Rain Garden

Design and Construction

A Northern Virginia Homeowner's Guide

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Glossary:

Drain Sleeve - A sleeve of loosely woven, elastic material that fits over a perforated drain pipe and prevents it from clogging
Drip line - The area underneath the entire branch network of a tree which is approximately equal to the critical root zone
Geotextile - A fabric that is stapled or otherwise attached to the ground to prevent the erosion of the underlying soil
Grade - The slope of an object, expressed as vertical rise over horizontal run
Impervious - Unable to let water pass through
Infiltrate - To pass through
Infiltration Rate - The speed by which water can pass through soil, generally measured in inches per hour
Mulch - A covering placed on a ground surface to prevent erosion and weeds and to provide insulation and decomposable organic matter
Pervious - Able to let water pass through
Ponding Depth - The maximum depth of standing water above the soil surface in your rain garden
Porous - Full of pores and easy to infiltrate
Saturation - The point at which soil can hold no more moisture
Soil compaction - The increase in soil density and decrease in soil porosity and infiltration rate that result when weight is applied to the soil surface
Swale - A shallow ditch
Water Table - The zone of soil and rock saturated with ground water

A rain garden adds form and function to an elementary school's landscape.

What is a Rain Garden?

A rain garden is a functional landscaped area constructed to capture and hold stormwater so that it infiltrates into the soil rather than becoming surface runoff. Rain gardens not only beautify an area, they bring larger benefits to the environment, both locally and beyond.

How to Use This Guide

Rain garden style is a matter of individual taste, but rain garden function is the result of careful planning and measurement. The goal of a properly functioning rain garden is to reduce polluted stormwater runoff and recharge the water table. This guide provides technical and practical information to help you set reasonable goals and build the rain garden that functions best at your site. Where technical detail is needed, it is provided, but the final decisions - including appearance, size, and construction techniques - are up to you!

Rain Gardens

Why the Need?

In natural landscapes there's very little stormwater runoff because most rainwater filters down through the soil or evaporates back into the atmosphere. In developed landscapes' compacted soils, impervious surfaces like asphalt and the removal of vegetation result in a huge increase in stormwater runoff. Runoff flows over developed surfaces, enters storm drains and is piped to the nearest stream. The fast-flowing polluted runoff scours away stream banks, widens and deepens the channel, and blankets downstream areas with the dislodged sediment. The deepened stream channel lowers the water table so that nearby vegetation may suffer drought or even death.

Eroded stream banks caused by excess stormwater runoff.

Rain gardens try to re-create the natural water cycle and reduce water quality problems. A rain garden is a shallow, landscaped basin that pools stormwater runoff on its surface allowing it to slowly infiltrate into the soil. Infiltration through the soil removes solid and dissolved pollutants. Some of the filtered stormwater recharges the groundwater while some is held in the pore spaces between the soil particles and rocks. Both groundwater and pore space water are available to plants.

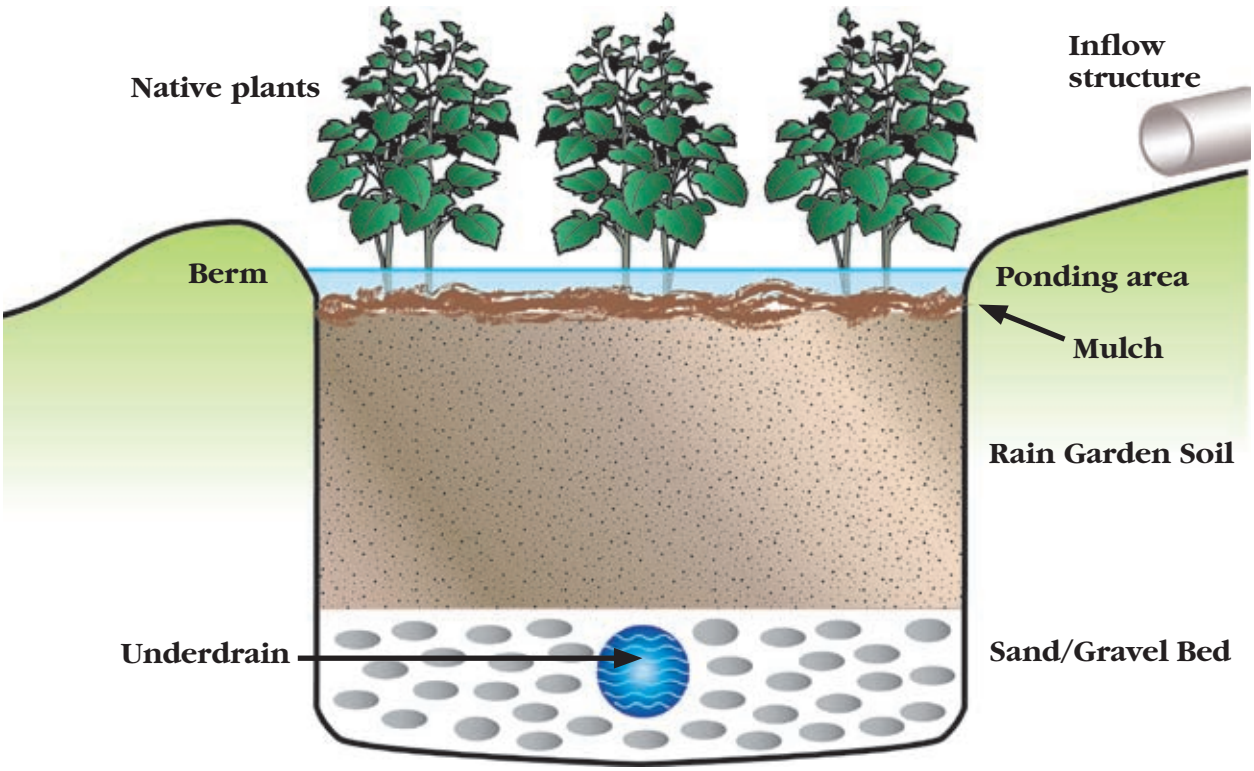
The Structure

A rain garden consists of several standard features.

- The inflow structure directs stormwater to the rain garden. The inflow can be a gutter downspout, a grassed or stone lined swale, or any other mechanism that can direct runoff to the rain garden without causing erosion.
- The ponding area is the basin that allows stormwater to collect on the rain garden's surface. The depth of the ponding area is created by excavating soil from the surface and building up an earthen berm on the downslope edge of the garden.
- A thin layer of mulch lies on the rain garden's surface. Mulch filters out many of the pollutants found in stormwater and physically protects the underlying soil.
- The rain garden is planted with native plants that tolerate periodic inundation. Native plants need less maintenance, take up some of the stormwater and pollutants, are acclimated to local growing conditions, provide habitat and food for native species and improve the aesthetics of the garden.
- The rain garden soil filters the polluted stormwater, stores some in its pores, and lets the rest flow

to the groundwater. Soils with naturally high infiltration rates are desirable as they can filter a large volume of stormwater quickly.

- *Optional:* A gravel bed is useful at the bottom of rain gardens built in soil with slow infiltration. The bed allows for increased storage of stormwater and prevents water logging in the layers above.
- *Optional:* A perforated PVC underdrain is necessary for rain gardens built in soil with slow infiltration. An underdrain pipes excess water out of the rain garden and is the surest way to prevent back up and flooding in the garden.
- The overflow structure allows water to exit the rain garden when the ponding area becomes full. The overflow structure can be a rock-lined notch in the berm, a grass lined swale, or anything that will allow stormwater to leave the ponding area without causing erosion. If the berm is built strongly enough and erosion is not a concern, you can let the ponding water flow over the top of the berm with no further modifications.



Designing Your Own Rain Garden

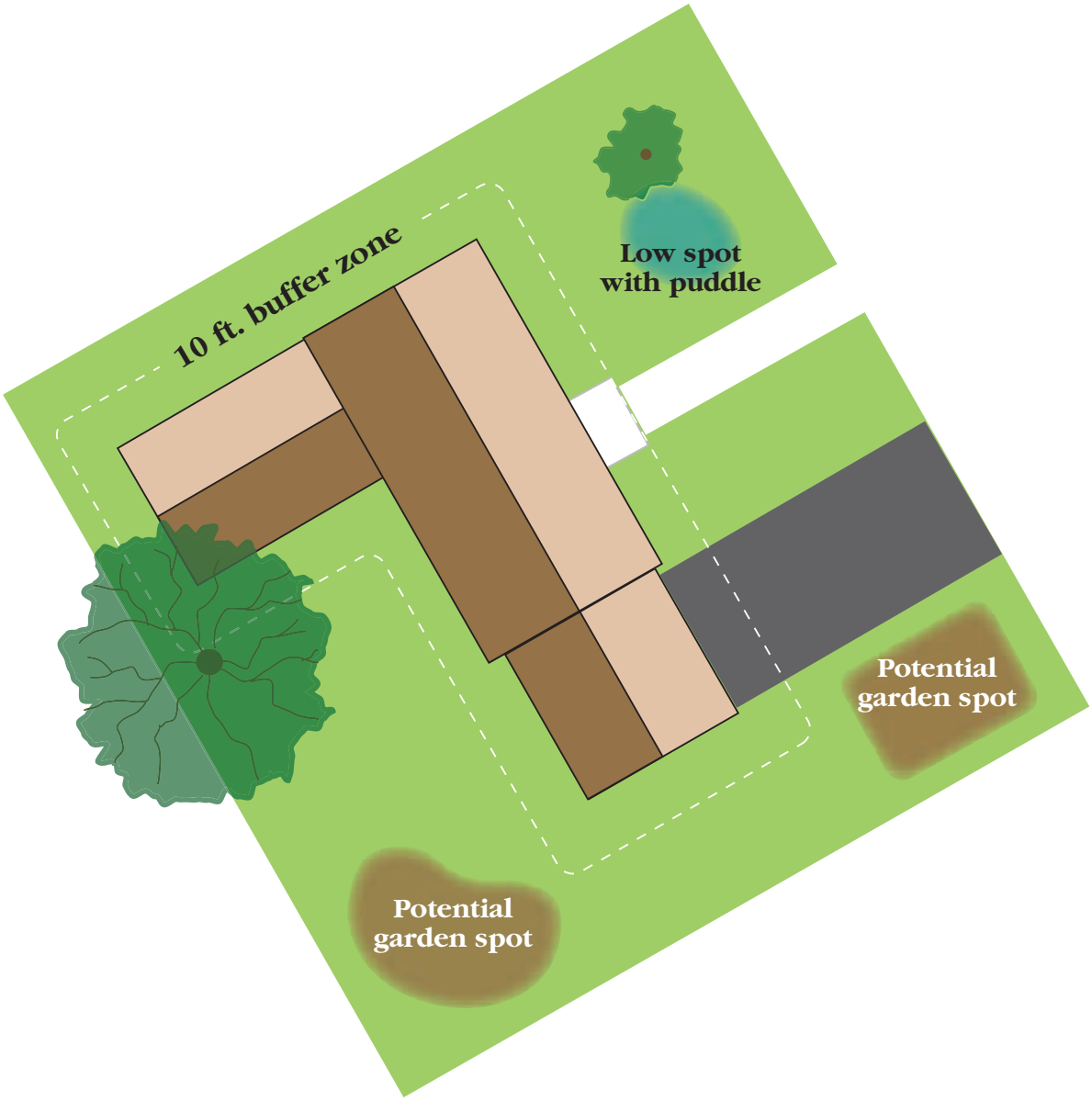
A rain garden is an advanced do-it-yourself project that requires hard labor, but no special skills beyond the guidance and calculations offered in this guide. Landscaping or engineering firms can also do the job for you. If you hire a professional, use this guide to familiarize yourself with the types of decisions that will be made.

Location of Your Rain Garden

When placing a rain garden, some areas should be avoided.

- Rain gardens should be a minimum of 10 feet from structures (yours and your neighbor's) to prevent seepage into the foundations.

- Locate the rain garden outside of a tree's drip line to avoid cutting roots.
- Do not place a rain garden near a septic system.
- Keep the rain garden away from utility lines and any easements. Before you dig, contact Miss Utility at 811 to have utility locations marked. Easement locations are noted on your property plat which is available from the Zoning Permit Review Branch: (703) 222-1082, TTY 711.
- Do not place a rain garden in a spot where water pools after a storm. Puddled water is a sign of slow soil infiltration. Building a rain garden in such soil is difficult. If you wish to eliminate an existing puddle, build a rain garden upslope to intercept the runoff.
- Do not build a rain garden in soil that has a high water table. For a description of the soil in your yard, reference the soil survey (http://www.fairfaxcounty.gov/nvswcd/soilsinfo.htm) or call the Conservation District, 703-324-1460.
- Since a rain garden surface must be flat, the amount of grading required during construction increases with slope. Rain gardens should not be built on land with a slope greater than 15%.

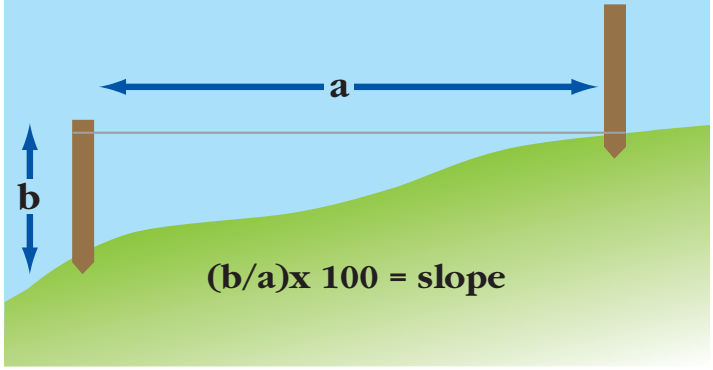


After eliminating the unsuitable spots, note your property's high and low areas and slope. During the next big rain, observe where runoff flows. To narrow down potential locations for your rain garden, consider the following:

- What runoff will you be collecting? For instance, will your rain garden be capturing runoff from the roof, the driveway, the lawn or a combination? The closer you locate the garden to the flow path of the runoff, the easier it will be to direct the runoff into the garden.
- Will any runoff from neighboring properties flow to your rain garden? Careful! Capturing runoff from other properties may greatly increase the volume of stormwater and the size of the rain garden needed to treat it.
- Keep in mind the type of native plants you wish to have in your rain garden and whether or not they are suited for the location you choose. Is there adequate sunlight? If your rain garden will be receiving runoff from surfaces that may be salted during winter weather, will this harm the plants? Will the plants blend in with your existing landscaping? A list of common native rain garden plants can be found in *Appendix B*.

Measuring Slope

- Pound two stakes into the ground; one at the uphill side of your rain garden and one at the downhill side.
- Tie a string to the uphill stake at ground level.
- Tie the other end of the string to the downhill stake, ensuring the string is level.
- Measure the width in inches between the two stakes (a).
- Measure the height in inches from the ground to the string of the downhill stake (b).
- Divide the height (b) by the width (a) and multiply by 100 to calculate the percentage slope of the land.



Testing the Soil

Once you have identified possible locations for your rain garden, test the soil. The success of your rain garden depends heavily on the infiltration rate of the soil. You can determine the rate with a simple procedure.

- Dig a 12-inch deep hole at the proposed site of your rain garden and fill it completely with water.
- Allow the water to sit for at least an hour so that the soil can saturate.
- Refill the hole so it is full.
- From this point on, observe to see if the water drains into the soil.
- If the water drains within 48 hours, the site is suitable for a rain garden, however it is highly recommended that the soil be amended with some compost and sand.
- If the water does not drain in 48 hours, select a different location or amend or replace the soil and install an underdrain. It may be easier to choose another location.
- You may choose to run the infiltration test more than once, in the same hole or in different holes, to ensure an accurate result.

The county soil survey and a soil texture test can be used as supplements to the infiltration test. The sur-

Remember, it is much less complicated to construct a rain garden in soil with a quick infiltration rate. Construction becomes more difficult when the infiltration is slow. Slow infiltration can be caused by high percentages of clay, soil compaction, or both; features which are common in Northern Virginia soils.

vey includes likely infiltration rates for your property, and a texture test measures the soil's percentage of sand silt and clay. Call the Conservation District for help with either resource.

Altering the Soil

Based on the infiltration test results, soils can be altered to make the rain garden more efficient. There are two ways to do this: 1) amend the natural soil with compost or a mixture of compost and sand to make it more porous, or 2) completely excavate and replace the natural soil with an engineered mixture of sand, topsoil and organic matter.

Amending soil is fairly easy with equipment such as a hoe or a rototiller. Removing and replacing soil is expensive and should be used only in the poorest soils.

In soils that pass the 48-hour infiltration test, it is highly recommended, but not required, that you incorporate 6 to 12 inches of compost and sand into the soil during construction. Most of the soil in Northern Virginia has a high clay content, and, over time, may become compacted and less porous due to the weight of the water that is collected in the rain garden. Think of amended soil as an insurance policy for the future performance of your rain garden. An underdrain can be installed at these sites, but it is optional. A gravel bed is not recommended due to the increase in excavation it requires.

In soils that do not pass the 48-hour infiltration test, you can still install a rain garden as long as you increase the infiltration rate of the soil. If you add amendments, incorporate at least 18 inches of compost and sand into the soil. For the poorest soils - those with a very high clay content and/or those that failed to drain the majority of water in 48 hours - removing and replacing the soil may be necessary. To justify the time and expense, it is recommended that you excavate and replace the soil to a depth of at least 24 inches. Be aware that the volume of soil excavated from a medium-sized rain garden is often enough to fill a dump truck. A small piece of construction equipment, such as a mini-excavator, will greatly ease the process. Engineered soil mix is available from landscaping and engineering companies. Contact the Conservation District for help finding a vendor.

An underdrain is essential in any rain garden installed in soil that does not pass the infiltration test. After the natural soil is amended or excavated, stormwater will infiltrate quickly through the altered soil. However, it will not drain through the natural soil underneath (a process called "perching"). An underdrain removes the perched water and prevents the rain garden from backing up and becoming a soggy mess. A gravel bed below the rain garden can help to increase the

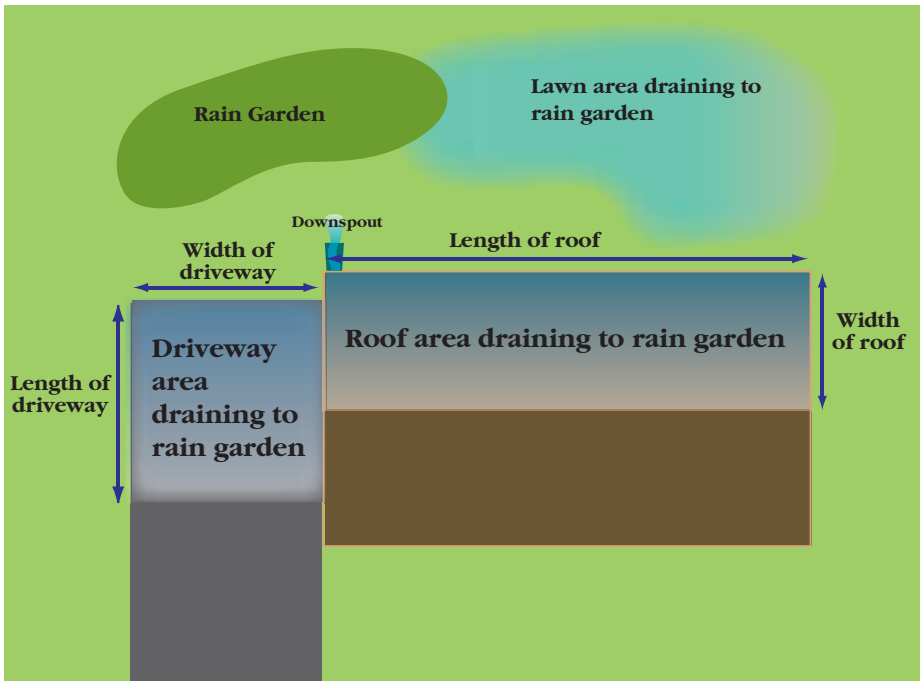
A rototiller is used to incorporate compost into the soil of a large rain garden in McLean.

storage capacity. Installing a gravel bed entails excavating, if just temporarily, all of the soil above it. This is time consuming and likely will require construction equipment. If you are planning to excavate and replace the natural soil anyway, then adding a gravel bed requires little extra effort.

Sizing Your Rain Garden

The size of your rain garden depends on the area and type of land that drains to the garden as well as the amount of stormwater that you wish to treat. Ninety percent of storms in Fairfax County produce less than one inch of rainfall; therefore, sizing calculations included in this manual are based on a one-inch storm. During storms that produce more than one inch of rain, your rain garden may overflow. This is normal. Of course, you may choose to make your rain garden any size. A smaller rain garden will capture less stormwater and will overflow more frequently but will still benefit water quality. In general, 100 to 300 square feet is a practical size for homeowner designed rain gardens.

The area that drains to your rain garden is called the drainage area. The type of land surface (pervious, such as lawn, or impervious, such as rooftop or driveway) affects the amount of runoff. More runoff occurs on impervious surfaces than pervious. Generally, the entire drainage area should be one-half acre or less to keep the total runoff volume reasonable. To calculate your rain garden's drainage area, follow these basic steps and record your data on the sizing worksheet in *Appendix A:*



- If you are capturing roof runoff, determine the surface area of the roof that will drain to the rain garden by measuring the length and width of the portion of the roof that drains to the downspout(s) routed to your rain garden. Multiply those numbers and record the result on line 1 of the sizing worksheet.
- If you are capturing runoff from driveways, patios or other impervious surfaces, measure their length and width. Multiply those numbers to get the surface area. Record this result on line 2 of the worksheet.
- To get the total impervious surface area, add lines 1 and 2. Put the sum on line 3 of the worksheet.
- If you are capturing runoff from pervious surfaces such as your lawn, determine the surface area that will drain to the rain garden and record it on line 4 of the worksheet. If you need help determining the parts of your lawn that will drain to the rain garden, observe your property's runoff patterns during a storm. The Conservation District can supply helpful topographic maps.
- Decide on the depth of your ponding area. That depth is the distance from the top of the berm to

the rain garden soil (not the mulch). It is recommended that the depth be between 6 and 12 inches. The ponding area depth determines the rain garden's depth factor, a number which is used in the final sizing equation. Because the amount of stormwater a rain garden can hold is equal to the ponding area depth multiplied by the rain garden's surface area, the deeper the ponding area depth, the smaller the rain garden surface area can be. However, be sure the underlying soil can reliably drain the deeper depth of water in a reasonable period of time. Once you have chosen a ponding area depth, look up the corresponding depth factor in table 1 and record it on line 5 of the sizing worksheet.

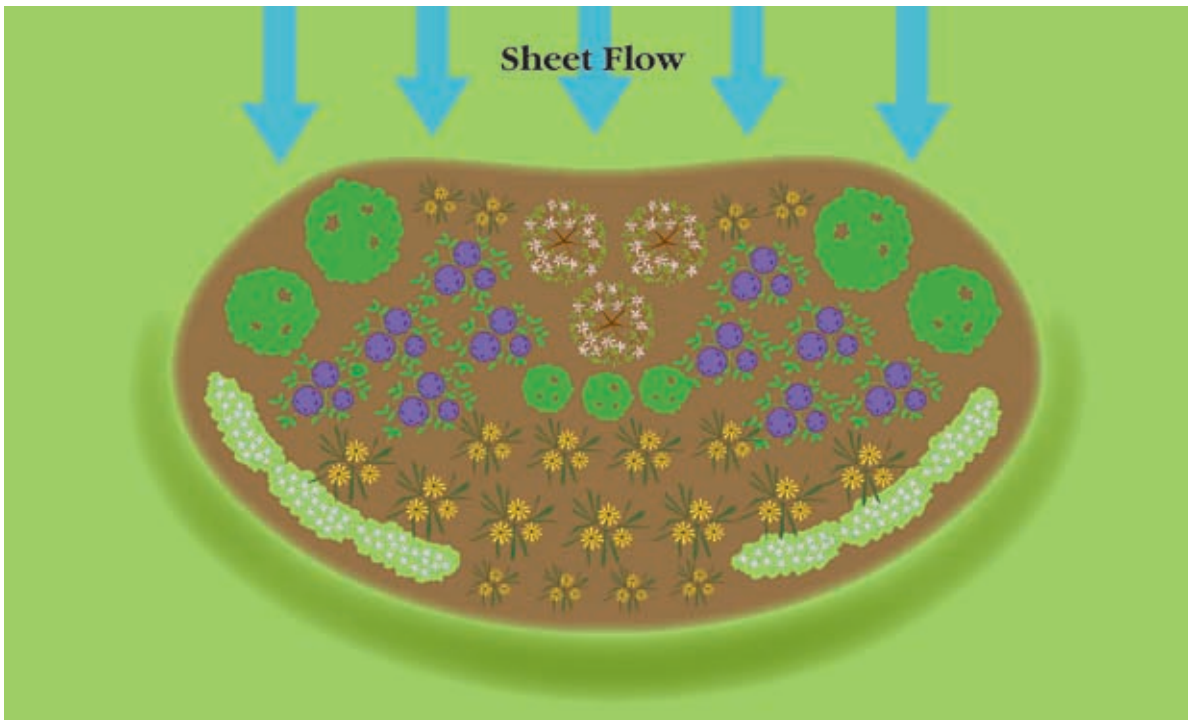
Table 1: Depth

Ponding Depth	6"	9"	12"
Depth Factor	2.0	1.3	1.0

- Next, calculate the size of the rain garden needed to capture and treat the runoff during a one-inch storm. To do this, multiply the impervious (line 3) and pervious (line 4) drainage areas by the depth factor (line 5) and a runoff estimator. The runoff estimator is a number that estimates the proportion of rainfall that is likely to become surface runoff. For impervious surfaces, the estimator is 0.072; for pervious surfaces, 0.028. The results go on lines 6 (impervious surfaces) and line 7 (pervious surfaces).
- If the rain garden will be capturing runoff from both pervious and impervious surfaces, add lines 6 and 7. Put the sum on line 8. That's the total rain garden surface area. If you are only capturing runoff from one type of surface, the relevant surface area calculated in line 6 or 7 represents your total rain garden surface area

Shape

A rain garden can be any shape as long as it successfully captures the runoff and integrates into your current landscaping. The flow pattern of the runoff can determine the most effective design. In general, if you have runoff that flows in a wide swath, a rain garden that is wider than it is long, with the width perpendicular to the flow of the runoff, is best.



Plants

Native plants that are tolerant of wet and dry conditions are best suited for rain gardens. Native plants are adapted to the local environment, do not need extra water or fertilizer once they are established, provide food and habitat for wildlife and are attractive to pollinators. It is not recommended that you plant full size trees in your rain garden. *Appendix B* has a list and description of many native plants suitable for rain gardens. Your local nursery also may provide advice. In addition to the sunlight and salt considerations mentioned earlier, consider these factors when deciding on a plant list:

- Height and width of full grown plants
- Color and type of seeds, berries, flowers or other growth
- Seasonal timing of growth so that color and wildlife food are available year round
- Species of wildlife you wish to attract
- Coordination with existing landscaping.

Clockwise from top left: foxglove, smooth blue aster, partridge pea, swamp milkweed.

Construction of Your Rain Garden

Setting the schedule

Building a rain garden is a big job. Ask family, friends and neighbors to help. Check the weather forecast and be sure that rain isn't predicted during construction. Rain will complicate construction and cause sediment from the site to wash into nearby storm drains and streams. Make sure all material and equipment is onsite and ready to be used when construction starts.

You may hire a landscaping company or contractor to do the construction. Be sure that any professionals you hire are aware of your rain garden's specific design criteria.

Site Preparation

Before construction, contact Miss Utility at 811 to get your utilities marked. You may also want to clear the vegetation off the rain garden surface area and the planned footprints of the berm and any swales or other structures you will dig to create the inflow and overflow.

Mark the borders with stakes, flags or spray paint. The vegetation, especially if it is grass or other ground cover, can be killed by placing plastic, newspaper or any opaque material over it. Killing the vegetation will make excavation significantly easier if you are digging by hand. It also will ensure that the berm is

solidly anchored to the ground surface. Allow at least one week for utility marking and vegetation clearing. Remove any material you used to kill the grass before digging; you don't want to incorporate it into the berm or rain garden.

Choosing Materials

If you need to amend your soil, figure out the type and amount of soil amendments you will use and arrange to pick them up or have them delivered. A mix of half sand, half compost is ideal in most rain gardens. Sand is best at increasing the infiltration rate of soil over the long term, but it is heavy, hard to transport and has no effect on soil fertility. Compost increases infiltration rates less reliably than sand, but it increases soil fertility and is relatively light and easy to transport. If you decide to completely excavate and replace the natural soil, a variety of soil mixes are available, but all will consist of a mixture of sand, topsoil with very little clay and organic compost.

You also will need to obtain mulch. If your design includes an underdrain and a gravel bed, you will need a perforated plastic pipe (either corrugated downspout pipe or PVC) and either pea gravel or V-DOT #57 stone (a specific size of gravel often used in road construction). Underdrains built into the rain garden soil are surrounded by a thin layer of gravel to prevent them from becoming clogged with loose soil particles. If you include an underdrain, you will need stone even if you aren't installing a gravel bed. Larger stone, such as river rock, can be used if you are building a stone-lined inlet or outlet structure or if you are using it as a decorative feature.

Free composted leaf mulch and shredded hardwood mulch are seasonably available from Fairfax County. Composted leaf mulch is an excellent soil amendment and is suitable for the surface mulch layer. Hardwood mulch can be used for the surface mulch layer but may float when the rain garden fills with water. For pickup locations, see www.fairfaxcounty.gov/dpwes/trash/dispmulch.htm. Sand, compost, mulch, perforated pipe, pea gravel, V-DOT #57 stone and river rock can be purchased from hardware stores, gardening and landscaping supply stores or nurseries.

Volume of Materials

Once you have chosen your materials, you will need to know how much to buy. You also may want to know how much natural soil will be excavated from the rain garden, especially if it is to be hauled away. These volumes can be calculated by using this equation:

$$V = SA \times (T/12).$$

V is the total volume of material needed, SA is the surface area of the rain garden in square feet, and T is the thickness of the material in inches.

By now, you know the planned surface area of your rain garden. The thickness (T) of the layers in your rain garden is at your discretion, but there are general guidelines to ensure the garden's proper functioning.

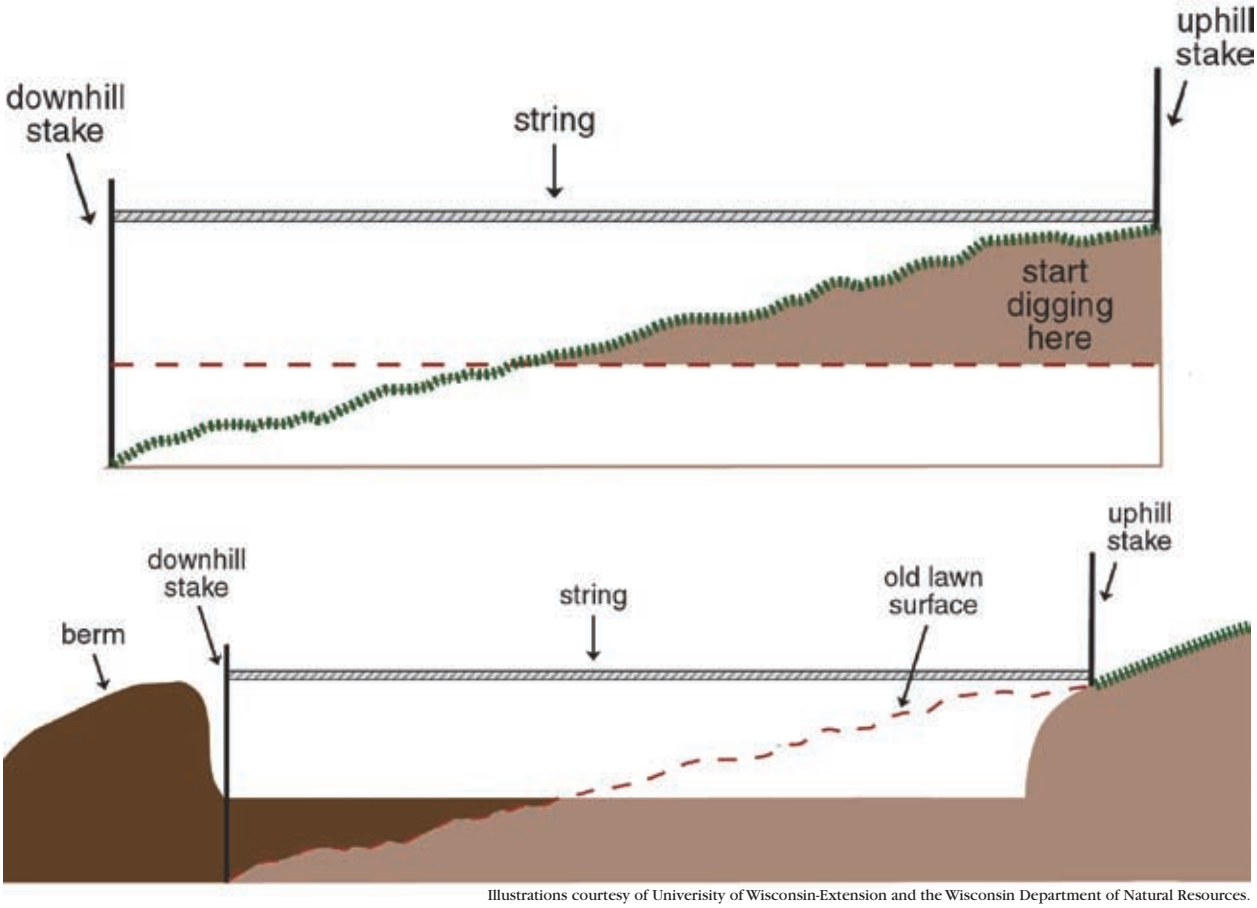
- Mix at least 6 to 12 inches of amendments into the soil for sites that pass the 48-hour infiltration test, and at least 18 inches for sites that do not pass.
- If you excavate and replace the natural soil with engineered soil, remove and replace at least 24 inches to justify the time and expense.
- The mulch layer should be 2 to 3 inches thick.
- The gravel bed, if used, should be at least 6 to 12 inches thick.

- Before mixing in soil amendments, you will have to remove some natural soil to make room for the new material. Compost compacts over time when tilled into soil, but sand does not. No soil needs to be removed to compensate for compost. If adding sand, however, remove soil equal to the amount of sand being added. If the amendments raise the soil up too high and the depth of your ponding area is less than you want, compensate by raising the height of the berm or removing a little soil from the rain garden surface. Alternatively, wait a day or two to see if the amended soil begins to compact and recede. If the ponding area is too deep, add more amendments to the soil or reduce the berm's height.

There is one exception to using the equation. In calculating the volume of soil you will need to excavate for the ponding area, if the land surface at your site is sloped, the equation is not applicable. If the land surface is flat or nearly flat, the equation can be used. Since most, if not all, of the soil removed to create the ponding area will be used to build the berm, this is a minor issue.

Start Digging!

You can now begin to dig out your rain garden! Whether you dig down two or more feet and replace the soil with an engineered soil mix or excavate just a few inches to create the ponding area on top of well-draining natural soil, it is very important that the bottom of the excavation and all layers within the rain garden be as flat as possible. This provides the calculated amount of ponding and minimizes pressure against the berm.



Illustrations courtesy of Univerisity of Wisconsin-Extension and the Wisconsin Department of Natural Resources.

A stone-lined swale serves as the inlet structure for a rain garden in Merrifield.

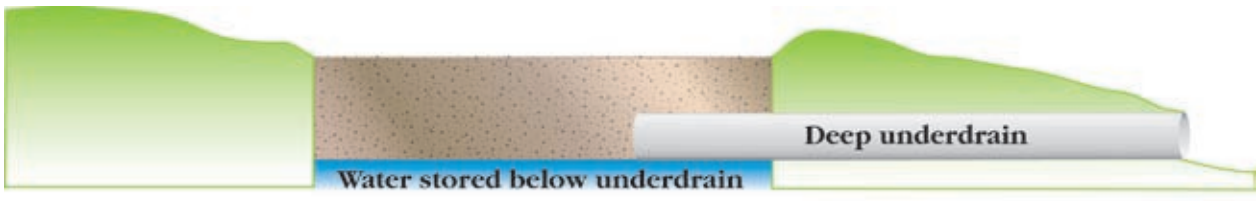
A flat surface can be assured by a simple method similar to the one used earlier to determine slope. Assemble stakes and tie a level string between them just as described in the slope method. This time, use a tape measure or yard stick to measure the distance from the string to the bottom of the excavation. When the desired depth is reached, stop digging. This measurement can be repeated for all areas of the rain garden by keeping the upslope stake in place and moving the downslope stake around the perimeter of the rain garden. The rain garden can then be dug out like slices of a pie.

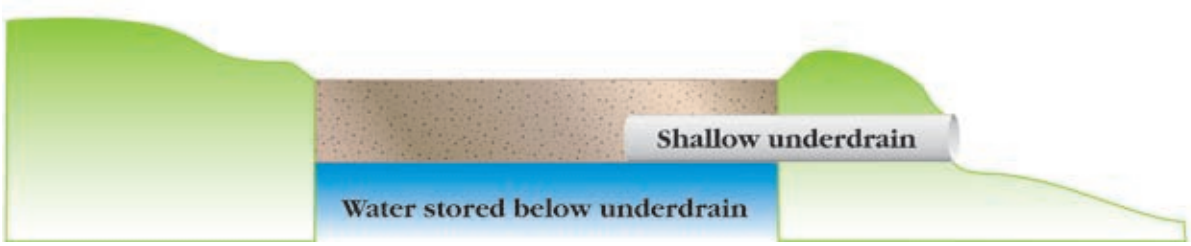
The point where the string is tied to the downslope stake is equal to the height of the berm at that location. Soil excavated from the rain garden can be used to build the berm. On steeper slopes where more material must be excavated, the extra soil can be used to raise the ground level on the downslope side.

At the same time that you excavate the rain garden, you can dig the inflow and overflow structures. If the rain garden is in the path of stormwater flow, or if you plan to route water to the garden by means of a downspout extension, you may need to dig little, if at all. If you are building rock-lined structures, placing geotextile material under the rocks will prevent stormwater from eroding the underlying soil.

The Underdrain

The underdrain should be placed at least several inches below the surface. The underdrain captures water as it fills the rain garden. Water rising from below enters the underdrain and is piped to an outlet downslope of the rain garden. The underdrain must maintain a small, constant downward grade so that water flows freely out of the rain garden. There is an advantage to placing the underdrain towards the top of the rain garden; the higher the underdrain is placed, the less distance the pipe travels underground before it reaches the surface. An underdrain too near the top of the garden may lead to surface sogginess in and around the garden.

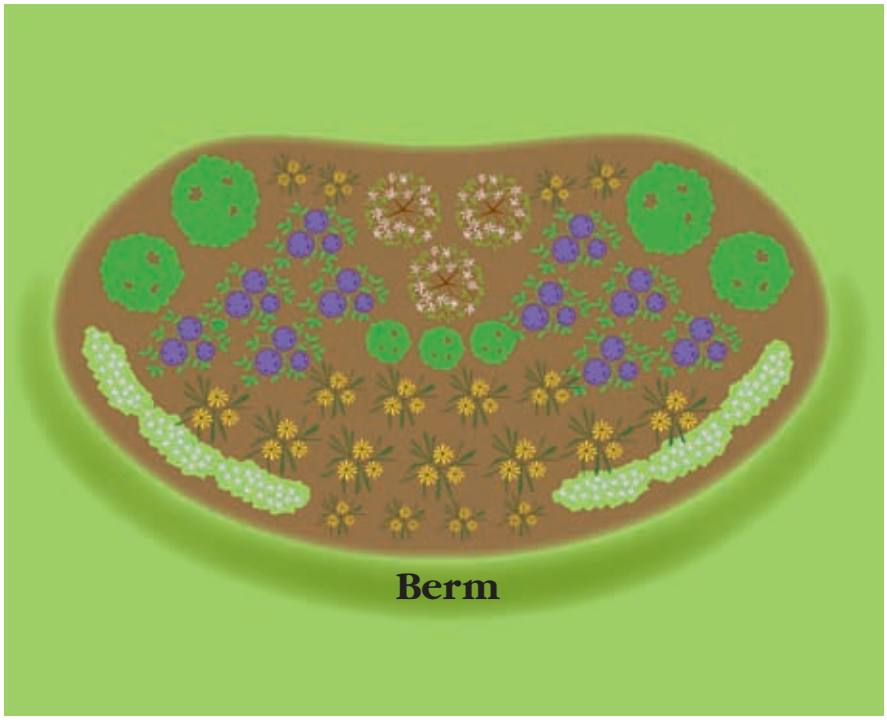




Remember to surround your underdrain on all sides with a thin layer of pea gravel or VDOT #57 stone. This layer will help filter out small particles that may clog the underdrain's perforations. You may further protect the pipe by wrapping it with a drain sleeve or several layers of chicken wire before surrounding it with gravel. Do not wrap the underdrain with geotextile or other tightly woven material. This will cause the pipe to clog.

The Berm

Excess soil from the excavation can be used to construct the berm. The distance from the top of the berm to the rain garden soil (not the mulch) is equal to the ponding area depth. The berm will be tallest along the downslope edge of the rain garden and will gradually taper down to nothing on the upslope edge where storm water enters the rain garden. Remove any vegetation from the ground and roughen the existing soil surface. Build up the berm in layers by placing a few inches of excavated soil on the ground and compacting it firmly with a hand tamper or the back of a shovel. Repeat this process until a gently rounded, solid and aesthetically pleasing berm is formed. To prevent erosion, immediately seed the berm with grass and cover it with an erosion prevention material such as straw or burlap while the grass takes root. You may also choose to cover it with sod. Failure to cover the berm may result in a breach or erosion of the berm into your rain garden and clogging of the rain garden soil! If you do not want grass on the berm, one option is to plant with drought tolerant native plants that prefer well-drained soils.



Native plants are placed in a rain garden in Falls Church.

Planting

Try to avoid stepping in your garden as much as possible. Dig the planting holes shallow and wide, and place the plants in them. Fill the holes gently but firmly, but do not step on them. Water the plants immediately after installation regardless of the soil conditions. Stick identification tags in the soil next to the plants and leave them there until the plants' warranties have expired. Plant shrubs a minimum of three feet apart; perennials and annuals at least one foot apart. Rain gardens do not have to be planted immediately, but if you are delaying your planting, cover the soil with the mulch layer. If you are planting after the mulch has been laid, remove the mulch around the planting hole and plant according to the directions above, then replace the mulch.

For any areas of bare soil adjacent to the rain garden - such as the inflow and overflow - re-vegetate immediately following the same planting procedures used for the berm. This is especially important for areas uphill of the rain garden that can erode into and clog the rain garden's soil.

Mulching

Spread mulch on the surface of the rain garden no more than 2 to 3 inches deep. Mulch helps to maintain soil temperature and moisture, control weeds, filter pollutants - especially heavy metals - and protect against erosion and surface crusting. Additionally, as the mulch breaks down, it adds organic matter to the soil. The mulch should be applied in an even layer across the entire surface of the rain garden.

Straw covers the berm and soil around a recently built rain garden. The white PVC pipes allow for inspection of the underdrain and are not part of most home gardens.

Establishment Phase

Erosion of fine soil particles into your rain garden can lead to clogs, and erosion of the berm or overflow structure can lead to a breach. To avoid this, you may choose to disable your inflow structure to prevent runoff from entering your rain garden until the vegetation, both inside and outside the rain garden, is well established. If you are using a downspout connection, disconnect it from the gutter or reroute it. If you have built a swale, block the front of it with a rock, log or other obstruction. Make sure that the redirected runoff does not cause an erosion problem elsewhere. Your rain garden will sit unused until the plants are established, but this is a small price to pay to ensure the long-term performance of your garden.

Maintenance

The maintenance requirements of your rain garden are similar to those of your regular garden and may even be less because of the native plants.

- **Plants:** Water plants regularly until they are established. Check them regularly for signs of distress and remove dead material after the growing season to add to your compost pile. Weed as necessary.
- **Berm, Inflow, and Overflow Structure:** Periodically check the berm, inflow and overflow for signs of erosion. Tamp more soil into place if you notice rills and gullies formed by erosion, and replant immediately. If the inflow or overflow structure is a stone-lined swale and erosion is occurring, you may want to install geotextile material under the stone.
- **Soil and Ponding Area:** You should not see water in your rain garden 72 hours after a one-inch storm. If water is held for longer than 72-96 hours in the ponding area, the soil pores may be clogged. Check for an accumulation of fine sediment on the mulch surface and remove it. Rough or till the top of the soil as best you can. For rain gardens built without soil amendments, if water still ponds you may have to amend the natural soil with sand and compost. If the rain garden was built with amended soil, use an auger or post hole digger to bore down to the bottom of the rain garden. If you do not have an auger, you can borrow one from the

Conservation District. If the rain garden then begins draining, fill the boring with pure sand. You may want to make more than one sand-filled boring for a large rain garden.

If you have an underdrain, it may become clogged and cause the rain garden to back up. Follow the auger/post hole boring procedures above. If the rain garden drains, a clogged underdrain can be ruled out. If the garden does not drain, dig down to expose a portion of the underdrain. Clear out any obstructions in the exposed perforations and see if the rain garden begins to drain. If it does, repeat the procedure until most or all of the perforations have been cleared.

If none of the above procedures work, you may need to excavate and replace the rain garden soil.

- **Mulch:** Check the mulch for signs of erosion and replace mulch that is washed away. Mulch will naturally decompose, so additions may be needed as frequently as once a year.

A successful rain garden is an attractive addition to the landscape.

Appendix A: Size worksheet

1. Roof surface area (length times width of roof)	_____ Sq. ft.
2. Other impervious surfaces area (length times width of other surfaces)	_____ Sq. ft.
3. Total impervious surface area (line 1 + line 2)	_____ Sq. ft.
4. Pervious surface area	_____ Sq. ft.
5. Depth Factor	_____
6. **Size of rain garden:** Impervious surfaces (Line 3 x line 5 x .072)	_____ Sq. ft.
7. **Size of rain garden:** Pervious surfaces (Line 4 x line 5 x .028)	_____ Sq. ft.
8. **Size of rain garden:** Impervious plus pervious surfaces (Line 6 + line 7)	_____ Sq. ft.

Appendix B: Native Plants

Common Name	Scientific Name	Preferred Growing Conditions		Size
		Light	Moisture	
Flowering Perennials				
Swamp milkweed	*Asclepias incarnata*	Sun-pt. shade	Moist-Wet	2-4’
Description/Notes: Rose flowers May-June, host for Monarch butterfly, attracts butterflies and beneficial insects.Can tolerate drought. Deer resistant.				
New England Aster	*Symphotrichum novae-angliae*	Sun	Moist	2-4’
Blue to lt. purple flowers Aug.-Oct., host for the Pearl crescent butterfly, attracts butterflies and bees.Tolerates drought and flooding.				
Turtlehead	*Chelone glabra*	Sun-shade	Moist-Wet	3-6’
White flowers Jul-Oct, host for Baltimore checkerspot butterfly, attracts butterflies and hummingbirds. Needs continuously moist or wet soils.				
Blue mistflower	*Conoclinium coelestinum*	Sun-shade	Dry-Wet	1-3’
Violet-purple flowers Jul-Oct, attracts bees and butterflies. Can be aggressive in the garden.				
Joe-Pye weed	*Eupatorium fistulosum*	Sun-pt. shade	Dry-Wet	3-8’
Pink-purple flowers Jul-Oct, attracts butterflies, songbirds and hummingbirds.				
Ox-eye sunflower	*Heliopsis helianthoides*	Sun-pt. shade	Dry-Moist	3-5’
Yellow flowers Jun-Sep, attracts butterflies and hummingbirds.				
Marsh mallow	*Hibiscus moscheutos*	Sun	Moist-Wet	3-5’
White, pink or magenta flowers Jun-Aug, attracts hummingbirds.				
Blue flag	*Iris versicolor*	Sun-pt. shade	Moist-Wet	2-3’
Blue-violet flowers May-Jun, attracts songbirds, waterfowls and mammals. Can flourish in normal garden soils, but also tolerates flooding.				
Blazingstar	*Liatris spicata*	Sun-pt. shade	Dry-Moist	3-4’
Rose-purple flowers Jul-Aug, attracts butterflies, bees and songbirds.				
Cardinal flower	*Lobelia cardinalis*	Sun-shade	Moist-Wet	3-6’
Red flowers Jul-Oct, attracts butterflies, hummingbirds, songbirds, and beneficial insects. Needs continuously moist or wet soils.				
Beardtongue	*Penstemon digitalis*	Sun-pt. shade	Dry-Moist	2-5’
White flowers Jun-Jul, attracts hummingbirds. Tolerates poor drainage/occasionally saturated soils.				
Obedient plant	*Physostegia virginian*a	Sun-shade	Dry-Wet	3-5’
Pink flowers Aug-Nov, attracts butterflies, hummingbirds and beneficial insects. Deer resistant. Can be aggressive in the garden.				
Wild bergamot	*Monarda fistulosa*	Sun-pt. shade	Dry-Moist	2-4’
Pink-purple flowers Jun-Sep, attracts butterflies, songbirds and hummingbirds. Deer resistant.				
Beebalm	*Monarda didyma*	Sun-pt. shade	Moist-Wet	3-4’
Red flowers Jul-Sep, attracts butterflies, hummingbirds and beneficial insects. Deer resistant.				
Black-eyed susan	*Rudbeckia hirta*	Sun-pt. shade	Dry-Moist	1-3’
Yellow flowers with black centers, Jun-Nov, attracts butterflies, songbirds, and beneficial insects. Extremely drought tolerant.				
Rough-stemmed goldenrod	*Solidago rugosa*	Sun-pt. shade	Moist-Wet	3-5’
Yellow flowers Aug-Sept, attracts bees, songbirds and beneficial insects. Tolerates drought. Will spread.				
Blue vervain	*Verbena hastata*	Sun-pt. shade	Moist-Wet	2-5’
Blue to purple flowers Jun-Oct, attracts butterflies and songbirds.				
Ironweed	*Vernonia noveboracensis*	Sun-pt. shade	Moist-Wet	5-8’
Purple flowers Aug-Oct, attracts butterflies.				

Common Name	Scientific Name	Preferred Growing Conditions		Size
		Light	Moisture	
Grasses, Grass-like Plants & Ferns				
Broomsedge	*Andropogon virginicus*	Sun-pt. shade	Dry-Wet	1-3’
Grows in tufts, flowers Aug-Nov, reddish-tan fall color. Host for the Zabulon skipper butterfly. Used by mammals, songbirds and butterflies.				
Sea oats	*Chasmanthium latifolium*	Sun-pt. shade	Dry-Moist	2-4’
Clumping grass, attractive oat-like seedheads, flowers Jul-Sept, tan-gold fall color. Used by mammals, songbirds and butterflies. Deer resistant.				
Soft rush	*Juncus effusus*	Sun-pt. shade	Moist-Wet	1-3’
Grows in clumps, greenish-brown flowers Jun-Sep. Used by songbirds, waterfowl and mammals. Needs continuously moist-wet soils.				
Cinnamon fern	*Osmunda cinnamonea*	Sun-shade	Moist-Wet	3-5’
Reddish-brown fertile fronds Apr-May. Needs continuous moisture in full sun, but can tolerate drought in shade. Used by songbirds and mammals.				
Royal fern	*Osmunda regalis*	Sun-shade	Moist-Wet	2-6’
Reddish-brown fertile fronds Apr-Jun. Delicate lacy foliage. Needs continuous moisture in full sun, but can tolerate drought in shade. Used by mammals.				
Switchgrass	*Panicum virgatum*	Sun-pt. shade	Dry-Wet	3-6’
Clumping grass, flowers Jul-Oct, pale-bright yellow color in fall. Many attractive cultivars available. Host for the Delaware skipper butterfly. Used by mammals, songbirds and butterflies.				
Indian grass	*Sorghastrum nutans*	Sun-pt. shade	Dry-Moist	3-6’
Clumping grass can reach 8’, flowers Aug-Sep, frond-like seed heads, tan-rose fall color. Host for the salt and pepper skipper butterfly. Used by mammals, songbirds and butterflies.				
Shrubs & Trees				
Serviceberry	*Amelanchier canadensis*	Sun-shade	Moist-Wet	15-25’
White flowers Apr-May. Red-purple berries Jun-Jul. Fall color is orange to red. Multi-trunked. Used by songbirds and mammals.				
Red chokeberry	*Aronia arbutifolia*	Sun-pt. shade	Dry-Wet	6-12’
White flowers May-Jul. Red berries Sep-Dec. Fall color is orange to red. Tolerates flooding. Used by songbirds and mammals.				
Black chokeberry	*Aronia melanocarpa*	Sun-pt. shade	Dry-Wet	3-6’
White flowers Apr-May. Black berries Sep-Nov. Fall color is orange to red. Multi-trunked. Used by songbirds and mammals.				
Buttonbush	*Cephalanthus occidentalis*	Sun-shade	Moist-Wet	6-12’
White ball-like flowers Jul-Aug. Interesting green-brown fruits Sep-Jan. Tolerates flooding. Attracts birds, mammals, butterflies and beneficial insects.				
Silky dogwood	*Cornus amomum*	Sun-shade	Moist-Wet	6-12’
White flowers May-Jun. Blue berries Aug. Fall color is orange, red or purple. Maroon twigs. High wildlife value. Used by birds and mammals.				
Winterberry	*Ilex verticillata*	Sun-shade	Moist-Wet	6-12’
White flowers May-Jul. Bright red berries on female plants Aug-Feb. Male plants needed for pollination (5:1 ratio F:M). Tolerates drought. High wildlife value. Used by birds and mammals.				
Virginia sweetspire	*Itea virginica*	Sun-shade	Moist-Wet	4-8’
White flower tassels Jun-Jul. Fall color is red to purple. Tolerates drought and flooding. Attracts birds, mammals and beneficial insects.				
Spicebush	*Lindera benzoin*	Pt. shade-shade	Moist-Wet	6-12’
Yellow flowers Mar-May. Scarlet berries Sep-Oct. Yellow fall color. High wildlife value. Host for Spicebush and Eastern tiger swallowtail butterflies. Attracts butterflies, birds and mammals.				
Ninebark	*Physocarpus opulifolius*	Sun-pt. shade	Dry-Wet	6-12’
White-pink flowers May-Jul. Orange to red capsule-like fruits Jul-Mar. Fall color is yellow to purple. Attractive peeling bark. Attracts birds, mammals and beneficial insects.				
Elderberry	*Sambucus canadensis*	Sun-shade	Dry-Wet	6-12’
Showy white flowers Jun-Jul. Purplish-black berries Aug-Sept. High wildlife value. Used by birds and mammals.				
Highbush blueberry	*Vaccinium corymbosum*	Sun-shade	Dry-Wet	6-12’
White flowers Apr-Jun. Blue-black berries Jul-Aug. Bright yellow to red fall color. High wildlife value. Attracts butterflies, birds and mammals.				
Arrowwood viburnum	*Viburnum dentatum*	Sun-shade	Dry-Wet	6-8’
White flowers May-Jun. Blue-black berries Sept-Nov. Red-purple fall color. Attractive form in winter. High wildlife value. Host plant for the spring azure butterfly. Also used by birds and mammals.				

Rain Garden

Design and Construction

A Northern Virginia Homeowner's Guide

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