction drawings or GIS mapping
- Calculate small storm volume (i.e. Volume from 0.5 – 1.5 inch storms) to set target capture volumes from drainage area.
- Evaluate soils conditions by excavation with deep test holes and infiltration testing and/or perform bulk density testing. Ensure adequate separation from bedrock for plant growth. Soil sampling for composition analysis.
- Evaluate inlet/outlet location for short-circuited conditions. Evaluate existing condition and identify areas of erosion, wet saturated conditions, etc.
- Use retentive grading and/or other means (i.e. check dams) to increase sinuosity and lengthen stormwater flow path in retrofit design
- Modify outlet structure to hold small storm volumes to meet target capture volume established above. Anticipate that this will be small volume of runoff from drainage area.
- Verify that overall flood storage capacity of basin is unchanged as a result of grading. May require routing basin to verify performance.
- Verify that all stabilization is adequate to prevent erosion from high velocity flows. Improve if necessary.
- Consider soil restoration by amendment with compost, air spade, etc.
- Design to maintain access to control structures for maintenance and inspection.
- Consider invasive seed bank adjacent to site. Re-vegetate with plants considered to be generalists. Keep planting palette simple.

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