Understanding Volume and Area with Rain Gardens
Lesson Plans

## General Lesson Information

Title: Understanding Volume and Area with Rain Gardens

Overview/Annotation- *A short summary or description of the lesson including activities and science concepts.*
This lesson plan introduces students to the concept of environmental engineering, it's importance in protecting our air, land, and water, what techniques are used to clean our water, and provides a hands-on activity where students will design and create a map of their own rain garden. Students will use area, volume, and unit conversion calculations throughout this assessment to learn about rain gardens and will have an activity where they can design a rain garden in their school with the proper dimensions for the amount of water retention required.

Setting or format (outdoors, in groups, lab, etc.): In groups in standard classroom or lab

Intended group size (if groups are used): Groups of 3-4 students

Intended grade level(s):
Math - 7th

Approximate Time of Lesson (*Ideally break down into 20-50 minute periods*):
Four 50 minute periods

## Researcher Biography

Name & Professional Title: Julia Kendall (she/her), Graduate Environmental Engineering Student, and Mary Ashley Hand (she/her), Senior Civil Engineering Student

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https://www.youtube.com/@trainthetrainers5857/videos

Brief Description of Research Interests:
Through our program "Train the Trainers," we aim to educate local teachers and students in the Tuscaloosa/Northport area about the importance of Environmental Engineering to bring awareness to its concepts and provide opportunities for K-12 students to engage with S.T.E.M. concepts at this critical learning period. We create videos, lesson plans, and activities to allow students to connect and learn about our water quality and filtration research at an approachable and engaging level.

## Associated Standards and Objectives

Content Standards- *List Alabama Course of Study Standards that connect to lesson*

[RP]
1. Compute unit rates associated with ratios of fractions, including ratios of lengths, areas, and other quantities measured in like or different units. [7-RP1]

[G]
11. Solve problems involving scale drawings of geometric figures, including computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scale. [7-G1]

14. Know the formulas for the area and circumference of a circle, and use them to solve problems; give an informal derivation of the relationship between the circumference and area of a circle. [7-G4]

16. Solve real-world and mathematical problems involving area, volume, and surface area of two- and three-dimensional objects composed of triangles, quadrilaterals, polygons, cubes, and right prisms. [7-G6]

Primary Learning Objectives- *Sentences beginning with "Students will be able to…" that describe what students will do in the lesson that relates to how students will be assessed.*

See attached lesson plan below.

Additional Learning Objectives- *Any learning outcomes that are not directly related to the content standards but may relate to other local or national standards*

See attached lesson plan below.

## Preparation Information

Total Duration- *How many minutes will the lesson last?*
Four 50 minute periods – 200 minutes of instruction/activities

Materials and Resources- *List of materials teacher will need to gather or prepare for lesson*
PowerPoint – see attachments below

Technology Resources Needed- *What technology will teacher and students need for the lesson?*
Smart board/projector for the attached PowerPoint, calculators.

Background and Preparation- *Description of information (science content, use of materials, etc.) teacher and/or students will need to know prior to this lesson; list steps for any preparation prior to the lesson*
Review the resources provided and become familiar with the different types of engineering and how environmental engineers aim to protect human health and our environment. Review

SciREN Understanding Volume and Area with Rain Gardens – Activity Information
PowerPoint and other resources provided about rain gardens and why they matter to the community while serving an important purpose in environmental engineering.
SciREN Understanding Volume and Area with Rain Gardens – Facts and Guidelines

- Worksheet and other resources attached.

## Procedures and Activities

*Step-by-step description of lesson that would allow another teacher to successfully complete the lesson (suggest possible reflection or comprehension questions along with examples of correct answers or common misconceptions)*
See attached lesson plan and PowerPoint below.

*Engagement* (sparking interest, introducing phenomenon, engage students' everyday experiences)
See attached lesson plan below.

*Main activity* (suggest possible reflection or comprehension questions along with examples of correct answers or common misconceptions)
See attached lesson plan below.

*Wrap up and Reflection* (wrap up activity, reflecting on learning, informal assessments of student learning)
See attached lesson plan below.

*Final product/Summative evaluation* (e.g. quiz, presentation, essay, etc., may occur during a later class period)
See attached lesson plan below.

Attachments- *Any materials for the lesson such as video links, worksheets, etc., listed here:*
SciREN Understanding Volume and Area with Rain Gardens – Lesson Plan

SciREN Understanding Volume and Area with Rain Gardens - PowerPoint

SciREN Understanding Volume and Area with Rain Gardens - Worksheet

SciREN Understanding Volume and Area with Rain Gardens – Activity Information

SciREN Understanding Volume and Area with Rain Gardens – Facts and Guidelines

# Day 1: Introduction to Rain Gardens and Mathematical Concepts

1. **Engage (10 minutes)**

   Show a video or images of rain gardens and discuss their importance in managing stormwater. [also linked in PowerPoint]

   https://www.youtube.com/watch?v=CdnCIM-bBMk

   https://groundwater.org/rain-gardens/

2. **Explain (15 minutes)**

   Explain what rain gardens are, how they work, and their environmental significance.

   The EPA [environmental protection agency] defines a rain garden as: "a depressed area in the landscape that collects rainwater from a roof, driveway or street and allows it to soak into the ground."

   These gardens are often planted with grasses and flowering plants.

   Benefits of rain gardens: cost effective and beautiful way to reduce runoff from your property. Rain gardens can also help filter out pollutants in runoff and provide food and shelter for butterflies, song birds and other wildlife

3. **Explore: (20 minutes)**

   Math Concept Introduction

   - Define volume, flow rate, and surface area.
   - Provide basic formulas and real-world examples related to rain gardens.

4. **Reflection (5 minutes)**
   Ask students to brainstorm how math can help design rain gardens.

# Day 2: Calculating Volume of Rain Gardens

1. **Objectives:**

- Understand how to calculate the volume of different shapes of rain gardens.
- Apply volume formulas to real-world scenarios.

2. **Review (5 minutes)**

Recap concepts of volume and discuss the significance of understanding capacity.

3. **Guided Practice (15 minutes)**

Work through examples of calculating volume for rectangular and circular rain gardens.

1. Example: “A circular rain garden has a diameter of 5 feet and is 3 feet deep. What is its volume? What is its surface area?”
2. Example 2: "A rectangular rain garden measures 10 ft by 6 ft and is 2 ft deep. What is its volume?”

4. **Paired Practice (20 minutes)**

Students work in pairs to solve additional volume problems on the worksheet.

5. **Reflection (10 minutes)**

Discuss why understanding volume and area is critical for effective rain garden design.

# Day 3: Flow Rate and Surface Area Calculations

1. **Objectives:**
    - Solve problems involving flow rate to understand stormwater movement.
    - Calculate surface area to determine planting space in rain gardens.
2. **Engage (5-7 minutes)**

Discuss what happens to rainwater in heavy storms and how flow rate impacts rain garden efficiency.

https://www.youtube.com/watch?v=ipWTYwZ_Okg

I liked this video because we see a rain garden in an urban area not just a backyard. We also have a nice visual of water flowing from the street into rain garden.

3. **Explain (15 minutes)**

    1. Flow rate formula: Flow Rate = Volume / Time.
    2. Surface area formulas for rectangular and circular gardens.
    3. Real-world example: "A rain garden with a flow rate of 15 cubic feet per minute receives 60 cubic feet of water. How long does it take to fill?"

4. **Explore (20 minutes)**

Group Practice. Students collaborate in small groups to solve problems on flow rate and surface area.

5. **Reflection (10 minutes)**

Turn and talk. Discuss how these calculations guide plant selection and garden layout.

# Day 4: Applying Concepts to a Real-World Design

1. **Objectives**

- Apply volume, flow rate, and surface area calculations to design a hypothetical rain garden.
- Present and justify design choices.

2. **Materials:**

    - Rain garden design worksheet
    - Graph paper
    - Rulers
    - Calculators
    - Whiteboard and markers
    - Example of rain garden components (physical model or printed visuals)
    - "What is a Rain Garden?" informational handout

3. **Review (5 minutes)**

Review formulas and concepts of volume, area, and flow rate. Explain the design challenge: "Design a rain garden for a schoolyard to manage stormwater effectively."

4. **Explore (30 minutes)**

    1. Students work in teams to create a design using given dimensions and rainfall data.
    2. Calculate volume, flow rate, and surface area to support their design choices.

5. **Presentations (10 minutes)**

Teams present their designs to the class, explaining their calculations and decisions.

6. **Wrap-Up (5 minutes)**

Reflect on how math and engineering can solve environmental challenges.

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https://groundwater.org/rain-gardens/

**Middle School Math Activity: Designing a Rain Garden**

**Objective**: Students will use basic math skills to calculate the size and capacity of a rain garden that can reduce runoff and prevent flooding in an area.

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**Activity Steps**

1. **Introduction (5-7 minutes)**
    - Discuss **rain gardens** and their purpose in environmental engineering:
        - They collect and filter rainwater to reduce flooding and pollution.
        - Plants in rain gardens absorb water and clean it naturally.
    - Explain that the class will design a rain garden for their school or a hypothetical area.
2. **Math Challenge: Calculating Runoff (15 minutes)**
    - Provide students with a scenario:
      *"An area of 100 square feet collects rainfall from a roof. If 1 inch of rain falls, how much water runs off into the rain garden?"*

**Steps to calculate runoff**:

- 1 inch of rain over 1 square foot = 0.623 gallons of water.
- Multiply 0.623 by the roof area (100 sq. ft.).
- **Answer**: 62.3 gallons of water.

    - Have students work in groups to calculate runoff for different roof sizes or rainfall amounts.
3. **Designing the Rain Garden (15 minutes)**
    - Using the runoff calculations, students will design a rain garden:
        - The garden needs to absorb all the water.
        - Provide a formula for garden size based on soil type (e.g., sandy soil absorbs more water, so it needs less space).
        - Example: *For every 10 gallons of water, the rain garden should be 1 square foot*.

        - Students can calculate the area of the rain garden based on their runoff values.

4. **Optional Hands-On Component (15 minutes)**
    - Bring a **model of soil types** (sand, clay, loam) and have students pour water to see how quickly each absorbs water.
    - Discuss why soil choice matters for environmental engineers designing rain gardens.

--Unit conversion on train trainers

-- don't have to be there all day but be there a lot :D

--Delaney help w math project

--tryengieering.org damn

Supplies & links to purchase

- Water resources- dam
- Water quality- filter

Lots of tradeoffs in engineering

*cost – items ordered by Jan.

*plans

*organize and divide materials for teachers before Feb. 14th

*in class TWF, not Thursday.

*new box for everyone in project

*prioritize morning periods

*Dr. Steel – survey and other forms – early Jan.

**Activity Title: Design a Stormwater-Friendly Schoolyard**

**Objective:** Students will use basic math and measurement skills to calculate how much water a schoolyard can hold and how changes like adding rain gardens or pervious pavement could reduce flooding.

**Materials Needed:**

- Graph paper or printed maps of the schoolyard
- Rulers
- Colored pencils
- A small worksheet with rainfall data (e.g., "1 inch of rain = X gallons of water per square foot")
- Calculator (or scratch paper for manual calculations)

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**Lesson Plan:**

1. **Introduction (5 minutes):** Begin with a discussion about what happens when it rains.
    - Where does all the water go?
    - Talk about flooding, storm drains, and runoff.
    - Explain how engineers design landscapes to manage rainwater using things like rain gardens, bioswales, and pervious pavement.
2. **Activity (20 minutes):**
    - Give students a "map" of the schoolyard (or let them imagine their own).
    - Assign areas of the map to be paved, grassy, or garden. Students calculate the runoff using simple math formulas (like, "Rainfall x Area = Runoff Volume").
    - Challenge students to redesign their schoolyard to reduce runoff.
    - Options include adding rain gardens, swapping pavement for grass, or designing new drainage areas.
3. **Wrap-Up (5 minutes):**
    - Students present their ideas to the class. Discuss which solutions seem most practical and why.
    - Tie it back to environmental engineering and how they just solved a real-world problem.

**Company Name**: _____ **Group Members**: _____

# Design a Stormwater-Friendly Schoolyard

**Objective:** Design a rain garden for your school courtyard. The rain garden must be able to hold a **minimum of 800 gallons of water**. Your rain garden may be a rectangle, circle, or some other composite shape of your design. You will submit this paper along with your design drawing on graph paper.

Helpful information:

- Conversion Rate: 1 cubic foot of water is equal to 7.48 gallons
- Volume Formulas
  - Rectangle: $length \times width \times height(depth)$
  - Circle: $\pi(3.14) \times radius^2 \times depth$
- Area Formulas:
  - Rectangle: $length \times width$
  - Circle: $\pi(3.14) \times radius^2$

Answer each question below. Include your calculations and show all work for how you arrived at each answer.

1. The dimensions of our water garden are (in feet):

2. The area of our garden is: _____

3. The volume of our garden is: _____

4. Our water garden can hold _____ gallons of water.

Angela D. Alsobrooks
County Executive

Prince George's County
DEPARTMENT OF THE ENVIRONMENT

# Rain Garden Fact Sheet

## What is a rain garden?

A rain garden is a planted shallow depression that uses water-tolerant native plants and landscaping to soak up stormwater flowing from downspouts or hard (impervious) surfaces, such as your driveway, patio, or sidewalk. Rain gardens allow water to slowly seep into the ground, reducing the amount of water that flows directly into the nearest storm drain, creek, or river. Rain gardens typically consist of an absorbent soil mix, a mulch layer, and plants such as shrubs, grasses, and flowering plants. Rain gardens are a beautiful, low-tech, inexpensive way for homeowners, communities, and businesses to help ease stormwater problems and reduce pollution in local streams and rivers.

## What are the benefits to property owners and communities?

- Reduces stormwater problems on your property such as ponding or erosion.
- Protects local streams and the Chesapeake Bay.
- Replenishes the groundwater supply.
- Provides habitat for wildlife and increases the diversity of birds and butterflies.
- Provides an attractive alternative to traditional lawns and requires less maintenance.

## How can you determine if your property is suitable for a rain garden?

Most properties are suitable for a rain garden--all you need is some sun exposure and enough space in the right place. Consider the following points to help you determine whether a rain garden will work on your property.

- Locate your rain garden at least 10 feet away and downhill from the foundations of any nearby homes.
- Place your rain garden at least 25 feet away from a septic field or a well head.
- Choose a gently sloped place that regularly receives runoff from hard surfaces or where downspouts can direct rainwater into your rain garden.
- Locate your rain garden in full or partial sun, avoid large tree roots, and identify areas that naturally pond.
- Evaluate the soil type at the location of the rain garden. Water must be able to seep into the soil quickly enough when the rain garden is full so that it will drain in 24 to 36 hours.
- Ensure that bedrock and groundwater is located at least 2 feet below the rain garden's surface.

## Qualifying for a rebate

| Project | Individual Residence or Individual Members of a Housing Cooperative | Commercial, Homeowner Associations, Condominium Associations, Civic Associations, Multi-Family Dwellings, Nonprofit, Not-for-Profit Organizations, Housing Cooperatives |
|---|---|---|
| Rain Gardens | $10 per square foot (minimum of 100 square feet) | $10 per square foot (minimum of 100 square feet) |

## What are the costs?

Costs range from $4 to $35 per square foot, depending on the source of the materials, site conditions and who does the work. Use of a professional contractor and landscaper will result in higher costs.

rain check

## Can you do this project yourself?

Yes. A professional designer or qualified contractor may be needed if you must treat off-site drainage, have a steep slope, soils that don't drain well where an underdrain system is needed, are considering terracing, or have many trees (roots) on your property.

*For more information, call 410-974-2941 or visit The Chesapeake Bay Trust (cbtrust.org).*

Angela D. Alsobrooks
County Executive

Guidelines for

Prince George's County
DEPARTMENT OF THE ENVIRONMENT

# Rain Garden

## What is a rain garden?

A rain garden is a planted shallow depression that uses water-tolerant native plants and landscaping to soak up stormwater flowing from downspouts or hard (impervious) surfaces, such as your driveway, patio, or sidewalk. By absorbing and filtering this runoff, rain gardens allow water to slowly seep into the ground, reducing the amount of water that flows directly into the nearest storm drain, creek, or river. Rain gardens typically consist of an absorbent soil mix, a mulch layer, and shrubs, grasses, and flowering plants. Rain gardens are a beautiful, low-tech, inexpensive way for homeowners, communities, and businesses to help ease stormwater problems and reduce their contribution to the pollution of local streams, rivers, and the Chesapeake Bay.

## What are the benefits to property owners and communities?

Rain gardens, when properly designed and installed, can help reduce stormwater problems on your property such as ponding or erosion. Gutters, downspouts, and paved surfaces collect and move the stormwater to the street, where it's carried into the storm drain system and into local streams. As it flows, stormwater picks up pollutants (such as dirt and toxins, fertilizers, trash and pet waste) and carries them into our waterways.


Once here, these pollutants have many harmful effects.

- Bacteria and other pathogens create health hazards for people and wildlife.
- Debris (e.g., plastic bags, six-pack rings, bottles, and cigarette butts) can choke and kill aquatic life such as ducks, fish, turtles, and birds.
- Excess nutrients cause algae blooms that can destroy aquatic habitats and impact recreational opportunities.

Rain gardens can address these problems by filtering pollutants from stormwater and allowing more clean water to soak into the ground before it gets to local streams or enters the storm drain system. Compared to an equal area of traditional lawn, a rain garden allows at least 30% more water to soak into the ground. In addition to reducing the amount of pollution that reaches our streams through runoff, this helps replenish the groundwater supply.

Rain gardens provide many other benefits to the community and the local environment. They can provide habitat for wildlife and increase the diversity of birds and butterflies. Rain gardens provide an attractive and creative alternative to traditional lawns and require less maintenance because they do not need to be mowed, fertilized, or watered once established. Adopted on a community or neighborhood scale, rain gardens can reduce stormwater surges that cause.

## How can your rain garden quality for a rebate?

The Rain Check Rebate Program offers rebates to property owners who install rain gardens. The rebate for both residential properties and commercial businesses, homeowner associations, condominium associations, civic

associations, multi-family dwellings, nonprofits and not-for-profit organizations is $10 per square foot with a minimum size of 100 square feet.

To alleviate costs, the Rain Check Rebate Program provides a rebate of up to $6,000 for residential properties, and up to $20,000 for commercial businesses, homeowner associations, condominium associations, civic associations, multi-family dwellings, nonprofits and not-for-profit organizations.

## How can you determine if your property is suitable for a rain garden?

Most properties are suitable for a rain garden—all you need is some sun exposure and enough space in the right place. Walk around your property while it's raining so you can see how the rain flows across existing landscape features and hard surfaces, like your house, driveway, and sidewalks, and where it ends up. A rain garden should intercept the runoff before it flows off of your property. Consider the following points to help you determine whether a rain garden will work on your property.

- Place your rain garden at least 10 feet away from your home and your neighbors' homes and downhill from the foundations of any nearby homes. When the garden overflows, the excess water must flow away from your home and your neighbors' properties.
- Place your rain garden at least 25 feet away from a septic field or a well head.
- Choose a gently sloping place that regularly receives runoff from patios, sidewalks, or other hard surfaces or where downspouts, rain barrel outlets, or sump pump outlets can direct rainwater into your rain garden.
- Locate your rain garden in full or partial sun.
- Avoid placing your rain garden under a large tree because the roots will make it difficult to dig.
- Identify low-lying areas that naturally pond (as long as they drain well) as they may be good places to locate rain gardens.
- Evaluate the soil type at the location of the rain garden. Water must be able to seep into the soil quickly enough when the rain garden is full so that it will drain in 24 to 36 hours (see the Assessing the soil section).
- Ensure that bedrock and groundwater is located at least 2 feet below the rain garden's surface.

Remember to fit the rain garden into your current landscape—let it complement the house and other yard features and be a source of enjoyment for you.

### *Assessing the soil*

Soils that are suitable for a rain garden will drain within 24 or 36 hours. Soils high in sand and silt usually provide good drainage. Soils high in clay will not drain well and may not be suitable unless you amend the soil (mix in soil of a more appropriate type) or add an underdrain system. An example of an underdrain system is a slotted pipe that collects water below the surface of the rain garden and discharges it into the storm drain system or to a stable outfall. In cases where infiltration is not possible due to existing soils, you will need to consult with Rain Check Rebate staff or a qualified professional to find out whether a rain garden with an underdrain is an option for you.

It's easy to find out whether your soil is suitable for a rain garden. Dig a hole in the ground about 1 foot wide by 2 feet deep and fill it with water. If the water drains in less than 24 hours, the soil should be suitable. To be sure, refill the hole with water within 12 hours and make sure that it takes no longer than 36 hours to drain. Do this test in the spring, not in the middle of the summer when the soil is dry and cracked and may give an erroneous result. This test should not be performed within 24 hours of a rain event, as that might also give an erroneous result.

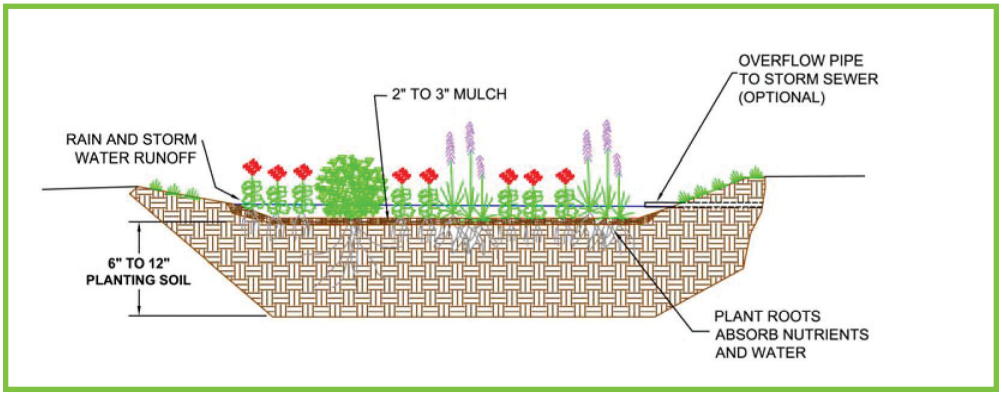
You may have excess soil after completing your garden that you will need to dispose of. If your rain garden is on a slight hill you may want to use some of the soil for a berm on the downhill side. Any excess soil can be used or stored somewhere else on your property, as long as it does not create drainage problems elsewhere.

### *Identify and avoid utilities*

Prior to starting your rain garden project, find existing underground utilities, such as water mains, telecommunication lines, and gas lines, so you can avoid them. Call Miss Utility at 811 or 1-800-257-7777, or visit their website at http://www.missutility.net/maryland/ for assistance.

***How can you determine the proper size and configuration?***

Rain gardens are highly versatile and can be constructed in a wide variety of shapes and sizes. The size of your rain garden is determined by a number of variables. Some of these are established by the conditions of your yard (such as soil type), while others are determined by you (such as amount surface area collected). To properly size your rain garden, estimate the area of the hard surface (rooftop, driveway, patio, etc.) that will drain to the rain garden. If you plan to connect a downspout to the rain garden, estimate the footprint (ground area, measured as length x width) of your house or other structure and determine how much of the rooftop area drains to the downspout you will be directing to the rain garden. For gutters with a downspout at each end, assume that half of the water goes to each downspout. Do not take into account the slope of the roof when calculating the roof area, just use the house footprint. If your rain garden will capture runoff from other hard surfaces, such as a patio, just determine the area that will drain to the rain garden.




**Maryland Stormwater Design Manual**

The surface area of your rain garden should be between 20% and 30% of the roof area (or other hard surface) that will drain into the rain garden. If your soils are very sandy, use 20%. For example, if your rooftop measures 30 feet by 30 feet, the area (footprint) would be 900 square feet. If one-quarter of this area drains to the downspout that will connect to the rain garden, then the roof area draining to the rain garden is 900 square feet divided by 4 = 225 square feet. 20% of 225 square feet = 45 square feet, and 30% of 225 square feet = 67 square feet. In this example, the rain garden area should be between 45 and 67 square feet. If you do not have enough space to install a properly sized rain garden, look at reducing the amount of area draining to your rain garden or splitting your drainage area into two rain gardens.

Be sure to maintain a gentle slope from the surrounding area down to the rain garden. You may have to create a shallow ditch, swale (low area), or underground pipe to carry the stormwater runoff from a disconnected downspout to the rain garden.

If you build a rain garden around your yard drain, the water that overflows from the garden will be conveyed safely to that drain. Otherwise, be sure the overflow is directed away from neighboring properties.

***Planting your rain garden***

A rain garden planted with a variety of plants adapted to rain garden conditions will provide years of enjoyment. General garden composition principles apply to rain gardens. For example, choose plants that bloom at different seasons so that you have year-round interest. Select plants and flowers of a variety of shapes, textures, heights, and colors. If you prefer a neater, more landscaped appearance, you may wish to select relatively short plants and plants that do not seed or root aggressively. Remember to keep maintenance requirements in mind as you develop your planting plan.

Plant selection for your rain garden is very important to its success. The best plants for rain gardens are native plants. 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. Native plants tend to have deep root systems that help hold the soil. In addition, the Rain Check Rebate Program requires the use of native species in rain gardens. Native plant lists and information are provided in the resource links beginning on page 8, including the U.S. Fish and Wildlife Service's *Native Plants for Wildlife Habitat and Conservation Landscaping*.

Most importantly, be sure to match a plant's water tolerance to its position in the rain garden. The center is usually the lowest point, so it will be the wettest. Plants that can withstand wet soil should go here. Plants at the edge will be those that prefer dry conditions. In between, put plants that prefer average soil conditions. All of your plants should be able to tolerate wet soils for up to 24 hours. The U.S. Fish and Wildlife Service resource mentioned above provides moisture tolerance information for each species listed.

Placing the plants close together will reduce the amount of weeding you will need to do. Planting closely (as nature does) also helps ensure that your rain garden won't wash out during heavy storms. In a few years, you will be able to divide some plants for use elsewhere in your yard, or to share with neighbors.

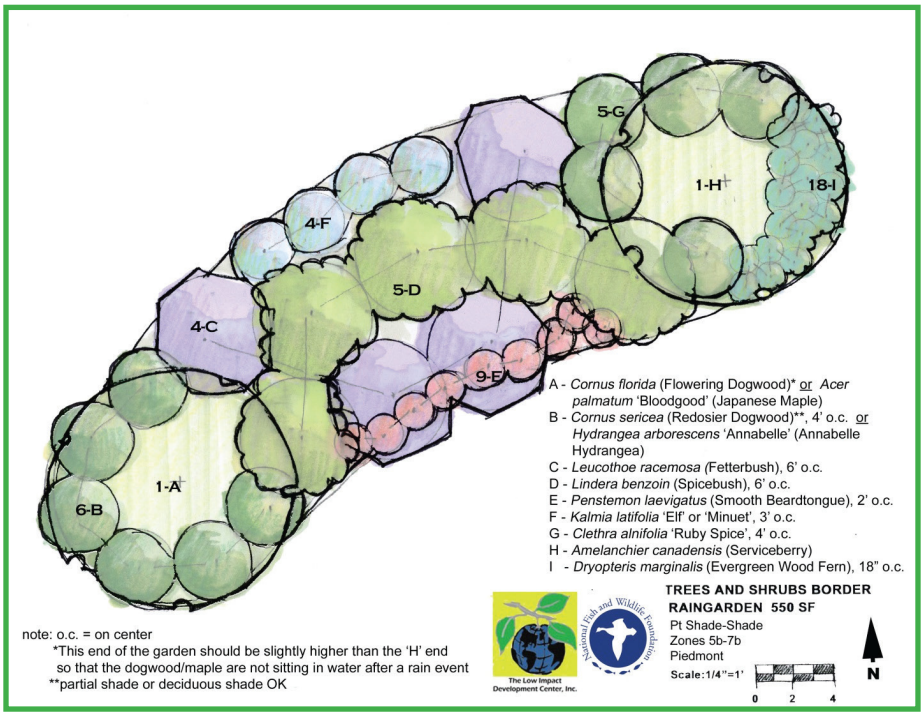
In addition to the sunlight and water tolerance considerations mentioned earlier, consider these factors when deciding on a plant list:

- Salt tolerance
- Height and width of full grown plants
- Color and type of seeds, berries, flowers, or other growth
- Species of wildlife you wish to attract
- Coordination with existing landscape

Plant trees 10 feet apart (center to center) and plant large shrubs 7 feet apart (center to center). Plant small shrubs 4 feet apart (center to center) and plant perennials 2 feet apart (center to center). An example rain garden planting plan is presented below.

It's a good idea to plant a variety of plants. Plants with different root types and growth habits will fill in all the available habitat layers both above ground and below ground, helping your garden function more like a natural plant community. A diverse array of plants is also more resilient to stress from pests or disease. However, this only works if whoever maintains the garden is familiar with the plants' appearance throughout their life cycles. If the garden is going to be maintained by a landscaper who is not familiar with native plants, a simple planting design will work better.

Additional resources listing native plants that work well in rain gardens and where to buy them are provided in the For More Information section.




***Getting water into the rain garden***

You can direct stormwater to your rain garden from a roof downspout or a rain barrel using a grass- or rock-lined swale or a buried PVC pipe. If you use a pipe, you will need to place rocks or smaller stones at the pipe's entrance to the rain garden to prevent erosion caused by water gushing out of the pipe. If you are collecting runoff from a driveway or other hard surface, you can create a shallow trench drain or install a short (about 1-inch tall) speed bump to divert water to your rain garden. To capture stormwater in a rain garden that is located on a hill, create a low berm around the downhill the edges of your rain garden.

*Providing for overflow during periods of heavy rainfall*

Any rain garden will overflow during periods of heavy rainfall. Overflow can be released from a 4- to 8-inch notch cut in the berm that surrounds your rain garden on the downhill side, if located on a slope. Reinforce the notch with grass, stepped stones, or an erosion control blanket to prevent erosion. Locate the notch so that the water goes where it normally went before the rain garden was constructed. If your rain garden is located in a flat landscape, you can create a shallow channel filled with stones that directs flow to a suitable area. This channel should be no more than half as deep as the rain garden so as not to drain the garden during rain storms. A lawn or shrub planting area is usually the best destination for overflow. Be sure that the overflow does not go toward the foundation of your home or onto your neighbors' properties.

## Which other techniques work well with rain gardens?

Rain gardens can work well together (two rain gardens in tandem); they can also work with rain barrels or green roofs to absorb some of the overflow.

## What are the costs?

The cost of completing a rain garden varies considerably, typically ranging from $4 per square foot to $35 per square foot, depending on the source of the materials and who does the work. Use of a professional contractor and landscaper will result in higher costs. Important factors in estimating the cost include (but are not limited to):

- material costs, such as landscaping, seed, stone, and plants;
- the size of the rain garden;
- size of the plants selected for the installation;
- whether heavy equipment and machinery will be required;
- ease of access to the site;
- whether soil will need to be disposed of offsite; and
- duration of construction.

Approval of your rain garden project through the Rain Check Rebate Program can help reduce costs.

## Can you do this project yourself?

Yes. You can do this project yourself under most circumstances. You may need to consider hiring a professional designer and/or a qualified contractor if you are trying to treat off-site drainage, have a steep slope, are considering terracing, or have many trees (and roots) on your property. You may also need a qualified professional or contractor when the existing soils do not drain well and an underdrain system is needed.

## How can you build a rain garden?

Once you have sized your rain garden, you will need to locate it and mark it out. Use a measuring tape and a rope, string, or hose to lay out the boundaries of the rain garden. Next, dig the rain garden. To be sure that the rain garden will hold several inches of water during a storm, the surface of your rain garden will have to be at least 4 inches below the surface of your yard. Dig out the garden bed 4 to 5 inches deep across the entire surface of the garden, creating a flat-bottomed bowl with gently sloping sides. You can improve the soil if needed by digging 6 to 7 inches deep, and adding 2 to 3 inches of humus or other organic planting material. Make sure the bottom of the garden is level.

Test how the garden will hold water during a storm by letting water flow from a hose onto the hard surface or from the direction of the downspout or outlet. Make any adjustments needed. Finally, add your plants to the rain garden. After all of the plants are in the ground, add a layer (at least 2 inches deep) of doubleshredded hardwood mulch to support moisture retention during the dry periods of the year.

## How should you choose a contractor?

Use of a professional is recommended for large and complex projects. If you decide to have a contractor design and install your rain garden, choose carefully. Ask potential contractors how much experience they

have installing rain gardens and developing planting plans. Ask them for a description of projects they have completed in the past and for references from past clients. An experienced contractor should be able to make a recommendation regarding the type, dimensions, and location of a rain garden that would best suit your property. Find out if they are insured, bonded, certified, or trained for accurately sizing and properly constructing rain gardens by a local jurisdiction, university, or state cooperative extension service. Ask potential contractors to explain what is included in their services, how long it should take to complete the project, and whether their work would be guaranteed. Ask potential contractors if large and heavy machinery would be used and, if so, whether noise will be kept to a minimum and in compliance with local laws and regulations.

## Is a permit required?

A permit is not required for most rain gardens. However, if installing your rain garden (on its own or in combination with a concurrent project on your property) results in more than 5,000 square feet and/or 100 cubic yards of earth-moving disturbance (such as grading, cutting, and filling), a permit will probably be required Contact the County's Department of Permitting, Inspections & Enforcement for more information: call 311 or https://www.princegeorgescountymd.gov/1024/Permitting-Inspections-and-Enforcement.

## What maintenance will be required?

Rain gardens require less maintenance compared to traditional gardens. Primary maintenance requirements involve weeding, repair, and replacement of components in the treatment area. The use of native plants reduces fertilizer, pesticide, water, and overall maintenance requirements. During the first growing season, the garden must be watered regularly during dry periods. However, if the soil is moist at a depth of 4 inches, and wilting plants recover at night, watering is not needed. Regularly remove any weeds, litter, sand, and sediment that enter the garden. Weeding should be accomplished routinely, at least monthly during the growing season. Rainwater entering a rain garden normally carries nutrients, so fertilization is normally not needed; however, if a soil test indicates very low soil fertility, an organic fertilizer may be applied. At least once a year, apply a new layer of double-shredded hardwood mulch, maintaining between 2 and 3 inches of cover. You may need to remove old mulch every year or two to maintain the appropriate depth for your rain garden to function properly. As with any garden, divide overcrowded plants in the spring or fall, and prune dead vegetation annually. Perennial plants can be cut back in the spring, when new growth starts, if desired for neatness, but it is not required for plant health. Plants can be pinched, pruned, sheared, or deadheaded during the growing season to encourage flowering, bushier growth, or fresh leaves. Diseased or damaged portions of plants should be pruned, as needed, and trees and shrubs can be pruned in the fall for shape or to increase fruit production.

**MAINTENANCE SCHEDULE FOR URBAN RAIN GARDENS**

| | | Spring | | | Summer | | | Fall | | | Winter | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Plant Care | Trimming, Pruning, and Thinning | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| | Mowing (turf areas only) | | ▪ | ■ | ■ | ■ | ■ | ■ | ▪ | | | | |
| | Weeding | ■ | ▪ | ▪ | ■ | ■ | ■ | ▪ | ▪ | ■ | ■ | ■ | ■ |
| | Watering (established and drought) | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | |
| | Fertilizing | ■ | ■ | | | | | ■ | ■ | ■ | | | |
| | Pest Management | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| | Plant Replacement | ■ | ■ | ■ | | | | ■ | ■ | ■ | ■ | ■ | ■ |
| Infiltration Maintenance | Ponding and Drainage Problems | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| | Trash and Debris Removal | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| | Mulching | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| | Pet Waste Removal | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |

■ Required ▪ Required at Low Frequency ■ Required as Necessary

Rain gardens are designed to have water standing for up to four hours. If this period is routinely exceeded, the garden may not be functioning properly. The surface blockage problem can often be corrected by removing the mulch layer and raking the surface. For blocked filter fabric, use lengths of small reinforcing bar (2'-3' #4 rebar) to puncture the fabric with holes every 1' on center. If the soils themselves are causing the problem, punch holes in the soil to increase aeration. In a worst case scenario, the entire rain garden may need to be re-installed. Check where the water enters the garden to be sure it is not being clogged by soil, mulch,or debris; and remove obstructions, as needed. Pet waste should not be left to decay in rain gardens.

## For more information

While Prince George's County does not endorse any one method of building or installing a rain garden, or any particular rain garden vendor, the following information is supplied for your consideration.

*General Information*

**Low Impact Development Center, Urban Design Center, Bioretention**
http://www.lid-stormwater.net/biotrans_home.htm

**Down the Drain: A Story About Urban Water, this booklet explains how multiple stormwater management techniques (including a rain garden) were used to retrofit the Yorktowne Square Condominium community**
http://landsandwaters.org/downloads/pdf/down-the-drain-a-story-of-urban-water.pdf

**EcoScaping: EcoScaping, RainScaping, BayScaping, GreenScaping...It's All About Conservation Landscaping and Habitat Restoration!**
http://www.chesapeakeecologycenter.org/esoscaping/principles-of-conservation-landscaping/

**Chesapeake Bay Trust, Rain Gardens**
www.cbtrust.org/site/c.miJPKXPCJnH/b.5458177/k.891D/Rain_Gardens.htm

**Prince George's County, Maryland, Department of the Environment, Programs and Planning Division, Low-Impact Development Design Strategies: An Integrated Design Approach**
https://www.princegeorgescountymd.gov/DocumentCenter/View/86/Low-Impact-Development-Design-Strategies-PDF

*Rain Garden Design, Installation, and Maintenance*

**Chapter 5.0 – Environmental Site Design, Maryland Stormwater Design Manual, This chapter of the Design Manual includes guidance on micro-scale practices like rain gardens**
https://mde.maryland.gov/programs/Water/StormwaterManagementProgram/Documents/www.mde.state.md.us/assets/document/Design%20Manual%20Chapter%205%2003%2024%202009.pdf

**Rain Gardens Across Maryland – Worcester County Natural Resources Division (guidebook includes easy rain garden instructions as well as more technical information)**
https://extension.umd.edu/sites/extension.umd.edu/files/_docs/articles/Rain_Gardens_Across_MD.pdf

**Low Impact Development Center, Rain Garden Templates**
https://lowimpactdevelopment.org/resources/rain-garden-templates-for-maryland/

**The Native Plant Society of New Jersey, Rain Garden Manual**
http://www.npsnj.org/pages/nativeplants_Rain_Gardens.html

*Information on Native Plants*

**Prince George's County Planning Department, Native Plants of Prince George's County, Maryland**
http://mncppcapps.org/planning/publications/BookDetail.cfm?item_id=234&Category_id=2

**Chesapeake Bay Native Plant Center**
http://www.nativeplantcenter.net/

**North America Native Plant Database**
https://www.wildflower.org/plants/

**Izel Plants**
https://www.izelplants.com

**U.S. Fish & Wildlife Service, Native Plants for Wildlife Habitat and Conservation Landscaping: Chesapeake Bay Watershed**
https://www.fws.gov/Chesapeakebay/pdf/NativePlantsforWildlifeHabitatandConservation Landscaping.pdf

**U.S. Fish and Wildlife Service, Native Plants Nurseries in the Chesapeake Bay Watershed**
https://www.fws.gov/chesapeakebay/BayScapes/bsresources/bs-nurseries.html

**Maryland Native Plant Society**
https://mdflora.org

*Rain Garden Calculator*

**Three Rivers Rain Garden Alliance**
http://raingardenalliance.org/right/calculator

*For more information, call 410-974-2941 or visit The Chesapeake Bay Trust (cbtrust.org).*