SINKING THE STORM

Easthampton Homeowner's Guide to Do-It-Yourself Stormwater Management Solutions that Improve Community Resilience

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PREPARED BY FUSS & O'NEILL

IN PARTNERSHIP WITH THE CITY OF EASTHAMPTON

MVP Municipal Vulnerability Preparedness

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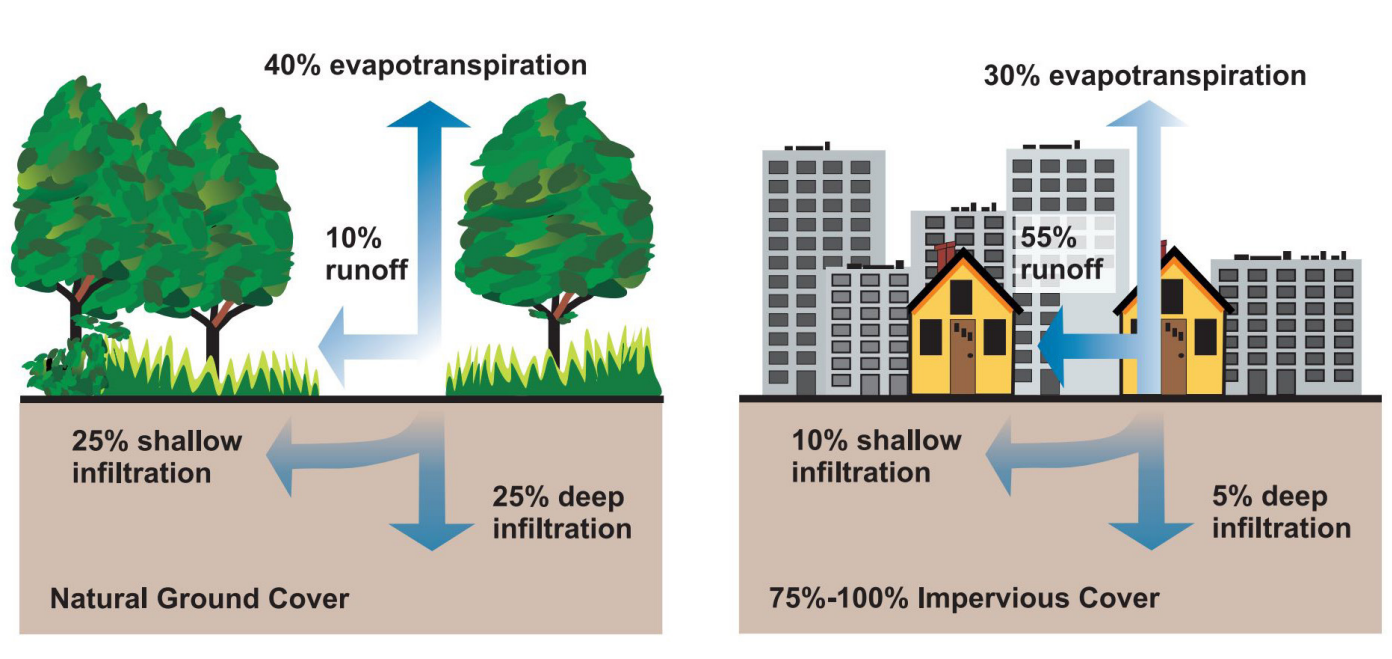


Relationship between impervious surfaces and surface runoff in natural (image on left) and highly developed (image on right) contexts. Impervious surfaces result in increased surface runoff. (EPA, 2003)

1 INTRODUCTION TO STORMWATER MANAGEMENT

WHAT IS STORMWATER?

Stormwater is water that comes from a precipitation event – like a rain or snowstorm. In natural environments, this water might soak into the ground, be absorbed by trees and plants, or flow into nearby streams, rivers, lakes, wetlands, or other water bodies. However, when stormwater flows over **impervious surfaces**, such as streets and parking lots, it is prevented from soaking into the ground and therefore increase overland flow, leading to the creation of **stormwater runoff**.

THE PROBLEM WITH STORMWATER RUNOFF

Excess stormwater runoff becomes a problem when nearby waterbodies must accommodate more water than they can naturally absorb. This can lead to problems like:

- **Flooding** – When excess stormwater runoff flows to nearby waterways more quickly than can be accommodated by natural landscapes, the duration, intensity, and frequency of floods can all increase.
- **Streambank erosion** – Excess stormwater runoff can increase stream volumes and velocities, leading to the deterioration of streambanks, which can place homes, roads, and other critical infrastructure at risk of failure.

Stormwater runoff can also carry increased concentrations of pollutants into **waterbodies**, which can make them unsafe for swimming and create unhealthy habitats for fish and other wildlife. As stormwater flows over land and impervious surfaces, it can pick up pollutants such as oil, fertilizers, pesticides, trash, and animal waste that can be carried directly into local waterbodies.

Massachusetts National Guard operates a front-end loader in an effort to preserve a flooded section of road (CC BY-ND 2.0)

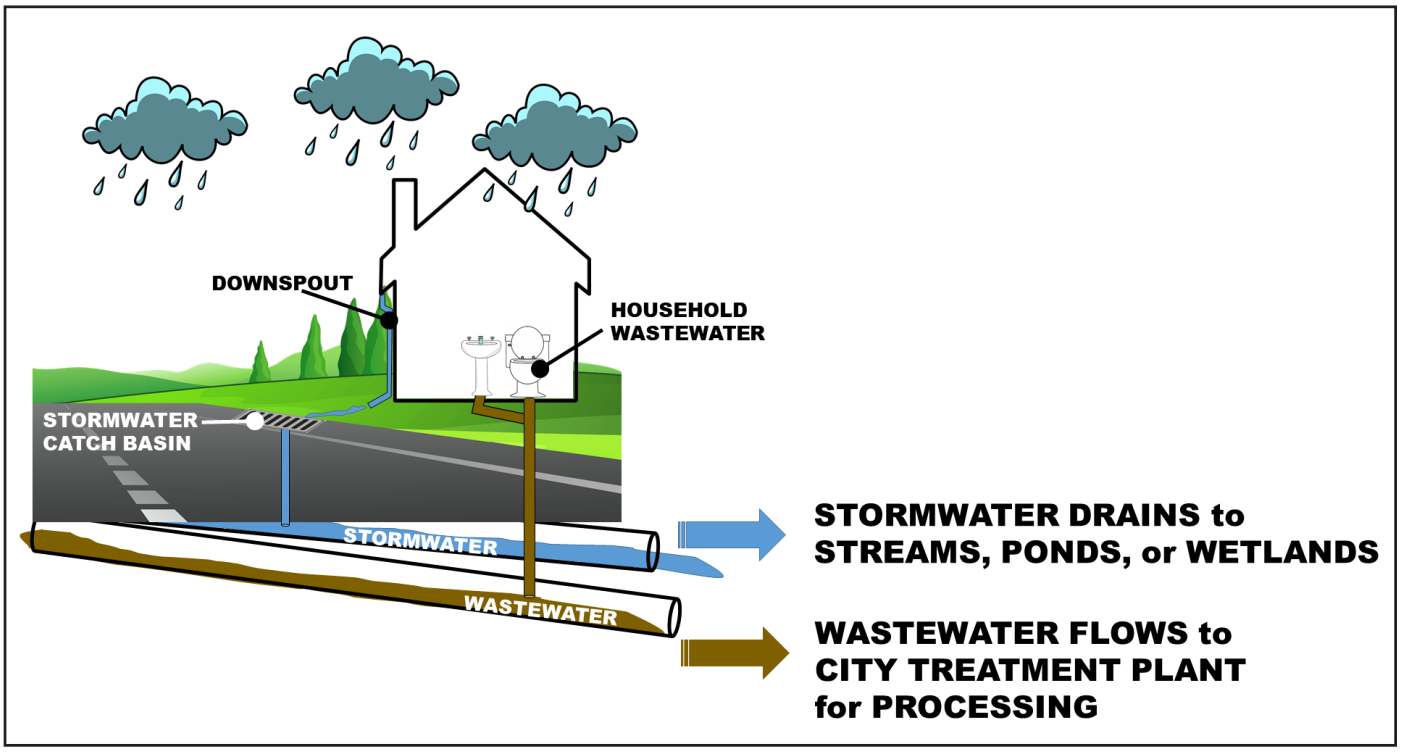
Pollutants can be carried downstream by stormwater runoffand impact local waterbodies.

DID YOU KNOW THAT STORMWATER RUNOFF CAN BE GENERATED RIGHT IN YOUR BACKYARD?

When water runs off impervious surfaces such as the roof of your home or your driveway, it creates stormwater runoff. Without management, stormwater runoff from your property can have an impact on the entire watershed. Fortunately, homeowners can do something about addressing the potential impacts of stormwater runoff.

STORMWATER IN EASTHAMPTON

The City operates an extensive drainage network to collect and convey stormwater, which consists of over 2,800 catch basins, 70 miles of drainage pipe, and nearly 200 outfalls where stormwater is ultimately conveyed to nearby streams and wetlands. However, much of this infrastructure is past its intended design lifespan, and in some cases, is beginning to fail. Additionally, these older drainage systems are frequently undersized to accommodate a greater frequency and intensity of storms, which makes them less resilient to the changing climate.



Stormwater and wastewater travel through separate systems. Wastewater flows to a water treatment facility. Stormwater, and everything collected with it, drains directly into streams, ponds, or wetlands.

While the City has taken active steps to plan for future upgrades and repairs to stormwater infrastructure systems, residents can also play an important role. By implementing strategies at home that better accommodate precipitation events and allow stormwater to infiltrate into the ground, residents can collectively contribute to improving the resiliency of stormwater management throughout the community.

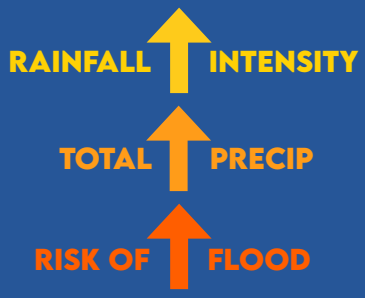
STORMWATER AND CLIMATE CHANGE

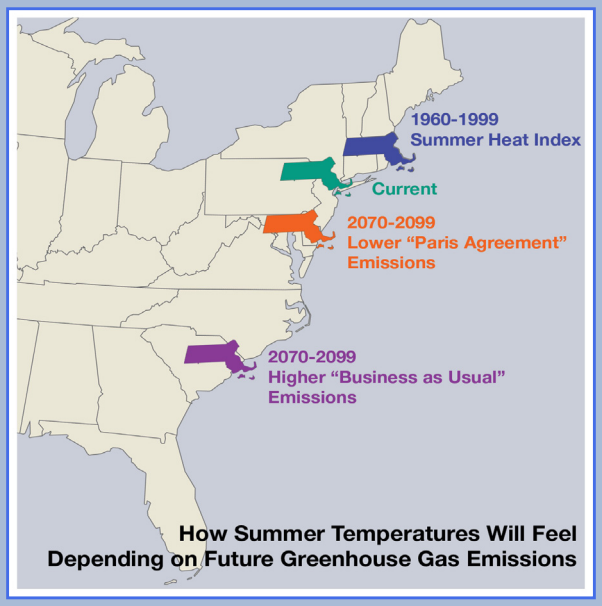
Both the acute and chronic impacts associated with extreme weather and natural and climate related hazards are an increasing concern for the communities of Western Massachusetts. Recent records indicate that the average daily precipitation in Easthampton during rainy or snowy days over the past several years is less than 0.50 inches, with a maximum daily precipitation of 3.58 inches (NOAA, 2021).[1] However, by the end of the century, the Connecticut River Basin could see a 13% increase in total precipitation.[2]

The threat from flooding has been growing with the increasing frequency of major storm events that deliver large amounts of precipitation over a short time period, and this threat is expected to continue to grow due to climate change. Here in the Connecticut River Basin, there has already been more than a doubling of heavy rainfall events over the last 60 years. As precipitation events become more frequent and intense, undersized and aging stormwater infrastructure is more likely to flood and fail, which can lead to the washout of roads, increased erosion, and other downstream impacts. Fortunately, many residents are aware of these potential impacts. When the City conducted a Community Resilience Building (CRB) workshop in February of 2019, key stakeholders identified flooding and severe storms as two of the top climate-related hazards facing the City.[3] Now it is time to address these hazards.

EASTHAMPTON'S CLIMATE IS CHANGING!

Easthampton, like communities across MA, will experience shifts in precipitation as a result of climate change: higher annual rainfall and more intense and frequent storm events, with longer periods of drought in between. These larger storms can overwhelm our existing stormwater systems and stream culverts, which weren't designed or built for these new conditions.





How Summer Temperatures Will Feel Depending on Future Greenhouse Gas Emissions

As time goes on, Easthampton's climate will begin to look more like the climate in the mid-Atlantic. By the end of the century, our climate here in Western Massachusetts will feel like that of the Carolinas today - in other words, we're looking at a hotter, wetter future.

[1] For more details on precipitation in the Easthampton area, visit the National Oceanic and Atmospheric Administration (NOAA) station details for Easthampton (https://www.ncdc.noaa.gov/cdo-web/datasets/GHCND/stations/GHCND:US1MAHS0026/detail) and/or the data from the National Weather Service on past and future/projected precipitation (https://www.weather.gov/).

[2] Resilient MA provides a user-friendly map which shows how precipitation projections and other climate related hazards may impact the area you live in (https://resilientma.org/map/).

[3] Top hazards and vulnerable areas are identified in the Summary of Findings from the 2019 Municipal Vulnerability Preparedness Community Resiliency Building Workshop (https://www.mass.gov/doc/easthampton-report/download).

RESILIENT STORMWATER MANAGEMENT

Resilient stormwater management is the practice of restoring the natural drainage patterns of an area so that it is more resilient to current and future impacts of stormwater runoff. This means trying to mirror the way that rain and melting snow have historically behaved on a property before it was developed to accommodate homes, driveways, yards, etc. Using resilient (also sometimes referred to as "green" or "low-impact") stormwater management strategies,[4] homeowners can focus on redeveloping their land and working with nature to manage stormwater as close to the source as possible.

WHAT ARE EXAMPLES OF RESILIENT STORMWATER MANAGEMENT STRATEGIES?

Easthampton homeowners have been implementing a variety of resilient stormwater management practices

INFILTRATION TRENCH

RAIN BARREL

TREE PLANTING

RAIN GARDEN

[4] The City of Easthampton refers to similar strategies as "green infrastructure" in its City-Wide Green Infrastructure Master Plan. View the plan here: https://easthamptonma.gov/DocumentCenter/View/2764/Green-Infrastructure-Master-Plan

PURPOSE AND USE OF GUIDE

The purpose of this guide is to help homeowners in Easthampton apply a do-it-yourself (DIY) approach to better manage stormwater on their property, and in turn, increase the resilience of their local community.

This guide:

- Identifies solutions to help residents take the next step toward managing stormwater and increasing climate resilience on their own property
- Highlights ways to take advantage of opportunities for greater stormwater infiltration by making use of the well-drained, sandy soils throughout Easthampton
- Includes activities for kids and families to assess the current resilience of their properties
- Provides practical advice for planning and tracking down resources needed to build your own resilient stormwater management practices at home

This guide is not intended to be a substitute for professional design and implementation services. Many of the solutions included in the guide have been selected in part because of their ease of implementation. However, for homeowners who may not have sufficient skills to do the work themselves, it is recommended that you consider working with a professional. Users should check with all appropriate regulatory authorities before relying upon this guide to plan or implement stormwater management practices on their property.

2 ASSESSING STORMWATER ON YOUR PROPERTY

Before you implement resilient stormwater management practices at home, you will need to answer the following questions:

- **Where is stormwater runoff being generated on your property?** Is it coming from your roof? The driveway? Other areas on your property?
- **What challenges are being created by stormwater runoff?** Do you see signs of erosion on your property (e.g., gullies, ditches, bare soils, soil or debris deposits, etc.)?
- **Where does the stormwater runoff flow?** Are there known low spots on your property? Do you have parts of your yard where the grass is typically flattened by runoff or areas where leaves and other debris tend to be pushed aside?
- **How much stormwater runoff is being generated?** Rough estimates of the total gallons of stormwater runoff generated during precipitation events can be made based on known areas of impervious surfaces on your property and typical rainfall/snowfall amounts.
- **What initial goal(s) should be established to address stormwater runoff in your backyard?** Is your biggest problem runoff from your roof? Are you frustrated with ponding or wet areas on your property? Are you interested in collecting rainwater for gardening?

The following steps will help you address each of these questions. And in true DIY fashion, they can be completed on your own or as a family through a series of simple activities.

STEP 1

CREATE A BASE MAP AND ESTIMATE AREAS OF KEY FEATURES

TASK 1:

Map your property. Sketch out a map of your property. You can do this using a pencil and paper or by using a web mapping platform (e.g., Google Maps). Mark the boundaries of your property on the map.

NOTE: If you are unsure of your property boundaries, you may be able to look them up on the deed to your house, your property tax assessment, or at the Hampshire County Assessor's Office.

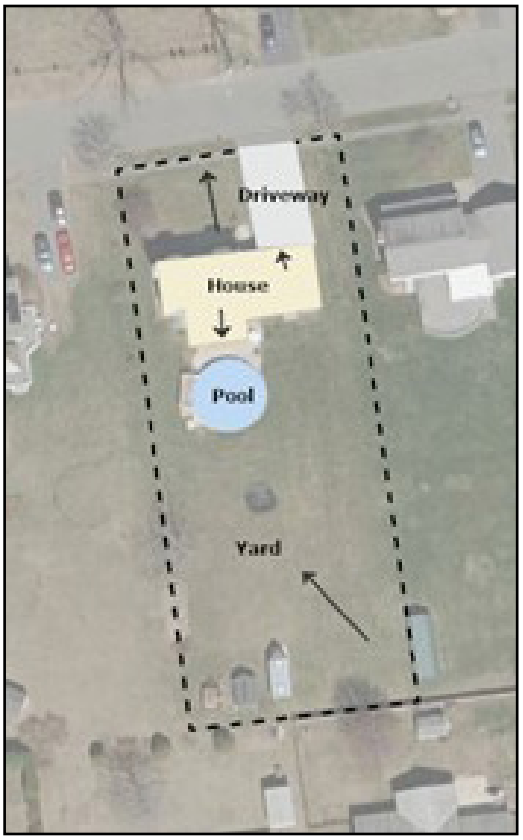
TIP: Using the AxisGIS platform on a browser, tablet, or mobile device, you can easily find property assessment information (e.g., parcel area, building footprint, roof type, etc.) for properties located in the Town of Easthampton.

You can even use "Draw," "Measure," and "Basemap" tools to add information to your map and print it out for easy reference.

See *https://www.axisgis.com/EasthamptonMA/* for more information

TASK 2:

Draw buildings and other key features on your map. Map any buildings, small structures (e.g., sheds), and the following key features on your map:



- **Waterbodies** – These could include streams, ponds, and even swimming pools that may be located on your property.
- **Lawn and landscaped areas** – These are parts of your property with grass or landscaping that you regularly maintain.
- **Natural vegetation areas** – These areas include woods, meadows, or other naturally-vegetated areas that you allow to grow naturally on your property.
- **Impervious surfaces** – These areas include hard surfaces on your property that make it difficult for stormwater to soak into the ground (e.g., driveways, decks, patios, walkways, and other hard surfaces).

TASK 3:

Write down the approximate size of each area identified in Task 2. For the most exact measurements of buildings and parcel sizes, use the City's GIS mapping (see prior page). You can also approximate the size of each key area on your property by measuring with a tape measure to calculate the square footage (or acreage). As a shortcut, if your property has no natural vegetation, you can subtract the area of the impervious surfaces from your total lot size to determine your lawn and landscaped area.

STEP 2

ASSESS STORMWATER RUNOFF

After creating an initial base map of your property, you will want to walk your property and assess how stormwater flows and identify any existing problems with runoff. Large puddles, wet basements, and areas of erosion can all be signs of stormwater runoff issues on your property. If you can, wait for the next rainstorm and try to identify and map the following during (or directly after) the storm:

- Downspouts – Find any roof downspouts and note the direction of flow from each downspout.
- Stormwater flows – Using arrows on your map, show the direction of overland stormwater flow off any impervious surfaces on your property.

TIP: If you have multiple flows, downspouts, ponding areas, or points of erosion, it may be helpful to number them so that you can refer to them later when establishing your goals and plans for implementing more resilient stormwater management practices on your property.

- Areas of ponding – In addition to noting flows, note any locations with large puddles of standing water (also known as "ponding") on your map.
- Points of erosion – Note any areas with soil erosion. These can be gullies or ditches that form seasonally or appear in existing drainage swales or channels. Either way, these should be drawn and labeled on your map.

STEP 3

ESTIMATE THE STORMWATER GENERATED ON YOUR PROPERTY

The amount of stormwater runoff generated on your property at any given time depends on a variety of factors. The intensity and duration of the rainstorm and the sloping and amount of impervious surface area can all affect the amount of stormwater runoff. However, in Easthampton most storms generate less than an inch of precipitation in a 24-hour period. You can roughly estimate the amount of stormwater runoff (in gallons) generated by impervious surfaces on your property during a 1-inch rain event using the following calculation:

1 inch of rain produces 62 gallons of runoff for every 100 square feet.

To calculate your runoff, multiply:

Square feet of impervious area X 0.62 = gallons of runoff from your property

STEP 4

SET YOUR GOALS FOR RESILIENT STORMWATER MANAGEMENT

Now that you know what areas on your property generate runoff, how much runoff, and where runoff flows on your property, you can establish preliminary goals for managing stormwater runoff at home. For example, you may have observed that most of the runoff generated on your property comes from your roof, which drains directly onto your yard where it pools in a large puddle for over a day. You may want to set a goal of addressing this issue by having your roof drain into a trench line (see p.21) or dry well (see p.25) where it can more easily infiltrate the ground. Alternatively, you may have a goal to enhance the visual appeal of your property by adding more decorative plants. While this goal is not directly tied to a stormwater runoff issue, implementing creative stormwater management solutions, like rain gardens (see p.39), not only address pressing stormwater runoff issues but also enhance the visual aesthetics of your yard. Specifically using native plantings in your yard not only promotes infiltration of stormwater runoff, but native plants also provide food and habitat for native pollinators like bees, birds, and butterflies. Plants that are native to Easthampton can be found using the Garden Plant Finder created by The Native Plant Trust.

https://plantfinder.nativeplanttrust.org/Plant-Search

TIP: The goals that you establish during Step 4 do not have to be fixed. In fact, as you work your way through the next steps of the guide and begin to consider additional constraints and limitations, you may want to revisit your initial goals and revise them accordingly. That is okay!

3 DEVELOPING A RESILIENT STORMWATER MANAGEMENT PLAN

After completing Steps 1 through 4, you should have a good sense of what areas generate stormwater, how it flows across your property, the amount of runoff you are generating, and what goals you want to achieve. However, before choosing and implementing a solution, it is important to consider several factors.

STEP 5

PROJECT CHECKLIST: CONSIDER CONSTRAINTS AND COMPLEMENTARY GOALS

☐ Are there any underground utilities in the area that I am considering?

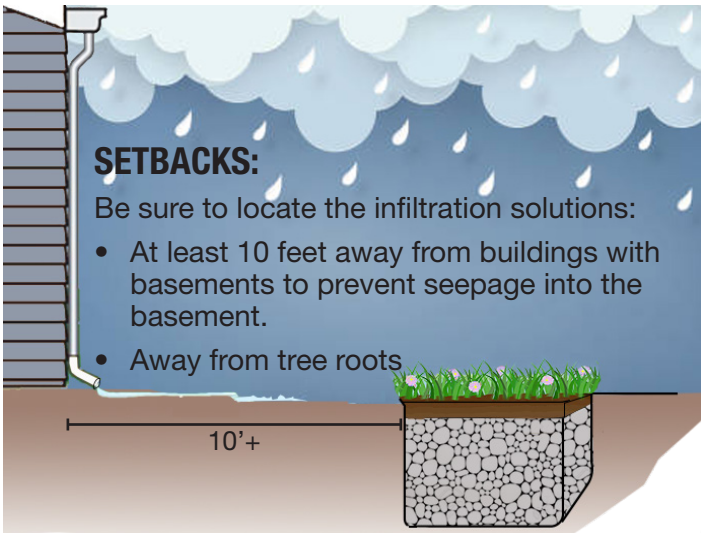
- *NOTE: Massachusetts State law requires that you notify Dig Safe in the event you are planning on any digging projects on your property. It does not matter how small the project. Dig Safe should be contacted whether you are installing a driveway infiltration trench or a mailbox.*

  Call Dig Safe at 811-Dig-Safe, or visit www.DigSafe.com. Dig Safe is a free service that can help you avoid potential utility service disruption, personal harm or harm to those around you, in addition to fines and repair costs.

☐ Do I have a drinking water well, septic tank, or leech field in the area?

- *Consult with the City's Planning Department to determine required distances between underground infrastructure and your chosen stormwater solutions.*

☐ Are there any tree roots, rocks, steep slopes, fences, or other structures that might limit implementing solutions in certain areas?



☐ What are the property boundaries and restrictions around local setbacks?

- *Consult with the City's Planning Department to determine required distances between property boundaries and your chosen stormwater solutions.*

☐ How close do I plan to build near buildings with foundation?

Complementary goals you may want to consider include:

☐ Do I want to enhance the visual aesthetic of my landscape?

☐ Do I want to reduce the time it takes to mow the lawn?

☐ Do I need to repair or improve existing driveways, patios, or walkways?

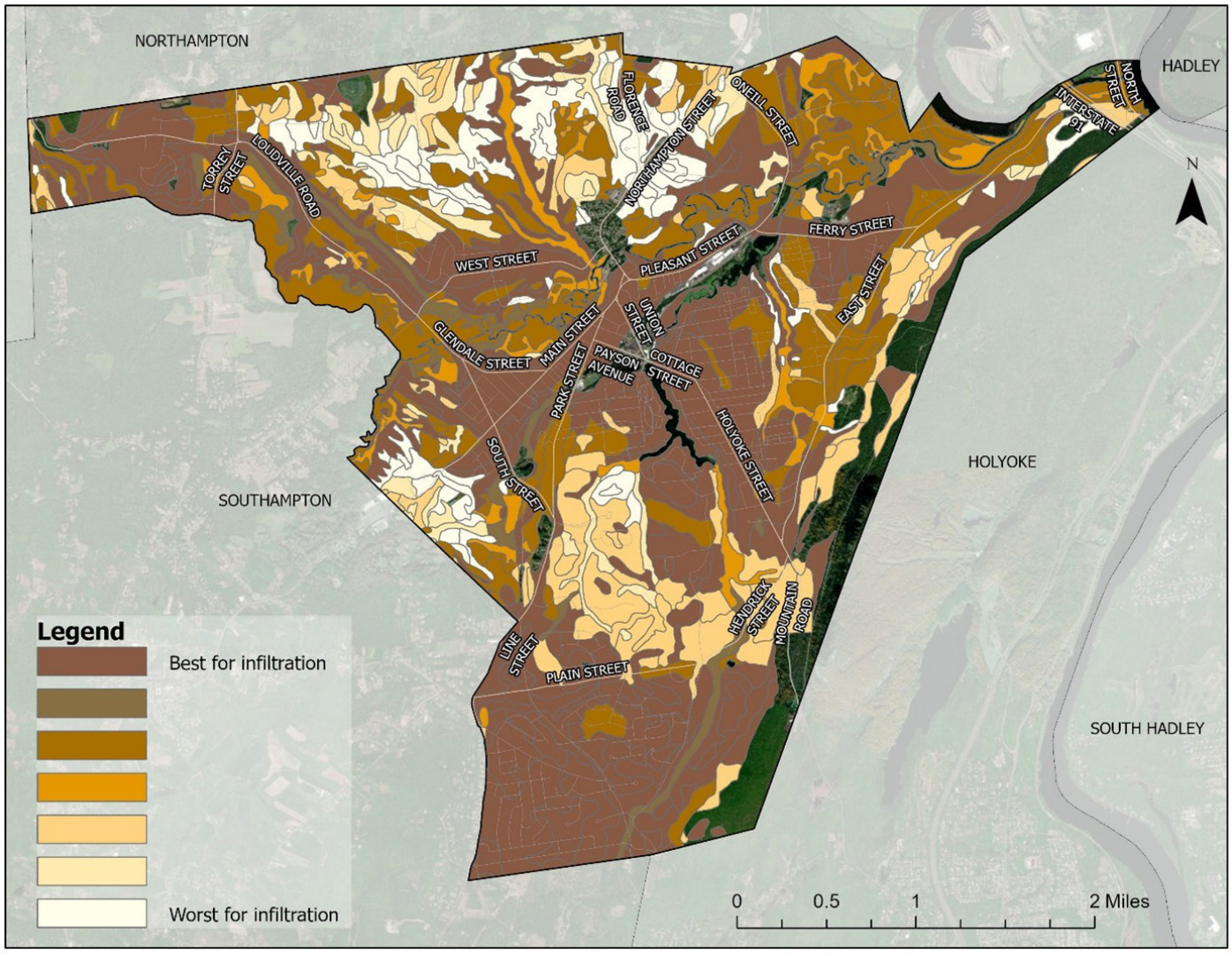
☐ Do I want more shade to cut down on air conditioning bills?

☐ Do I want to create new habitat for wildlife and birds or encourage pollinators?

STEP 6

TEST SOIL CONDITIONS USING 24-HOUR INFILTRATION TEST

A simple infiltration test to determine how well soils in a particular location will absorb stormwater can help with selecting the stormwater solution you may want to implement. Practices like dry wells and rain gardens need well drained soils where the soil can drain in 24 hours. Water that “ponds” or takes longer than 24 hours to drain can act as breeding grounds for mosquitoes. In these situations, storage and conveyance practices such as rain barrels (see p.35) or vegetated swales (see p.45) may be a more appropriate solution. Note: Rain gardens should never be in areas with existing ponding. Ponding is a good indication that the soil will not allow for easy infiltration. Instead, it may be more appropriate to contact your local nursery and use water-loving plants in these areas. Fortunately, much of Easthampton has sandy soils that drain very quickly and are ideal for infiltrating stormwater. The map below will give you a general idea of how suitable the soils in your neighborhood are for infiltration before you even run your test to confirm.



Map of soil types in Easthampton - Darker shades are better for infiltration techniques, lighter shades are better for storage or conveyance techniques.

HOW TO CONDUCT AN INFILTRATION TEST

Step 1: Use a shovel or post-hole digger to dig a 12-inch-deep hole in the area you are considering

Step 2: Fill the hole with water and allow it to drain completely (Note: if the hole fills with water on its own – or if water still exists in the hole after 24 hours, choose a new location)

Step 3: Fill the hole with water a second time and do one of the following:

- Place a ruler or yard stick in the hole. Note the water level and time. Multiply the change in water level by four to get the number of inches of infiltration per hour. A rate of at least 0.5 inches per hour indicates the soil is appropriate for an infiltration practice.
- Cover the hole for safety and check back 24 hours later. If the water has completely drained, this indicates the soil is appropriate for an infiltration practice. (McCarthy, 2019)

Credit: Oregon State University Extension

STEP 7
PRIORITIZE, SELECT, AND SITE STORMWATER RUNOFF SOLUTIONS

Building on your observations and soil information, you are now ready to make your initial selection of resilient stormwater management practices to help you achieve your goals.

Use the following decision trees, cost information, and DIY fact sheets to identify stormwater practices that make sense for your property. Remember, you can always decide to modify or revise your goals to incorporate other factors like cost, maintenance, etc.

I WANT TO DEAL WITH

Rooftop

I Have Gutters

Rain Garden

Rain Barrel

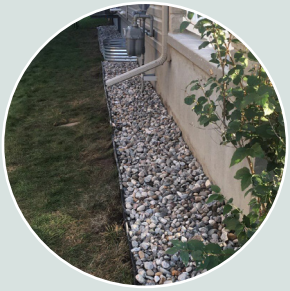
Dry Well

Downspout Disconnection

I Do Not Have Gutters

Dry Well

Dripline Infiltration Trench



Driveway or Patio

Paved

Infiltration Trench

Permeable Pavers

Rain Garden

Vegetated Swale

Unpaved

Infiltration Steps

Infiltration Trench

Dry Well

STORMWATER FROM MY...

Walkway

Walkway Follows Slope

Infiltration Steps

Slope Goes Across Walkway

Rain Garden

Infiltration Trench

Yard or Lawn

≤ 0.5 Acres

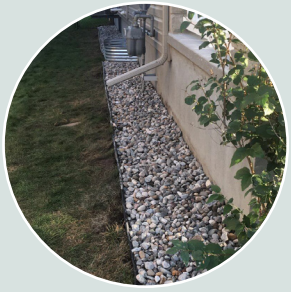
Longer Grass

Aeration

> 0.5 Acres

Longer Grass

Dripline Infiltration Trench



Low-Mow Zone/ Native Field

Tree Planting

Other factors can also play into your initial selection of stormwater management practices, such as the cost of installation, space constraints, and the ease of construction.

See the following key and table for additional variables that you may want to consider.

KEY:

Cost	
Minimal (< $100)	$
Moderate ($100-$500)	$ $
High (>$500)	$ $ $
Space Required	
Minimal (requires a parking stall (300-350 ft^2) or less area)	
Moderate (requires approximately two parking stalls of area, 600-700 ft^2)	
High (requires more than two parking stalls of area, >700 ft^2)	
Ease of Installation	
Minimal (requires 1-3 hours)	
Moderate (requires a half day)	
High (requires a full day or more)	
Ease of Maintenance	
Minimal (requires inspection/maintenance a couple of times per season)	
Moderate (requires inspection/maintenance 1-2 times per month)	
High (requires weekly inspection/maintenance)	

NOTE:
Many of these factors can vary based on the size of the area that you are trying to manage and/or the amount of runoff that you are trying to address.

Solution	Cost	Space Required	Ease of Installation	Ease of Installation	Primary Benefits	Primary Limitations
Downspout Disconnection	$				Conveys water away from impervious surfaces; Use if your downspout can easily be redirected to a vegetated area, dry well, or rain barrel	Not suitable for poorly drained soils
Dripline Infiltration Trench	$ $	OR	OR		Great approach for homes without gutters to reduce ponding; recharges groundwater	Prone to clogging if not maintained; limited applicability in areas with a high-water table
Driveway Infiltration Trench	$ $	OR	OR		Addresses ponding areas near driveways; recharges groundwater	Prone to clogging if not maintained
Dry Well	$ $		OR		Great option for poorly drained soils; low maintenance once installed	Not suitable for poorly drained soils
Infiltration Steps	$ $ $		OR		Enhances visual aesthetics; works as functioning staircase; great for moderate slopes	Not suitable for poorly drained soils
Permeable Pavers	$ $ $	OR			Enhances visual aesthetics; Increase infiltration and groundwater recharge; reduce runoff	Lower load-bearing capacity than conventional pavement
Rain Barrel	$				Conserves water; captures and reuses stormwater; reduces water bill for outside watering	Limited storage capacity for larger storm events
Rain Garden	$ $ OR $ $ $				Provides wildlife habitat; low-maintenance after first few years; aesthetic value	Plants can take time to establish; not suitable for poorly drained soils
Vegetated Swale	$ OR $ $				Enhances aesthetics; Conveys water on a slope that might be causing erosion, provides a location for snow storage	Limited capacity to infiltrate for larger storm events; can be difficult to install

4 SOLUTION FACT SHEETS

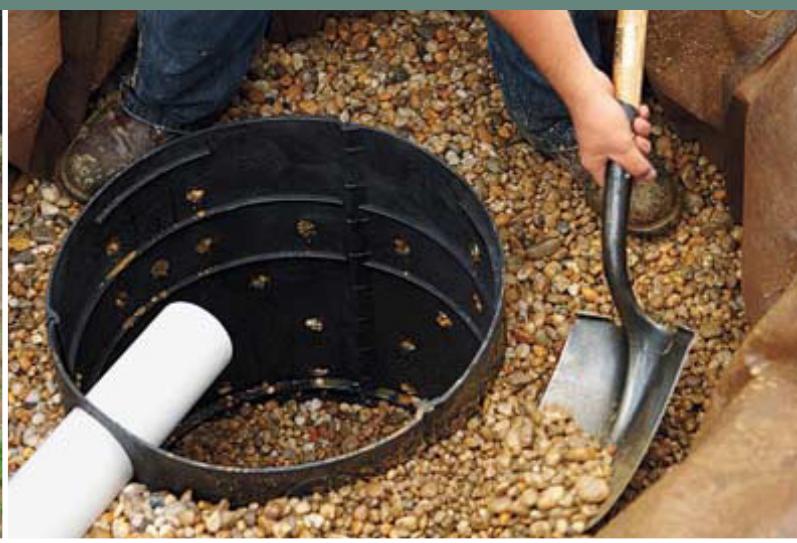
HOW CAN I BUILD THIS?

1 CALCULATE THE AMOUNT OF NEW RUNOFF YOUR PROJECT IS CREATING.

2 IDENTIFY WHICH GREEN SOLUTIONS FIT YOUR PROPERTY.

3 CALCULATE THE AMOUNT OF RUNOFF THOSE GREEN SOLUTIONS CAN MANAGE BY FOLLOWING THE INSTRUCTIONS ON THE FOLLOWING FACT SHEETS.

If you are going to install a rain garden, dripline or driveway infiltration trench, or dry well on your property, follow these steps for best results



DOWNSPOUT DISCONNECTION

Disconnecting a downspout redirects runoff to a vegetated area instead of a paved area, allowing it to soak into the ground. This solution is best-suited when roof downspouts drain to a driveway or sidewalk leading to the street or when connected directly to City storm drain.

Credit: Wisconsin Department of Natural Resources

DESIGN

Identify a stable, vegetated area to receive water from the downspout. This area should be at least 5' away from structures. It is critical that the disconnected downspout does not cause a hazard or nuisance to neighboring properties.

SIZING AND CREDIT

To be effective, water from the downspout needs to travel across at least 15 feet of a pervious surface, such as lawn or a gravel trench.

EQUIPMENT AND MATERIALS

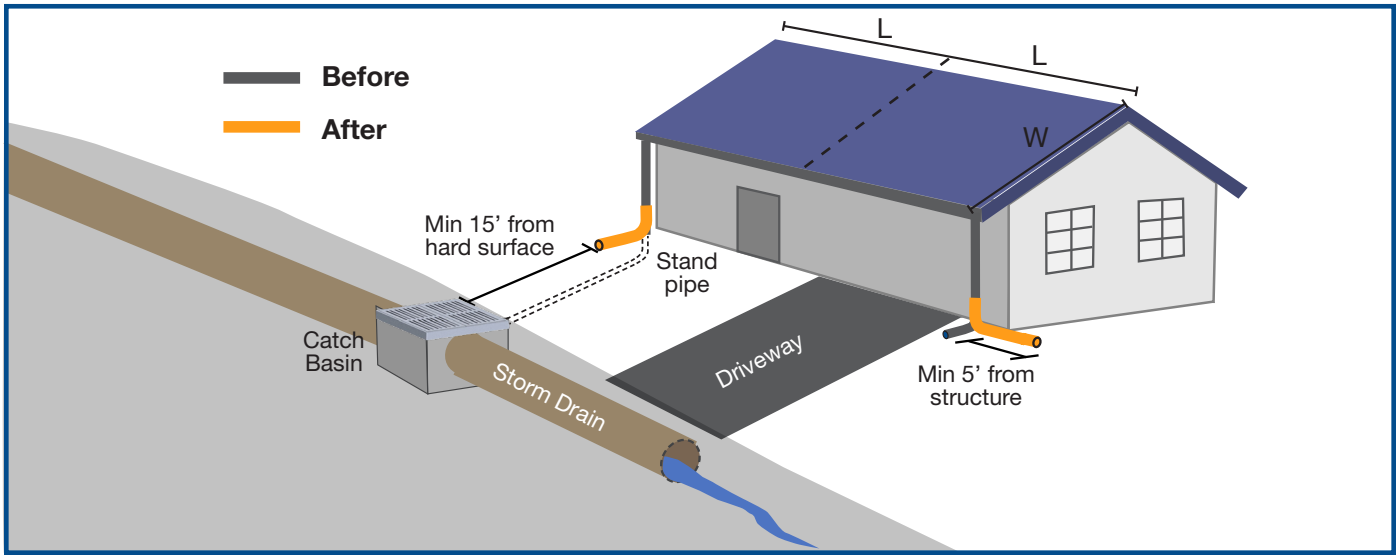
- Hacksaw
- Drill
- Screwdriver
- Pliers
- Tape measure
- Sheet metal screws
- Downspout elbow
- Downspout extension
- Standpipe cap
- Splash block

Calculating Volume of Stormwater Managed

Roof Area draining to Downspout ÷ 4 =

Cubic Feet Managed

TIP: If possible, redirect your downspout into a rain garden, dry well, or rain barrel. See those fact sheets for more information.



INSTALLATION

STEP 1:

For downspouts connected to a standpipe:

a. With a hacksaw, cut the downspout at an appropriate height (typically around 9” above the top of the standpipe).

b. Cap any pipe from the downspout connected to the street drainage system

STEP 2:

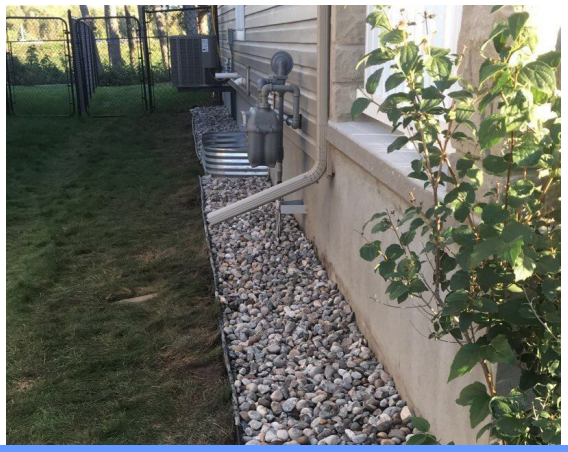
Connect a flexible or rigid downspout extension and add a splash block at the end in the vegetated area. Adding small stones after the splash block can help prevent erosion.

DESIGN REFERENCE

- New Hampshire Homeowner’s Guide to Stormwater Management 2016
- Vermont Guide to Stormwater for Homeowners 2018

DRIPLINE INFILTRATION TRENCH

An infiltration trench collects and infiltrates stormwater from your shed or garage until it soaks into the ground. It helps control stormwater from running off of your property. Use for roofs without gutters, for buildings without basements.



SIZING AND DESIGN

STEP 1:

Soffit depth. A soffit is the underside of a roof overhang. Measure the depth of the soffit by aligning your body under the edge of your roof and measuring the distance from your body to the house. **This is the reference line**.

STEP 2:

Reference line. Mark the reference line on the ground along the perimeter of your house where you will be installing the dripline trench.

STEP 3:

Outside boundary. Measure and mark 12” from the reference line away from your building. This is the outside boundary line for excavation.

STEP 4:

Inside boundary. Measure and mark 6” from the reference line toward your building. This is the inside boundary line for excavation.

Calculating Volume of Stormwater Managed

Trench Length x Width x Depth = Trench Volume (ft^3)

Trench Volume x 0.4 void ratio = Cubic feet managed

EQUIPMENT AND MATERIALS

- Measuring tape
- Shovel
- ½” to 1 ½” Crushed stone
- Landscaping weed fabric

OPTIONAL

- String or spray paint

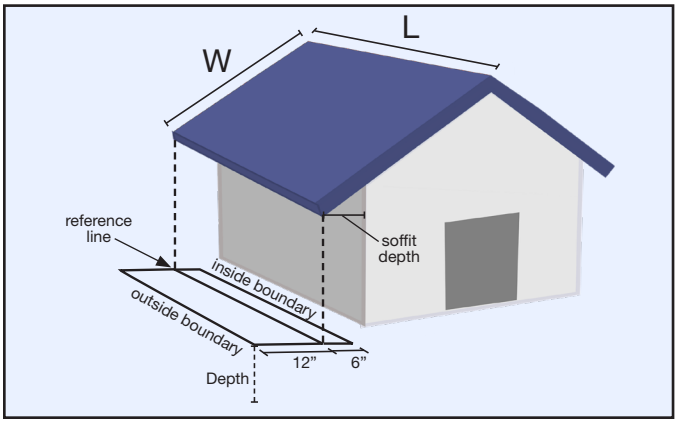
STEP 5:

Determine materials needed.

CRUSHED STONE Calculate the volume of the trench in cubic feet by using the calculation below. If needed, convert cubic feet to cubic yards by dividing cubic feet by 27.

Trench Length x Width x Depth = Trench Volume (ft^3)

Trench Length x Width x Depth ÷ 27 = Cubic Yards of Stone Needed



LANDSCAPE FABRIC To prevent migration of soil from the sides of the trench into the stone reservoir, it is recommended to line the sides of the trench with landscape fabric. For ease of maintenance, you may also want to line the top of the stone with landscape fabric Purchase enough landscape fabric to extend twice the length of the trench.

Trench Length x 2 = Landscape Fabric Needed

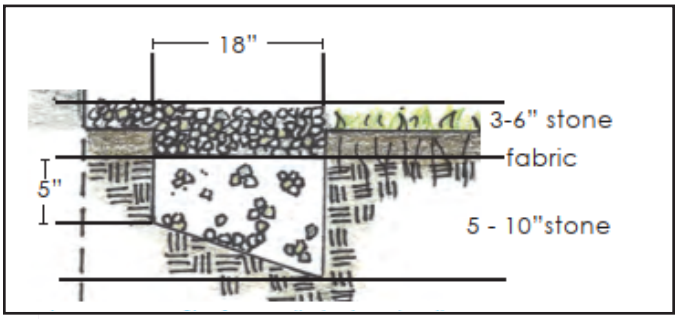


Figure 1: Trench cross section

Credit: NH Stormwater Guide

INSTALLATION

STEP 1:
Dig a trench at least 8" deep between the outside and inside boundary lines marked along the perimeter of your house. Slope the bottom of the trench away from the structure so that water will drain away from the foundation (Figure 1).

STEP 2:
Line the sides with a landscaping weed fabric to extend the life of the trench.

STEP 3:
Fill the trench with stone. Fill the trench with ½" to 1 ½" crushed stone until it is about 3" below the ground level. Place a piece of landscaping weed fabric over the stone layer and fill the remaining 3" with additional stone (Figure 1).

MAINTENANCE

Inspect: Periodically and after rain events, inspect the practice for any obvious signs of stress or potential failure. Remove accumulated debris and sediment as needed. Check for ponding or poorly draining water - this can be a sign of clogging.

Other Materials: Trenches lined with landscaping weed fabric will require less frequent maintenance, but will still clog over time. Ponding or slowly draining water can be a sign of clogging. The stone and fabric, if used, will need to be washed or replaced to remove the accumulated sediment and debris.

DESIGN REFERENCE

- New Hampshire Homeowner's Guide to Stormwater Management 2016
- Vermont Guide to Stormwater for Homeowners 2018

DRIVEWAY INFILTRATION TRENCH

An infiltration trench collects and infiltrates stormwater from your driveway until it soaks into the ground. It helps control stormwater from running off of your property.

EQUIPMENT AND MATERIALS

- Measuring tape
- Shovel
- ½" to 1 ½" Crushed stone
- Landscaping weed fabric

OPTIONAL

- String or spray paint

SIZING AND DESIGN

STEP 1:

Observe Driveway. Observe your driveway during a rain storm to determine how stormwater runoff flows across it. Depending on the volume of runoff and where it flows, you may only need an infiltration trench along one side or only a portion of your driveway.

STEP 2:

Determine Width. Decide the width of the trench you want to install. It should be between 12" and 18", as space allows. Mark the trench width (12" - 18") along the edge of your driveway where you will be installing the trench. This is the boundary line for excavation.

STEP 3:

Determine materials needed.

CRUSHED STONE Calculate the volume of the trench in cubic feet by using the calculation below. If needed, convert cubic feet to cubic yards by dividing cubic feet by 27.

Trench Length x Trench Width x Trench Depth = Trench Volume

Trench Length x Width x Depth ÷ 27 = Cubic Yards of Stone Needed

LANDSCAPE FABRIC To prevent migration of soil from the sides of the trench into the stone reservoir, it is recommended to line the sides of the trench with landscape fabric. For ease of maintenance, you may also want to line the top of the stone with landscape fabric. Purchase enough landscape fabric to extend twice the length of the trench.

Trench Length x 2 = Landscape Fabric Needed

Calculating Volume of Stormwater Managed

Trench Volume (ft^3) x 0.4 Void Ratio = Cubic Feet Managed

INSTALLATION

STEP 1:

Dig a trench at least 8" deep between the edge of your driveway and the excavation boundary line marked along the perimeter of your driveway.

Slope the bottom of the trench away from the driveway so that water will drain away from the foundation (Figure 1).

STEP 2:

Line the sides with a landscaping weed fabric to extend the life of the trench.

STEP 3:

Fill the trench with stone. Fill the trench with ½" to 1 ½" crushed stone until it is about 3" below the ground level. Place a piece of landscaping weed fabric over the stone layer and fill the remaining 3" with additional stone (Figure 1).

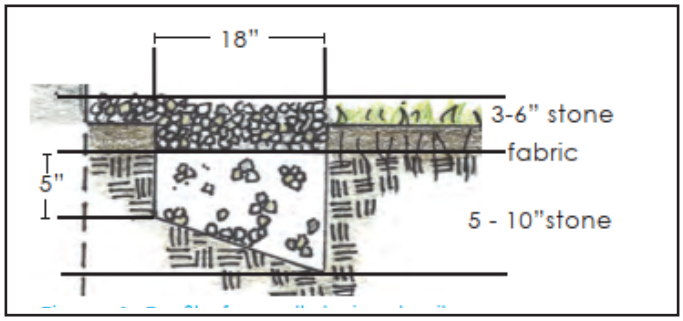


Figure 1: Trench cross section

Credit: NH Stormwater Guide

MAINTENANCE

Inspect: Periodically and after rain events, inspect the practice for any obvious signs of stress or potential failure. Remove accumulated debris and sediment as needed.

Check for ponding or poorly draining water - this can be a sign of clogging.

Other Materials: Trenches lined with non-woven geotextile fabric will require less frequent maintenance, but will still clog over time. Ponding or slowly draining water can be a sign of clogging.

The stone and fabric, if used, will need to be washed or replaced to remove the accumulated sediment and debris.

DESIGN REFERENCE

- New Hampshire Homeowner's Guide to Stormwater Management 2016
- Vermont Guide to Stormwater for Homeowners 2018

DRY WELL

A dry well collects runoff from gutter downspouts, roof valleys, and other areas where water concentrates and flows. They help infiltrate runoff and reduce erosion.

SIZING AND DESIGN

STEP 1:

Choose the location. A good location for a dry well is an area that can receive and infiltrate large amounts of concentrated runoff, such as from a roof valley or gutter downspout. The area should be large enough to accommodate the dry well and should have good separation to groundwater.

STEP 2:

Design how runoff will enter the dry well. Roof downspouts can be extended underground through a flexible pipe/trench into the dry well. This allows the dry well to be buried and planted. Consider installing a flow diverter to allow you to easily disconnect the gutter from the dry well during winter months if you are concerned with freezing conditions. In the following steps, fill the dry well with gravel up to the surface of your yard.

STEP 3:

Calculate runoff volume. To determine how large the dry well needs to be, you need to know the volume of water it will receive during a typical rain storm.

EQUIPMENT AND MATERIALS

- Measuring tape
- Shovel
- ½" to 1½" Crushed stone
- Landscape weed fabric for smaller projects

OPTIONAL

- String or spray paint
- Splash guard
- Gutter downspout extension

Complete steps a. through c. to calculate runoff volume.

a. Calculate the square footage of the drainage area:

Drainage Area Length (ft) x Drainage Area Width (ft) = Drainage Area (ft^2)

b. If multiple areas will be directed to the dry well, calculate the square footage of each and add them together.

c. Find the volume of stormwater from the total drainage area for a 2-inch storm by dividing the drainage area by 6 to convert the inches to feet:

Drainage Area (ft^2) ÷ 6 = Stormwater Volume (ft^3)

STEP 4:

Determine the dimensions of the dry well.

Dry wells are typically 3 feet deep and should be designed to accommodate the stormwater volume (determined in Step 2). Adjust the dimensions of your dry well as needed to fit your site.

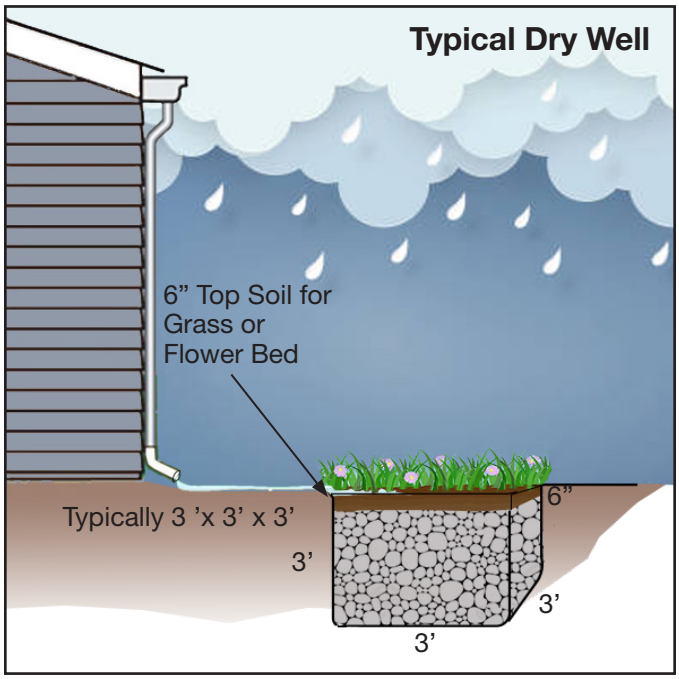
a. Calculate the surface area of your dry well in ft^2:

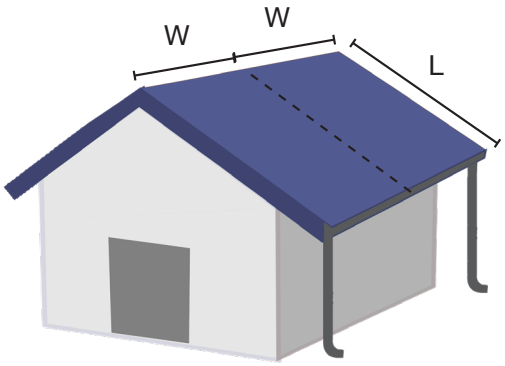
> Stormwater Volume (ft^3) ÷ 3ft (depth) ÷ 0.4 (void ratio) = Dry Well Area (ft^2)

b. Identify any limitations on the length or width of the dry well in the chosen location. For example, tree roots, large rocks, or other structures could be limiting factors. Use the most limiting dimension to help determine the shape. For example, if the dry well area should be $12ft^2$ and it can only be 2 feet wide, it will need to be 6 feet long to accommodate the stormwater volume.

Calculating Volume of Stormwater Managed

Length (ft) x Width (ft) x Depth to dig (in) ÷12 x 0.4 void ratio = Cubic Feet Managed





Example: If two downspouts, divide roof evenly.

STEP 5:

Determine materials needed.

CRUSHED STONE: To calculate the volume of stone needed, use the dimensions of the dry well, determined in Step 4. If burying the downspout, you will also need to purchase extra stone to fill in the trench around the inlet pipe. If needed, convert cubic feet to cubic yards by dividing cubic feet by 27.

TIP: Crushed stone takes up about 60% of the space in a dry well, leaving about 40% for water storage. A typical dry well is 3'x3'x3'. This will store about $11ft^3$ of water, which is equal to the runoff from a 12 ft. x 6 ft. drainage area in a storm that produces two inches of rain.

LANDSCAPE FABRIC: To prevent migration of soil from the sides of the dry well into the stone reservoir, it is recommended to line the sides of the dry well with landscape fabric. For ease of maintenance, you may also want to line the top of the stone with landscape fabric.

DOWNSPOUT ADAPTER AND FLEXIBLE PIPE: If you are trenching your downspout into the dry well underground, you will need to purchase a downspout adapter and flexible pipe, which can be purchased at a local hardware store.

INSTALLATION

STEP 1:

Mark the boundaries. Once you have determined the location and dimensions, clearly mark the boundary of your dry well to identify where to dig. Landscape flags, string, or spray paint work well.

STEP 2:

Dig the dry well. Excavate down 3' within the marked dry well boundary. Consider separating the good topsoil from the deeper soil layers to use as a planting bed.

STEP 3:

Dig a trench to bury your inlet pipe from the gutter downspout to the dry well. Carefully remove and set aside the sod growing over the trench to use later to re-cover once it is complete. Be sure to pitch the trench toward the dry well so that the water easily drains from the gutter to the dry well.

STEP 4:

Shape the bottom. Slope the bottom of the dry well away from the building or other buildings so that water drains away from the foundation.

STEP 5:

Line with landscape fabric. Extend the life of the dry well by lining the sides with non-woven landscape fabric.

STEP 6:

Fill with stone. Fill the excavated dry well with crushed stone to the depth where the pipe from the gutter will be laid. Be sure to place the pipe deep enough to allow for a 6" planting bed or sod layer on top.

STEP 7 (Optional):

Install the flow diverter. Flow diverters allow you to easily direct flow from your gutter downspout into your dry well during warm seasons. They can be closed during winter month, which allows your gutter to operate normally. To install the diverter, cut the gutter with a hand saw and install per manufacturers' instructions at a height that allows the water to flow from the diverter into the dry well.

STEP 8:

Connect pipe to dry well. Attach the pipe to the downspout or flow diverter, if using one. Lay the pipe in the trench with the outlet near the center of the well. Use crushed stone and a level to make sure it is pitched toward the dry well so it will drain.

STEP 9:

Continue to Fill with Stone. Fill with stone to within 6" of the ground surface.

Cover with Landscape Fabric. Fold a flap of filter fabric over the top of the crushed stone.

STEP 10:

Top coat with soil. Cover landscape fabric with a 6" planting bed of soil. Densely plant dry wells with native groundcover, grasses, or other perennials. Fertilize sparingly and only as needed.

MAINTENANCE

Inspect: Seasonally and after large storms. Look for signs of clogging such as ponding at the surface or water backing up into gutter.

Clean Out: The use of filter fabric will extend the life of dry wells, but will eventually clog over time. If clogging occurs, remove and wash or replace stone and fabric.

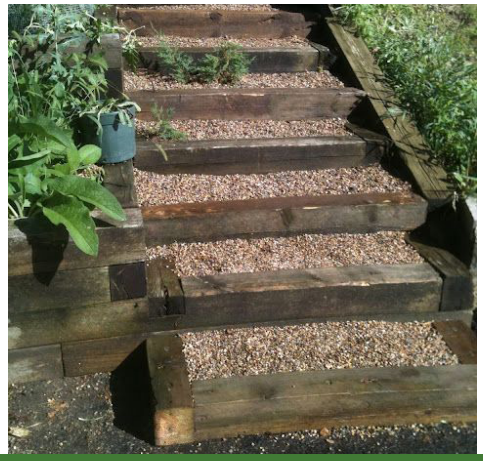
Plant Care: Prune, thin, or replace plants as needed on the surface of the dry well.

DESIGN REFERENCE

- New Hampshire Homeowner's Guide to Stormwater Management 2016

INFILTRATING LANDSCAPE STEPS

Infiltrating landscape steps slow down and infiltrate runoff on moderate slopes to reduce erosion and stormwater runoff.



SIZING AND MATERIALS

This retrofit works best on a slope of 1:1 or less (step height is same or less than step depth). For gentle slopes, wooden stakes or large rocks can also secure the timbers.

For slopes that are greater, this retrofit can still work by extending the run of the steps.

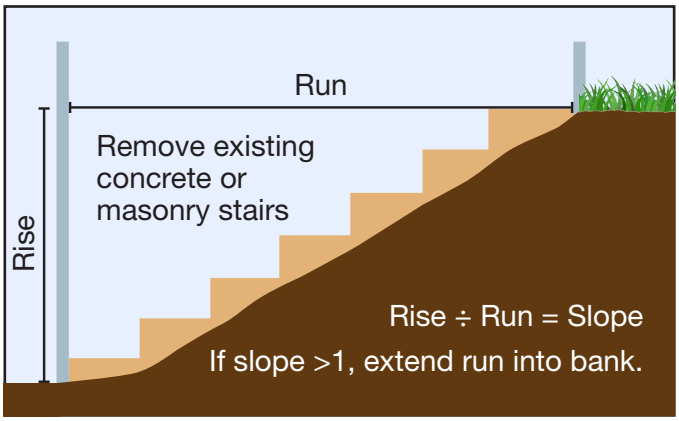


Figure 1

Rise ÷ Timber Height = Number Of Steps
Run ÷ Number Of Steps = Tread Depth
Measure existing step width = Step Width

TIP: Side timbers may not be needed if the steps are in a pathway where the surrounding land is higher. In this case, increase the length of the riser timbers so they extend into the adjacent banks 6" so water will not go around the steps.

Materials Needed:

TIMBERS: If you are using side timbers, add the length of each side timber (the tread depth) to the step width to get the total length of timber you'll need per step. As a guide, use the following equations to estimate the length (in feet) of timber material you will need.

Step Width + (2 x Tread Depth)
= Timber Length Per Step

Timber Length Per Step x Number of Steps
= Total Timber Length

EQUIPMENT AND MATERIALS

- Measuring tape
- Shovel
- Sledge hammer
- 2 Wooden stakes
- String or spray paint
- Level
- ¾" crushed stone or pea stone
- Landscaping weed fabric
- 6" x 6" pressure treated or cedar timbers
- 24" long pieces of ½" diameter steel rebar
- Power drill with 5/8" drill bit

REBAR:

Each step:

4 x 24” Rebar

LANDSCAPE FABRIC (NON-WOVEN):

Number of Steps x Step Width (ft) x Tread Depth (ft) = Square feet of landscape fabric

CRUSHED STONE OR PEA GRAVEL:

Number of Steps x Step Width (ft) x Tread Depth (ft) x Timber Height (ft) = Cubic Feet of Stone

Cubic Feet of Stone ÷ 27 = Cubic Yards of Stone

Calculating Volume of Stormwater Managed

Cubic Feet of Stone x 0.4 void ratio = Cubic Feet Managed

INSTALLATION

STEP 1:

Prepare materials. Cut the timbers to the appropriate length. For each step, cut one riser timber as long as the step width and 2 timbers as long as the tread depth for the side timbers (remember that each side timber should extend 6” past the next step’s riser timber).

For each timber, drill a minimum 5/8”-diameter, vertical hole 3 inches from each end of the timber, along the center line of the timber.

TIP: Most lumber supply stores have a cutting station to cut timbers to the correct length if you do not have a saw.

STEP 2:

Remove existing step material.

BOTTOM STEP

STEP 3:

Position timbers. Position the timbers in the step and remove or add soil as needed to level them.

STEP 4:

Anchor timbers. Drive the 24” steel rebar through the drilled holes on the end of each timber and into the ground. Make sure the rebar is level with the timber surface or slightly recessed since the edges may be sharp (Figure 2).

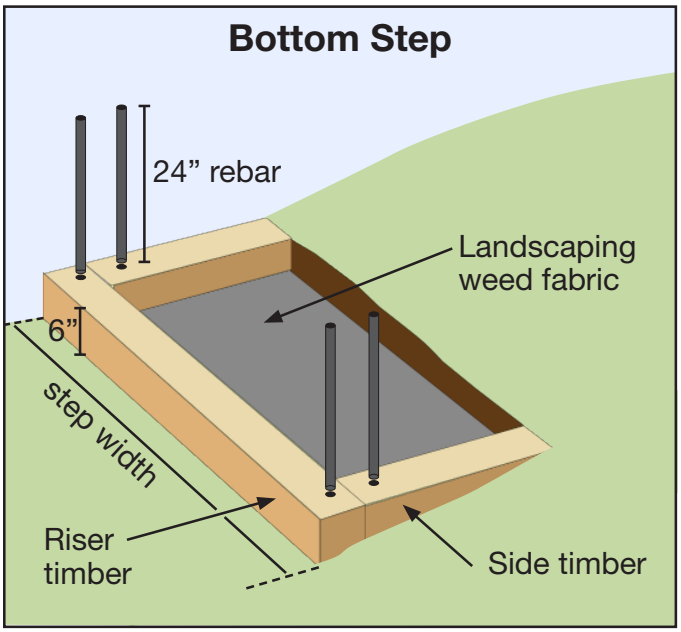


Figure 2

STEP 5:

Dig and level inside step. Shovel out the soil inside the step to create a surface roughly level with the bottom of the timbers. Additional soil can be removed to provide more area for infiltration if desired. Make sure to dispose of excavated soil in a place where it will not wash away (Figure 2).

SECOND STEP AND UP

STEP 6:

Build next step. To build the next step, place the riser timber across the side timbers and attach the riser timber to the side timbers with the galvanized bolts. Measure from the front of the riser timber below and mark the tread depth on the side timbers below with a pencil.

STEP 7:

Excavate side timbers. Align the front of the next step riser timber with the pencil lines on the side timbers of the step below. Secure the side timbers to the timbers below using 24" rebar (Figure 3).

Set and anchor side timbers by driving the steel rebar through the drilled holes on the end of each timber into the ground (Figure 3).

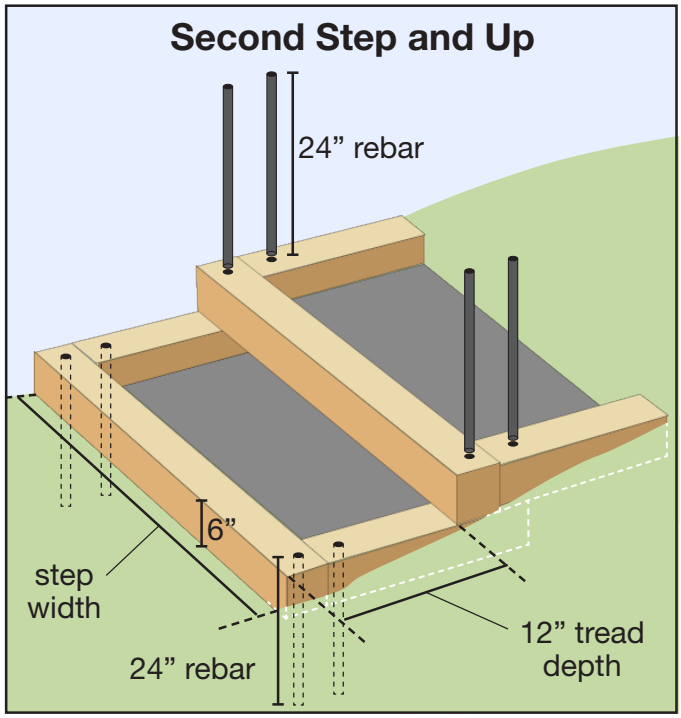


Figure 3

STEP 8:

Dig and level inside step. Shovel out the soil inside the step to create a surface roughly level with the bottom of the timbers as in Step 5.

STEP 9:

Repeat. Repeat Steps 6 through 8 for each remaining step. When installing the top step, cut the side timbers 6" shorter than the ones on the lower steps - these timbers do not need the extra length since no stairs will rest on them.

STEP 10:

Fabric and backfill. Lay down landscape fabric and backfill with stone.

a. Line the area inside each set of timbers with non-woven geotextile fabric. Make sure the fabric is long enough to extend a few inches up the sides of the timbers.
b. Fill each step with ¾" crushed stone or pea stone until it is about 1" below the top of the timber (Figure 4).
c. Seed and/or mulch bare soil adjacent to the steps.

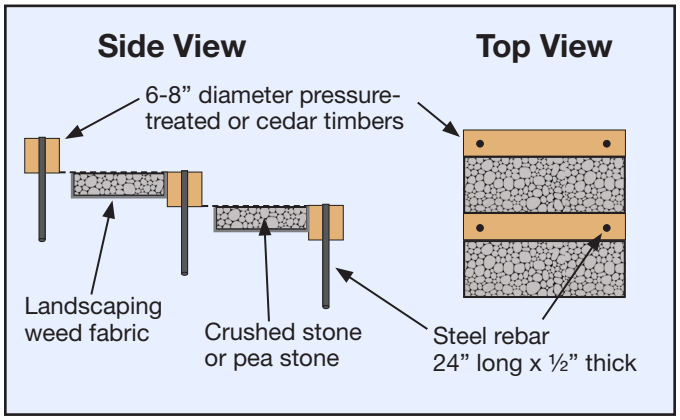


Figure 4

MAINTENANCE

Inspect: Seasonally and after large storms, look for signs of erosion or clogging such as ponding at the surface or accumulated sediment.

Clean Out: If clogging occurs, remove and wash or replace stone and fabric. Remove any vegetation growing on the steps if not included in the design.

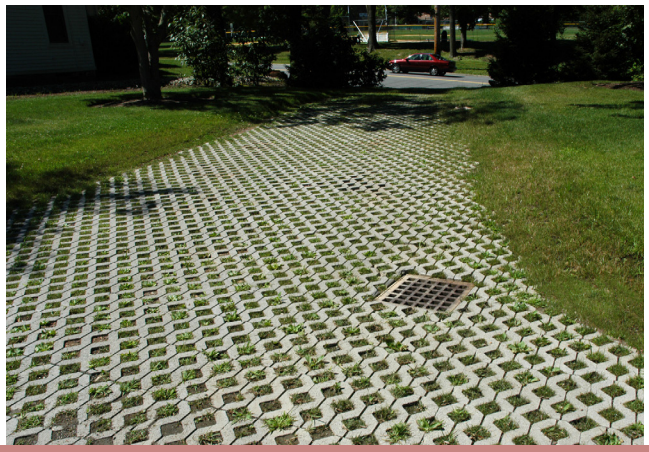
Replace: Replace timbers if damaged or rotted, as needed.

DESIGN REFERENCE

- New Hampshire Homeowner's Guide to Stormwater Management 2016

PERVIOUS PATIOS, DRIVEWAYS, AND WALKWAYS

Pervious pavers look like traditional pavers, but are able to absorb and store stormwater and snowmelt to reduce runoff from your property.



Pervious pavers can actually last longer than conventional paved driveways and walkways when properly maintained. Pervious paver manufacturers typically provide instructions for design and installation. **If the information in this fact sheet differs from the manufacturer's instructions, follow the manufacturer's instructions.**

SIZING AND DESIGN

STEP 1:

Identify installation area.

Determine the areas where you will be installing pervious pavers. Pervious pavers are best for areas with slopes of less than 5%.

STEP 2:

Determine depth to dig.

Paver thickness (inches)
- 6" of 3/8" pea gravel
- 4" to 12" of 1 ½" crushed stone

Paver Thickness + 6" + Crushed Stone Depth (in) = Depth to Dig (in)

Calculating Volume of Stormwater Managed

L (ft) x W (ft) x Depth to dig (in) ÷ 12
x 0.4 void ratio = Cubic Feet Managed

EQUIPMENT AND MATERIALS

- Measuring tape
- Shovel
- Rake
- Broom
- 1 ½" crushed stone
- 3/8" pea stone
- Landscaping weed fabric
- Tamper or roller
- Pervious pavers
- Level

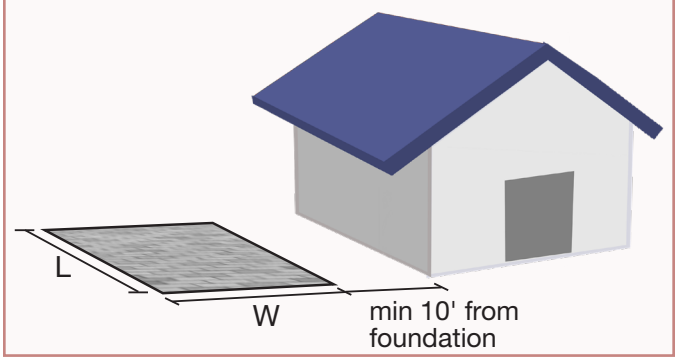
STEP 3:

Determine materials needed.

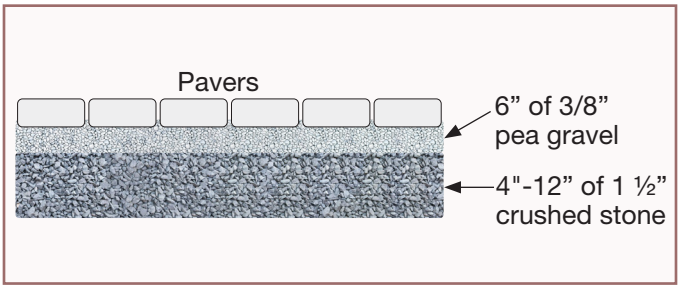
L (ft) x W (ft) = Pavement Area (ft^2)

Pavement Area (ft^2) x Crushed Stone Depth (in) ÷ 12 ÷ 27 = Cubic Yards of Crushed Stone

Pavement Area (ft^2) x 0.5ft ÷ 27 (ft^3/yd) = Cubic Yards of 3/8" Pea Gravel



Note: Stormwater is considered managed by pervious pavers only if the pervious pavers replace existing impervious cover



INSTALLATION

STEP 1:

Prepare the site. Remove any existing walkway, driveway or patio material. Excavate to Depth to Dig calculated above where pavers will be installed. Ensure the bottom of the trench is slightly sloped away from any structures.

STEP 2:

Install a layer of landscaping weed fabric.

STEP 3:

Fill the bottom of the trench with at least 4" crushed stone.

STEP 4:

Add 6” of pea gravel

STEP 5:

Lay the pavers with appropriate spacing. Use a level to make sure they are installed uniformly. The manufacturer will provide recommendations depending on the paver type. Most pervious pavers have tabs on the edges to create proper spacing between them.

STEP 6:

Once the pavers are installed, **spread more pea gravel** over the top and use a push broom to work the pea stone into the space between the pavers.

MAINTENANCE

Inspect: Seasonally and after large storms, look for signs of clogging such as ponding at the surface or accumulated sediment.

Clean Out: If clogging occurs, remove and wash or replace pea stone and fabric. Remove any vegetation growing on the steps if not included in the design. Refer to manufacturer’s instructions for power washing or vacuuming.

DESIGN REFERENCE

- New Hampshire Homeowner’s Guide to Stormwater Management 2016
- Vermont Guide to Stormwater for Homeowners 2018

RAIN BARREL

A rain barrel captures stormwater from your roof to reduce runoff from your property and provide water for lawns and gardens in dry weather.

SIZING AND DESIGN

STEP 1:

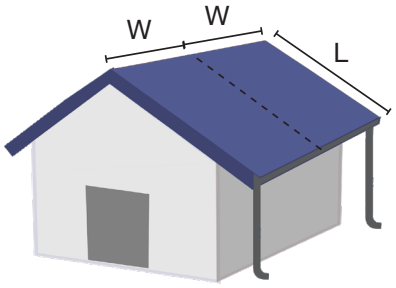
Observe your roof runoff. Note where you have existing roof gutter downspouts, roof valleys, or edges that drain large amounts of water.

STEP 2:

Calculate the runoff volume. To determine how many rain barrels you need and whether you should designate an area to direct the rain barrel overflow, you need to know the volume of water the barrels will receive during a typical rain storm.

Complete steps a. through d. to calculate runoff volume.

Example: If two downspouts, divide roof evenly.



a. Calculate the square footage of the drainage area:

Drainage Area Length (ft) x Drainage Area Width (ft) = Drainage Area (ft^2)

b. If more than one surface will drain to the rain barrel, calculate the square footage of each area and add them together.

EQUIPMENT AND MATERIALS

- Purchased or home-made rain barrel (food-grade)
- Downspout diverter (purchased or made)
- Shovel
- Elevated base (e.g. with cinder blocks or wood)
- Level

OPTIONAL

- Soaker hose
- Crushed stone
- Mulch
- Splash guard

c. Find the volume of stormwater from the drainage area for a 2-inch storm by dividing the drainage area by 6 to convert the inch to feet:

Total Drainage Area (ft^2) ÷ 6 = Stormwater Volume (ft^3)

d. Most rain barrels give the holding capacity in gallons. Convert the cubic feet to gallons by multiplying by 7.48.

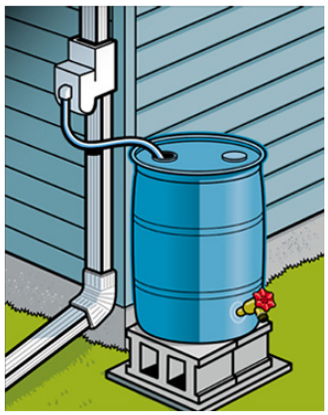
Stormwater Volume (ft^3) x 7.48 Gallons = Stormwater Volume (gallons)

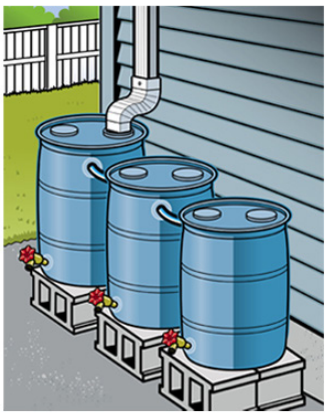
STEP 3:

Determine how many rain barrels are needed. Attempt to capture the volume from a two-inch storm, if yard space is available.

Stormwater Volume (gallons) ÷ Rain Barrel Storage Capacity (gallons) = Number of Rain Barrels Needed

TIP: You are not limited to one rain barrel. Rain barrels can be linked together so that the overflow from one goes into the next.





STEP 4:

Address the overflow. Be sure to note where the overflow will go during larger storms. Avoid directing the overflow next to building foundations. Plan to use a splash guard, install a soaker hose, or build a slight swale to direct overflow away from your home and into an area where it can be absorbed, such as a naturally vegetated area, a rain garden, or dry well.

Calculating Volume of Stormwater Managed

Number of Rain Barrels x Rain Barrel Capacity (gallons) ÷ 7.48 = Cubic Feet Managed

INSTALLATION

STEP 1:

Level the area. Once you have determined where you want your rain barrels to go, level the ground surface. You can use crushed stone or mulch to stabilize the ground.

TIP: Your rain barrel **must** be secured on a firm, level surface. A full, 55-gallon rain barrel weighs over 400 pounds.

STEP 2:

Install blocks or stand. Elevating the rain barrel is necessary to allow room for a watering can, bucket, or hose attachment under the spigot. Elevating the barrels will also create stronger water pressure. Place the blocks or other materials to create a stand on the leveled ground and recheck for level. Adjust as needed to achieve level.

STEP 3:

Connect the downspout to the rain barrel. Downspout diverters allow you to easily direct flow from your gutter downspout into your rain barrel during warm seasons. They can be closed during winter month, which allows your gutter to operate normally. To install the diverter, temporarily place the rain barrel on the blocks to mark where the diverter needs to be installed. Cut the gutter with a hand saw and install the diverter per the manufacturer's instructions, at a height that allows the water to flow from the diverter into the barrel. If not using a flow diverter, the gutter downspout can be directed or connected directly to the barrel.

STEP 4:

Install the rain barrel.

a. Place the rain barrel on the blocks or stand.
b. Direct flow from gutter downspout or diverter into the barrel.
c. Cover the open top of the rain barrel with screen to prevent mosquitoes from breeding in the standing water and to reduce the amount of debris entering the barrel. Most rain barrels that you purchase pre-made will come with a screened cover.
d. Direct the overflow hose from the rain barrel to a vegetated area or another stormwater practice, where it can soak into the ground.

MAINTENANCE

Inspect: Check after storms to determine how soon you need to empty the barrel. Remember that a rain barrel only works if it has space to contain more water.

Empty: Empty the rain barrel between storms or, at a minimum, when full. The water can be used on perennial gardens, house plants, and other non-potable or non-drinking water needs. Carefully consider what you water with your rain barrel. This water has the potential to contain pollutants from your roof that you may not want to come in contact with vegetables or other edible crops.

Clean: Keep the screen clear of debris and clean with a soft brush as needed. Periodically clean out the inside of the barrel if debris has collected. Keep gutters and downspouts clean and clear to prevent debris, such as leaves and pine needles from entering the rain barrel.

Winter Storage: It is recommended that you completely empty your rain barrel and store it indoors through the freezing winter months. When the rain barrel is removed for the season, the gutters and downspouts should be returned to their normal function to drain the roof during winter storms. This can be done by closing or removing the diverter and extending the downspout back to the ground.

BUILD YOUR OWN RAIN BARREL

Pre-made rain barrels are available in many sizes and styles. They range in price from $50 to over $200. To save money, you can make your own rain barrel out of a food grade drum and plumbing parts that you can find at most hardware stores. An internet search of ***"How do I make a rain barrel"*** will result in a long list of how-to sites and videos, similar to this one

http://www.instructables.com/id/Rainwater-harvesting-Rain-Barrel-DIY

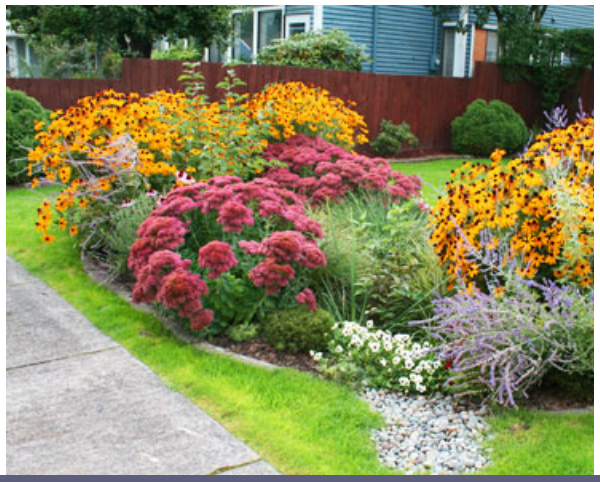
Whichever instructions you follow, a food grade drum is preferable. We recommend avoiding trash barrels, which may not stand up to the pressure of being full of water.

DESIGN REFERENCE

- New Hampshire Homeowner's Guide to Stormwater Management 2016
- Vermont Guide to Stormwater for Homeowners 2018

RAIN GARDEN

A rain garden is a sunken, flat-bottomed garden that uses soil and plants to capture and absorb stormwater. This helps to reduce street flooding and recharges groundwater.



EQUIPMENT AND MATERIALS

- Calculator
- Measuring tape
- Spray paint
- Yard stick
- 6-12 Stakes
- 2-4 long stakes (4')
- String
- Shovels
- Carpenter's level
- String level
- Rakes
- Compost/ Wood chips
- Mulch
- Crushed stone
- Flat stones or pavers
- Tarp(s)
- Wheel Barrow(s)
- Plants

SIZING

Use the following steps to determine the dimensions of the rain garden.

STEP 1

Total drainage area. Identify the impervious surface(s) that will drain to the rain garden. Multiply the length by the width to get the drainage area in square feet.

Drainage Area Length (ft) x Drainage Area Width (ft) = Drainage Area (ft^2)

If more than one surface will contribute runoff to the rain garden, add them together. For example, if a roof drains onto a driveway and flow from the driveway will drain to the rain garden add the roof area and the driveway area together.

STEP 2:

Rain Garden Area. A typical rain garden is 6" deep. Use Table 1 to determine the corresponding footprint of the rain garden.

The long side of the rain garden should be perpendicular to the slope of the drainage area. Overall a rain garden works best when it is twice as long as it is wide. This allows the rain garden to capture as much stormwater as possible. Curved shapes are the most effective, just be sure to approximate the required area from the table. Depending upon your property, it may be easier to break up stormwater flows to create multiple, smaller rain gardens rather than one larger one.

Table 1: Surface area (ft^2)

Drainage Area	Rain Garden Recommended Footprint
100	33
200	67
300	100
400	133
500	167
600	200
700	233
800	267
900	300
1,000	333

STEP 3:

Determine depth to dig. A working rain garden needs a 6” to 12”-deep planting bed. A 2”-thick hardwood mulch layer is also recommended to retain moisture and prevent weeds.

6” Ponding Depth + 6” to 12” Planting Bed Depth + 2” Mulch Layer Depth = Total Depth to Dig

Calculating Volume of Stormwater Managed

Rain Garden Footprint (ft^2) x Ponding Depth (in) ÷ 12 + Rain Garden Footprint (ft^2)
x Planting Bed Depth (in) ÷ 12 x 0.33 void ratio = Cubic Feet Managed

DESIGN

STEP 1:

Design the berm. A berm is needed on the downslope side of the rain garden to hold water in the garden. The berm should be the same height as the upslope edge of the garden to make the entire perimeter of the garden level. This creates the ponding area. The berm should be no more than 12” high in order to blend with the surrounding landscape and to be easier to maintain.

STEP 2:

Plan the inlet and outlet.

a. *Inlet.* The location where runoff enters a rain garden is called the inlet. The inlet might be a gutter downspout, a trench, or from sheet flow. It is important to protect the inlet from erosion and scouring during rain storms. To reduce erosion and scouring, the inlet should be reinforced with stone or gravel. A flat rock or paver can also be placed at the inlet, directly under where runoff enters the garden to help spread out the flow.

b. *Outlet.* The location where water exits or overflows from a rain garden is called the outlet. This is the lowest part of the berm and must be below the inlet for the rain garden to work properly. While the rain garden is designed to contain most rain storms, the outlet provides a safe and controlled place for water to overflow during storms that produce a lot of rain. An outlet can also be created along a portion of the berm on the downslope side of a rain garden. An outlet is created by lowering a 1’ to 2’ wide section of the berm a couple of inches. Similar to the inlet, the outlet needs to be protected against erosion and scour and needs to be reinforced with stone or directed toward a City storm drain or the street.

STEP 3:

Create your planting plan. Select appropriate plant species for the rain garden from the ***Rhode Island Coastal Plant Guide***. Set the Rain Gardens filter to “+” and the Native Status to “+”. A good planting plan includes at least three plant species and a mix of shrubs and grasses. See Figure 1 below for an example plan, but feel free to create your own.

The Coastal Plant Guide also indicates which local nurseries may stock these plants, but calling ahead is recommended.

- ***Hoogendorn Nurseries***, 408 Turner Road, Middletown, RI, 401-847-3405
- ***The Farmer’s Daughter,*** 716 Mooresfield Road (Rt 138), Wakefield, RI, 401-792-1340
- ***The Rhode Island Nurseries, Inc.***, 736 East Main Road, Middletown, RI, 401-846-0721

STEP 4:

Determine materials needed. Based on the area and depth to dig of your rain garden, follow Table 2 to approximate the amount of soil, compost, mulch and other materials that you may need. If needed, convert cubic feet to cubic yards by dividing cubic feet by 27.

Table 2: Material Thickness and Coverage

Material Thickness (inches)	Area Covered (in ft^2) per Cubic Yard (yd^3) of Material
1”	324 ft^2
2”	162 ft^2
3”	108 ft^2
4”	81 ft^2
5”	67 ft^2
6”	54 ft^2
7”	47 ft^2
8”	40 ft^2
9”	36 ft^2
10”	33 ft^2
11”	30 ft^2
12”	27 ft^2

A working rain garden needs a 6” to 12”-inch deep planting bed. A 2”-thick hardwood mulch layer is also recommended to retain moisture and prevent weeds. Softwood mulches are not recommended because it is more prone to floating away in a rainstorm.

Rain Garden Area ÷ Area Covered per Cubic Yard = Cubic Yards of Material Needed

STONE: About a half of a cubic yard of crushed stone is useful for securing the inlet and outlet and achieving the pitch of the inlet pipe from a downspout. Two or more 1-ft^2 or larger flat stones or pavers are useful for placing at the inlet. The outlet can also be reinforced with stones that you find as you dig out the rain garden area.

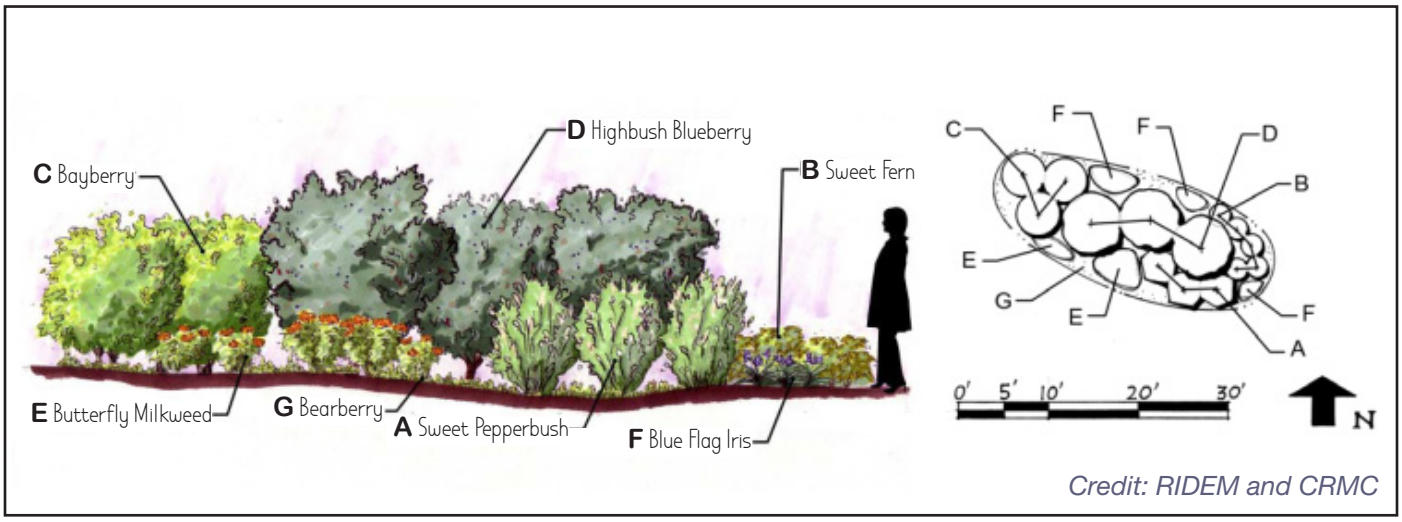
INSTALLATION

STEP 1:

Define Borders. Use string or spray paint to outline the shape of the rain garden. The berm, if needed, will be built outside of the outline.

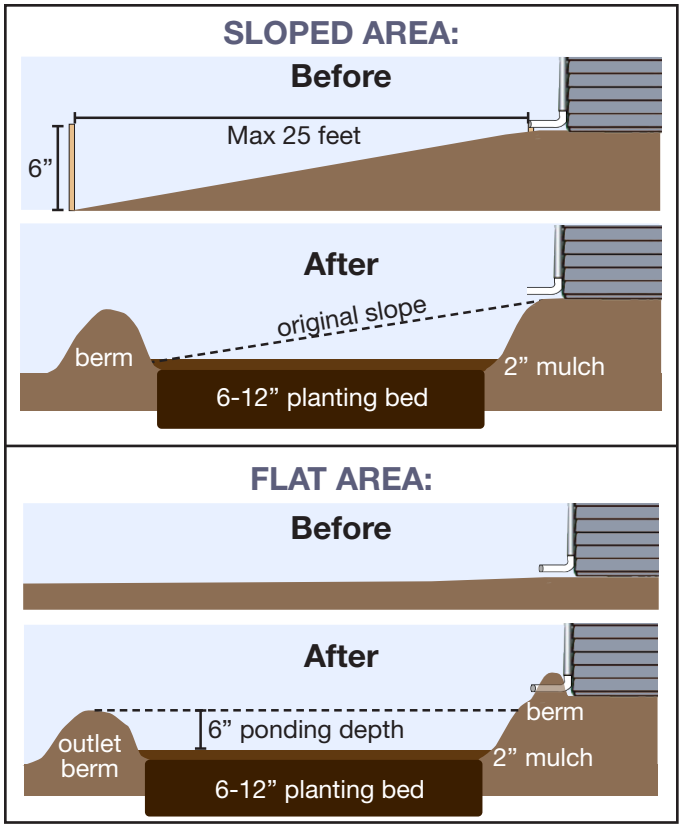
STEP 2:

Start Digging. Start digging. Remove the soil from within the rain garden area. Form a gentle slope along the edges as you dig. Lay out tarps to temporarily sort and store sod, top soil, and lower soil layers to use later in building the berm and preparing the soil planting bed.



Credit: RIDEM and CRMC

Figure 1: Rain Garden Example Planting Plan



STEP 3:

Set the berm height. Once you are close to having the entire garden area dug down to the “total depth to dig”, hammer stakes along the perimeter of the rain garden about 4-6 feet apart, starting with the highest edge, and working around the garden. Attach a string to the base of the highest stake. Use a string level to mark the leveled height on each stake around the perimeter of the garden. This will be your berm height. The berm height should be 6” to 12”.

STEP 4:

Level the bottom. The rain garden must have a level bottom to encourage the water to spread evenly throughout. Once all of your stakes are marked with the berm height, use a leveled string and a yard stick or measuring tape to measure the distance from the bottom of the rain garden to the string throughout the rain garden. You may find that you need to dig out additional material or rake it out to get rid of high or low spots.

STEP 5:

Prepare inlet. If your rain garden is capturing roof runoff from a gutter, you can dig a trench to bury your inlet pipe from the gutter downspout to the garden. Carefully remove the sod growing over the trench and set it aside to use as a cover, if desired, once the trench is complete. Be sure to pitch the trench toward the rain garden so that the water easily drains from the gutter to the garden and doesn’t back up. You can use a carpenter’s level to check the pitch.

Inside the rain garden, stabilize the inlet area with crushed stone to prevent erosion and scour of the inlet. Place one or more flat stones or pavers directly under the inlet pipe to further reduce erosion and to prevent a channel from forming in your rain garden.

Credit: UConn NEMO

Credit: Save the Bay

STEP 6:

Build berm and outlet. Using the marked stakes along the edge of the rain garden as a guide, use overturned sod and soil to build and shape the berm to the specified berm height. Designate a 1- to 2-foot section of the berm to be the outlet. The outlet should be a few inches lower than the rest of the berm height. After shaping the berm and the outlet, compact the soil. Reinforce the outlet with stone.

STEP 7 :

Add planting bed materials. Before adding the planting bed materials into the rain garden, hammer tall stakes into the bottom of the rain garden and mark them with the planting bed depth, which should be between 6” to 12”. Use this line as a guide as you evenly distribute a mix of native soil and other amendments, such as sand and yard waste, as needed to create a planting bed. Mix well and be sure to place some planting bed material up the sloped sides of the rain garden so that they may also be planted. Rake the bed level. To avoid compacting the planting bed, work from the center of the garden outward.

STEP 8:

Plant. Place plants while still in their pots into the garden according to the planting plan. Make adjustments for spacing as indicated in the Coastal Plant Guide. When you are ready to plant, remove one plant at a time from its pot and loosen the root ball with your fingers to encourage root growth. Plant to the same depth or slightly deeper than they were in the pot.

STEP 9:

Apply Mulch. Apply a 2” layer of mulch over the entire rain garden to help retain moisture in the soil and to prevent weeds.

STEP 10:

Water thoroughly. Water thoroughly immediately after planting. Give the plants an inch of water every week for the first growing season. Once the plants have been established, water only as needed during extended dry weather.

MAINTENANCE

Rain garden maintenance is similar to the maintenance of any perennial garden, with a few extra tasks:

Inspect: After storms to verify the inlet and outlet are stable, no channels have formed, that plants are healthy, and that it is draining. Adjust and repair if needed.

Plant Care: Weed and water as needed. Replace dead plants as needed. Cut back, prune, or divide plants when appropriate to encourage growth.

Clean: If the rain garden is receiving runoff that contains sand or debris, such as from a driveway, clean out and dispose of accumulated materials as needed.

DESIGN REFERENCE

- Rhode Island Stormwater Management Guidance for Single-Family Residential Lot Development 2013
- New Hampshire Homeowner’s Guide to Stormwater Management 2016
- Vermont Guide to Stormwater for Homeowners 2018

VEGETATED SWALE

An open channel lined with vegetation intended to convey excess stormwater runoff from an impervious surface to a vegetated landscape.

Vegetated swale with tree planting and sedges. "Recessed areas slow and infiltrate water into soil on site"

Credit: Lauren Jolly Roberts, licensed under CC BY 2.0.

SIZING AND DESIGN

Recommended slope is 1-4%. Check dams are suggested for slopes up to 5%. Swales should run with the contour lines of the landscape.

Native species of grasses and sedges should be used to the furthest extent.

Consider the size. The bottom of the swale should be 2-4 feet above the seasonal high water table, and generally between 2 and 8 feet wide.

INSTALLATION

STEP 1:
Ensure erosion and sediment control measures are in place prior to construction.

STEP 2:
Rough grade the vegetated swale to achieve the desired shape and slope. Avoid excessive compaction and/or land disturbance. Excavating equipment should never operate on the bottom of the swale, only on the side using a swing arm.

EQUIPMENT AND MATERIALS

- Excavator with a swing arm
- Native sedges and grasses
- Mulch

STEP 3:
Construct check dams if necessary.

STEP 4:
Fine grade the vegetated swale to achieve desired contour and elevation, readying the swale for planting. Focus on making the surface uniform and smooth.

STEP 5:
Seed and vegetate the swale. Plant during the time of year when establishment of vegetation without irrigation is most likely, typically late spring.

STEP 6:
Remove temporary erosion controls once all tributary areas are stabilized.

STEP 7:
Follow the maintenance guidelines as suggested on this fact sheet.

MAINTENANCE

Inspect: In the first few months, inspect periodically to ensure the vegetation in the swale has been adequately established. After vegetation is established, inspect on a semi-annual basis for slope integrity, soil moisture, plant health, erosion, and ponding.

On-going Care: Water vegetation as necessary to prevent plants from dying. Remove trash and other debris that may obstruct water flow.

DESIGN REFERENCE

- MAPC's Massachusetts Low Impact Development Toolkit, 2014
- Vermont Low Impact Development Guide for Residential and Small Sites, 2010
- Pennsylvania Stormwater Best Management Practices Manual., 2006
- Atlantic Maintenance Group's Differences Between Rough and Finish Grading, 2020

5 NOTES ON GOOD HOUSEKEEPING & OTHER SIMPLE

The following practices are intended to serve as complements to the stormwater solutions presented earlier in the guide, as they are designed to help reduce additional runoff and prevent pollutants from entering the local watershed.

CAR WASHING

- Take your car to a local car wash that recycles and reuses wash water and uses non-toxic cleaners.

TIP: Not sure of where to find a commercial carwash? Wanting to know more about the technologies being used at carwashes in your areas? The New England Carwash Association (NECA) website: (*http://www.newenglandcarwash.org/index.cfm*) maintains a list (with the locations) of all the carwashes located in Massachusetts. Consumers can also call the NECA at (781) 245-7400 to get more information on the latest technologies that carwashes are using to address pollution in your community.

- When washing your car at home, park on pervious areas (e.g., your lawn), use non-toxic soaps, and reduce the amount of water that you use by running the hose only when you need it.
- Pour your bucket of soapy water down the sink when you are done instead of pouring it directly on your lawn or driveway.

LAWN CARE AND LANDSCAPING

AERATION

- Regular use of your lawn can compact the soil making it difficult for rain water to absorb. Aerating your lawn is the process of poking small holes into the ground to loosen up the soil.
- Aerator tools vary in type, size, and cost.

An aeration tool rolls over your lawn to poke holes in the soil. *Credit: allispossible.org.uk*

NATIVE PLANTINGS, LONGER GRASS, AND LOW-MOW AREAS

- Choose native grasses and ground covering as alternatives to conventional turf lawns. Native plants have originated and evolved in the area and generally require less water, herbicides, pesticides, fertilizers, and trimming. Native plants also provide habitat and a food source for pollinators. The Native Plant Trust (*https://www.nativeplanttrust.org/*) can help you find plants native to Easthampton. You can also talk to your local nursery to learn more about what plants might be local to your area and do well in your yard.

YARD PRACTICES

- Designating an area of your lawn, or your entire lawn, for longer grass, is an easy way to help grass do its job to naturally infiltrate stormwater. This means cutting the grass less frequently, and letting it grow to at least a few inches tall before mowing.
- You can even designate an area of your lawn that you **only mow a few times per year**. This is a simple and inexpensive way to help prevent stormwater runoff.

TREE PLANTING

- While it takes time for trees to grow, trees and shrubs increase infiltration of stormwater, filter pollutants, provide habitat and offer shade, among other benefits.

Tree plantings will help infiltrate stormwater before the water runs into the road, and ultimately into the stormwater drains.

FERTILIZER USE

- Before applying fertilizers to your lawn and gardens, have your soil tested. You may find that you do not need to add any fertilizer. To have your soil tested, call the University of Massachusetts (UMass) Extension Soil Testing Lab at (413) 545-2311 or download a soil test order form from *http://www.umass.edu/soiltest/*.
- When fertilizer is necessary, avoid using fertilizers before a rainstorm, use sparingly, and consider using organic or slow-release fertilizers that release nutrients more slowly and help you avoid excess nutrients from running off your lawn.
- Consider leaving mulched grass clippings on your lawn to naturally fertilize and prevent evaporation, reducing the amount you need to water your lawn.

TIP: If your residence is within Easthampton's Aquifer Protection Overlay District, fertilizers, pesticides, herbicides, lawn care chemicals or other leachable materials must be used in accordance with Lawn Care Regulations of the Massachusetts Pesticide Board, 333 CMR 10.03 (30, 31).

YARD WASTE AND DEBRIS

- Keep yard debris away from storm drains, waterbodies, and wetlands.
- Dispose of your yard waste at your local transfer station or compost in your backyard. For more information on backyard composting, see the Massachusetts Department of Environmental Protection's website on Home Composting & Green Landscaping: *https://www.mass.gov/lists/home-composting-green-landscaping#backyard-composting-*

TIP: A drop-off area for residential yard waste - brush, grass, leaves (brush no larger than 6 inches in diameter) is available at the end of Oliver Street. A permit sticker or punch card is required for these services. *Trash & Recycling | Easthampton, MA (easthamptonma.gov)*

WATER USE

- Observe local outdoor water bans, place sprinklers in areas where you will not be wastefully watering impervious surfaces (e.g., driveways and walkways), and water early in the morning to minimize evaporation and lessen the need for more water.

ADDITIONAL RESOURCES

- Massachusetts Department of Environmental Protection's (DEP) guide, *Education in Nonpoint Source Pollution Prevention*: *https://www.mass.gov/guides/education-in-nonpoint-source-pollution-prevention#-car-washing-*
- DEP's guide, *Lawns and Landscapes in Your Watershed*: *https://www.mass.gov/guides/lawns-and-landscapes-in-your-watershed*
- Massachusetts Department of Agricultural Resource, *A Homeowner's Guide to Environmentally Sound Lawncare*: *https://www.mass.gov/doc/a-homeowners-guide-to-environmentally-sound-lawncare/download*.

WINTER GROUNDSKEEPING

- Reduce the amount of salt and sand that you apply to your driveway and walkways. Shoveling or other manual forms of snow clearance can reduce or avoid the need for salt or sand, which can run off into local waterbodies during snowmelt.

PET WASTE

- Take the time to scoop up pet waste and dispose of it properly.
- **Remember:** Stormwater and wastewater travel through separate drainage systems. As stormwater rushes over lawns, sidewalks, roads, and trails, the stormwater collects everything in its path, including pet waste, and drains directly into streams, ponds, or wetlands.
- **Always** properly dispose of pet waste, and never dump pet waste into a storm drain or catch basin, since the average dog dropping produces 3 billion fecal coliform bacteria.

6 GLOSSARY

Impervious Surfaces -
Hard surfaces, such as roofs, sidewalks, driveways, streets and parking lots, that prevent water from soaking into the ground

Landscaped Area -
Areas on your property with grass and/or landscaping that you regularly maintain

Natural Vegetation Area -
Areas on your property that are not regularly maintained, and you allow to grow naturally, such as woods, meadows, or other naturally-vegetated areas

Ponding -
Any location with large puddles of standing water

Resilient Stormwater Management -
Practice of trying to restore the natural drainage patterns of an area so that it is more resilient to current and future impacts resulting from stormwater runoff

Stormwater -
Water that comes from a precipitation event – like a rain or snowstorm

Stormwater Runoff -
Precipitation that does not evaporate or soak into the ground but instead runs across the land and into the drainage system or nearest waterway

Wastewater -
Water that is used in your home or in a commercial building that drains through pipes to a wastewater treatment plant

Watershed -
Landscape area in which water drain to a given stream, lake, wetland, estuary, or ocean

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MVP
Municipal Vulnerability Preparedness

PREPARED BY FUSS & O'NEILL

IN PARTNERSHIP WITH THE CITY OF EASTHAMPTON