



Rain Garden Guidelines for Southwest Ohio



A Practical Handbook
for Home Gardeners

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Introduction

Rain gardens are a unique and practical landscape feature that can enhance the beauty of home gardens. When properly installed, they are one method of limiting the negative effects of rainfall runoff in urban areas. Indeed, rain gardens turn a "negative" into a "positive" by capturing water runoff to nurture plants and recharge soils rather than allowing the water to flow into storm drains. This publication is intended to provide guidance for designing, constructing, and maintaining residential rain gardens.

More detailed information on rain gardens can be found in the The Ohio State University Extension (OSUE) publication titled: *"Guidelines for Utilizing Rain Gardens as a Storm Water Management Tool in the Metropolitan Sewer District of Greater Cincinnati"* [http://hamilton.osu.edu/Horticulture_Floriculture/guidelines-for-utilizing-rain-gardens].



Fig. 1 Rain Garden, Cincinnati Zoo & Botanical Garden
(Photo Courtesy of CZBG)

The primary goal of a rain garden is to receive excess storm water runoff from impervious areas such as rooftops and driveways. Rain gardens give the runoff a place to go where it can recharge groundwater and not overload the storm sewer system, contribute to local flooding, or damage streams and other aquatic ecosystems.

Other benefits of rain gardens include:

- ✓ They are a highly desirable landscape feature.
- ✓ They can provide a home to unique landscape plants.
- ✓ They provide habitat for desirable wildlife including beneficial insects.
- ✓ They transform rainfall runoff into a resource rather than a nuisance.
- ✓ They improve storm water quality as it is infiltrated and redistributed through soils.

There are several points to consider before planning your rain garden. A rain garden should:

- ✓ Be relatively easy to build and maintain.
- ✓ Reliably capture water runoff throughout the warm season and also catch runoff generated from the majority of cold weather thaws.
- ✓ Maintain its performance with few inputs (minimal additions of fertilizer, minor seasonal pruning, etc.) over the long term.

Rain gardens are a type of "infiltration planting." These are landscape features that are designed to capture and infiltrate water into the soil. Other types of infiltration plantings include terraces, swales, and contour plantings (Fig. 2). All should be considered when determining the best method(s) for using your landscape gardens to enhance water infiltration into the soil and reduce rain water runoff from your property.



Fig. 2 Contour Planting and Turfgrass Swale
(Photo by Dave Dyke)

Selecting the Location of Your Rain Garden. The first, and most important, step in constructing a rain garden is to select a good location. Rain gardens are often best placed between storm water runoff sources such as roofs, driveways, parking lots, etc., and runoff destinations such as storm drains, streets, and streams. In some cases, curb cuts can facilitate drainage from driveways and parking areas into the gardens (Fig. 3).

Other factors that you must consider when selecting the site for your garden are presented below in the form of "restrictions" and "optimizers." The restrictions are conditions that can either prevent a site on your property from being used as a rain garden or seriously reduce the effectiveness of a rain garden. The optimizers are conditions and situations that enhance the function of a rain garden:



Site Selection Restrictions Checklist:

- ♦ **Water Infiltration:** The purpose of a rain garden is to move excess rain water into the soil (infiltrate) rather than allowing it to runoff your property. A rain garden will not function properly if the surface infiltration rate is less than 0.5" to 1" per hour. Many areas in the Greater Cincinnati area have heavy clay soils and water moves very slowly into these soils. Also, water infiltrates slowly into soils that have been compacted by construction or other activities.

Soils with infiltration rates that are less than the 0.5" to 1" per hour will have to be amended during rain garden construction. In extreme situations, the rain garden may need to have subsurface drainage installed. Both of these solutions to poor water infiltration will increase the cost and complexity of installing a rain garden. A simpler solution is to search for an appropriate site on your property that has soil with a good water infiltration rate.

The 5 Steps in Determining the Water Infiltration Rate:

1. Dig a hole that matches the approximate dimensions of a 1 gallon milk jug (same width and depth) in the location where you plan to install your rain garden.
2. Fill the hole with about 3" of water and allow it to fully drain from the soil. This will saturate the soil. Your water infiltration rate measurement must be done on saturated soil because you want your rain garden to function throughout recurring periods of heavy rain.
3. Insert a ruler into the bottom of the hole so you can measure, in inches, a falling water level when water is added to the hole. A pencil or dowel rod with 1" incremental markings can also be used. Make sure that at least 3 incremental inch markings are visible above the bottom of the hole.
4. Fill a gallon milk jug with 3" of water. It is helpful to make a mark at the side of the jug at the 3" level. Pour the water into the hole and observe for 3 hours, or until all the water has drained away. If the water drains away before 3 hours, note the elapsed time.
5. After 3 hours, record in inches the amount of water that has drained into the soil. This is the infiltration rate, determined in inches per hour, for your soil that is close to saturation.

Note that if you completely fill the gallon jug with water, pour the water into the hole and record the time required for water to drain away, you will be able to measure the infiltration rate of your soil in

terms of "gallon per hour." This number is helpful in determining the impact of your rain garden in terms of the gallons of water the garden is preventing from running into storm sewers or other drainage systems.

You can gain helpful knowledge of the native soils on your property including inherent water infiltration rates by consulting your county soil survey. A hard copy of the soil survey can be obtained by contacting your Soil and Water Conservation District. In Hamilton County, contact the Hamilton County Soil and Water Conservation District (513-772-7645) or access its website at: <http://www.hcswcd.org>

- ◆ **Call Before You Dig:** Prior to excavating for a rain garden in the state of Ohio, you will need to contact the Ohio Utility Protection Service (1-800-362-2764) to determine if there are any underground lines or utilities in the location where you wish to site the rain garden. If so, you will need to select another location.
- ◆ **Soil Types:** As already noted, properly amending some types of soil, such as heavy clay soils, can help to mitigate drainage challenges in rain gardens. However, another soil type, known as "hydric soils," can present such a problem with water infiltration that it is recommended that rain gardens not be installed on these soils. Drainage is so poor that rain gardens will fail to function and drainage mitigation efforts are considered impractical and cost prohibitive. Hydric soils are found in mucky, wetland areas, and are uncommon in southwest Ohio.
- ◆ **Structures:** Rain gardens should be located at least 10 - 15 ft. from a home or structure with a basement AND must be located down slope of the structure so that surface or subsurface flow is directed away from the structure's foundation. The shallower the slope, the further the rain garden should be located away from the structure.
- ◆ **Existing Trees and Other Landscape Plants:** The construction of a rain garden can require a considerable amount of soil disturbance, and the function of a rain garden is to concentrate rain water runoff. Both can have serious negative effects on existing trees and shrubs. Rain gardens should not be located near existing mature trees and shrubs, unless these plants are tolerant of wet conditions and root disturbances.
- ◆ **Flood Plains:** Rain gardens should never be installed in a flood plain. If you have questions, consult with your Flood Plain Manager in your local jurisdiction.
- ◆ **Steep Slopes:** Where existing or proposed slopes are 20% or steeper, the rain garden site design should be evaluated by a geotechnical engineer. Indeed, depending on factors such as the project size and scope, it is suggested that a geotechnical design evaluation be considered for cases where slopes exceed 12%. If steep slopes are an issue, consider consulting with your County Soil and Water Conservation District before installing your rain garden. See Figure 7 to learn how to measure and calculate the slope of your rain garden site.
- ◆ **Septic Systems:** A rain garden can shunt enough water into a private waste-treatment system to overwhelm the system. So, rain gardens cannot be located within 50 ft. of a private, on-site septic treatment system (e.g. septic tank), or the leach field for a septic treatment system. Also, water from the rain garden cannot be allowed to flow into a private septic treatment system.
- ◆ **Other Important Site Selection Limitations and Considerations:**
 - There must be no impacts to adjacent properties.
 - A rain garden cannot be placed within 500 ft. of a closed hazardous waste remediation or Resource Conservation and Recovery Act (RCRA) site.
 - Do not place a rain garden in an endangered species habitat.
 - The rain garden cannot fall within a "source water protection area." The site cannot be located within 100 ft. of a drinking water wells or waterways.



- A rain garden site should not be located within 100 feet from drinking water wells or waterways.
- The base of the rain garden should be located 2 – 5 ft. above a seasonably-high ground water table, particularly in areas with potential pollutant loads.

Site Selection "Optimizers" Checklist: Following are a list of points you should consider that will help to make your rain garden both effective and environmentally friendly:

- ◆ **Capture Every Drop.** You should locate your rain garden to maximize the amount of rain water runoff that flows into the garden rather than off your property. Hoses, extended downspouts, bio-swales, and contour infiltration plantings can be used to route and spread runoff into the rain garden (Fig. 4).
- ◆ **Exploit Your Terrain.** You should evaluate the terrain of your property and pick a location for your rain garden that takes advantage of the natural flow of surface water. Relying upon the natural terrain to funnel surface water to your rain garden will make the installation less costly and complex.
- ◆ **Intercept the Water.** If you live near a stream, try to place the rain garden between the sources of surface runoff and the stream to prevent runoff from going directly into the stream. The same strategy can be applied to prevent surface runoff from flowing onto streets and other hard surfaces that drain into storm sewers.
- ◆ **Don't Fight the Soil.** As noted above, some types of soil (e.g. heavy clay) may need to be amended to achieve the desired infiltration rate of 0.5" to 1" per hour for a properly functioning rain garden. The relative percentage of sand, silt, and clay contained in the soil is called the "soil texture." The soil texture can be determined with a soil test. In Hamilton County, you can acquire a soil test kit by contacting the Hamilton County Soil and Water Conservation District. A soil test will:
 1. Provide a soil "textural analysis," if requested. You should use the soil test results to avoid locations with heavy clay soils.
 2. Help you to learn if the proposed site lacks critical plant nutrients. If additional nutrients are required, the test results will include fertilizer recommendations that address plant health needs without over-fertilization.

After going through this list, you may find that your proposed site is not suitable for a rain garden. Do not despair, because the solution may be to simply find another site on your property that is more appropriate for your rain garden.

Also, rain gardens are only one tool for managing rain water runoff. There are other devices and landscape features that can utilize rain water runoff to enhance your landscape and reduce the negative effects of water runoff into storm drains. These include: rain barrels (Fig. 5) or cisterns for detention; green roofs; small retention ponds; contour infiltration plantings; and bio-swales.



Fig. 4 Rain water piped from downspouts into a rain garden
Photo by Joe Boggs



Fig. 5 Rain barrel collecting water from a downspout
Photo by Joe Boggs

Rain Garden Construction

1. **Determine the Soil's Infiltration Rate.** As noted above, this is an important step in selecting the location for your rain garden. Remember that the desired infiltration rate for a properly functioning rain garden is 0.5" to 1" per hour. You should measure soil's water infiltration rate both before and after you construct your rain garden. The infiltration rate can be adjusted by using soil amendments, or in extreme cases, by installing sub-surface drainage (e.g. "underdrain"). The construction of your rain garden will be much less costly and complicated if the soil already provides the desired final water infiltration rate prior to construction.
2. **Determine the Garden's Size, Depth, and Shape.** The size of your rain garden will mainly depend upon the:
 - ✓ Depth of the rain garden.
 - ✓ Type of soil medium used in the garden (water infiltration rate).
 - ✓ Size of the drainage area and the volume of the runoff draining into the garden. The rain garden must have enough capacity to handle all of the runoff water that is routed to the garden.
- a. **Rain Garden Size.** An optimum ratio between the size of a rain garden and the size of the impervious area (e.g. roofs, driveways, etc.) to be drained is 0.15 – 0.20. In other words, the size of the rain garden should be at least 15% to 20% of the size of the impervious area that drains into the rain garden. Following is an example of the calculations for determining the proper size of your rain garden.

Example: Calculating the Right Size for a Rain Garden

A house has a total roof area of 50 ft. by 40 ft. The rain garden for this home will receive water from two downspouts. Together, the two downspouts collect about half (50% = 0.5) of all the water that falls onto the roof. How large should the rain garden be for this situation?

Step 1: Calculate the drainage area for the water flowing into the rain garden

- a) The total roof area is 50 ft. x 40 ft. = 2,000 sq. ft.
- b) The rain garden will receive water from about half (50% = 0.5) of this area.
- c) Total Drainage Area: $2000 \times 0.5 = 1,000$ sq. ft.

Step 2: Calculate the size of the rain garden based on the size of the drainage area. A rain garden should 15% – 20% the size of the drainage area.

- a) We will use 20% = 0.2
- b) Size of the Rain Garden: $1,000 \text{ sq. ft.} \times 0.2 = 200 \text{ sq. ft.}$

Note: A rain garden that is 10 ft. wide and 20 ft. long will cover an area of 200 sq. ft.:
The area of a rectangle = length x width; $20 \text{ ft.} \times 10 \text{ ft.} = 200 \text{ sq. ft.}$

You will need to consider a different sizing for different types of landscape designs and land-use types. Rain gardens that primarily drain rooftops, driveways, and "hardscapes" such as concrete patios will need to be larger than rain gardens that primarily drain "greenscapes" such as turfgrass, flower beds, and tree and shrub plantings. An optimum ratio between the size of a rain garden and the size of the greenscape area to be drained is typically 10 to 15%.

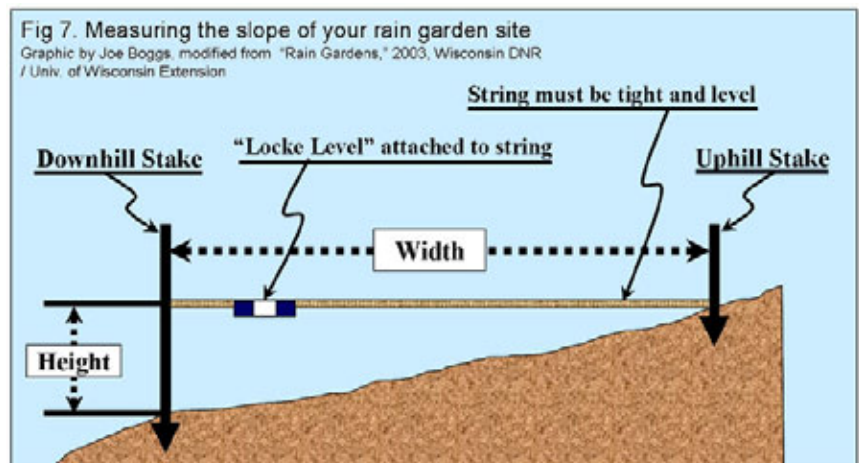
- b. Rain Garden Depth.** In general, your rain garden should be flat in the center and sloped around the inside edges. This modified bowl-shape provides for water ponding above the rooting zone. The maximum ponding depth should be 10", with a rooting zone no shallower than 12" if an underdrain is installed. If an underdrain is not installed, the rooting zone should be no shallower than 24".

The depth of your rain garden depends on the slope of the site and whether or not you intend to install an underdrain. As noted above, where existing or proposed slopes are 20% or steeper, the rain garden site design should be evaluated by a geotechnical engineer. Even a 12% slope may need to be evaluated depending on factors such as the project size and scope. Figure 7 illustrates an easy and effective way to measure the slope of the site.



Steps for Measuring and Calculating the Slope:

- Drive two stakes, one at the top of the slope (the "uphill stake") and one at the bottom of the slope (the "downhill stake"). The distance between the two stakes should be slightly greater than the planned diameter of your rain garden.
- Tie a string to the uphill stake at ground level and stretch the string to the downhill stake. Stretch the string tight and tie it to the downhill stake in such a way to allow it to be moved up and down on the downhill stake.
- Attach a "locke level" to the string and move the string up and down on the downhill stake until the string is level. A locke level is a type of "bubble level" that uses an air bubble floating in a horizontal tube to indicate when the device is level. Locke levels that attach to a string are also referred to as a "string level." An inexpensive string level can be purchased at most hardware stores.
- Measure the height between ground level at the downhill stake and the point where the level string attaches to the stake.
- You now have all the information needed to calculate the slope.



Example: Calculating the Slope	
The distance between an "uphill stake" and a "downhill stake" is 20 ft. (240 inches). The height between ground level at the downhill stake and the point where a level string marks the ground level at the uphill stake is 19.5 inches.	
The Formula: $\frac{\text{Height}}{\text{Width}} \times 100 = \% \text{ Slope}$	The Math: $\frac{19.5}{240} \times 100 = 8.12 \% \text{ Slope}$

When you're creating a garden on a slope, you will be digging out soil from the uphill side and adding it to the downhill side as a berm. Of course, the amount of soil that you must dig out on the uphill side, and that you will use to construct the downhill berm, will be directly correlated with the slope. A steeper slope means more digging on the uphill side, and a higher berm on the downhill side, compared to a shallower slope. Remember that the bottom of your rain garden must be level.

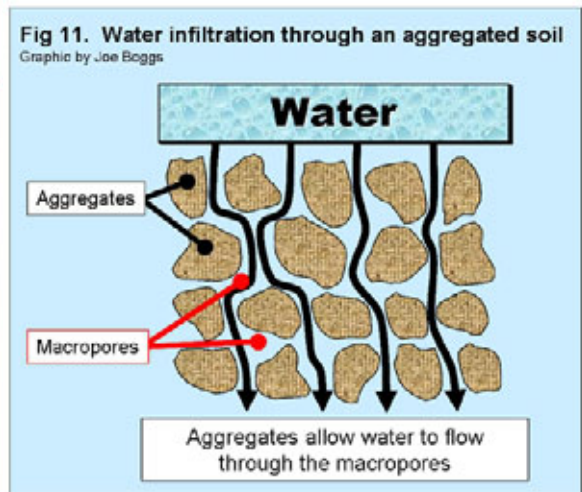
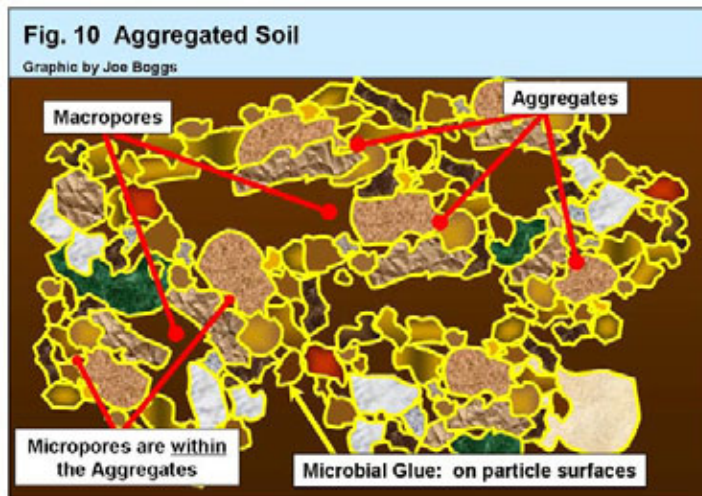
3. Building Your Rain Garden Your rain garden should provide two important functions in your landscaping:

- ✓ All of the water directed into your garden should infiltrate into the soil of the garden rather than washing over the edges, and the water should infiltrate into your garden within 24 – 40 hours. It should not function as a wetland or water garden! **NOTE:** It is very important that your rain garden drains within 24 – 40 hours in order to avoid problems with biting and nuisance aquatic insects such as mosquitoes and midge flies. A properly functioning rain garden will not contribute to the development of these pestiferous insects.
 - ✓ Your garden should enhance rather than detract from your overall landscape design. Your rain garden should be aesthetically pleasing, support the growth and survival of strong plants, and "fit" into the rest of your landscaping. This function is strongly influenced by plant selection and by plant health management including providing soil conditions that support plant establishment and survival.
- a. **Drainage:** The ability for your rain garden to drain water into the soil can be influenced by the addition of soil amendments and by installing a drainage system (underdrain) beneath your garden. However, it is strongly recommended that you focus on using soil amendments as your primary method to enhance drainage and only consider using an underdrain as a secondary method that is reserved for solving extreme problems with drainage.



- **Soil amendments** are grouped into two general categories: organic (e.g. compost, peat moss, bark fines, etc.), and inorganic (e.g. sand). Organic amendments are preferred for improving drainage because they provide both physical and horticultural benefits. These benefits include:
 - Enhancing water movement and plant root growth by making the soil more porous.
 - Holding some soil moisture to support the continual growth and survival of plants.
 - Releasing nutrients to support plant health and the health of soil micro and macro organisms.

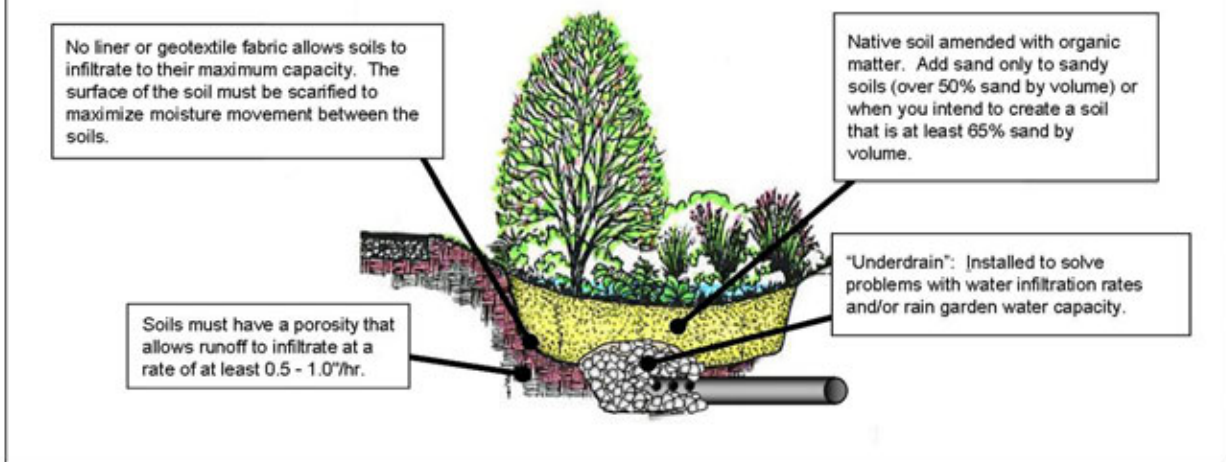
- Promoting the development of good **soil structure** by supporting the formation of "**soil aggregates**." Soil aggregates are created when soil particles (e.g. sand, silt, clay, organic material, etc.) are held together by sticky substances ("microbial glue") exuded by micro and macro soil organisms (Fig. 10). The aggregates provide the following benefits:
 - Large pores (macropores) are formed between the aggregates allowing water to more easily flow into and through the soil. Aggregated soil significantly enhances water infiltration.
 - The macropores support plant root growth and development by loosening the soil.
 - Clay particles within the aggregates will hold onto plant nutrients. The particles will also hold some soil moisture to support plant growth.



Some rain garden designs recommend the use of sand to achieve good drainage. These recommendations range from amending the existing soil with various percentages of sand to completely removing the existing soil and replacing it with sand. While sand will provide rapid drainage, we do not recommend the use of sand as a soil amendment for the following reasons:

- Soils in Greater Cincinnati tend to have high percentages of clay. When sand is added to a clay soil, the pore spaces between the large sand particles will become filled with the small clay particles. This produces a soil density that mimics concrete! A soil must consist of 50 – 60% sand by volume before it will enhance water infiltration without becoming negatively affected by the clay particles.
 - Removing the existing soil and replacing it with sand means sand must be purchased and hauled to your rain garden site. The existing soil must be hauled away and disposed. Both add to the costs and overall complexity in constructing your rain garden.
 - Sand has a very low cationic exchange capacity (CEC), which is a measure of the soil's ability to hold onto plant nutrients. This means nutrients must constantly be added to sandy soil. This creates an ongoing risk the nutrients will wash through the sand to contaminate the ground water beneath the rain garden.
- **Underdrains** are sometimes installed beneath a rain garden to solve extreme problems with water infiltration and drainage. Underdrains are used to solve the following problems:
 - Water infiltration is extremely slow due to the condition of the subsoil beneath the garden.
 - The garden cannot be sized to accommodate the volume of rain water runoff directed into the garden. For example, the size of your rain garden may be limited by the size of your property, or the amount of space in your landscaping that can be devoted to a rain garden.

Fig. 12 Rain garden design with a mixed soil medium and an underdrain
 Graphic by Joe Boggs modified from DER, 2002



The underdrain pipe (Fig. 12) is usually a 3" – 6" diameter black PVC drainage pipe. It is recommended that a pea gravel blanket is used to surround the underdrain pipe instead of filter fabric. Note that the underdrain will need to be installed first, after excavation. The underdrain must be installed so that it slopes away from the rain garden (a nominal 1 – 3% slope) so that water does not back up.

Underdrains are not generally included in "standard" rain garden designs because the pipe(s) remove some of the water from the site rather than allowing all of the water to recharge the soil beneath the site. Still, a rain garden that includes an underdrain will slow the movement of water off-site so that it does not contribute to problems with urban storm water management. If you plan to include an underdrain in your rain garden design, you will also need to plan for the redistribution of the water that is discharged from the drain pipe.

b. 10 Steps for Preparing Your Rain Garden's Site, Soil, and Planting Bed:

- (1) Develop a "check-list" of materials and tools that you will need to construct your rain garden. Having all of the materials on-site when you begin construction will save time.
- (2) Select a day when your soil is only slightly moist. Dry soil will be difficult to dig and digging in wet soil will lead to soil compaction. If your soil is too dry, you can add water sparingly to moisten the soil; however, do not overwater!
- (3) Use spray paint to outline the "footprint" of your rain garden.
- (4) Dig your garden to the desired depth, and then dig down an additional 4" – 6".
 - This additional digging is known as "over-digging" or "double-digging,"
 - It will be used to produce a transition zone between the amended soil in your rain garden and the soil beneath your garden. Water does not easily flow between soils with differing textures. This is known as "soil incompatibility." The transition zone will include a mix of the soil beneath your garden and the amended soil in your garden.
- (5) Use a shovel or coarse rake to roughen the soil in the bottom and along the sides of the rain garden hole. This is known as "scarifying" the soil and it serves to further reduce soil incompatibility by "blurring the boundaries" between the surrounding soil and the soil in the rain garden. No matter how it is done, the sides of the hole should never be smooth.

- (6) Mix the soil amendment(s) into the soil you have dug from the rain garden hole. The mixing ratio should be around 1:3; organic matter to native soil. Remember that the addition of the soil amendment will raise the total volume of the finished amended soil. You will not use all of the amended soil to backfill your rain garden since you want your rain garden to be concave (bowl-shaped), not convex (humped). It is best to mix the amendment into the soil in small batches, and then add the amended mixture to the garden as needed.
- (7) The first soil that you will return to the garden will be a 50:50 mix of the amended soil and the existing soil. This will create the transition zone. Fill the hole with this mixture until you reach the level of desired depth of your rain garden. DO NOT compact the soil.
- (8) Next, fill the garden to the desired depth and contour with the soil that has been amended to the 1:3 ratio. Again, DO NOT compact the soil.
- (9) The excess soil mix from the hole may be used in the construction of a berm along the lower side of the garden to prevent water from over-washing the garden during heavy rain events. The berm should be taller on the downhill side and gradually become lower until it is even with the grade on the uphill side. Do not compact the berm. Plant the berm with dry-tolerant plants, then mulch with 1" – 2" of shredded hardwood mulch.
- (10) If water will enter the rain garden with force, you should consider installing an erosion control mat or a rock swale to disperse some of the power. A thick stand of healthy turf above and below the garden will help to slow down and infiltrate water and greatly reduce erosion.

4. Planting. In general, the planting recommendations for your rain garden are the same as for any other landscape garden. Remember that your rain garden should function both as an aesthetically pleasing landscape feature as well as a tool for managing rain water runoff. The long-term success of your garden depends on providing a good start for the plants installed in your garden.

- (1) Design your garden to allow plenty of space between plants because perennials need room to grow (Fig. 13). Remember that perennials usually look best when planted in clumps or groups of plants of the same variety.
- (2) Dig a hole for each plant large enough to accept its root system comfortably. Lift out each plant from its flat or container with a block of soil surrounding its roots.
- (3) If containerized plants have become root bound, disturb the root system by gently pulling the roots apart before planting.
- (4) Set the soil block in a planting hole and backfill it so the plant sits at the same level as the surrounding soil. Planting depth should be the same as container depth or to soil line on bare root plants; do not bury the crowns. If planted too deeply, crowns and roots may rot; if too shallow, they may dry out.
- (5) Thoroughly irrigate each newly installed plant with a "starter solution" of high phosphate liquid fertilizer.
- (6) Cover your rain garden to a depth of no more than 1" – 2" with high quality organic mulch, preferably shredded bark mulch. Non-shredded mulch tends to float and wash away.



Fig 13. Planting a Rain Garden
Photo by Dave Dyke

Rain Garden Maintenance

There are few differences between the plant health practices recommended for maintaining your rain garden plants and the general horticultural practices recommended for maintaining healthy plants elsewhere in your landscaping. The exceptions are related to the special function of your rain garden.

Landscape management practices that interfere with water infiltration will interfere with the rain garden's function. For example, as organic mulch decays, large particles become small particles and the small organic particles can interfere with water movement, particularly if allowed to dry out. In fact, the decayed mulch can become hydrophobic meaning that it will repel water. Periodically rake and redistribute the mulch to prevent this problem.

The rapid movement of water into the soil beneath a rain garden also increases the risk for ground water contamination. This should always be considered when making fertilizer and pesticide decisions involving your rain garden.

Soil Fertility Management

As with all plants in your landscape, the plants in your rain garden will do best if provided with the right amount of nutrients and if the pH of the soil matches their needs. Remember that too much fertilizer can be just as bad as not enough. The best way to learn what is "just right" is to have the soil tested.

A standard soil test will provide information on the status of several important plant nutrients as well as the soil pH, the cation exchange capacity (CEC), and the base saturation (Fig. 15). Additional tests are available for iron (Fe), zinc (Zn), manganese (Mn). These nutrients move very slowly into and through most soils. The exception is sandy soils. As mentioned earlier, sandy soils have a very low CEC, meaning that they do not hold onto nutrients.

Instead, the nutrients are easily washed from the sandy soil, which presents a serious risk to ground water contamination beneath your rain garden. Soil testing labs always provide a fertilizer recommendation specific to the test results. You should carefully follow the fertilizer recommendations.



Fig. 14 A small residential rain garden in Ohio
Photo by Joe Boggs

Fig. 15 Ideal Soil Test Result Values

Graphic by Joe Boggs

pH	Phosphorus P lbs. / A*	Potassium K lbs. / A*	Calcium Ca lbs. / A*	Magnesium Mg lbs. / A*	Cationic Exchange Capacity C.E.C. meq./100 gms	Base Saturation		
						% Ca	% Mg	% K
5.5 to 6.5	50 to 100	250 to 400	800 plus	150 to 250	7 to 10 or higher	40 % to 80%	10% to 40%	3% to 5%

* To convert lb/A (pounds per acre) to ppm (parts per million), divide by 2.
Example: 100 lb/A = 50 ppm

Standard soil tests do not provide information on nitrogen (N) in the soil. This is because nitrogen can move quickly through soil which makes the test results very time-sensitive. Nitrogen should be added sparingly and only when plants need it. It is generally recommended that perennials be fertilized in spring as new growth emerges, and again eight weeks later. Using a "slow-release" form of nitrogen will reduce the risk of ground water contamination beneath your rain garden.

You should have the soil in your rain garden tested as soon as you complete its construction. Testing the soil prior to adding amendments will not provide accurate results relative to the "finished" product. For instructions on how to take and submit soil samples for testing, refer to the Ohio State University Extension FactSheet HYG-1133-99 titled "Soil Testing is an Excellent Investment for Garden Plants and Commercial Crops" [<http://ohioline.osu.edu/hyg-fact/1000/1133.html>]. The factsheet also lists soil testing labs. In Hamilton County, you can contact the Hamilton County Soil and Water Conservation District (513-772-7645) to acquire a soil testing kit.

Watering

Additional water may be required to keep your rain garden plants healthy during the growing season.

- ◆ In general, plants need 1" of water per week as rainfall and/or applied water.
- ◆ Plants that are recently planted or transplanted may need additional water during the establishment period.
- ◆ Watering should be done in the morning at soil level rather than sprinkled over the top of plants, which may spread disease.
- ◆ When watering, moisten the entire bed thoroughly, but do not water so heavily that the soil becomes soggy. After watering, allow the soil to dry moderately before watering again.
- ◆ Soaker hoses, bubblers, and other watering devices that slowly distribute water to the soil rather than onto the foliage of plants all aid in following proper watering practices.

Mulching

Use mulch to help prevent mud-splashed blooms, conserve moisture, moderate soil temperatures, and suppress weeds. Organic mulch will also continually infuse organic matter into the soil as they decay.

- ◆ Mulch can be applied in the spring, after the soil has warmed, or in the fall.
- ◆ Mulch should only be applied to a depth of 1" – 2", and it should be kept away from plant stems.
- ◆ Never use more than 3" unless it is used for winter protection. For example, perennials that are transplanted or newly divided in the fall should have 3" – 4" of mulch applied over the crowns after the ground freezes to prevent soil from freezing and thawing and potentially heaving plants out of the ground. Plants that are marginally hardy should also have 3" – 4" of mulch for winter protection. Pull the mulch back from the crowns once new growth begins to emerge in spring.
- ◆ Compost, chipped or shredded bark, pine needles, etc., are all suitable for rain gardens. However, shredded hardwood bark is best for rain gardens and contour infiltration plantings because it will not easily float or wash away.



Weed Management

It is critical to control weeds in your rain garden. Once established, weeds may be very difficult to control due to weed seed production and the establishment of vegetative structures such as roots and rhizomes.

- ◆ Weeds can be prevented and controlled using several "cultural" methods such as hand pulling, cultivation, and mulching.
- ◆ Perennial weeds are best killed prior to planting using a postemergent, non-residual, non-selective, herbicide (e.g. glyphosate). A postemergent herbicide kills growing plants, and non-residual means the herbicide breaks-down quickly and will not infiltrate through the soil. Non-selective means the herbicide kills almost all plants.
- ◆ Weeds can be prevented from establishing from seed by using a preemergent herbicide. These herbicides will prevent weed seed germination; however, they do not control established weeds. Many preemergent herbicides products are labeled for use around flowering plants. The products are applied to a weed-free soil surface in spring after the bed is planted to control summer annual weeds, and in late-summer to control winter annual weeds. Be very careful when using pesticides that could potentially end up in ground or other water systems. As with all pesticides, read and follow product label directions.



Fig. 17 Lesser Celandine (*Ranunculus ficaria*), also known as Fig Buttercup, is a non-native highly invasive weed
Photo by Joe Boggs

Pest and Disease Management

Perennials have their share of pest and disease problems. Research the plants that interest you and become knowledgeable of specific problems. Selecting plants that have few pest and disease problems is one of the most effective ways to avoid these problems.

- ◆ Large animal pests such as rabbits, squirrels, chipmunks, and deer can be managed using exclusion methods, such as fencing, and by using chemical repellents to directly protect plants. Plant selection is also important. For example, the Cincinnati Zoo and Botanical Garden has a list of plants [www.cincinnati-zoo.org] that have been found to be the most deer resistant.
- ◆ Small animal pests such as insects should be managed using three steps:
 - First, you must identify the pest. This includes separating the "good insects," such as insect predators from the "bad insects," the pests.
 - Next, you must decide whether or not the pest is actually causing significant damage to the overall health of the plant(s). There are many pests, such as aphids, that only appear to cause damage to plants; however, they are not harming the health of the plant.
 - Finally, you need to devise a pest management strategy using Integrated Pest Management (IPM) tactics.

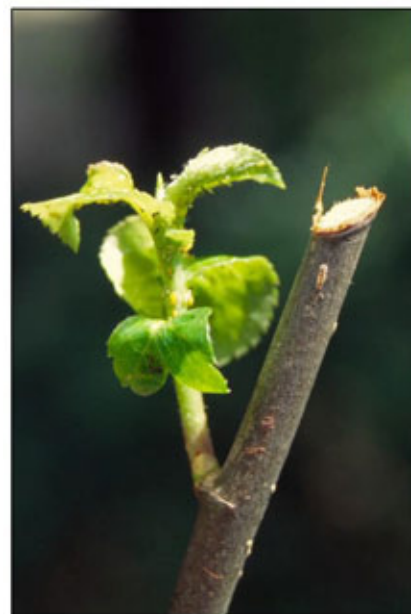
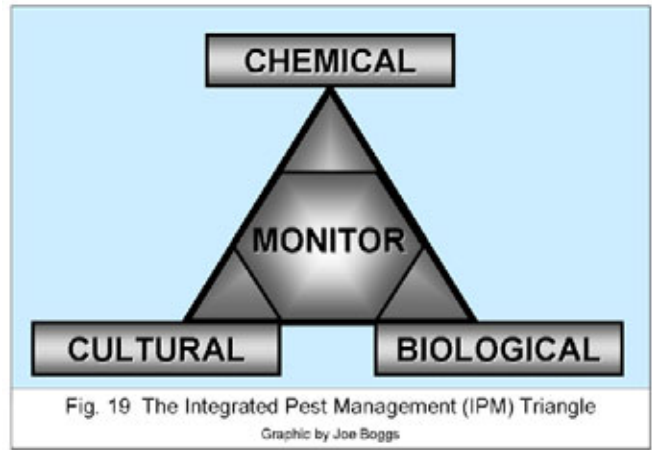


Fig. 18 Rabbit damage: note the 45° angled cut
Photo by Joe Boggs

o Figure 19 shows the IPM tactics:

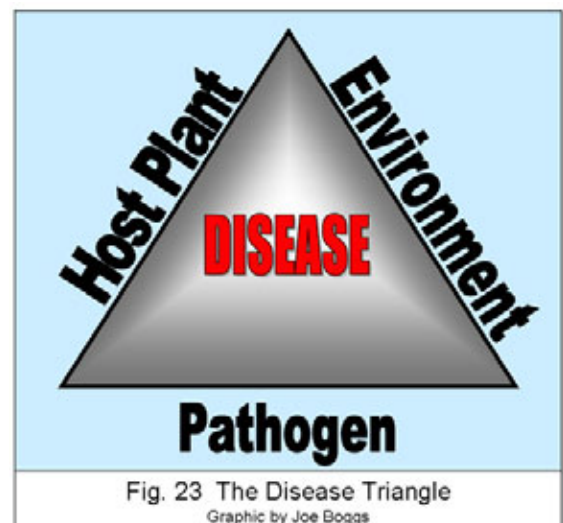
- Chemical control includes all forms of insecticides; however, this tactic should be reserved as a "last resort" and the insecticides should have a limited impact on biological control tactics.
- Cultural control includes plant selection as well as practices that enhance the health of plants, such as proper fertilization.
- Biological control primarily focuses on actions that enhance beneficial insects, such as selecting plants that provide nectar and pollen to feed adult beneficial insects (e.g. parasitoid wasps). Also, you should avoid actions that limit the effects of beneficials, such as killing them with an insecticide.



◆ Disease Management employs a different triangle; the Disease Triangle (Fig. 23).

o The Disease Triangle illustrates that a disease can develop only when you have a plant pathogen present at the same time that you have a susceptible host and environmental conditions that will support disease development. If you remove any one of these three conditions, a plant disease will not develop. Here are some examples:

- **Environmental:** A number of fungal diseases require an abundance of water on plant leaves. This condition can be reduced by avoiding wetting the leaves during watering.
- **Host Plant:** Plant diseases often develop on stressed plants. Plant health management practices, such as proper fertilization, are also plant disease management practices. Selecting disease resistant plants will also remove the host from the triangle.
- **Pathogen:** Pruning to remove diseased tissue will help to remove the pathogen.



Plant Selection and Use

Plants used in storm water management applications, such as rain gardens, have been typically thought of as plants that can tolerate both wet soils in the late winter and spring and dry soils in the summer. However, what we are really concerned with is selecting plants that will thrive in the different ecosystems created by many green storm water management systems. This includes everything from bio-swales to contour infiltration plantings to rain gardens.

Native plants are often suggested for use in rain gardens based on the belief that they are better adapted to local conditions than non-native plants. Consider using all plants that do well in our area under the soil and site conditions found in your rain garden, or other storm water management systems. Both native and non-native plants should be considered.

We urge that you refer to the list included in this publication for guidance in making your plant selections. Consider all types of plant materials, including trees and shrubs that are relatively low maintenance, instead of only selecting the more traditional herbaceous plant materials associated with infiltration plantings. Remember that a garden can provide many functions in addition to storm water management, including shade and wildlife habitat. Finally, it is important that you consider the following when making your plant selections:



Fig. 24 *Helianthus angustifolius*
'Gold Lace'
Photo by Steve Foltz

- ◆ **Recommendations/local trials.** Use plants that have been successfully grown and/or trialed in this area by reputable non-biased agencies, organizations, companies, or individuals under the conditions for which they will be used. The plants recommended in this publication have been chosen by Steve Foltz, Horticulture Director, Cincinnati Zoo and Botanical Garden, subsequent to many years of experience and trials. All plants are trialed at the zoo without the use of pesticides. They are generally trialed over a period of 2 or more years in several garden plantings involving a variety of environmental conditions, including soils and light, and usually receive a minimal amount of fertilizer. In order to be recommended, they must maintain their vigor and a superior appearance over most or all of the growing season with insignificant insect or disease damage.
- ◆ **Hardiness.** Hardiness zone refers to minimum winter temperatures. In general, the northern half of Ohio is in Zone 5 with -10° F to -20° F; southern Ohio is in Zone 6, with 0° F to -10° F minimum temperatures. However, southern Ohio has been as low as -24° F.
- ◆ **Light.** Light exposure is critical for plant growth and bloom. "Full sun" is considered to be 6 hours or more of direct sun. "Partial shade" is a half day of sun (morning sun and afternoon shade) or a filtered shade through high branched trees. "Full shade" is no direct sun exposure. Some plants are particular as to light required while others are more adaptable.
- ◆ **Moisture.** Rain gardens have 3 moisture zones: moist at the bottom of garden, average on the sides, and dry around the top edges. Plants that need saturated soil (e.g. wetland plants) or dry soil should generally be avoided.
 - Plants to be planted in the lower "moist zone" of a rain garden may be at least partially submerged for 24 hours or more during periods of extended rainfall. The soil may be saturated for extended periods. Soils that drain poorly, especially in winter, cause the death of many perennials due to crown rot. Therefore, it is extremely important that plants you choose for the wet zone be adapted to wet conditions.

- Plants that do well in average moisture conditions should be planted along the sides of the rain garden.
- Use plants that grow well in average to drier conditions around the top edges.
- ◆ **Fertility and pH.** The fertility and pH requirements of plants should be considered when selecting them. The plants on our recommended plant list will do well in the pH ranges most typically found in our area. Some plants, such as certain natives, their cultivars, and others, may do well in a good loam garden soil with minimal or no fertilization. Others may require fertilizer applications to thrive. You should always consult soil test results for guidance in making fertilizer applications.
- ◆ **Planting size.** For best appearance and ease of establishment, plants grown in 4" pots or larger should be selected for planting. If budgetary constraints dictate more inexpensive materials, plugs may be used if they are planted in the spring. As a general rule, the larger the plants the better.
- ◆ **Physical characteristics.** It is best to select plants with a purpose in mind, such as low-growing edging plants, accents, masses of color, etc.
 - Size: Consider the height and width of mature plants. If planted too close, some will be crowded out and plant health and garden appearance will be affected. Plant taller plants in groups in the middle of a garden that is to be observed from all sides and towards the back of those designed to be observed primarily from the front.
 - Aggressiveness: Spreading and fast-growing plants can overpower other plants in the garden. Therefore, it important to group plants that have similar growth rates.
 - Color, texture, and bloom time: Your garden can have a very pleasing appearance throughout the growing season with careful planning. Be sure to consider both the color of foliage and the blooms when selecting plants.
 - Clustering plants: When using the same plants in clusters, odd numbers (3, 5, and 7) will generally give a more pleasing appearance than even numbers.
 - Appearance: Native plants may sometimes produce a "weedy" appearance. Select named varieties for a good display from a limited number of plants in a limited space.
- ◆ **Deer resistance.** Deer can be a major problem in Ohio gardens, and they will feed on a wide variety of plants. If deer are a problem in your landscaping, we recommend that you consider selecting plants for your rain garden that are generally resistant to deer damage, unless you can protect your plants with adequate fencing. The Cincinnati Zoo and Botanical Garden [www.cincinnati-zoo.org] has developed a list of plants that have been found to be less attractive to deer. Of course, you must remember that if deer are hungry, they may even feed on "deer resistant" plants.
- ◆ **Special considerations.** You may want use plants in your rain garden that are attractive to butterflies, hummingbirds, birds, etc. There are many lists available that highlight plants that are attractive to wildlife. If you consult these lists, we recommend that you make your final selection based on plants that are also found in the plant selection list included in this publication.

To see photos of plants included in the following plant list, visit www.plantplaces.com. The website catalogs ornamental plants that are successfully growing in the Greater Cincinnati Region. Also visit www.planttrials.com to see herbaceous plants that are being trialed around the Greater Cincinnati Region. Both websites can be helpful in selecting plants for your landscape.



Fig. 25 *Eupatorium maculatum* 'Gateway' (Joe-Pye Weed), *Sedum* sp. (Sedum), and *Echinacea* sp. (Coneflower)

Photo by Steve Foltz

Plants for Green Storm Water Management Controls in Southwest Ohio

Perennials

Note: ♦ is the symbol used for plants that can tolerate wet soils

Full Sun

Native Perennials Under 2'

Asclepias tuberosa – Butterfly Weed
Amsonia 'Blue Ice' – Blue Ice Bluestar
Aster oblongifolius -
 'Raydon's Favorite' – Raydon's Favorite Aster
 'October Skies' – October Skies Aster
Aster novae-angliae 'Purple Dome' – Purple Dome Aster
Coreopsis verticillata 'Moonbeam' – Moonbeam Coreopsis
Coreopsis auriculata 'Nana' – Yellow Coreopsis
Coreopsis lanceolata – Lance-leaved Coreopsis
Echinacea tenesseeensis 'Rocky Top' – Tennessee Coneflower
Echinacea purpurea 'Kims Knee High' – Kim's Knee High Coneflower
Eryngium yuccifolium – Rattlesnake Master
Gaillardia 'FanFare' – Fanfare Blanketflower
Heuchera villosa 'Caramel' – Caramel Alum Root
♦ Iris versicolor – Blue Flag Iris
Liatris microcephala – Dwarf Blazing Star
Liatris spicata – Blazing Star
♦ Lobelia cardinalis – Cardinal Flower
Oenothera fruticosa 'Fireworks' – Fireworks Sundrops
Phlox subulata - Creeping Phlox
 'Emerald Cushion Pink', 'Emerald Cushion Blue'
Sedum ternatum – Native Sedum
Silene regia – Royal Catchfly
Solidago sphaceolata 'Golden Fleece' – Golden Fleece Goldenrod
Solidago ohioensis – Ohio Goldenrod

♦ Spiranthes cernua v. odorata – Chadds Ford Fragrant Lady's Tresses
Stokesia 'Klaus Jelitto' – Stoke's Aster
♦ Tradescantia ohioensis – Spiderwort

Non Native Perennials Under 2'

Dianthus x gratianopolitanus 'Bath's Pink' – Bath's Pink Dianthus
Geranium x cantabrigiensis 'Biokova' and 'Karmina'
Geranium sanguineum – Bloodred Geranium
Hemerocallis 'Happy Returns', 'Stella d'Oro', (many others)
Iris siberica – Siberian Iris
Liriope spicata – Creeping Liriope
Liriope 'Big Blue' – Big Blue Liriope
Nepeta 'Six Hills Giant' – Catmint
Salvia 'Blue Hill' – Blue Hill Salvia
Salvia 'May Night' – May Night Salvia
Sedum 'Autumn Joy' – Autumn Joy Sedum
Stachys 'Helen von Stein' – Lamb's Ears
Thymus serpyllum – Creeping Tyme

Native Perennials 2'-4'

♦ Acorus calamus – Sweetflag 'Variegata'
♦ Asclepias incarnata (swamp milkweed)
Amsonia tabernaemontana – Blue Star Amsonia
Amsonia hubrichtii – Arkansas Amsonia
Baptisia australis – Wild Blue Indigo
Baptisia australis var. minor – Wild Blue Indigo
Baptisia 'Purple Smoke' – Purple Smoke Baptisia
Baptisia sphaerocarpa – Yellow Wild Indigo
Echinacea purpurea – Coneflower 'Magnus', 'Ruby Star', 'White Swan', 'Fragrant Angel'
 (Echinacea Big Sky Series
♦ Helianthus angustifolius 'First Light' – First Light Swamp Sunflower
♦ Monarda – Bee Balm
 ('Jacob Cline', Marshall's Delight', Raspberry Wine'

Phlox paniculata 'David' – David Garden Phlox
 'Katherine' – Katherine Garden Phlox
Rudbeckia fulgida 'Goldsturm' – Goldsturm Black-eyed Susan

Solidago rugosa 'Fireworks' – Fireworks Goldenrod
Thermopsis caroliniana – Carolina Lupine

Non Native Perennials 2'-4'

Perovskia atroplicifolia – Russian Sage
Leucanthemum 'Becky' – Becky Shasta Daisy
Paeonia – Peony
Hemerocallis Assorted Cultivars

Native Perennials 4' and larger

Boltonia asteroides 'Snowbank' – Thousand Flowered Aster
Coreopsis tripteris – Tall Coreopsis (
♦ Eupatorium maculatum 'Gateway' – Gateway Joe-Pye Weed
Helenium autumnale – Sneezeweed
♦ Helianthus angustifolius 'Gold Lace' – Gold Lace Swamp Sunflower
♦ Hibiscus moscheutos - Swamp Rose Mallow
 ('Sweet Caroline', 'Moy Grande', 'Pink Cloud')
Ratibida pinnata – Prairie Coneflower
♦ Rudbeckia nitida 'Autumn Sun' – Autumn Sun Coneflower
Rudbeckia submentosa – Sweet Coneflower
Rudbeckia maxima – Great Coneflower
Silphium laciniatum – Compass Plant
Silphium perfoliatum – Cup Plant
Silphium terebinthenaceum – Prairie Dock
♦ Veronicastrum virginicum – Culver's Root

Perennials for Shade

Native Perennials Under 3'

Aquilegia canadensis – Wild Columbine, 'Corbett' (Yellow), 'Little Lanterns' (red/orange)

Asarum canadense – Wild Ginger
♦ Chelone lyonii 'Hot Lips' – Pink Turtlehead
Dicentra eximia – Wild Bleeding Heart
Dodecatheon meadia – Shooting Star
Geranium maculatum – Wild Geranium
Heuchera americana – American Alumroot
Heuchera villosa – Hairy Alumroot
Iris cristata – Dwarf Crested Iris, 'Alba', 'Eco Bluebird', 'Powder Blue Giant'
Mertensia virginica – Virginia Bluebells
Pachysandra procumbens – Alleghany Spurge
Phlox divaricata – Wild Phlox, 'London Grove Blue', 'May Breeze'
Phlox stolonifera – Creeping Phlox, 'Blue Ridge', 'Sherwood Purple'
Stylophorum diphyllum – Celandine Poppy
Tiarella cordifolia – Foam Flower
Viola labradorica – Labrador Violet

Non Native Shade Perennials

Anemone japonica – Japanese Anemone
Arum italicum – Italian Arum
Asarum europeum – European Ginger
♣Astilbe chinensis ‘Pumila’ – Chinese Astilbe
Begonia grandis – Hardy Begonia
Brunnera macrophylla – Siberian Bugloss, ‘Langtrees’, ‘Variegata’, ‘Jack Frost’
Epimedium x versicolor ‘Sulphureum’ – Yellow Barrenwort
Epimedium x rubrum – Red Barrenwort
Galium odoratum – Sweet Woodruff
Pachysandra terminalis – Pachysandra
♣Helleborus orientalis – Lenten Rose
Helleborus foetidus – Green Hellebore
Dicentra spectabilis – Bleeding Heart
♣Hosta
Blue – ‘Elegans’, ‘Blue Umbrellas’, ‘Blue Angel’, ‘Krossa Regal’, ‘Blue Cadet’
Yellow – ‘Sum & Substance’, ‘Gold Standard’, ‘Solar Flare’, ‘Lemon Lime’
Variegated – ‘Francee’, ‘Patriot’, ‘Sage’
Polygonatum odoratum ‘Variegatum’ – Variegated Solomon’s Seal
Rohdea japonica – Sacred Lily

Native Shade Perennials 3’ and larger

♣Aruncus dioicus – Goatsbeard
♣Veronicastrum virginicum – Culver’s Root

Ornamental Grasses

Native Grasses

Carex spp. – Many different types to choose from
Sporobolus heterolepis – Prairie Dropseed
Schizachyrium scoparium – Little Bluestem ‘The Blues’
Panicum virgatum – Switch Grass, ‘Hanse Herms’, ‘Northwind’, ‘Cloud Nine’, ‘Shenandoah’, ‘Dallas Blues’

Non Native Ornamental Grasses

1’-3’

Pennisetum alopecuroides ‘Hameln’ – Hameln Fountain Grass
Pennisetum orientale – Oriental Fountain Grass

3’-5’

Calamagrostis x acutiflora ‘Karl Foerster’ – Karl Foerster Feather Reed Grass
Pennisetum alopecuroides – Fountain Grass
Miscanthus sinensis ‘Little Nicky’ – Little Nicky Zebra Grass
Miscanthus sinensis ‘Adagio’ – Adagio Maiden Grass
Miscanthus sinensis ‘Morning Light’ – Morning Light Maiden Grass

5’-8’

Miscanthus sinensis ‘Variegatus’ – Variegated Silver Grass
Miscanthus sinensis ‘Strictus’ – Porcupine Grass
Miscanthus sinensis ‘Gracillimus’ – Maiden Grass

8’+

Miscanthus ‘Giganteus’ – Giant Silver Grass
Arundo donax – Giant Reed Grass
Saccharum (Erianthus) ravennae – Ravenna Grass

Ferns

Adiantum pedatum (northern maidenhair fern))
Athyrium filix-femina (lady fern))
Dennstaedtia punctilobula (hay-scented fern))
Dryopteris marginalis (marginal wood fern))
Onoclea sensibilis (sensitive fern, bead fern))
Osmunda cinnamomea (cinnamon fern))
Osmunda claytoniana (interrupted fern))
Osmunda regalis (royal fern))
Polystichum acrostichoides (Christmas fern))

Trees, Shrubs and Vines

Note: ♣ denotes plants that can tolerate wet soils

Native Large Trees (50' or more)

Maple:

Black Maple (*Acer nigrum*)
♣Autumn Blaze Maple (*Acer x freemanii* 'Autumn Blaze')
♣Red Maple (*Acer rubrum* 'Red Sunset', 'October Glory')
Sugar Maple (*Acer saccharum*)

Birch:

♣River Birch (*Betula nigra*)
♣Heritage River Birch (*Betula nigra* 'Heritage')

Hickory:

Pignut Hickory (*Carya glabra*)
Shagbark Hickory (*Carya ovata*)

Oak:

White Oak (*Quercus alba*)
♣Swamp White Oak (*Quercus bicolor*)
Scarlet Oak (*Quercus coccinea*)
Shingle Oak (*Quercus imbricaria*)
Bur Oak (*Quercus macrocarpa*)
Chinkapin Oak (*Quercus muehlenbergii*)
♣Pin Oak (*Quercus palustris*)
Red Oak (*Quercus rubra*)
Shumard Red Oak (*Quercus shumardii*)

Others:

Yellow Buckeye (*Aesculus flava*)
Northern Catalpa (*Catalpa speciosa*)
Common Hackberry (*Celtis occidentalis*)
Persimmon (*Diospyros virginiana*)
American Beech (*Fagus grandifolia*)
♣Thornless Honeylocust (*Gleditsia triacanthos* var. *inermis* 'Skyline', 'Shademaster', 'Sunburst', 'Imperial')
Kentucky Coffeetree (*Gymnocladus dioica* (male clones available))
♣Sweetgum (*Liquidambar styraciflua*)
Tuliptree (*Liriodendron tulipifera*)
Cucumber Magnolia (*Magnolia acuminata*)
Osage Orange (*Maclura pomifera* (Male clone))
♣Black Tupelo (*Nyssa sylvatica*)
♣Sycamore (*Platanus occidentalis*)
♣Bald Cypress (*Taxodium distichum* 'Shawnee Brave')
American Linden (*Tilia americana*)
Valley Forge American Elm (*Ulmus americana* 'Valley Forge')

Non Native/non-invasive Large Trees

Horsechestnut (*Aesculus hippocastanum*)
Hardy Rubber Tree (*Eucommia ulmoides*)
European Beech (*Fagus sylvatica*)
Ginkgo (*Ginkgo biloba* (male clone))
♣Dawn Redwood (*Metasequoia glyptostroboides*)
♣Bloodgood Londonplane Tree (*Plantanus x acerifolia* 'Bloodgood')
English Oak (*Quercus robur* 'Regal Prince')
Japanese Pagoda Tree (*Sophora japonica*)
Littleleaf Linden (*Tilia cordata*)
Silver Linden (*Tilia tomentosa* 'Sterling Silver')
Accolade Elm (*Ulmus* 'Accolade')
Chinese Elm (*Ulmus parvifolia* 'Allee')
Japanese Zelkova (*Zelkova serrata*)

Native Small to Medium Flowering Trees

25’-50’

American Hornbeam (*Carpinus caroliniana*)
American Yellowwood (*Cladrastis kentukea*)
Umbrella Magnolia (*Magnolia tripetala*)
Bigleaf Magnolia (*Magnolia macrophylla*)
American Hophornbeam (*Ostrya virginiana*)
Sassafras (*Sassafras albidum*)

Under 25'

Birch:

- ◆Weeping River Birch (*Betula nigra* 'Summer Cascade')
- ◆Sweet Birch (*Betula lenta*)

Hawthorn:

- Cockspur Hawthorn (*Crateagus crusgalli* var. *inermis*)
- Washington Hawthorn (*Crataegus phaenopyrum*)
- Winter King Hawthorn (*Crataegus viridis* 'Winter King')

Dogwood:

- Pagoda Dogwood (*Cornus alternifolia*)
- Flowering Dogwood (*Cornus florida* 'Cloud Nine', 'Cherokee Princess')
- ◆Red-Panicked Dogwood (*Cornus racemosa*)

Others:

- Red Buckeye (*Aesculus pavia*)
- ◆Apple Serviceberry (*Amelanchier x grandiflora* 'Autumn Brilliance', 'Princess Diana')
- Allegheny Serviceberry (*Amelanchier laevis* 'Cumulus')
- Common Pawpaw (*Asimina triloba*)
- ◆Little King River Birch (*Betula nigra* 'Little King')
- Eastern Redbud (*Cercis canadensis* 'Alba', 'Appalachian Red')
- Weeping Redbud (*Cercis canadensis* 'Lavender Twist')
- Fringe Tree (*Chionanthus virginicus*)
- Eastern Wahoo (*Euonymus atropurpureus*)
- ◆Sweetbay Magnolia (*Magnolia virginiana* 'Northern Belle')
- ◆Peve's Mineret Bald Cypress (*Taxodium distichum* Peve's Mineret)
- ◆Weeping Bald Cypress (*Taxodium distichum* 'Cascade Falls')

Non Native/non-invasive Small to Medium Trees

Maple:

- Miyabei Maple (*Acer miyabei* 'State Street')
- Japanese Maple (*Acer palmatum* 'Burgundy Lace', 'Bloodgood')
- Girard's Hybrid Paperbark Maple (*Acer griseum x nikoense*)
- Flame Amur Maple (*Acer ginnala* 'Flame')

Magnolia:

- Saucer Magnolia (*Magnolia x soulangiana*)
- Star Magnolia (*Magnolia stellata*)
- Loebneri Magnolia (*Magnolia x loebneri* 'Merril', 'Jane Platt')

Cherry:

- Sargent Cherry (*Prunus sargentii*)
- Yoshino Cherry (*Prunus x yedoensis* 'Akebono')
- Weeping Cherry (*Prunus subhirtella* 'Pendula')
- Snow Fountain Weeping Cherry (*Prunus* 'Snow Fountain')

Others:

- Horsechestnut (*Aesculus hippocastanum*)
- Columnar European Hornbeam (*Carpinus betulus* 'Fastigiata')
- Chinese Chestnut (*Castanea mollissima*)
- Turkish Filbert (*Corylus colurna*)
- Seven Son's Tree (*Heptacodium miconioides*)
- Golden Rain Tree (*Koeleruteria paniculata*)
- Amur Maackia (*Maackia amurensis*)
- Donald Wyman Crabapple (*Malus* 'Donald Wyman', 'Sugar Tyme')
- Fruitless Mulberry (*Morus alba* 'Strybling')
- Persian Parrotia (*Parrotia persica*)
- Globe Black Locust (*Robinia pseudoacacia* 'Umbraculifera')
- Korean Mountainash (*Sorbus alnifolia*)
- Ivory Silk Lilac (*Syringa reticulata* 'Ivory Silk')

SHRUBS

Native Shrubs over 8'

Sumac:

- Shining Sumac (*Rhus copallina* 'Prairie Flame')
- Smooth Sumac (*Rhus glabra*)
- Staghorn Sumac (*Rhus typhina*)

Viburnum:

- Nannyberry Viburnum (*Viburnum lentago*)
- Blackhaw Viburnum (*Viburnum prunifolium*)
- Southern Blackhaw Viburnum (*Viburnum rufidulum*)
- American Cranberrybush Viburnum (*Viburnum trilobum* 'Wentworth')

Others:

- ◆Bottlebrush Buckeye (*Aesculus parviflora*)
- ◆Devils Walking Stick (*Aralia spinosa*)
- ◆Alleghany Serviceberry (*Amelanchier laevis*)
- ◆Gray Dogwood.....*Cornus racemosa*)
- ◆Giant Gray Dogwood (*Cornus drummondii*)
- American Hazelnut (*Corylus americana*)
- Fringe Tree.....*Chionanthus virginicus*)
- Common Witchhazel (*Hamamelis virginiana*)
- ◆Vernal Witchhazel (*Hamamelis vernalis*)
- ◆Bayberry (*Myrica pensylvanica*)
- ◆Ninebark (*Physocarpus opulifolius* 'Summer Wine', 'Diabolo')
- Wafer-ash (*Ptelea trifoliata*)
- Carolina Buckthorn (*Rhamnus caroliniana*)
- ◆Elderberry (*Sambucus canadensis*)
- Scarlet Elder (*Sambucus pubens*)
- American Bladdernut (*Staphylea trifolia*)

Non Native Large Shrubs 8'+

- Cornelian Cherry Dogwood (*Cornus mas* 'Golden Glory')
- Japanese Cornell Dogwood (*Cornus officinalis*)
- Smokebush (*Cotinus coggygia* 'Daydream', 'Velvet Cloak',)
- Godsall Pink Deutzia (*Deutzia scabra* 'Godsall Pink')
- Pearlbush (*Exochorda racemosa*)
- Forsythia (*Forsythia x intermedia* 'Meadowlark', 'Northern Sun')
- Beauty Bush (*Kolkwitzia amabilis*)
- Crape Myrtle (*Lagerstroemia* 'Hopi', 'Acoma' 'Catawba')
- Fragrant Honeysuckle (*Lonicera fragrantissima*)
- Japanese Orixia (*Orixia japonica*)
- Assesseppi Lilac (*Syringa x hyacinthiflora* 'Assesseppi')
- Fragrant Viburnum (*Viburnum x carlecephalum*)
- Burkwood Viburnum (*Viburnum x burkwoodii* 'Mohawk', 'Chanaultii')
- Alleghany Viburnum (*Viburnum x rhytidophylloides* 'Alleghany')

Native Shrubs 4' - 8'

- ◆Indigo Bush (*Amorpha fruticosa*)
- ◆Red Chokeberry (*Aronia arbutifolia* 'Brilliantissima')
- ◆Carolina Allspice (*Calycanthus floridus*)
- ◆Buttonbush (*Cephalanthus occidentalis*)
- ◆Summersweet (*Clethra alnifolia* 'Ruby Spice')
- ◆Silky dogwood (*Cornus amomum*)
- ◆Redosier Dogwood (*Cornus sericea* 'Bailey', 'Cardinal', 'Flavramea')
- Leatherwood (*Dirca palustris*)
- Large Fothergilla (*Fothergilla major*)
- Oakleaf Hydrangea (*Hydrangea quercifolia*)
- Annabelle Hydrangea (*Hydrangea arborescens* 'Annabelle')
- St.John's Wort (*Hypericum kalmianum*)
- ◆Sweetspire (*Itea virginica* 'Henry's Garnet')
- ◆Sparkleberry Winterberry Holly (*Ilex verticillata* 'Sparkleberry')
- Spicebush (*Lindera benzoin*)
- Shining Sumac (*Rhus copallina* 'Prairie Flame')
- ◆Hardhack (*Spiraea tomentosa*)
- ◆Arrowwood Viburnum (*Viburnum dentatum* 'Chicago Lustre', 'Northern Burgundy', 'Blue Muffin', 'Red Feathers',)
- ◆Smooth Witherrod Viburnum (*Viburnum nudum* 'Winterthur')

Non Native Medium Shrubs 4'-8'

Five Leaved Aralia. (*Acanthopanax sieboldianus*)
Flowering Quince (*Chaenomeles speciosa* 'Texas Scarlet', 'Cameo')
Contorted Filbert. (*Corylus avellana* 'Contorta')
Sunrise Forsythia. (*Forsythia* 'Sunrise')
Weeping Forsythia (*Forsythia suspensa*)
Panicled Hydrangea. (*Hydrangea paniculata* 'Tardiva', 'Limelight')
Gibraltar Bushclover (*Lespedeza thunbergii* 'Gibraltar', 'Avalanche')
Chinese Neillia. (*Neillia sinensis*)
Gnome Pyracantha (*Pyracantha* 'Gnome', 'Kasan', 'Lowboy')
Ural False Spirea. (*Sorbaria sorbifolia* 'Sem')
Grefsheim Spirea. (*Spiraea x cinerea* 'Grefsheim')
Vanhoutte Spirea. (*Spiraea x vanhouttei*)
Snowmound Spirea. (*Spiraea nipponica* 'Snowmound')
Dwarf Korean Lilac (*Syringa meyeri* 'Palibin')
Miss Kim Lilac (*Syringa patula* 'Miss Kim')
Korean Spice Viburnum. (*Viburnum carlesii*)
Judd Viburnum. (*Viburnum x juddii*)
Eskimo Viburnum. (*Viburnum x* 'Eskimo')
Chaste Tree. (*Vitex agnus-castus*)
Old Fashioned Weigela (*Weigela florida* 'Variegata', 'Wine and Roses')

Native Shrubs under 4'

♦Black Chokeberry (*Aronia melanocarpa* 'Iriquois Beauty', 'Viking')
♦Compact Sweetshrub. (*Clethra alnifolia* 'Hummingbird', 'Sixteen Candles')
♦Red Sprite Winterberry (*Ilex verticillata* 'Red Sprite', 'Afterglow'. 'Shavers'(need a male to pollinate female for fruit set.))
♦Henry's Garnet Sweetspire (*Itea virginica* 'Henry's Garnet')
♦Little Henry Sweetspire (*Itea virginica* 'Little Henry')
Dwarf bush Honeysuckle (*Diervilla lonicera*)
Southern Bush Honeysuckle (*Diervilla sessilifolia*)
Dwarf Fothergilla (*Fothergilla gardenii*)
Fragrant Sumac (*Rhus aromatica* 'Gro Low'; 'Green Globe')
Flowering Raspberry. (*Rubus odoratus*)
Indian Currant (*Symphoricarpos orbiculatus*)
Indian Currant (*Symphoricarpos x chenaultii* 'Hancock')
♦Yellowroot (*Xanthorhiza simplicissima*)
Sunburst St. John's Wort (*Hypericum frondosum* 'Sunburst')
Jetbead. (*Rhodotypos scandens*)

Non Native Shrubs under 4'

Glossy Abelia. (*Abelia x grandiflora*)
Purple Beautyberry. (*Callicarpa dichotoma* 'Issai', 'Early Amethyst')
Jet Trail Quince (*Chaenomeles speciosa* 'Jet Trail')
Cranberry Cotoneaster. (*Cotoneaster apiculatus*)
Bearberry Cotoneaster. (*Cotoneaster dammeri* 'Coral Beauty')
Golden Peep Forsythia. (*Forsythia* 'Golden Peep')
Kirilow Indigo. (*Indigofera kirilowii*)
Japanese Spirea. (*Spiraea japonica* 'Little Princess', 'Goldmound')
Bumald Spirea. (*Spiraea x bumalda* 'Goldflame')
Conoy Viburnum (*Viburnum x* 'Conoy')

Native Evergreen Trees

American Holly (*Ilex opaca*)
Eastern Red Cedar (*Juniperus virginiana* 'Carnaeartii'; 'Burkii'; 'Emerald Sentinel')
Southern Magnolia (*Magnolia grandiflora* 'Bracken's Brown Beauty'; 'D.D. Blanchard')
Evergreen Sweetbay Magnolia (*Magnolia virginiana* var. *australis* 'Northern Belle', 'Henry Hicks')
White Pine (*Pinus strobus*)
Eastern Arborvitae (*Thuja occidentalis*)
Canadian Hemlock (*Tsuga canadensis*)

Non Native Evergreen Trees

Nordman Fir (*Abies nordmaniana*)
Cedar of Lebanon (*Cedrus libani* var. *stenocoma*)
Needled Juniper (*Juniperus rigida*)
Norway Spruce (*Picea abies*)
Blue Spruce (*Picea pungens* 'Hoopsi', 'Fat Albert', 'Moerheim')
Lacebark Pine (*Pinus bungeana*)

Swiss Stone Pine (*Pinus cembra*)
Tanyosho Pine (*Pinus densiflora* 'Umbraculifera')
Limber Pine (*Pinus flexilis* 'Vanderwolf's Pyramid')
Austrian Pine (*Pinus nigra*)
Japanese White Pine (*Pinus parviflora* 'Glaucua')
Scots Pine (*Pinus sylvestris*)
Douglas Fir (*Pseudotsuga menziesii*)
Western Arborvitae (*Thuja plicata* 'Spring Grove', 'Green Giant')

Evergreen Shrubs

Boxwood (*Buxus* 'Wintergreen', 'Winter Gem', 'Green Velvet', 'Green Mountain', 'Vardar Valley')
Blue Holly (*Ilex x meserveae* 'Blue Prince', 'Blue Princess')
Grey Owl Juniper (*Juniperus virginiana* 'Grey Owl')
Spreading Juniper (*Juniperus chinensis* 'Sea Green', 'Old Gold', 'Gold Star',)
Blue Pacific Juniper (*Juniperus conferta* 'Blue Pacific')
Blue Rug Juniper (*Juniperus horizontalis* 'Wiltonii')
Oregon Grapeholly (*Mahonia aquifolium* 'Compacta')
Mugo Pine (*Pinus mugo*)
Japanese Yew (*Taxus x media* 'Runyan', 'Wardi', 'Densiformis')
Karen's Azalea (*Rhododendron* 'Karen's')

Native Vines

Cross-vine (*Bignonia capreolata* 'Tangerine Beauty')
Trumpet Creeper (*Campsis radicans* 'Flava', 'Mme Galen')
Virgin's Bower (*Clematis virginiana*)
Trumpet Honeysuckle (*Lonicera sempervirens* 'Magnifica', 'Blanch Sandman', 'John Clayton')
Virginia Creeper (*Parthenocissus quinquefolia*)
Amethyst Falls Wisteria (*Wisteria frutescens* 'Amethyst Falls')
Kentucky Wisteria (*Wisteria macrostachys*)

References:

"Guidelines for Utilizing Rain Gardens as a Stormwater Management Tool in the Metropolitan Sewer District of Greater Cincinnati" [http://hamilton.osu.edu/Horticulture_Floriculture/guidelines-for-utilizing-rain-gardens] and [<http://www.hcswcd.org/newsltr/MSDManualDraft.pdf>]



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