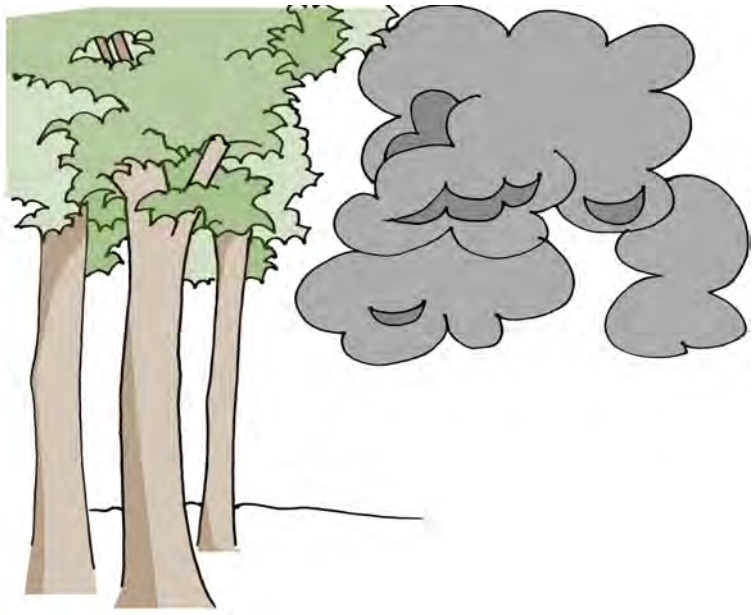
Lycoming County
Planning & Community Development



## Guide to

# Minor Stormwater Management Plans

**REVISED 11/23/10**

# Small Site Stormwater Management

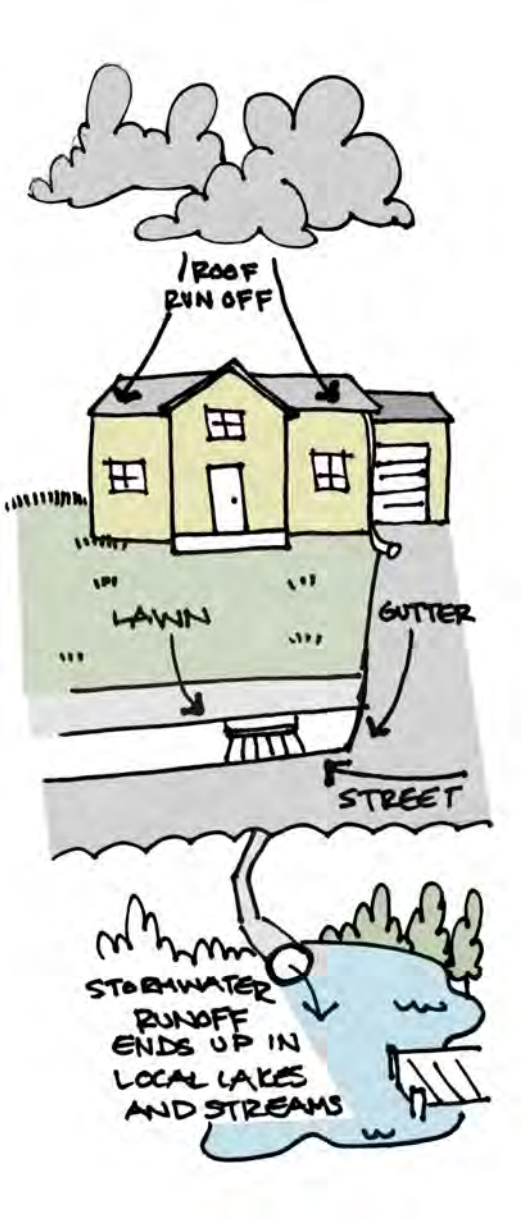
**Contents**

## Purpose of this guide

This manual offers an introduction that can help you manage the storm water on your site, to fit with the requirements of the storm water ordinance. With it you can determine which stormwater management system (or systems) is appropriate for your site, based on use, size, infiltration quantities, and price.

## Why is stormwater management important?

Development affects the quality and flow-patterns of water. In natural environments, storm water, or the runoff produced by rainstorms, infiltrates into the ground. In this infiltration process, the water is filtered of many impurities, and continues in the hydrologic cycle as groundwater.




This process is altered when development activity reduces water's ability to infiltrate. Hard (or impervious) surfaces, such as concrete and asphalt, and compacted surfaces, such as lawns and agricultural fields, create increased runoff.

When this runoff is not managed, its increased volume can create damaging flooding, which is an issue that affects our region. Pennsylvania is the most flood-prone state in the country, a problem that is increasing with increased development and increased impervious surfaces. Lycoming Creek area in particular has 1,600 structures within the 100-year floodplain (16% of total structures)

Poorly managed stormwater can also cause:

- Peak discharge increase, or increased amount of water in a river during the greatest flow time
- Reduced groundwater recharge, where less water moves from the surface water to ground water, and water quality degradation, as stormwater runoff carries pollutants like organic chemicals, excessive nutrients, and petroleum hydrocarbons, which end up in our lakes and streams.
- Stream bank loss, where increased water volume turns meandering streams into eroded channels

Increased development throughout the area is magnifying these issues. Lycoming County's Stormwater Management Plan and Ordinances address water quality, to protect the viability of our natural resources and the health of our communities. The plan also addresses water quantity—a pressing issue in a county with increasing flooding issues.

Through sensitive designs and implementation, it is possible to mitigate some of the detrimental effects of development. Stormwater management systems can be relatively simple to create and maintain. The systems can blend in with the developmnet, or even be attractive landscape features.

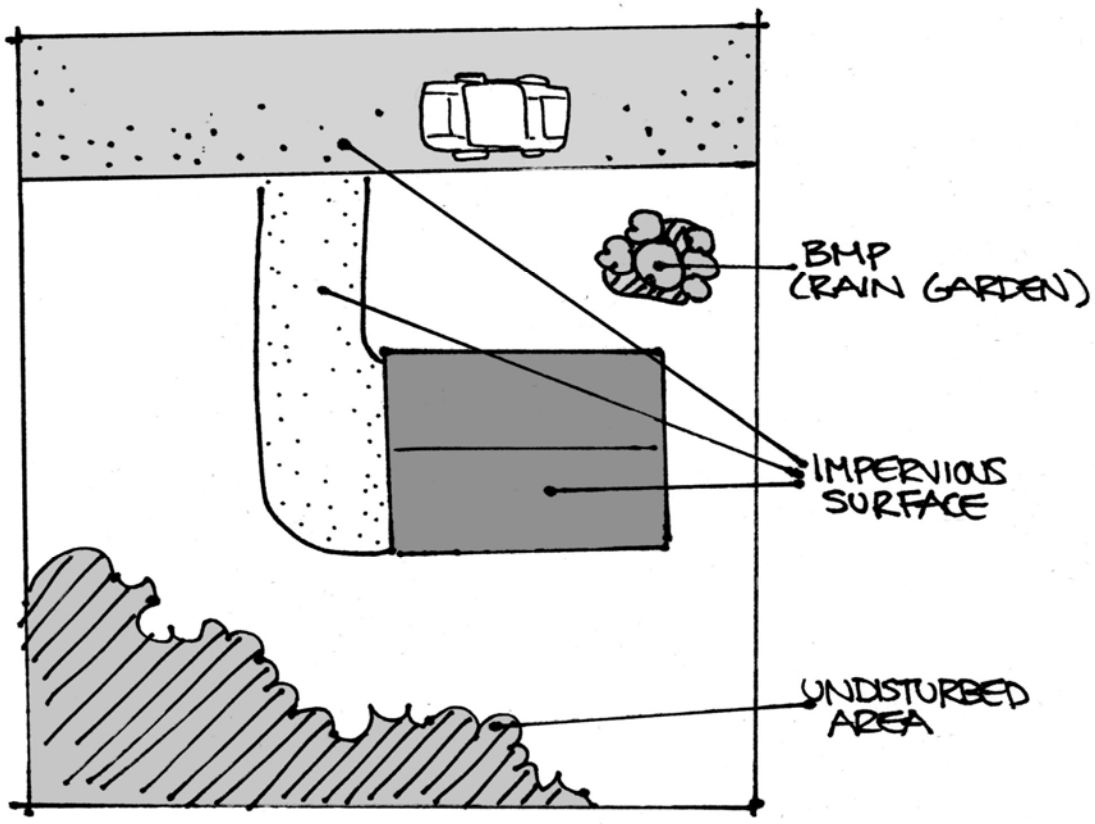
## Helpful Definitions

**Best Management Practice (BMP)-** Activities, facilities, designs, measures, or procedures used to mange stormwater impacts (such as rain gardens, drywells, vegetated swales, ect)

**Impervious Area**- A surface that prevents the infiltration of water into the ground…including (but not limited to) roofs, additional indoor living spaces, patios, garages, storage sheds, and new streets or sidewalks

**Disturbed Area**- An unstabilized land area where a earth disturbance is occurring or has occurred (the opposite of a undisturbed area, where natural vegetation still exists)

**Disconnected Impervious Area (DIA)-** An impervious or impermeable surface which is disconnect from any stormwater drainage or conveyance system and is redirected or directed to a pervious area, which in turn allows for increased infiltration (see Appendix B- Disconnected Impervious Area, or Disconnection Page 9).




**Riparian Area:** An area of land directly influenced by water. An ecosystem that is transitional between land and water ecosystem. River sides, lake borders, and marshes are typical riparian areas.

## What kind of stormwater management plan do you need?

Pennsylvania's ACT 167 Stormwater Management gave PA municipalities the responsibility to regulate stormwater runoff. Lycoming County has created requirements for development to consider stormwater management. These requirements affect all development in the region.

Larger scale developments require a formal Stormwater Management Plan. Smaller scale projects, such as individual home construction and additions, may not need professional services. **This manual is designed to help those who need Minor SMPs**, without professional services. If you require a formal SMP, you need to consult an engineer.

### Stormwater Management Plan (SMP) Requirements From the Lycoming Creek Model Stormwater Ordinance

| Plan Required | Impervious Area | Disturbed Area | Reference in Stormwater Ordinance | Next Step |
|---|---|---|---|---|
| Exempt* | Less than 1,000 sq ft impervious area OR 1,000-5,000 sq ft. IF disconnected from Impervious areas** | Less than 5,000 sq ft disturbed area, OR 5,000 sq. ft. to < 20,000 sq. ft. WITHOUT point source discharge to surface waters | 302. A. 302. B. Appendix B | No SMP plan needed |
| Minor Stormwater Management Plan Needed* | 1,000 sq. ft to < 5,000 sq ft. IF connected to impervious areas** | 5,000 to < 20,000 sq ft WITH point source discharge to surface waters | Section 305.N. Appendix B, Appendix C. | Create a Minor SMP |
| Stormwater Management Plan Needed | 5,000 sq ft. or greater | 20,000 sq. ft. or greater | Article IV | Consult an Engineer |

*To meet the requirements as Exempt or Minor SMP, you must meet both the Impervious Area and Disturbed Area requirements

** See "Disconnection" Section for more details p.9

## What do I need to send to the Municipality?

**A minor SMP should include**
A scaled drawing showing key site features including:

- a line showing areas cleared for buildings, driveways, and lawns
- the location of all structure (house, shed, garage, etc.), existing and proposed. Also include driveways, parking areas, and other impervious surfaces
- the location of property boundaries, streams/wetlands, and the distances between structures and any streams
- the angle/slope of the property in relation to any stream/body of water

See the example Minor Stormwater Management Plan (SMP) in the back of this guide on page 23

## Step 1: Before you build

## Site Conditions

**Identify** qualities of the site and inventory site features, to get an understanding of the opportunities and constraints the site offers. Compile this data into a drawing of the site. Check for:

1. **Existing flow-pathways.** Where is water flowing to on the site? Are there any nearby rivers or waterways? Try to get an understanding of the existing stormwater patterns on the site.

2. **Existing vegetation.** Notice the vegetated areas on the site. These are probably current or potential areas stormwater can drain to.

3. **Critical Areas.** Notice certain areas that are undesirable or impossible to develop, including:

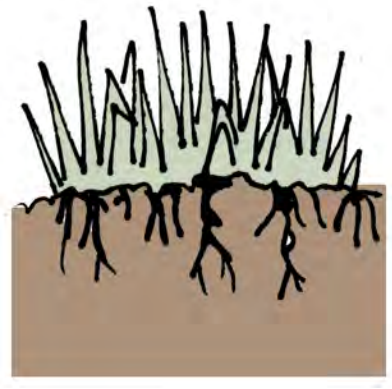
   **Special Value Areas:** damaging these areas complicate stormwater management procedures necessary on site, as they are naturally well-suited for infiltration. These include:

   - Wetlands
   - Flood Plains
   - Riparian Areas

   **Sensitive Areas:** these are not desirable places to create Best Management Practices (BMPs) or to develop:

   - Steep Slopes (over 20%)
   - Areas of shallow bedrock
   - Areas with a high-water table
   - Swales or existing drainage ways

## Check Soils



Certain soil types are better suited for development. Analyze the existing soils for permeability.
The most important thing to know about your soils is the "Hydrologic Class," a ranking of A, B, C, or D, based on infiltration. A soils have the highest infiltration rates, the lowest runoff potential, and are well drained. Conversely, D soils have low infiltration rates and high runoff potential.
**Soils with D classifications are areas where stormwater management practices cannot drain to**, and it is important to recognize those areas before a BMP is installed.

**Texture**
If you know your soil's texture, you can determine its hydrologic group and infiltration ability:

| Hydrologic Soil Group | Soil Texture | Infiltration Ability |
|---|---|---|
| A | Sand, loamy sand or sandy loam | Excellent |
| B | Silt loam or loam | Good |
| C | Sandy clay loam | Fair |
| D | Clay loam, silty clay loam, sandy clay, silty clay, or clay | Poor |

**Web Tools**
If you aren't aware of your soils' class or texture, a useful resource is the USDA Web Soil Survey application.
At:
http://websoilsurvey.nrcs.usda.gov/app/

- Click the green "Start WSS" button,
- Find your site location in the map by entering your address (under Quick Navigation)
- On the map on the right hand side, click the button that says AOI (area of Interest) and draw a box around your site
- Go to the tabs at the top of the page and select "Soil Data Explorer"
- Select the "Soil Properties and Qualities" tab
- From the table on the left, click the "Soil Qualities and Features" bar
- Select the "Hydrologic Soil Group"
- Click the "View Description" button to get more information, or the "View Rating" to find how your soils rank
- The map on the right, and the table under it, will demonstrated what types of soil make up your site and which Hydrologic Soil Groups they belong to.

**Contact an Agricultural Extension Agent**
An agricultural extension agent in the Lycoming County Conservation District may be able to tell you the infiltration ability of soils in your area.

More information at: http://lycoming.extension.psu.edu/
Phone: 570-433-3040
Email: LycomingExt@psu.edu

## Design Considerations

**Sensitive Design**

- Create a design that and preserves critical and sensitive areas.
- Create a buffer around riparian areas and stream corridors, to aid infiltration and maintain stream integrity
- Protect existing flow pathways

**Reduce Impervious Materials**

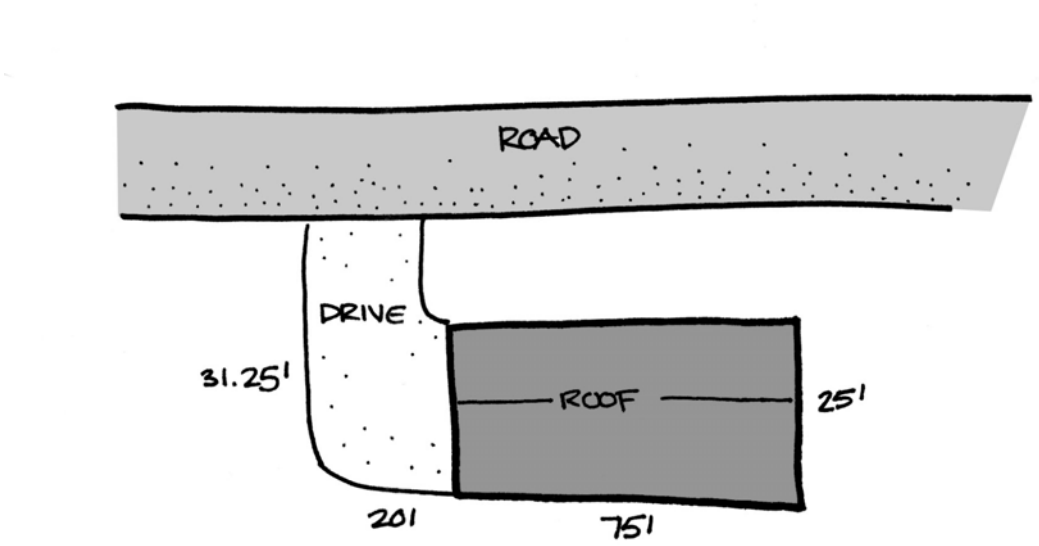
- The more impervious materials on site, the more stormwater needs to be managed, so create spaces with less paved material.
- Keep driveways as short and narrow as possible, reduce yard size
- Reduce the amount of lawn space, increase the amount of plants and groundcover

**Minimize Disturbances**

- Keep built structures clustered to preserve as much open natural area as possible
- Avoid extensive regrading, or find ways to have less cut and less fill on a site
- Preserve vegetation nearby and around the site
- While building, avoid compaction and limit construction traffic on top of site soils
- After construction, introduce soil restoration efforts
- Encourage reintroducing native vegetation on site

## Step 2: Calculate the Volume of Stormwater Runoff

This means determining the amount of storm water that is created by your site's impervious surfaces.




**Part 1. Identify Total Impervious Area**

Identify new impervious areas, and note these on your drawing. Calculate the sum of these areas.

| | | | |
|---|---|---|---|
| ie | | 25'x75' house | 1875 sq ft |
| | + | 20'x31'3" drive | 625 sq ft |
| | | Total Impervious Area | 2,500 sq ft |

**Part 2.Calculate Stormwater Runoff Volume**

Multiply new Total Impervious Area square footage by **(2.85in / 12in/ft) or 0.24**

2.85 inches is the 2-year-24-hour rainfall amount for Lycoming County

ie 2,500 sq ft x (0.24) = 600 cubic ft

**600 cubic ft** is the amount of stormwater you need to manage on your site

**Part 3.Determine Disconnected Impervious Areas Reduction**

Creating a DIA (Disconnected Impervious Area), or directing runoff to pervious areas, can make areas of impervious surface excluded from the count of total impervious surfaces.

See the next section on Disconnection to find out how to create a DIA

## Disconnection: Creating DIAs (Disconnected Impervious Areas)

### Rooftop Disconnection

Rooftop downspouts or leaders can be disconnected and directed into lawns or vegetated areas (away from conventional conveyance systems).

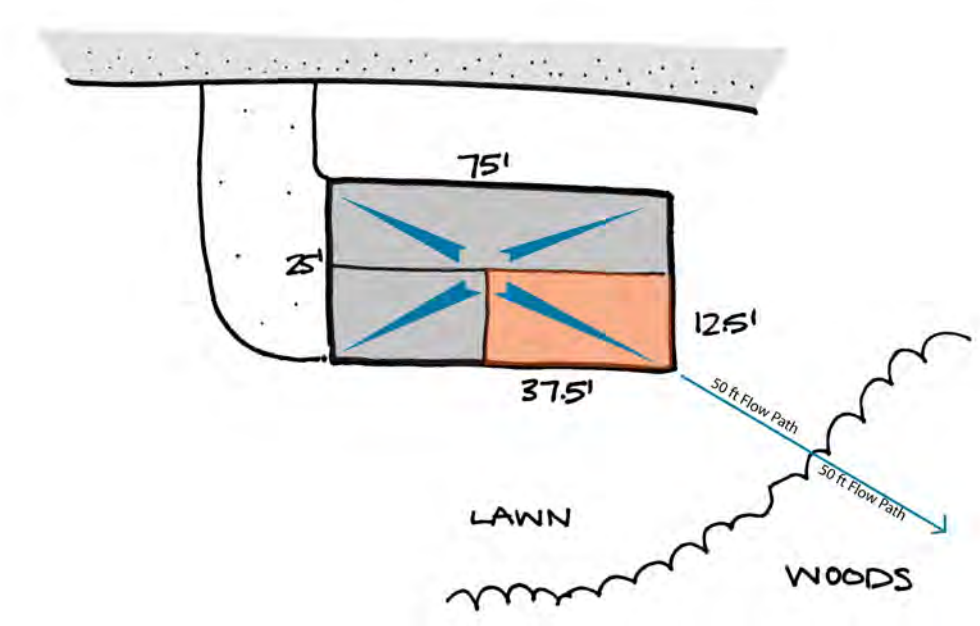
A roof is considered disconnected if:

- The area of roof is 500 sq ft or less
- The soil is better than hydrologic group D
- The slope away from the discharge area is 0-5%

**Table B.1: Partial Rooftop Disconnection**

| Length of Pervious Flow Path * (ft) | Roof Area Treated as Disconnected (% of contributing area) |
|---|---|
| 0 – 14 | 0 |
| 15 – 29 | 20 |
| 30 – 44 | 40 |
| 45 – 59 | 60 |
| 60 – 74 | 80 |
| 75 or more | 100 |

* Flow path cannot include impervious surfaces and must be at least 15 feet from any impervious surfaces.




i.e. Impervious Area of Roof Quarter 37.5'x12.5' = 468.75 sq ft
Flow path of 50'

468.75 sq ft x 60% = 281.25 sq ft Roof Area **to be treated as disconnected**

1875 ft sq ft (area of roof) – 281.25 sq ft = 1593.75 sq ft
**Now 1593.75 sq ft is the Total Impervious Area of Roof**

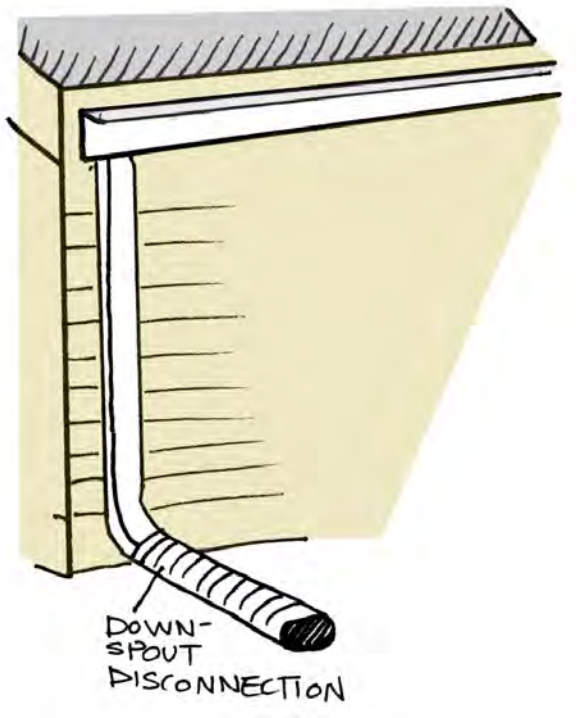
**Making 2218.75 the total Impervious Area (roof and driveway) on the sample site**

**Pavement Disconnection**

Paved surfaces can also be disconnected and directed into lawns or vegetated areas, to qualify as DIAs and be excluded from the calculation of Total Impervious Area. This applies to surfaces like driveways, walkways, bikeways.

Pavement is considered disconnected if:

- Runoff does not flow over impervious pavement for more than 75 feet
- The length of the overland flow is greater than or equal to contributing length
- The soil is better than hydrologic group D
- The slope of the paved area is 0-5%
- The surface slope away from the pavement is 0-5%




**Installing disconnection systems**

Disconnected surfaces can also be rerouted to lawns, or to created vegetated areas, such as swales or rain gardens, or lawns with desirable slopes.

Installing a downspout disconnection for rooftop is best done with a downspout extension, and instructions are available from the downspout extension manufacturer. Extensions are available at most home maintenance stores.

A level spreader is recommended for rerouting runoff to lawns. See the level spreader section on page 12.

If you wish to plant a vegetated area for your rooftop to disconnect to, reference the Vegetated Bmp section for installation advice and prices.

**Costs**

An extension costs about $10 to $25, and they are available at most home-maintenance stores.

### Step 3: Selecting a Best Management Practices

The following pages will help you select a BMP, using the volume you found for the amount of stormwater runoff to be managed on site.

## Simple BMP Sizing

Although each BMP's page explains its sizing calculations, sizing a BMP can be simplified using this chart. Find the amount of sq ft of impervious surface you need the BMP to handle, and then **look in the grey area to see the cubic footage the BMP needs to be**. You can determine how the BMP meets the cubic footage yourself. For example, if you have a 1000 sq ft Impervious Area and must handle 260 cu ft in a Biorention system, you could have a 20' x 4' x 3.5' rain garden, or a 13.5' x 13.5' x 1.5' rain garden, or even a 40' x 2' x 3.5' vegetated swale.

If the amount of impervious surface you have is between two values, round UP to the next highest value (i.e. half the rooftop in the example House adds up to 930 sq ft, so round UP to 1000 sq ft).

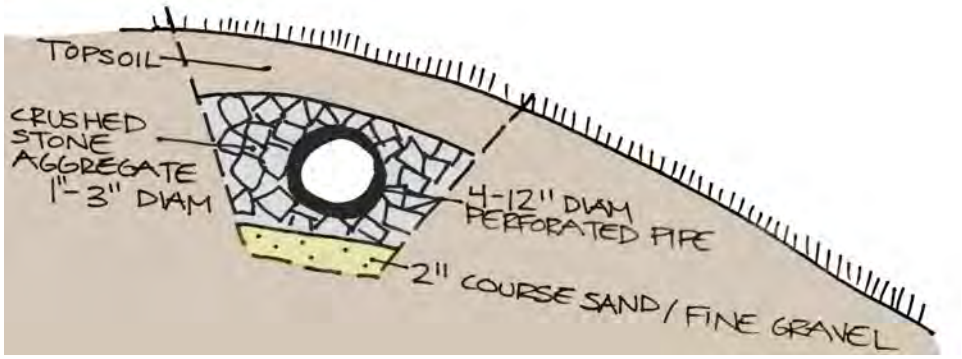
| BMP Type | | Amt. New Impervious Area sq ft | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 250 | 500 | 750 | 1000 | 1500 | 2000 | 2500 | 3000 | 3500 | 4000 | 4500 | 5000 |
| Bioretention | Rain Garden, Vegetated Swale (simple) | 60 | 120 | 180 | 240 | 360 | 480 | 600 | 720 | 840 | 960 | 1080 | 1200 |
| Infiltration | Dry Well, Infiltration Trench | 180 | 360 | 540 | 720 | 1080 | 1440 | 1800 | 2160 | 2520 | 2880 | 3240 | 3600 |

# Level Spreader

A level spreader reduces the impact of high-volume stormwater runoff. It changes the quickly-moving channel flow into a sheet flow, which allows for easier infiltration into the soil.
Level spreaders are recommended for **rooftop and pavement disconnections**, and also benefit vegetated filter strips, rain gardens, and vegetated swales. Level spreaders are not suitable BMPs on their own, and work in conjunction with Disconnection or other systems.

**Installation**
Simple level spreaders are often made of an earth berm or perforated pipe, while more complex level spreaders are made up of a concrete or metal lip with a concrete footer.

The easiest level spreader design to install is a stand-alone outflow level spreader, which distributes runoff from impervious areas less than 500 sq feet. These often work with disconnected rooftops, distributing runoff into a lawn space.




When installing a level spreader pipe, first dig a shallow trench for the pipe. Downspout disconnects can be connected to this pipe. The trench should run evenly along a slope contour. The trench should be bedded with about 2” of course sand, and contain uniformly crushed stone, pieces 1”-3” in diameter. Level spreaders should have a **minimum length of 10 feet**, for impervious areas around 500 sq ft. Add 10-30 additional feet for larger impervious surfaces.

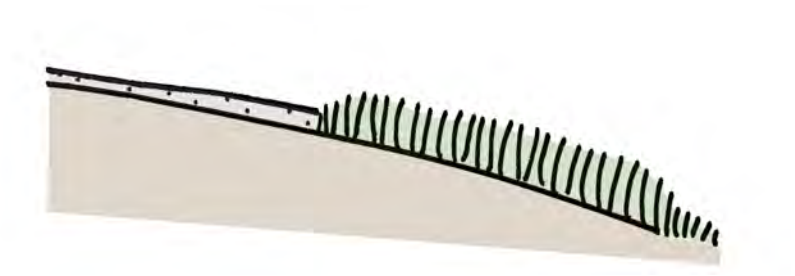
Next, place the continuously-perforated pipe in the trench, making sure that the pipe is level. If the pipe does not lay evenly, the stormwater will not create a sheetflow, creating erosion. Pipes can vary from 4 to 12 inches in diameter. Consider adding an overflow pipe that reaches above ground and ends in a cap. Cover pipe over with un-compacted top soil.

**Maintenance**
Level spreaders are low-maintenance BMPs. The area below a level spreader requires checks semi-annually or after storm events, to make sure erosion is not occurring. Vegetation below a level spreader must be cared for and maintained.

**Cost**
Commercial level spreaders and directions to install them come from the manufacturer. Costs range from $5 to $20 per foot, with perforated pipe level spreaders rarely costing more than $10 per foot.
The example level spreader in this section (10 ft, perforated pipe) would cost $50 to $100.

## Vegetated Filter Strip

Vegetated filter strips are simply a strip of plantings, often a lawn, next to a BMP. Vegetated filter strips help capture runoff, and remove many sediments and pollutants. Filter strips are not suitable for stormwater management on their own, and they work together with dry wells, infiltration trenches, and rain gardens.



**Sizing**
Filter strips must be at least 1ft wide to be effective, however, wider filter strips are more effective, and 2.5-3 ft is desirable.

**Installation**
Installing a vegetated filter strip is very simple, and only involves creating a lawn or vegetated space.
Filter strips should be located on an even slope. It is best if the slope is even to create a sheet flow.
As stated, filter strips should be 1' in width or wider. The wider the filter strip, the more effective it is.
When planting a filter strip, it is more common to seed a lawn, although sod is also effective. Seed or sod the filter strip according to manufacturers instructions.
Advice about suitable grass varieties is available in the Plant Chart in the back of this packet.
Avoid soil compaction while seeding or sodding filter strip, as this reduces infiltration ability.

**Maintenance**
Maintenance of filter strips involves periodical mowing, and controlled weeding in the filter strips early months. The filter strip should be reseeded every 2-5 years.

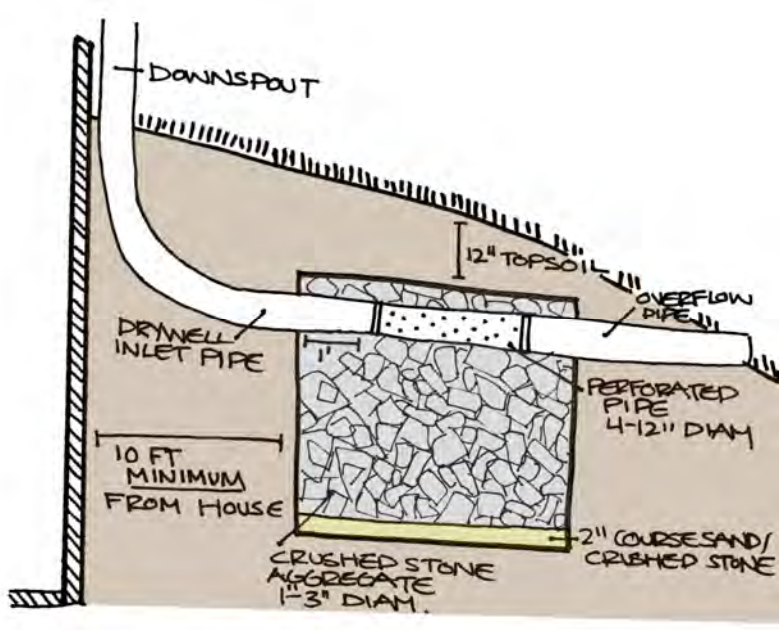
**Costs**
30 cents per square foot to seed
70 cents per square foot for sod

**Infiltration BMPs:** The following BMPs infiltrate Stormwater on site.

## Dry Well

Dry wells are an infiltration type Best Management Practice, and effective at infiltrating roof runoff. A drywell can be either a preconstructed chamber, or a dug pit filled with aggregate.

**Sizing**
First, calculate the amount of impervious surface on site, and then the cubic volume of storm water you need to manage. (See "calculate stormwater volume"). We'll call this the Drywell Required Volume.




If the drywell is filled with stone, use a 40% void ratio

1. Divide drywell required volume by 40%
   Ex required volume =75ft cu
   75ft cu/40%= **190ft cu**

2. A drywell's Actual Volume is calculated by (width x length x depth)
   (Remember L x W / D = < 4)

3. Since depth can be 3.5 ft max, calculate the drywell area
   190 ft cubed/3.5ft= 54.3 ft2

So the example drywell dimensions are 3'6" depth, 7'4"lenth, 7'4"width

**Installation**
Excavate drywell bottom to a uniform level. Select a location at least 10 feet from your home, to avoid flooding. Avoid compaction of soil during construction, and know that drywells deeper than 3 1/2 feet aren't recommended. Remember to dig 12" deeper than your measurements for the depth of your drywell, so you have space to cover the drywell in 12" of topsoil.

Cover drywell floor with 2" sand or finely crushed stone. Install drywell inlet pipe and perforated pipe, which connect to roof downspouts. Inlet pipes run underground, and overflow pipes run horizontally until they emerge above ground, and they should have a cap on the end. Overflow pipes allow for easier maintenance and help avoid flooding damage during very large storms.

Fill the dry well with stone aggregate. Aggregate fill should be 1" to 3" diameter. Cover with a layer of topsoil (12"s), and seed and vegetate topsoil to stabilize and aid infiltration.

**Maintenance**
Drywells should be inspected seasonally and after large-storms for debris build-up. The builder may want to install a monitoring pipe.

**Costs**
Drywells typically cost from $4 to $9 per cubic foot, and most drywell costs are associated with the amount of gravel. The example drywell from this section would cost $800 to $1500.
Drywell installation kits for pre-sized drywells are also available. Online, prices are around $150 to $200.

# Infiltration Trench

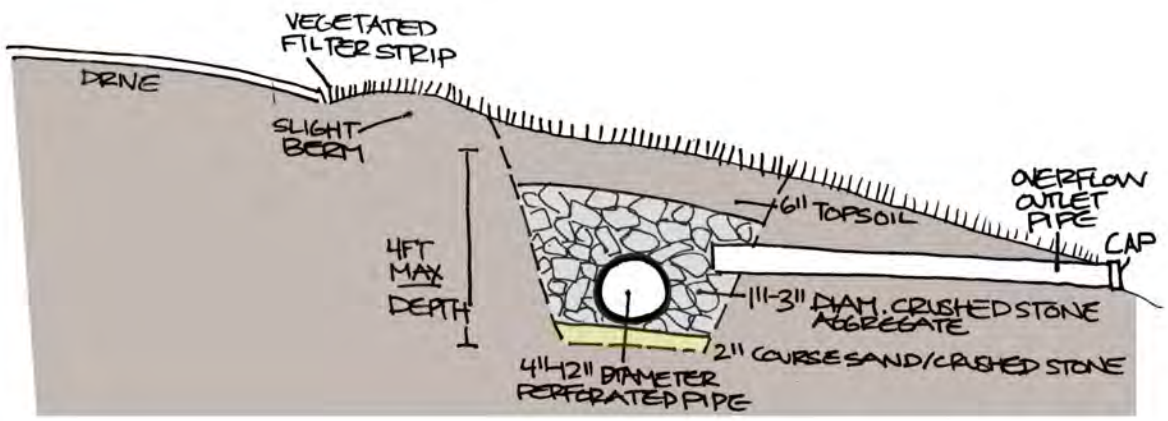
An infiltration trench is a stone-filled trench that stores, infiltrates, and cleans stormwater runoff. Infiltration trenches work well for catching water from small impervious areas, such as a disconnected patio, path, driveway, or even rooftop. Infiltration trenches MUST be adjacent to a vegetated filter strip, to help purify water.

**Sizing**

1. Find the Stormwater Runoff Volume (Step 2). Use this number to determine how much stormwater you must manage. We'll call this volume Trench Required Dimensions"

2. "Trench Required Dimensions" = Trench Void Volume / 40% void ratio*
*(void ratio is a result of the gaps between stone aggregate)
161.25ft cu = stormwater volume of half of the example driveway
161.25 ft cu (Trench Required Dimensions)= Trench Void Volume /40%
Trench Void Volume = 64.5ft cu

3. Sizing of the Trench
Trench Void Volume = width** x length x depth*
*maximum depth should be 3.5'
**average trench width is about .5'
64.5ft cu (Trench Void Volume) = 1ft width x 3.5 ft depth x 18.42 ft length




**Installation**
Avoid soil compaction during the construction process. Excavate the trench, according to calculated sizing, creating a level un-compacted bottom. It is very important that the bottom of the trench is very flat.
Line the trench with 2" sand or finely crushed stone. Place inside a level perforated pipe, and consider overflow pipe that runs horizontally until above ground, like one on a drywell. The overflow outlet pipe should have a cap on the end.
Fill with stone aggregate. Aggregate fill should be 1" to 3" diameter. Place 6" of topsoil on top of trench, and re-seed the topsoil.

**Maintenance**
Vegetation along the surface of the trench, and on the filter strip, should be maintained. Avoid driving on or compacting soil on top of an infiltration trench. Inspect the overflow pipe regularly to check for leakage.

**Cost**
Typical construction costs tend to be $4 to $9 per cubic foot. Costs are associated with the labor (if used) and materials.
The cost of the example trench would be $650 to $1400.

**Bio-retention BMPs:** The following BMPs utilize bio-retention to mange stormwater on your site.

## Rain Garden

Rain gardens are a shallow depression planted with native vegetation that capture, filter, and infiltrate stormwater. They work well infiltrating rooftop, driveway, path, and patio runoff. Rain gardens are versatile and attractive, and can take a variety of shapes and forms.

**Sizing**

1. Determine Total Impervious Surfaces
   ie ¼ Rooftop runoff: 12.5 ft x 37.5 ft = 468.75 ft sq

2. Using a loading ratio of **5:1(impervious to rain garden),** determine minimum size of rain garden Bed:
   (Impervious Area)/5= (468.75)/5=93.75 ft sq
   Size of Rain Garden Bed = 93.75 ft sq
   This means, the rain garden's dimensions can be 9.7ft x 9.7ft, or 3ft by 31 ft, or any dimension that contains 93.75 ft sq

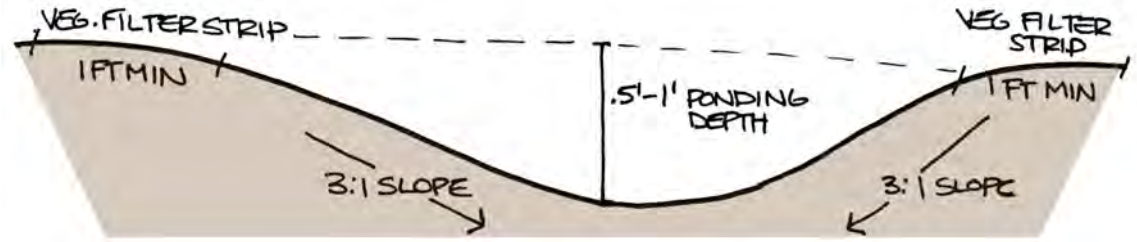
3. Sizing of Rain Garden
Total Volume of rain garden = Surface storage + soil storage

a. Surface Storage Volume (ft3) = Bed Area (ft2) x Average Design Water Depth (12")
Surface Storage Volume (ft3) = 93.75 ft sq x 1 ft = 93.75 ft cu

b. Soil Storage Volume (ft3) = Bed Area (ft2) x Depth of Amended Soil (ft) x Holding Capacity (typically 10-20% can be greater if soils amended with organic matter)

Soil Storage Volume (ft3) = 93.75 ft sq x 2.5 ft x 15% = 35.16 ft cu

Total Volume of rain garden = Surface storage + soil storage
Total Volume of rain garden = 93.75 ft cu + 35.16 ft cu = 128.91 ft cu




**Installation**

Select an area at least 10 feet from your house, ideally in a naturally occurring low spot. The rain garden should have full to partial sun.
Mark out the size of your garden, and start to dig. Try to create a level area around the outer edge of the rain garden, to create sheet flow and act as a filter strip. You can use some of the cut soil to create a small berm around the garden. The slopes of the sides should be fairly gradual, or about 3:1.

Create the ponding area. Avoid creating a surface pond depth lower than 12"s, for safety and maintenance reasons. The ponding area should meet the required storage volume without exceeding 12"s.

Planting soil depth should be about 18"s, or deeper with different tree species. Planting soil should be loam, and 20-30% organic material/compost. Planting soil should be about 4" deeper than the bottom of the largest root ball.

**Planting**
Plant a vegetated filter strip around the slopes of the ponding area to keep the rain garden healthy (see page 13)

Select native floodplain species to make up the rain garden area. See the recommended plant list (p 21) for tips about plant selection. A mix of trees and shrubs is recommended, with about one tree for every three shrubs. Plants native to Pennsylvania are most effective, as they are lower maintenance and resist disease. Get creative with your plant palette, and select different plants with interesting textures and colors.

Plant trees and shrubs first, about a foot apart, and fill in with plugs of grasses and flowers. Seeding isn't effective in rain gardens, so plugs are recommended.

Mulch helps filter pollutants and protect soil. Compost or leaf mulch is preferred, and wood mulch should be shredded. Mulch layer should be no thicker than 2-3".


**Maintenance**
Rain gardens require a little initial maintenance to stay healthy. For the first 2 weeks, water the garden every other day (unless it rains). For the first year, the garden requires weeding, and about an inch of water a week.
A rain garden also needs to be re-mulched annually, and raked regularly, to prevent weed-growth. Once during spring and fall dead vegetation should also be removed from the rain garden, and replacement plants should be planted.

**Costs**
Rain gardens are a fairly low-cost BMP, with their simple installation and maintenance. Most of the costs come from the price of plants.
Creating your own rain garden costs $3 to $5 per square foot, but if a landscaper is hired to do everything, it will cost $10 to $12 per square foot.
Building the example rain garden yourself would cost $280 to $470, while hiring a landscaper to install it would cost $940 to $1100.
See the plant chart in the back for individual plants price estimates.

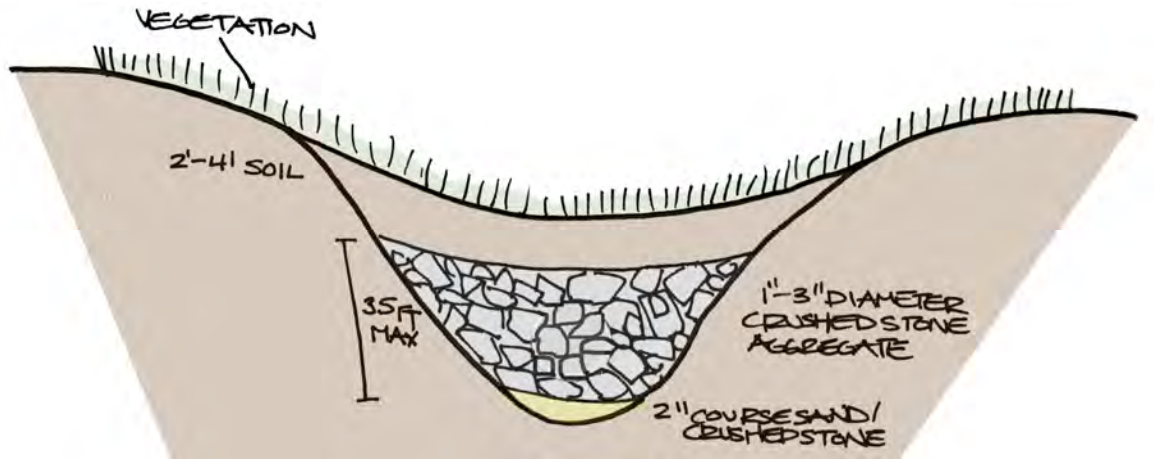
## Vegetated Swale

A vegetated swale is a planted channel that infiltrates runoff and filters pollutants. They handle impervious surfaces like driveways, patios, and walkways. Vegetated swales can be simple, purely bioretention systems (like a rain garden), or they can include an infiltration trench.

**Sizing**
Sizing a vegetated swale is similar to sizing an Infiltration Trench (Page 15).
Determine Volume of stormwater Swale must handle (Step 2), use this value as the Swale Required Dimensions.

1. Swale Required Dimensions = Swale Void Volume / 40% Void Ratio (result of gaps in gravel)
   ½ of driveway stormwater volume (161.25 ft cu) = Swale Required Dimensions
   161.25ft cu = Swale Void Volume/40%
   Swale Void Volume = 64.5 ft cu

2. Swale Void Volume = width (.5ft - 1.5ft) x length x depth (max 3.5ft) x ½ (Triangle shape)
   64.5 ft cu = 1 ft (width) x length x 3.5 ft (depth) x ½
   Length = 36.9 ft
   Final Swale Dimensions are 36.9' x 1' x 3.5'




**Installation**
Dig swale pit. Triangular shapes are most effective. Swale depth should be 2'-5' from surface. Simple veg. swales should be filled with well-drained soils, planted like a rain garden, and mulched.
If you would like to add an infiltration system to your vegetated swale, as shown above, line bottom of pit with course sand or finely crushed stone. Fill 1'-2' with 1-3" diameter stone aggregate. Lay over 2-4' of permeable soil, and plant.
When planting vegetation, consult planting tips in rain garden section, and use the plant list supplement in this pamphlet (p21). Grasses are particularly effective at purifying and infiltrating stormwater runoff.

**Maintenance**
Vegetation must be maintained, and checked regularly for health. Inspect swale for litter and debris, and mow or weed when necessary. Be sure to water swale during dry periods, especially after initial planting.

**Costs**
Swales are a much cheaper and longer-lasting option than traditional curbs and gutters. Costs for grass swales range 30-70 cents per square foot, but vary greatly with plant choice. Grassed swales are cheaper than swales vegetated with shrubs and wildflowers.

## BMP Summary Chart

A summary of the suitabilities and costs of different BMPs.

| BMP | Best Suitable For | Standalone BMP* | Ease of Installation, (1-5, 1 being easiest) | Cost Estimate | Total Project Cost Estimate |
|---|---|---|---|---|---|
| Disconnection | rooftop, pavement runoff | No | 1 | $10 to $25 total | $10 to $25 |
| Level Spreader | rooftop, pavement runoff, working with filter strips, rain gardens, and vegetated swales | No | 3 | $5 to $10 per ft | $50 to $100 |
| Vegetated Filter Strip | working with dry wells, infiltration trenches, and rain gardens | No | 2 | 30 to 70 cents per sq ft | $10 to $100 |
| Dry Well | rooftop runoff | Yes | 5 | $4 to $9 per cubic ft | $800 to $1500 |
| Infiltration Trench | patio, path, driveway, rooftop | Yes | 4 | $4 to $9 per cubic ft | $650 to $1400 |
| Rain Garden | patio, path, driveway, rooftop | Yes | 4 | $3 to $5 per square ft | $280 to $470 |
| Vegetated Swale | patio, path, driveway, or even rooftop | Yes | 4 | 50 cents to $5 per sq ft | $64 to $400 |

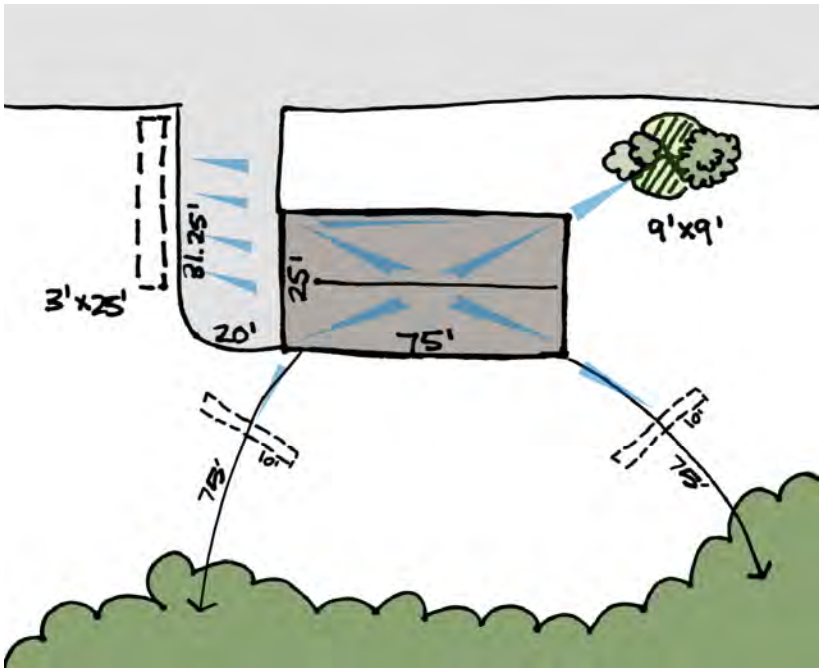
* Standalone BMPs can function without the aid of any other BMPS

## Example Site

This is an example project, showing how a small home and driveway met its stormwater management requirements.

The Total Impervious Area on the Site = 2,500 sq ft

**1/2 the Roof** 12.5' x 75' = 937.5 sq ft
Using the Simple BMP Sizing Chart (pg 11)
**Rain Garden** to manage this much impervious footage must be 240 cu ft
Rain Garden size= 3' deep x 9' x 9'




**the Drive**
20' x 31.25' = 625 sq ft
Using the Simple BMP Sizing Chart (pg 11)
A **Simple VegetatedSwale** must be 180 cu ft
Swale size =
2.5' deep x 3' wide x 25' long

**1/2 the Roof**
12.5' x 75' = 937.5 sq ft
- 468.75 sq ft (See Creating a DIA pg 9)

Two **level spreaders** are required approx 10 feet each (impervious surface under 500 ft)

## Summary of Costs

| | Estimated Materials Cost (self installed) | Estimated Cost w/ Professional Installation |
|---|---|---|
| Rain Garden | $324 | $891 |
| Simple Vegetated Swale | $80 | $220 |
| Two Level Spreaders | $200 | $550 |
| Two Downspout Disconnecters | $50 | $137 |
| **Total Cost** | $654 | $1798 |

## Recommended Plants Chart

This chart is intended as a guide to aid in selecting plants for BMPs. They are organized alphabetically by Plant type. Plant prices are subject to variation and change. Consult your local nursery for advice on substitutions and plant selection.

| Common Name | Scientific Name | Plant Type | Characteristics | Notes | Approximate Price |
|---|---|---|---|---|---|
| Swamp Milkweed | Asclepias incarnata | wildflower | Attractive flowers, not eaten by wildlife | 1 gallon pot | $4** |
| White Wood Aster | Aster divercatus | wildflower | Long-lasting white flowers | 2 gallon pot | $6** |
| Turtlehead | Chelone glabra | wildflower | White flowers, hardy plant | 2 gallon pot | $8 |
| Foxglove | Digitalis purpurea | wildflower | Purple flowers, showy purple flowers | 1 gallon pot | $8 |
| Spotted Joe-pye-weed | Eupatorium maculatum | wildflower | Tall plant, pale purple flowers | 1 gallon pot | $7** |
| Little Joe-pye-weed (Baby Joe) | Eupatorium maculatum | wildflower | Full form, showy purple flowers | 1 gallon pot | $10 |
| Queen of the Prarie | Filipendula venusta | wildflower | Soft reddish flowers | 5 gallon pot | $8 |
| Fall Sunflower | Heliopsis helianthoides | wildflower | Large yellow flower, attracts birds and wildlife | 2 gallon pot | $8 |
| Rocket Ligularia | Ligularia stenocephala | wildflower | Tall plant with dark foliage, yellow flowers | 2 gallon pot | $8 |
| Scarlet beebalm | Monarda didyma | wildflower | Red showy flowers, hummingbirds | 1 gallon pot | $8 |
| Stokes Aster | Stokesia laevis | wildflower | Pale purple flowers | 1 gallon pot | $10 |
| Purple Aster | Symphyotrichum patens | wildflower | Attractive purple flowers | 1 gallon pot | $8 |
| Creeping Bentgrass | Agrostis palustris | grass | Salt tolerant, good for wet swales | sod/see | varies |
| Thread Sedge | Carex filifolia | grass | Drought tolerant, full form | 1 gallon pot | $6 |
| Sedge Carex Evergold | Carex hachijoensis | grass | Hardy, drought tolerance | 2 gallon pot | $10 |
| Red Fescue | Festuca rubra | grass | Hardy, not for wet swales | seed | varies |
| Switchgrass | Panicum virgatum | grass | Hardy, drought tolerance | 1/2 gallon pot | $6 |
| Alkai Saltgrass | Puccinellia distans | grass | Salt tolerant, good for wet swales | seed | varies |
| Sweet Pepper-bush | Clethra alnifolia | shrub | Attractive white flower spikes | 1 gallon pot | $10** |
| Silky Dogwood | Cornus amomum | shrub | High wildlife value, white flowers and fruit, bank stabalizer | 5 gallon pot | $35** |
| Gray Dogwood | Cornus racemosa | shrub | High wildlife value, white flowers and fruit | 5 gallon pot | $35** |
| Redtwig Dogwood | Cornus sericia | shrub | High wildlife value, white flowers and fruit, bank stabalizer | 2 gallon pot | $25 |
| Inkberry | Ilex glabra | shrub | High wildlife value, evergreen, shade toleranct | 1 gallon pot | $15** |
| Northern Bayberry | Myrica pennslvanica | shrub | High wildlife value, berries into winter, roots fix nitrogen | 2 gallon pot | $30** |
| Swamp Rose (Easy Elegance) | Rosa palustris | shrub | Disease resistant, hardy plant, flowering | 2 gallon pot | $30 |
| Dwarf European Cranberry Bush | Viburnum opulus compactum | shrub | High wildlife value, berries, hardy plant with thick foliage | 2 gallon pot | $30 |

| | | | | | |
|---|---|---|---|---|---|
| Serviceberry | Amelanchier arborea | small tree | Attractive form, early spring flowers | 2 gallon pot | $75 |
| Jane Magnolia | Magnolia virginiana | small tree | Attractive and fragrant flowers | 5 gallon pot | $55 |
| Red Maple | Acer rubrum | tree | High wildlife value, striking fall foliage, rapid growth, tolerates acidic soils | 5 gallon pot | $70 |
| River Birch | Betula nigra | tree | Attractive form, attracts songbirds, erosion control | 10 gallon | $100 |
| Eastern Red Cedar | Juniperus virginiana | tree | Wildlife value, evergreen, good screening | 4-5 ft ball and burlap | $30** |
| Sweetgum | Liquidambar styraciflua | tree | Attractive form, striking fall foliage | 4-5 ft ball and burlap | $25** |

Prices Approximaged by local nurseries, including
Simmers Nursery 101 Park Rd, Mountoursville PA, (570) 998-8272
Snyders Nursery 807 N Loyalsock Ave, Mountoursville, PA 368-3377
Lowes Hardware

**Price Approximated from Online Nursery Listings. Price does not include shipping

## SAMPLE MINOR STORMWATER MANAGEMENT PLAN

Property Owner _____

Tax ID # _____

Proposed by _____

Date _____ Drawn by _____

Scale _____