

State of Rhode Island Stormwater Management Guidance for Individual Single-Family Residential Lot Development

Section 300.6 of the RI Coastal Resources Management Program (RICRMP) and Rule 7.12 of the DEM Rules and Regulations Governing the Administration of the RI Freshwater Wetlands Act require stormwater management for projects on individual single-family residential lots that create 600 square feet or more of **new** impervious roof surface area, and all new driveway and parking areas. This document provides guidance for meeting those requirements, and may also be used by applicants under the jurisdiction of CRMC Freshwater Wetlands in the Vicinity of the Coast.

The guidance provided in this document may not be used to meet stormwater requirements for residential subdivisions or any project types other than individual single-family residential lot development.

CRMC Supplemental Stormwater Application Requirements:

- Completed CRMC application (4 copies) including all forms, fees and required enclosures.
- 8.5 x 11 inch site plan that depicts the information detailed in the checklist under Step 5 on page of this document.

DEM Application Requirements:

- Completed DEM Application package including all forms, fees and required enclosures (see DEM Rules 7.00 and either 9.00 or 10.00 as applicable)
- Ensure site plans (DEM Rule 7.03) include all elements detailed in the checklist under Step 5 on page 17 of this document.

Residential Stormwater Management Overview

A single residential lot might not be the most obvious source of pollution problems, but behind a suburban landscape, there may be activities that can threaten water quality. Pollutants commonly present on residential lots include pesticides fertilizers used in landscaping. Other pollutants may include sediment from erosion-prone areas, yard waste such as leaves and grass clippings, pet waste and oil and gas from driveway surfaces. Even runoff from rooftops can contain pollutants known to occur in rainfall. These have the potential to be transported in stormwater to surface water bodies, posing risks to the environment and human health. While the contribution from an individual yard may seem small, the cumulative effects of stormwater runoff coming from hundreds or thousands of homes within a watershed can be significant. Reducing the amount of stormwater that leaves your property as runoff helps to prevent pollutants from reaching our streams, lakes, ponds and coastal waters.

Rule Applicability

Under RICRMP Section 300.6 and DEM Rule 7.12, applicants for individual single-family residential projects are required to treat the water quality volume, or one inch of stormwater runoff from any **new** rooftop impervious surfaces of 600 square feet or greater in size, and all new driveways and parking areas. This guidance document describes stormwater management practices for reducing runoff volumes and pollutant levels. It also provides guidance for designing, installing and maintaining stormwater management practices that meet the requirements for new or enlarged single-family dwellings, driveways and parking areas. The practices discussed in this document are part of a stormwater management approach known as low impact development or LID. This document is meant to be used as a generalized guide to help applicants meet storm water management requirements on individual single-family residential lots. For more complex projects, and for more detailed information on the design of storm water management practices, see the most recent version of the Rhode Island Stormwater Design and Installation Standards Manual for additional information at www.dem.ri.gov/pubs/regs/regs/water/swmanual.pdf.

Avoid, Reduce, and Manage Stormwater Impacts

There are a few steps to follow when managing stormwater on a residential lot. First, avoid the negative impacts of stormwater to the extent possible. Protect undisturbed open space and existing vegetation by minimizing land disturbance and making your construction footprint as small as possible on the parcel. Avoid impacts to natural drainage areas and limit soil compaction to the structural footprint only.

Next, reduce impacts by minimizing the amount of stormwater runoff that flows off your lot. Eliminating or reducing the size of rooftops, driveways and other paved surfaces will reduce the amount of stormwater runoff that is generated from these impervious surfaces. Plant native shrubs and trees and low-maintenance, drought-resistant turf grasses that require less irrigation, fertilizers, and pesticides. Use sustainable landscaping practices to promote plant health and limit the amount of chemicals applied to the landscape.

Finally, manage any stormwater runoff from the site that cannot be eliminated by directing it to pervious areas or stormwater management practices that will allow the water to infiltrate into the ground. The following sections provide guidance for designing, installing and maintaining practices that can be used to manage and treat stormwater runoff. To meet the applicable stormwater requirements, these practices must be designed to capture and treat the **water quality volume**, or 1 inch of runoff from all new contributing impervious surfaces. By designing stormwater practices in this way, they will capture 90% of the average annual volume of runoff generated.

*Please note that municipal stormwater management requirements may differ from, and may not be compliant with state requirements.

Steps to Meet Stormwater Permit Requirements for Single-family Residential Projects

- Step 1: Determine the surface area (ft²) of **new** rooftop and driveway areas;
- Step 2: Choose potential storm water management practice locations based on required regulatory setbacks. If you plan to install infiltration trenches or dry wells, it is in your interest to have a professional determine the depth to the Seasonal High Groundwater Table (SHGWT) to ensure proper functioning of the stormwater practice
- Step 3: Select appropriate storm water treatment practice(s) based on your site conditions and required elements for each practice. You may have to install more than one practice to meet your stormwater management requirements;
- Step 4: Size the selected stormwater treatment practice(s) to meet the water quality volume (WQ_v) requirement using drainage area and soil texture information;
- Step 5: Prepare a site plan depicting location of all proposed stormwater treatment practices, drainage areas, stormwater flow paths to each practice and other required elements detailed in the checklist on page 17 of this document.

Step 1: Determine the surface area of new rooftop and driveway areas

The purpose of this step is to calculate the surface area in square feet of all **new** rooftop, driveway and parking area surfaces associated with your project. Determine the area of new rooftops, driveways and parking areas by multiplying the length times the width. Alternatively for new homes or garages, use the footprint area of the building as measured from the site plan. If the total new rooftop area is greater than 600 square feet, then proceed to Step 2. For all new driveway and parking areas regardless of size, proceed to Step 2.

**Step 2: Choose potential storm water management practice locations based on required setbacks.
If needed, get a professional soil evaluation to determine soil drainage and texture ;**

When choosing locations for your stormwater management practices, be sure each location meets the required minimum separation distances, or setbacks, listed in Table 1 below.

Table 1. Minimum Setback Distances for Rain Gardens, Infiltration Trenches, Dry Wells and Permeable Pavement Practices on Single-Family Residential Lots

Landscape Feature	Required Setback (ft) for Infiltration Trenches and Dry Wells	Required Setback (ft) for Rain Gardens and Permeable Paving Practices
Public Drinking Water Supply Well – Drilled (rock), Driven, or Dug	200	200
Public Drinking Water Supply Well – Gravel Packed, Gravel Developed	400	400
Private Drinking Water Wells	50	25
Surface Water Drinking Water Supply Impoundment with Supply Intake	100	100
Tributaries that Discharge to the Surface Drinking Water Supply Impoundment	50	50
All Other Surface Waters	50	50
Up-gradient from Natural slopes > %15	25	25
Down-gradient from Building Structures	10	10
Up-gradient from Building Structures	10	10
Onsite Wastewater Treatment Systems (OWTS)	15	15
Coastal features, coastal buffer zones, regulated freshwater wetlands	As applicable	As applicable

To ensure proper functioning of a stormwater management practice, you must make sure it is located in an area with adequate soil drainage. Improper siting of stormwater management practices can cause extended ponding or overall failure of the practice, which can lead to flooding and possibly mosquito breeding problems on your site. To test a potential site, a 6 to 8 inch deep hole may be dug and filled with water. If the water does not drain within 12 hours, the location is not appropriate for a stormwater management practice. You can also have potential stormwater practice locations inspected by a professional licensed soil evaluator, registered professional engineer or certified soil scientist. If you plan to install an infiltration trench or dry well, you should determine the depth to the Seasonal High Groundwater Table (SHGWT). This is especially advisable if there is a known or suspected shallow depth to SHGWT anywhere on the site. Determinations of depth to the SHGWT are best done by a professional engineer, licensed soil evaluator or certified soil scientist. Alternatively, refer to a prior determination of the depth to SHGWT such as may appear on a prior onsite wastewater treatment system plan. The depth to SHGWT is **not** required when the selected practice is a Qualifying Pervious Area (QPA), vegetated swale, rain garden or permeable surface construction. Notify your local Dig Safe system (1-888-DIG-SAFE) at least three business days before you dig.

Additional soil testing guidelines are provided in Appendix H of the RI Stormwater Design and Installation Standards Manual.

Step 3: Select appropriate stormwater treatment practices based on your site conditions and the required elements of each practice.

Now that you have identified locations that are appropriate for stormwater management practices, you will need to select the type of practice to be installed at each location. Table 2 below lists LID stormwater management practices that may be applied on residential lots to meet the requirements for individual single-family residential projects. Each of these practices is explained in further detail in Sections A through E, which include design information to help you determine whether the practice is appropriate for your site. You may need to select more than one practice to meet your stormwater management requirements. The minimum criteria and required elements for each practice are derived from the specifications in the most recent version of the RI Stormwater Design and Installation Standards Manual.

Table 2. Residential stormwater management practices and their applicability

LID Practice	Can be used to treat runoff from rooftops	Can be used to treat runoff from driveways
Qualifying Pervious Area (QPA)	✓	✓
Vegetated Swale	✓	✓
Rain Garden	✓	✓
Infiltration Trench	✓	✓
Dry Well	✓	✓
Permeable Surface Construction		✓

Step 4: Size the selected stormwater treatment practice(s) to meet the water quality volume (WQ_v) requirement

After selecting the appropriate stormwater treatment practices for your site from Step 3 above, you'll need to size each practice to accommodate the water quality volume, or the first one inch of runoff from the contributing impervious surface. Use the sizing guidance in sections A through E for each stormwater management practice. You will need to determine the drainage area, or the area of impervious surface that drains to each practice. For example, if a practice will receive runoff from a single downspout that drains ¼ of a rooftop, you would calculate the drainage area by dividing the entire roof area by 4 (see Figure 1. below). To determine the water quality volume from each drainage area, multiply the drainage area in square feet by 0.083 (ft./in.).

Next, if you are proposing a vegetated swale, rain garden, infiltration trench or dry well, you will need to determine the texture of the soil at your chosen stormwater management practice locations (soil texture is **not** required for QPAs or permeable surface construction). This information will be used to determine the size of each practice. Texture can be determined by a soil professional in conjunction with the SHGWT depth determination, or you can send a sample for textural classification to a soil testing laboratory. Alternatively, you can make the conservative assumption that the soil is silty, and size your practices accordingly. This assumption will maximize the size of each practice. Additional soil testing guidelines are provided in Appendix H of the RI Stormwater Design and Installation Standards Manual.

Stormwater Management Practices for Individual Single-Family Residential Lots

A. Qualifying Pervious Areas

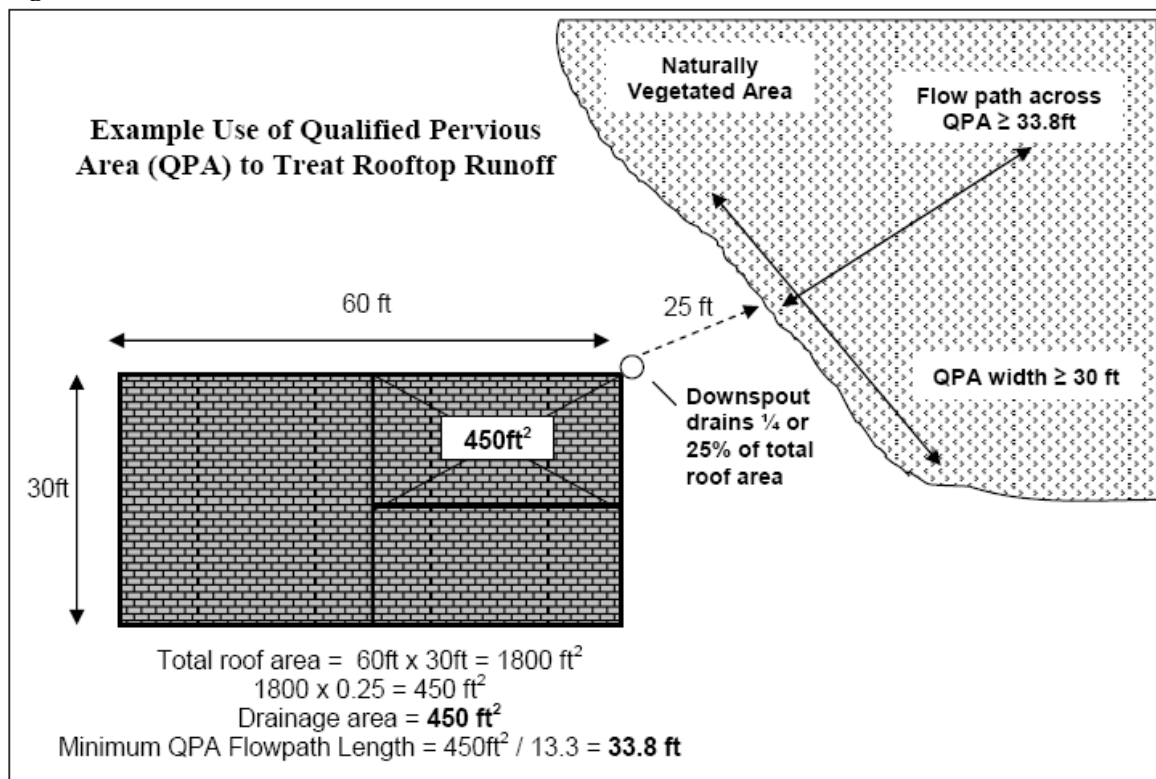
Qualifying Pervious Areas (QPAs) are natural or restored upland vegetated areas that meet specific requirements such as maximum slope and soil characteristics, which can be used to infiltrate storm water runoff. Wetland areas or coastal features may not be used as QPAs, with the exception of perimeter or riverbank wetlands as defined in DEM Rules Section 4.00. For individual single-family residential lot applications, QPAs must be areas of vegetation that are not highly managed or fertilized. Lawn areas may not be used as QPAs for individual single-family residential projects. In general, QPAs are relatively flat with well-drained soils, and receive small volumes of runoff as sheet (unconcentrated) flow. To utilize this practice, simply direct storm water flow to an area that meets the criteria in Table 3 below.

Table 3. Minimum Criteria for Qualifying Pervious Areas on Single-Family Residential Lots	
<i>Drainage Area and Size</i>	<ul style="list-style-type: none"> <input type="checkbox"/> The rooftop, driveway or parking area draining to any one QPA cannot exceed 1,000 ft². <input type="checkbox"/> For roof runoff, the length of the flow path through the QPA shall be equal to or greater than the contributing rooftop area divided by 13.3. The width of the QPA shall be equal to or greater than the length of the contributing rooftop area. <input type="checkbox"/> For driveway runoff, the length and width of the QPA shall be no less than the length and width of the driveway. For example, if a driveway is 15 feet wide and 40 feet long, the QPA width shall be no less than 15 feet wide and 40 feet long.
<i>Location</i>	<ul style="list-style-type: none"> <input type="checkbox"/> In locations where there is a history of groundwater seepage and/or basement flooding, QPAs should not be utilized. <input type="checkbox"/> The flow path through the QPA must be 25 feet from any onsite wastewater treatment system (OWTS). <input type="checkbox"/> The slope of the QPA shall be less than or equal to 5.0%. <input type="checkbox"/> Although they may abut, there shall be no overlap between QPAs. For example, the runoff from two 1,000 ft² sections of roof must be directed to separate QPAs. They shall not be directed to the same area.
<i>Conveyance</i>	<ul style="list-style-type: none"> <input type="checkbox"/> Lawn areas may not be used as QPAs for individual single-family residential lots. Stormwater runoff may be conveyed across a lawn area to a QPA provided the area of lawn between the discharge point and the QPA is less than 25 feet wide. <input type="checkbox"/> Wetlands and coastal features may not be used as QPAs, however part or all of an upland buffer zone, perimeter wetland or riverbank wetland (as defined in DEM Rules Section 4.00) may be used as a QPA. Activities such as planting or alteration of vegetation within a coastal buffer zone will require additional written approval from CRMC. <input type="checkbox"/> To prevent basement seepage, at a minimum, runoff must be directed away from the building foundation and be infiltrated at the QPA at least 10 feet away from the foundation. <input type="checkbox"/> Downspouts must discharge at least 10 feet away from the nearest impervious surface to prevent reconnection to any storm sewers. <input type="checkbox"/> Downspouts must include appropriate provisions, such as a splash block or level spreader to induce non-erosive sheet flow.

	<ul style="list-style-type: none"> <input type="checkbox"/> Where a gutter/downspout system is not used, the rooftop runoff must be designed to sheet flow at low velocity away from the structure housing the roof, and enter the QPA as sheet flow. <input type="checkbox"/> Runoff from driveways may be directed over soft shoulders, through curb cuts or level spreaders to QPAs. Measures must be employed at the discharge point to the QPA to prevent erosion and the runoff must enter the QPA as sheet flow.
Construction*	<ul style="list-style-type: none"> <input type="checkbox"/> To prevent compaction of the soil in the QPA, construction vehicles must not be allowed to drive over the area. If it becomes compacted, the soil must be suitably amended, tilled, and re-vegetated once construction is complete to restore infiltration capacity. <input type="checkbox"/> If you are restoring an area by planting to create an eligible QPA, use approved native plants from the RI Coastal Plant Guide (www.uri.edu/cels/ceoc/coastalPlants/CoastalPlantGuide.htm) or Appendix B of the RI Stormwater Design and Installation Standards Manual. Additional planting guidance can be found in the CRMC Coastal Buffer Zone Planting Guide (http://www.crmc.ri.gov/coastallandscapes/Coastal_Buffer_Planting_Guide.pdf).
Maintenance*	<ul style="list-style-type: none"> <input type="checkbox"/> The QPA must be inspected and maintained at least yearly to remove deposited sediment and address any ponding or erosion, and replant vegetation within the QPA that has died.

*Construction and maintenance activities within a coastal buffer zone will require additional written approval from CRMC

Figure 1.

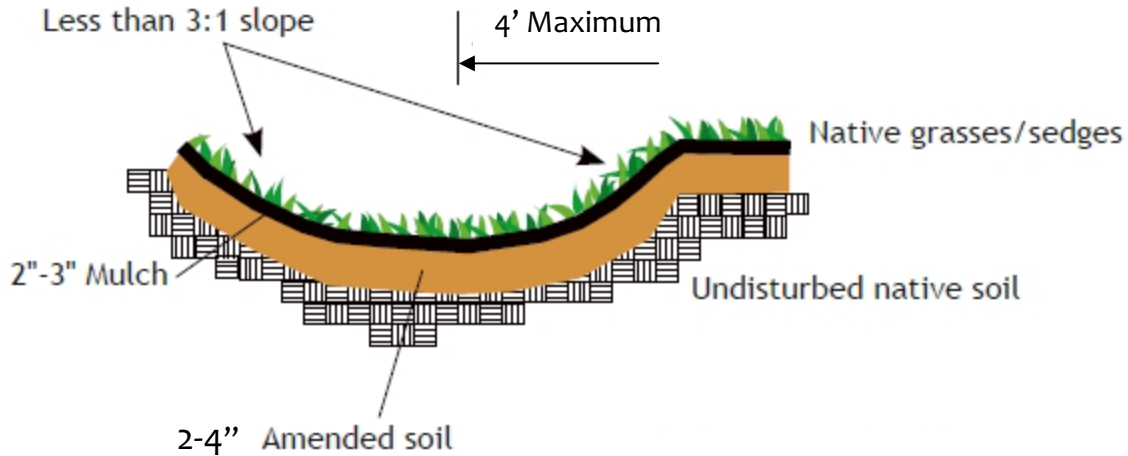


B. Vegetated Swales

Vegetated swales are open vegetated channels that are designed to capture and treat stormwater runoff. They are similar in concept and construction to a rain garden, except for their long, narrow shape and longitudinal slope. They are typically vegetated with grasses (see Appendix B, Section B.6 of the RI Stormwater Design and Installation Standards Manual for planting guidance). They may be used as a stand-alone stormwater management practice or as a conveyance to other practices.

Table 4. Required Elements for Vegetated Swales on Single-Family Residential Lots	
<i>Conveyance</i>	<ul style="list-style-type: none"> <input type="checkbox"/> Vegetated swales shall be designed with moderate side slopes flatter than 3:1 for most conditions. <input type="checkbox"/> Vegetated swales shall have a maximum longitudinal slope of 4% (e.g. 4 foot drop over a horizontal distance of 100 feet).
<i>Treatment</i>	<ul style="list-style-type: none"> <input type="checkbox"/> The average surface ponding depth shall be no more than a 8 inches deep. <input type="checkbox"/> The bottom width shall be no less than 2 feet and no greater than 8 feet wide <input type="checkbox"/> A maximum ponding depth of 1 ft should be maintained at the longitudinal midpoint of the vegetated swale and a maximum depth of 18 inches at the end point. <input type="checkbox"/> Swales should contain a 2 – 4 inch amended soil layer and a 2 – 3 inch mulch layer. <input type="checkbox"/> The amended soil layer of a vegetated swale should be a 50/50 mixture of the excavated native soils and mature organic compost.
<i>Vegetation</i>	<ul style="list-style-type: none"> <input type="checkbox"/> Grasses or sedges are typically used in vegetated swales, but other native plants can be used as well. Please refer to the RI Coastal Plant Guide (www.uri.edu/cels/ceoc/coastalPlants/CoastalPlantGuide.htm) and modify the selection for native plants suited to rain gardens.
<i>Maintenance</i>	<ul style="list-style-type: none"> <input type="checkbox"/> Vegetated swales shall be inspected annually and should be inspected after large storm events. <input type="checkbox"/> Eroded side slopes and channel bottoms shall be stabilized as necessary. <input type="checkbox"/> If the surface of the dry swale becomes clogged to the point that standing water is observed on the surface 48 hours after precipitation events, the bottom shall be roto-tilled or cultivated to break up any hard-packed sediment, and then reseeded. <input type="checkbox"/> Vegetation in dry swales shall be mowed as required to maintain minimum grass heights in the 4-6 inch range. <input type="checkbox"/> Every five years, the channel bottom of dry swales should be scraped to remove sediment and to restore original cross section and infiltration rate, and should be seeded to restore ground cover, where necessary.

Figure 2. Vegetated Swale, Typical Cross-Section



(Figure adapted from Vermont Department of Environmental Conservation’s Vermont LID Guide for Residential and Small Sites www.vtwaterquality.org/stormwater/docs/swimpairedwatersheds/sw_rda_small_sites_guide.pdf)

Sizing a Vegetated Swale:

Determine the area (in square feet) of impervious surface that will drain to the swale. This is the drainage area. Use Table 5 below to choose a pre-calculated size for an 8 inch deep swale based on the drainage area and soil texture. To do this, you may need to round up your drainage area size (don’t round down to avoid under-sizing your swale). Remember that your swale should be at least 2 but less than 8 feet wide at the bottom, and the sides should have a slope no steeper than 3:1. The sizing recommendations below are based on sizing guidance in the University of Wisconsin Extension publication “Rain Gardens: a how-to manual for homeowners,” which can be accessed at www.dnr.state.wi.us/runoff/pdf/rg/rgmanual.pdf. Alternatively, use sizing information and equations in Chapter 5 of the RI Stormwater Design and Installation Standards Manual at www.dem.ri.gov/pubs/regs/regs/water/swmanual.pdf. Be sure to demonstrate which sizing method was used on your submitted application.

Table 5. Vegetated Swale Sizing Guidance

Drainage Area (in square feet)	Bottom surface Area (in square feet) for an 8 in. deep swale	
	Sandy Soils*	Silty Soils*
200	16	32
400	32	64
600	48	96
800	64	128
1000	80	160

*In lieu of a soil texture determination, use the calculated surface areas for silty soils

C. Rain Gardens

Rain Gardens are shallow depressions that are excavated, backfilled with amended soil, and planted to capture runoff and allow it to infiltrate into the ground below. Rain gardens can be planted with a variety of plants, and are similar to regular planting beds or landscaped areas, except that they are designed and sited to intercept and detain stormwater runoff. They are ideal for receiving larger volumes of runoff from downspouts or impervious areas such as driveways.

Table 6. Required Elements for Rain Gardens on Single-Family Residential Lots

Location	<ul style="list-style-type: none"> <input type="checkbox"/> Rain gardens should be located in areas with less than a 12% slope (i.e. a 12 foot drop over a horizontal distance of 100 feet or a 6 foot drop over a distance of 50 feet). <input type="checkbox"/> Rain gardens should be located at least 10 ft from foundations to avoid basement seepage. <input type="checkbox"/> Rain gardens should be located at least 15 ft from onsite wastewater treatment systems and at least 25 ft from private drinking water wells (see Table 5 for additional setbacks).
Treatment	<ul style="list-style-type: none"> <input type="checkbox"/> The bottom of a rain garden should be level to encourage the even distribution of stormwater and increase infiltration capacity. <input type="checkbox"/> Rain gardens should be 4 to 8 inches deep with a 2 – 4 inch amended soil layer and a 2 – 3 inch layer of non-dyed aged shredded hardwood mulch. <input type="checkbox"/> The amended soil layer of a rain garden should be a 50/50 mixture of the excavated native soils and mature organic compost.
Vegetation	<ul style="list-style-type: none"> <input type="checkbox"/> Select plants for rain gardens using the Coastal Plant Guide at www.uri.edu/cels/ceoc/coastalPlants/CoastalPlantGuide.htm or Appendix B of the RI Stormwater Design and Installation Standards Manual. See example planting plans below.
Construction	<ul style="list-style-type: none"> <input type="checkbox"/> A crushed stone entrance should be installed at the inflow to prevent channeling. <input type="checkbox"/> A berm to detain stormwater should be constructed along the downhill side of the rain garden, perpendicular to the slope of the lawn <input type="checkbox"/> Be sure that the soil within the rain garden area does not become compacted by construction activities (i.e. heavy machinery). If soil becomes severely compacted it may need to be tilled and amended to maintain proper drainage.
Maintenance	<ul style="list-style-type: none"> <input type="checkbox"/> Rain gardens shall be inspected following at least the first two precipitation events of at least 1.0 inch to ensure that the system is functioning properly. Thereafter, the rain garden shall be monitored and maintained to assure proper functioning, plant growth and survival. Plants shall be replaced on an as-needed basis during the growing season. <input type="checkbox"/> Silt/sediment shall be removed from the rain garden when the accumulation exceeds one inch, or when water ponds on the surface of the rain garden for more than 48 hours). The top few inches of material shall be removed and shall be replaced with fresh soil mixture and mulch. <input type="checkbox"/> Pruning or replacement of woody vegetation shall occur when dead or dying vegetation is observed. <input type="checkbox"/> Soil erosion gullies shall be repaired when they occur. <input type="checkbox"/> Fertilizer or pesticides shall not be applied to plants within rain gardens. <input type="checkbox"/> Perennial plants and ground covers shall be replaced as necessary to maintain an adequate vegetated ground cover. Annual plants may also be used to maintain ground cover.

Sizing a Rain Garden

Determine the area of impervious surface that will drain to your rain garden. This is the drainage area. Use Tables 7 and 8 below to choose a pre-calculated size based on the drainage area, soil texture and depth. To do this, you may need to round up your drainage area size (don't round down to avoid under-sizing your rain garden). The sizing recommendations below are based on sizing guidance in the University of Wisconsin Extension publication "Rain Gardens: a how-to manual for homeowners," which can be accessed at clean-water.uwex.edu/pubs/pdf/rgmanual.pdf. Alternatively, use sizing information and equations in Chapter 5 of the RI Stormwater Design and Installation Standards Manual at www.dem.ri.gov/pubs/regs/regs/water/swmanual.pdf. Be sure to demonstrate which sizing method was used on your submitted application.

Tables 7. and 8. Rain Garden Sizing Guidance

Rain Garden Surface Area in Sandy Soils (Sands, Loamy Sands and Sandy Loams) (square feet)			
Drainage Area (Square feet)	for 4 inch deep garden	for 6 inch deep garden	for 8 inch deep garden
100	19	15	8
200	38	30	16
300	57	45	24
400	76	60	32
500	95	75	40
600	114	90	48
700	133	105	56
800	152	120	64
900	171	135	72
1000	190	150	80

Rain Garden Surface Area in Silty Soils (Loams and Silt Loams) (square feet)			
Drainage Area (Square feet)	for 4 inch deep garden	for 6 inch deep garden	for 8 inch deep garden
100	34	25	16
200	68	50	32
300	102	75	48
400	136	100	64
500	170	125	80
600	204	150	96
700	238	175	112
800	272	200	128
900	306	225	144
1000	340	250	160

*In lieu of a soil texture determination, use the calculated surface areas for silty soils

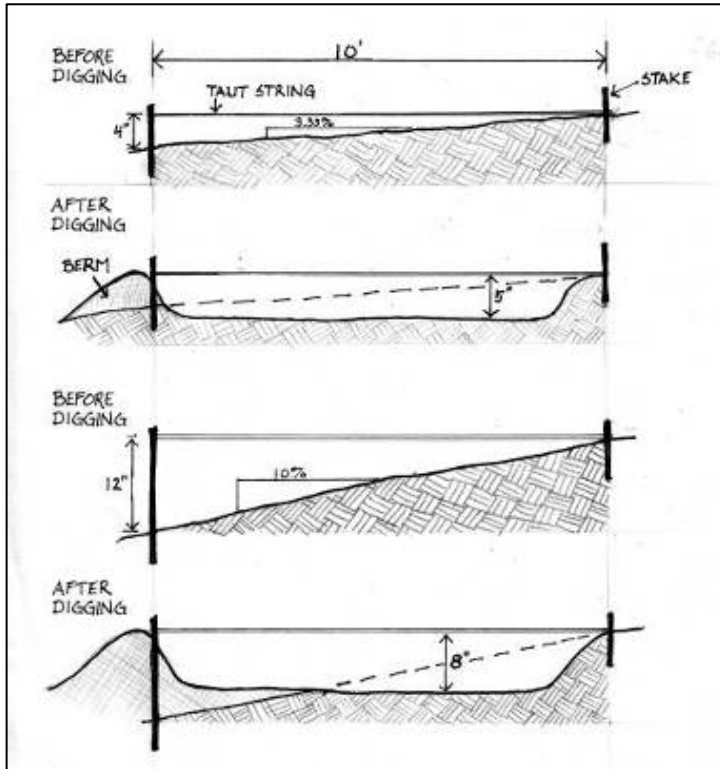
Rain Garden Dimensions and Shape

The length of the rain garden should be perpendicular to the slope of the lawn, and overall it should be twice as long as it is wide. This allows the garden to catch as much runoff as possible. Rounded or curvy shapes are the most effective, just be sure to approximate the required area from the table. Depending upon your site, it may be easier to break up stormwater flows to create multiple, smaller rain gardens than one larger one.

Rain Garden Installation

The best time to install a rain garden is in the spring, when digging will be easier and plants will be more likely to thrive. Be sure that the bottom of the rain garden is level and at the appropriate depth, and that you create a berm on the downhill side to retain stormwater (see Figure 3. below).

Figure 3. Digging the Rain Garden and Creating a Berm



Rain Garden Plant Selection

Plants that tend to do well in rain gardens are those that tolerate wet conditions, but also very dry conditions. Use the Rhode Island Coastal Plant Guide at www.uri.edu/cels/ceoc/coastalPlants/CoastalPlantGuide.htm to select appropriate species (filter your selection for “Rain Garden”) then create a planting plan to lay out where each plant will go. Below are two example planting plans for residential rain gardens, but feel free to create your own. To ensure proper functioning of the rain garden, your planting plan should include a minimum of three different plant species, including shrubs as well as herbaceous species. Additional guidance for plant selection can be found in Appendix B of the RI Stormwater Design and Installation Standards Manual or in the CRMC Coastal Buffer Zone Planting Guide at www.crmc.ri.gov/coastallandscapes/Coastal_Buffer_Planting_Guide.pdf. Submit your planting plan and a list of the species to be planted with your application.

Figure 4. Rain Garden Example - Planting Plan 1

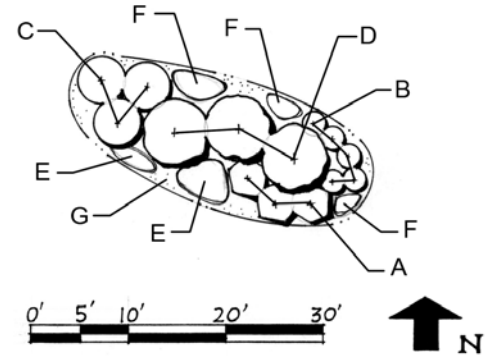
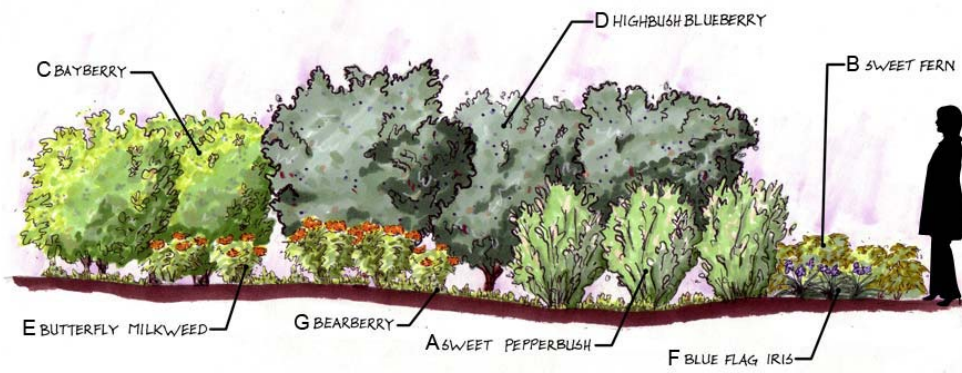
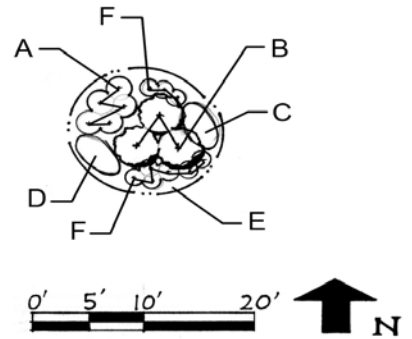
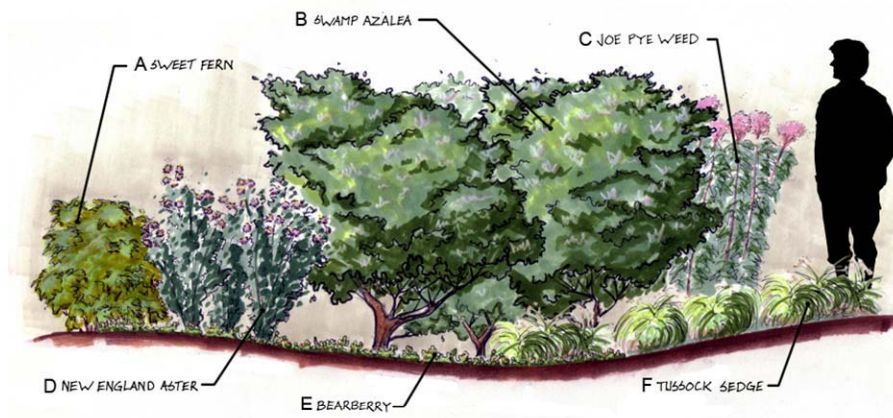


Figure 5. Rain Garden Example - Planting Plan 2



D. Infiltration Trench and Dry Well

Infiltration trenches and dry wells are dug chambers backfilled with crushed stone that capture and temporarily store stormwater before allowing it to infiltrate into the soil over a maximum period of 48 hours.

Table 9. Required Elements for Infiltration Practices (Trenches and Dry Wells) on Single-Family Residential Lots	
Location	<input type="checkbox"/> Trenches and dry wells must meet the setback requirements in Table 5 above. <input type="checkbox"/> Trenches and dry wells cannot be placed in locations that cause water problems (such as seepage which may cause slope failure) to downgrade properties.
Treatment	<input type="checkbox"/> The bottom of the stone reservoir should be completely flat or nearly so in order that infiltrated runoff will be able to infiltrate through the entire bottom surface area. <input type="checkbox"/> The bottom of infiltration practices must be separated by at least two feet vertically from the seasonal high groundwater table (SHGWT). Depth to the SHGWT should be determined by a licensed soil evaluator, registered professional engineer or certified soil scientist. <input type="checkbox"/> The bottom of infiltration practices must be located in the soil profile.
Construction	<input type="checkbox"/> Great care must be taken to prevent the infiltration area from compaction by marking off the location before the start of construction at the site and constructing the infiltration practice last. <input type="checkbox"/> An observation well shall be installed in every infiltration trench or dry well, consisting of an anchored 4- to 6-inch diameter perforated PVC pipe with a screw-top cap installed flush with the ground surface.
Maintenance	<input type="checkbox"/> Infiltration practices shall be inspected annually and repaired if necessary to ensure proper drainage. <input type="checkbox"/> Accumulated sediment and debris shall be removed from the surface of the infiltration practice annually.

Figure 6. Infiltration Trench, Typical Cross-Section

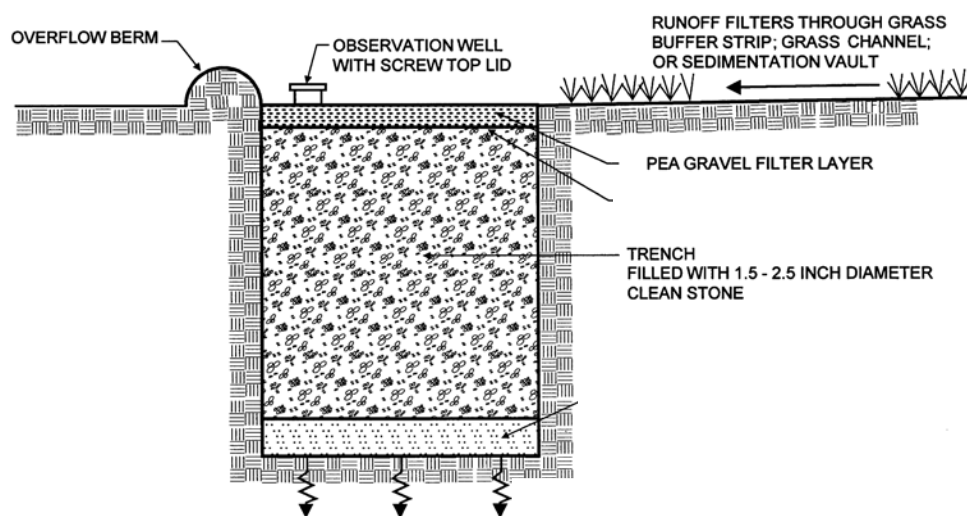
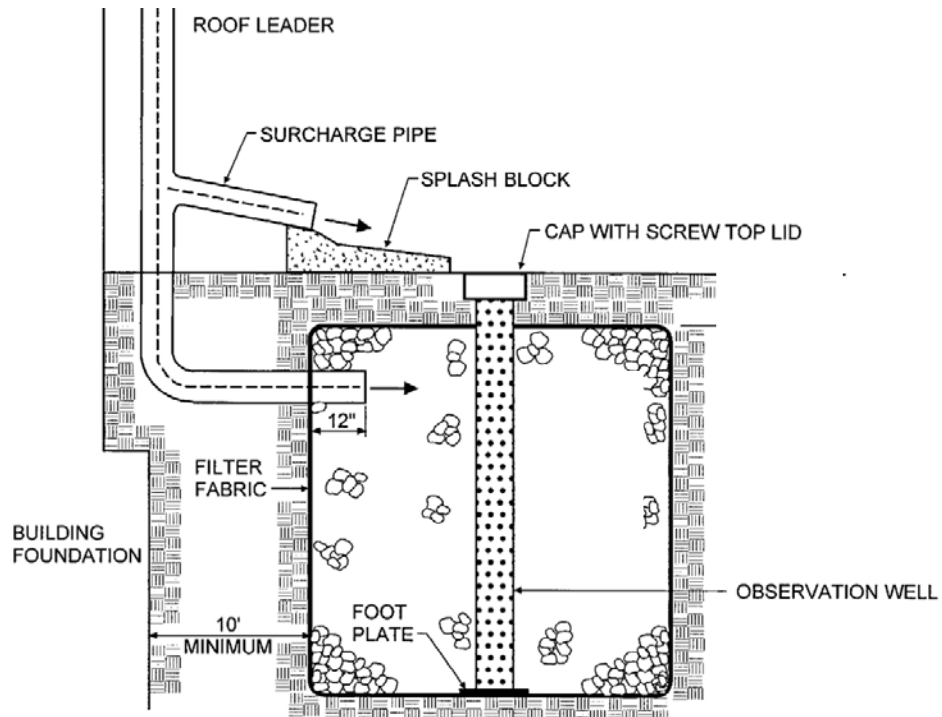


Figure 7. Dry Well, Typical Cross-Section



Sizing Infiltration Trenches and Dry Wells:

Determine the size (in square feet) of the impervious surface that will drain to your infiltration trench or dry well. This is the drainage area. Use Tables 10 and 11 below to determine the size of your infiltration trench or dry well. The sizing recommendations in the tables below are based on the sizing equations provided in the Rhode Island Stormwater Design and Installation Standards Manual, Section 5.3. For additional sizing information see Chapter 5 of the Manual at www.dem.ri.gov/pubs/regs/regs/water/swmanual.pdf. Be sure to detail which sizing method was used in your submitted application.

Tables 10. and 11. Sizing Guidance for Infiltration Trenches and Dry Wells

**Infiltration Trench / Dry Well Surface Area (square feet)
in Sandy Soils (Sands, Loamy Sands and Sandy Loams)**

Drainage Area (sq. ft.)	6 in. deep	12 in. deep	18 in. deep	24 in. deep	30 in. deep	36 in. deep	48 in. deep
100	24	16	12	10	8	7	5
200	48	32	24	19	16	14	11
300	72	48	36	29	24	21	16
400	96	64	48	39	32	28	21
500	119	80	60	48	40	34	27
600	143	96	72	58	48	41	32
700	167	112	84	67	56	48	38
800	191	128	96	77	64	55	43
900	215	144	108	87	72	62	48
1000	239	160	120	96	80	69	54

Infiltration Trench / Dry Well Surface Area (square feet) in Silty Soils (Loams and Silt Loams)

Drainage Area (sq. ft.)	6 in. deep	12 in. deep	18 in. deep	24 in. deep	30 in. deep	36 in. deep	48 in. deep
100	38	21	15	11	9	8	6
200	76	43	30	23	18	15	12
300	114	64	44	34	28	23	18
400	152	85	59	45	37	31	23
500	190	107	74	57	46	39	29
600	229	128	89	68	55	46	35
700	267	149	104	79	64	54	41
800	305	171	119	91	74	62	47
900	343	192	133	102	83	70	53
1000	381	213	148	113	92	77	59

E. Permeable Paving and Pavers

Permeable paving practices capture and temporarily store the water quality volume before allowing it to infiltrate into the soil. The two major types include porous asphalt or concrete and paver systems. For individual single-family residential projects only, crushed stone may be used without a grid system provided it meets the required elements below.

- **Porous asphalt and concrete** resemble traditional asphalt or concrete pavement but they have a 10%--25% void space and are constructed over an open-graded stone base course that doubles as the stormwater reservoir before it infiltrates into the subsoil. Porous asphalt and concrete must be designed and installed in accordance with specifications in Appendix F of the RI Stormwater Design and Installation Standards Manual.
- **Pavers** include permeable blocks, solid blocks with open-cell joints, as well as open-cell grids filled with either gravel or with sandy soil and then planted with turf, set on a prepared open-graded stone base course that also serves as a reservoir for the stormwater before it infiltrates into the subsoil.

Table 12. Required Elements for Permeable Paving and Pavers on Residential Lots

<i>Feasibility</i>	<ul style="list-style-type: none"> <input type="checkbox"/> Soil infiltration rate must be at least 0.5 inches per hour as determined by a soil professional or lab analysis. A professional soil textural analysis is required for permeable paving practices. <input type="checkbox"/> Separation from groundwater table and bedrock must be at least 2 feet.
<i>Location</i>	<ul style="list-style-type: none"> <input type="checkbox"/> Permeable pavement practices must meet the setbacks in Table 5 above <input type="checkbox"/> Permeable paving should be located in areas with less than 5% slope.
<i>Treatment</i>	<ul style="list-style-type: none"> <input type="checkbox"/> The water quality volume must exfiltrate through the floor of the practice in the soil horizon <input type="checkbox"/> Permeable paving systems shall be designed to fully de-water the entire water quality volume within 24 hours after the storm event <input type="checkbox"/> The bottom of the stone reservoir should be completely flat, or nearly so, to allow runoff to infiltrate through the entire bottom surface area.
<i>Vegetation</i>	<ul style="list-style-type: none"> <input type="checkbox"/> The site shall be completely stabilized before any flow is directed to the practice. <input type="checkbox"/> Pavers that are planted with grass require species with deep root systems.
<i>Construction</i>	<ul style="list-style-type: none"> <input type="checkbox"/> Pavers should be professionally installed in accordance with the manufacturer’s specifications. Additional information on paver systems including a list of approved installers can be found at Interlocking Concrete Pavement Institute website at: www.icpi.org. <input type="checkbox"/> Permeable blocks must have a minimum void ratio of 15% and meet the minimum criteria in Section 5.4 of the RI Stormwater Design and Installation Standards Manual. <input type="checkbox"/> Solid blocks with open-cell joints must meet the minimum criteria in Section 5.4 of the RI Stormwater Design and Installation Standards Manual. <input type="checkbox"/> For crushed stone driveway construction, the crushed stone used must be ¾ inch to 1½ inch diameter, washed, angular crushed stone installed to a minimum depth of 3 inches. The grade of the finished driveway shall not be higher than the adjacent ground elevation.
<i>Maintenance</i>	<ul style="list-style-type: none"> <input type="checkbox"/> The surface of permeable paving or pavers shall be monitored after storms to ensure it drains properly. The surface shall be inspected annually for deterioration and repaired as needed. <input type="checkbox"/> Maintenance shall be performed according to the manufacturer’s specifications for paver systems. <input type="checkbox"/> Paver grids planted with grass shall be mowed on a regular basis and reseeded as necessary. <input type="checkbox"/> Use of sand and salt on permeable paving and pavers shall be minimized. <input type="checkbox"/> Porous asphalt or concrete driveways shall not be repaved or resealed with impermeable products. <input type="checkbox"/> Crushed stone shall be replaced or re-grading performed as necessary in crushed stone driveways to maintain a minimum 3” depth of stone and a level surface.

Step 5: Prepare a site plan depicting location of all proposed stormwater treatment practices, drainage areas, stormwater flow paths to each practice and other required elements as detailed in the checklist below

The site plan submitted with the CRMC or DEM application should clearly show:

- New rooftop and driveway areas, with total area in square feet.
- Location of all stormwater management (LID) practices.
- Area of rooftop / driveway / parking area draining to each stormwater management practice,
- Location of collection points (such as downspouts), and direction of overland flowpath or other conveyance measures to stormwater practices.
- Location of buffer zones, freshwater wetlands, coastal features and other natural vegetation
- Depth to Seasonal High Ground Water Table (SHGWT) if proposing infiltration trenches or dry wells (depth to SHGWT **not** needed for QPAs, vegetated swales, rain gardens or permeable surface construction).
- Planting plan and plant list if proposing rain garden. See Appendix B of the RI Stormwater Installation Standards Manual, the CRMC Rhode Island Coastal Plant Guide at www.uri.edu/cels/ceoc/coastalPlants/CoastalPlantGuide.htm or the CRMC Coastal Buffer Zone Planting Guide at www.crmc.ri.gov/coastallandscapes/Coastal_Buffer_Planting_Guide.pdf for guidance