New Hampshire Homeowner's Guide to Stormwater Management

Do-It-Yourself Stormwater Solutions For Your Home

NHDES

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Do-It-Yourself Stormwater Solutions For Your Home

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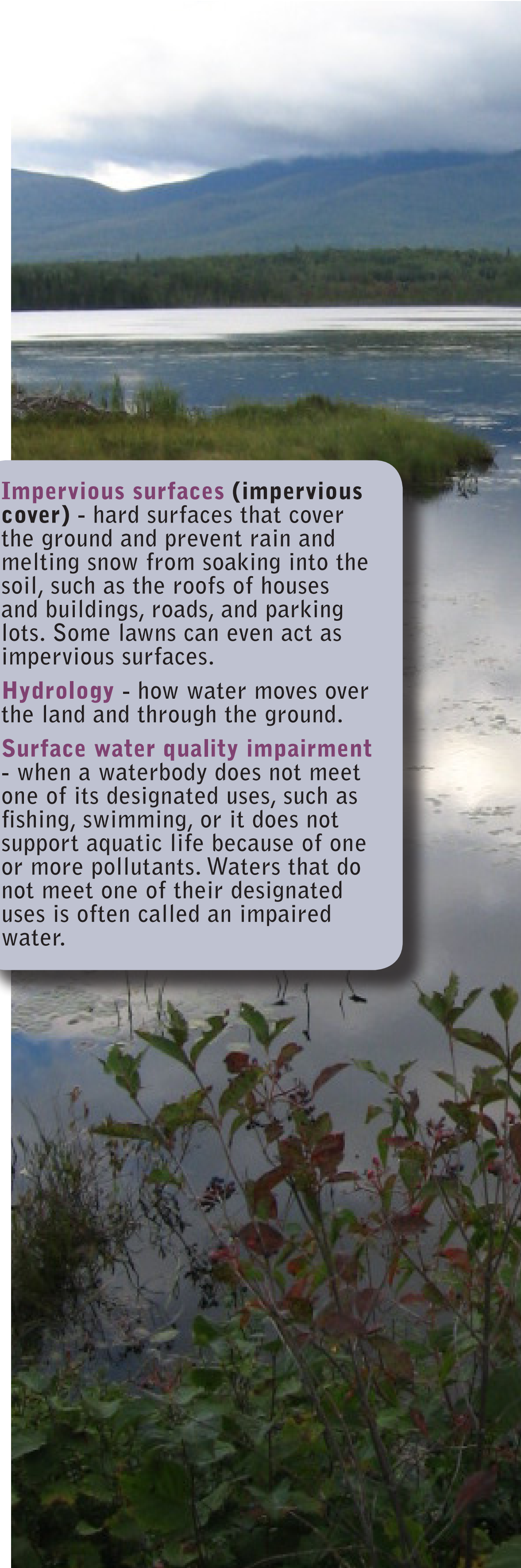
Contents

Introduction

What is Stormwater?

Stormwater is water from rain or melting snow that does not soak into the ground. In a forest, meadow, or other natural landscape, stormwater soaks into the ground and naturally filters through the soil. When forests and meadows are developed, they are replaced with neighborhoods, shopping centers, and other areas that introduce **impervious surfaces** such as rooftops, roads, parking lots, and even lawns. Impervious surfaces prevent rain or melting snow from soaking into the ground and create excess stormwater runoff and stormwater pollution.

In New Hampshire, stormwater contributes to over 80 percent of the **surface water quality impairments** in the state. All across New Hampshire, communities, businesses, and property owners experience the challenge of managing stormwater to maintain roads and drainage infrastructure, to protect water quality, and to simply keep our roads and driveways from washing out each year.



Impervious surfaces (impervious cover) - hard surfaces that cover the ground and prevent rain and melting snow from soaking into the soil, such as the roofs of houses and buildings, roads, and parking lots. Some lawns can even act as impervious surfaces.

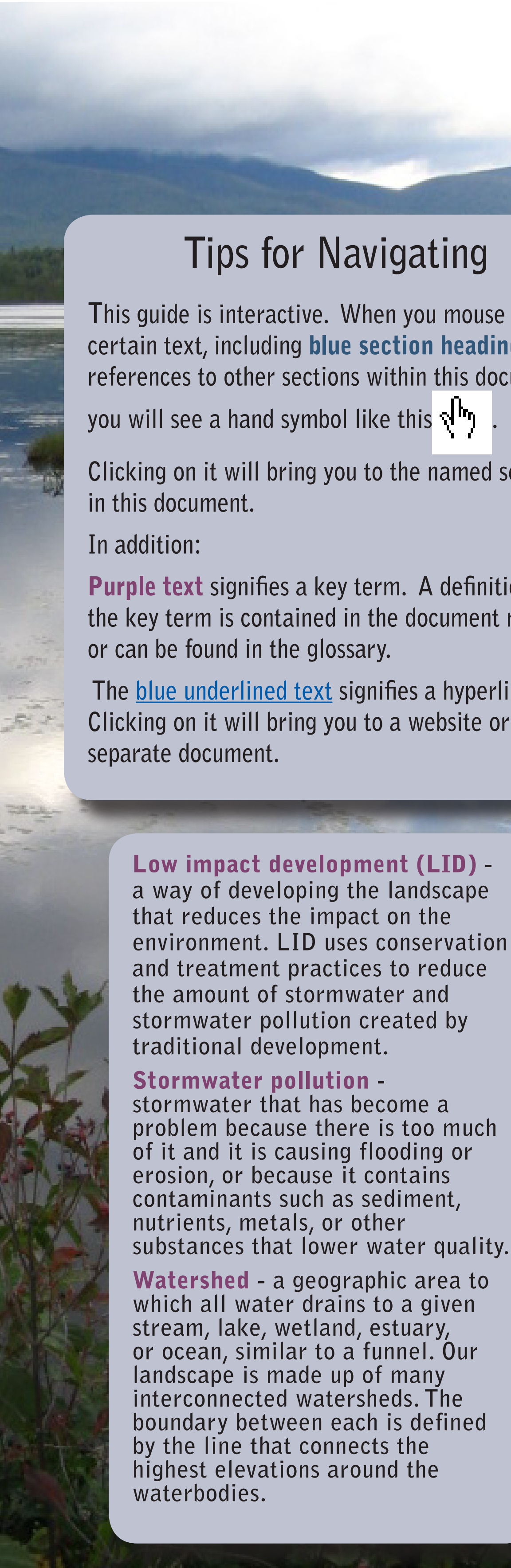
Hydrology - how water moves over the land and through the ground.

Surface water quality impairment - when a waterbody does not meet one of its designated uses, such as fishing, swimming, or it does not support aquatic life because of one or more pollutants. Waters that do not meet one of their designated uses is often called an impaired water.

Stormwater in Your Own Back Yard

It often seems like our actions don't make a difference. When it comes to stormwater pollution, every action, good or bad, makes a difference. What you do in your own back yard can affect the entire **watershed** and can impact the health of the water bodies that we play in and depend on.
Actions that seem as harmless as washing your driveway with a hose instead of sweeping it or dumping your yard waste in the back yard instead of composting it can cause excess stormwater runoff and can result in pollutants being washed into nearby streams and ponds.

Changing our habits, including yard care, is not easy, but there are good reasons to do so, especially if we are in danger of contributing to pollution.



Purpose of this Guide

This guide is designed to help you, the residential homeowner, better manage stormwater on your property.

It provides step-by-step instructions to install stormwater treatment practices, such as dry wells and rain gardens, on your property with your own two hands. These stormwater treatment practices, also called **low impact development** (LID) practices, help protect nearby streams and ponds from stormwater pollution, and help to reduce flooding, create wildlife habitat, recharge your well, and conserve water.

This guide also provides instructions on using the NH Residential Loading model to estimate the amount of stormwater pollutants that come from your property (your "stormwater footprint"), and how adding LID practices on your property can reduce your stormwater footprint.

Tips for Navigating

This guide is interactive. When you mouse over certain text, including **blue section headings** and references to other sections within this document, you will see a hand symbol like this .

Clicking on it will bring you to the named section in this document.

In addition:

Purple text signifies a key term. A definition of the key term is contained in the document margin or can be found in the glossary.

The blue underlined text signifies a hyperlink. Clicking on it will bring you to a website or a separate document.

Low impact development (LID) - a way of developing the landscape that reduces the impact on the environment. LID uses conservation and treatment practices to reduce the amount of stormwater and stormwater pollution created by traditional development.

Stormwater pollution - stormwater that has become a problem because there is too much of it and it is causing flooding or erosion, or because it contains contaminants such as sediment, nutrients, metals, or other substances that lower water quality.

Watershed - a geographic area to which all water drains to a given stream, lake, wetland, estuary, or ocean, similar to a funnel. Our landscape is made up of many interconnected watersheds. The boundary between each is defined by the line that connects the highest elevations around the waterbodies.

How to Use this Guide

This guide is divided into three sections:

a. INTRODUCTION: Describes the causes **stormwater pollution**, how stormwater pollution impacts the quality of our lakes and streams, and how LID can be used to reduce the stormwater problem.

b. DIY STORMWATER MANAGEMENT: Provides fact sheets for DIY LID practices, including material and equipment lists, illustrations, and step-by-step instructions to construct LID practices on your property.

c. NH RESIDENTIAL LOADING MODEL: Explains how to use the New Hampshire Residential Loading Model to estimate your "stormwater footprint" for the most common stormwater pollutants. You can also use the model to estimate how constructing one or more LID practices on your property reduces your footprint to help protect water quality in your **watershed**.

Typical Stormwater Problems and Their Effects

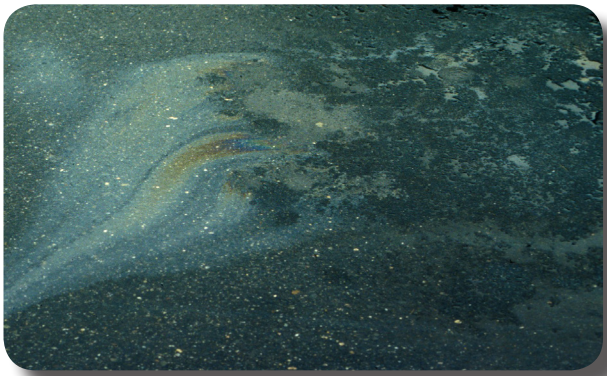
Stormwater causes many different problems including flooding, stream bank erosion, and water pollution. The pollutants in stormwater are essentially the same as the pollutants that we treat in our wastewater. They just come from different sources. Common stormwater problems and pollutants include the following.

CHANGES IN HYDROLOGY **Hydrology** is the term used to describe how water flows over and through the land. There is more stormwater runoff from developed land than undeveloped land. Too much stormwater runoff becomes a problem when streams have to accommodate more flow than nature designed them to. When this happens, flooding is more frequent, stream banks erode, and the groundwater table is lowered.

Example Sources of Stormwater Problems

Stock piled yard waste can add nutrients.

Poor erosion control can add sediment.



Leaking vehicle fluid can add toxic pollutants.

Washing driveways creates excess stormwater.

SEDIMENT can be washed or eroded into lakes and ponds from streams with unstable banks, dirt driveways, or other activities that disturb the land such as construction. Fine sediments stay suspended in the water. This makes the water appear cloudy and reduces how far you can see into the water. Fine sediments can clog the gills of fish, and sediment that settles to the bottom can smother fish habitat and bottom-dwellers. Sediment can literally fill in the lake, making it easier for plants, including invasive plants like purple loosestrife and exotic milfoil, to take root. Sediment tends to carry other pollutants such as nutrients and metals with it.

NUTRIENTS come from organic waste (including pet waste), septic systems, fertilizers, and eroding soils. Excess nutrients speed up plant and algae growth, including cyanobacteria, which can be harmful to humans and animals. Plants and algae can be a nuisance for swimming and boating, and can decrease the amount of oxygen in the water as they die and decompose. This means that less oxygen is available for fish and other organisms.

BACTERIA come from pet waste that is left on the ground, failing septic systems around a lake, and wildlife. Bacteria can make swimmers sick and can lead to beach closures. Bacteria not only pose a public health risk, but can cause an economic hardship for communities who rely on bathing beaches for tourism revenue.

CHLORIDES are found in road salts and other deicing materials that are applied to roads, highways, parking lots, and driveways in the winter months. Chlorides increase the salinity of our lakes. This stresses aquatic organisms that depend on freshwater habitats. As salinity increases, a lake becomes more susceptible to invasive plant species. Freshwater plants die off and salt-tolerant plants take over. Chloride can also contaminate drinking water supplies including private wells. Unlike other stormwater pollutants, there is no treatment for chloride pollution except for source control.

TOXIC CONTAMINANTS come from a variety of sources including petroleum products such as motor oil and gasoline, pesticides, and herbicides. Often, the products used to kill unwanted weeds and pests are also harmful to aquatic organisms, humans, and other animals.

THERMAL POLLUTION can occur when stormwater runs over hot pavement. This heats the stormwater and can increase the temperature or streams and ponds. Many fish and aquatic species depend on the higher oxygen concentrations that cool water temperatures provide. Warmer water has less oxygen and makes it more difficult for fish to breath.

Example Effects of Stormwater Problems

Algae blooms from excess nutrients.

Turbid streams from erosion and sediment.

Cloudy, discolored water, surface sheens and build-up from toxic contaminants.

Fish kills and harm to aquatic life.

Infiltrate - when rain and snowmelt soak into the soil

Managing Stormwater With Low Impact Development

What is Low Impact Development?

Low Impact Development (LID) is a stormwater management approach that focuses on controlling stormwater through thoughtful land management, good housekeeping, and construction of small, dispersed LID practices, like dry wells and rain gardens, to treat stormwater close to its source.

How do LID Practices Work?

LID practices capture runoff from roofs, driveways, patios, and even lawns and **infiltrate** it into stone reservoirs, natural soils, or filter media. The plants and soils filter and remove stormwater pollutants. Infiltration reduces the volume of stormwater running off of a property and also reduces the potential for stormwater pollution.

How Can You Benefit from LID?

- Reduce damage and cost from property and neighborhood flooding, such as your driveway or road washing out.
- Increase curb appeal with LID practices that improve landscaping, add vegetation, improve wildlife habitat, and reduce erosion potential.
- Conserve water for reuse.
- Help supply the groundwater that fills your well.
- Reduce the volume of stormwater draining to the municipal storm drainage system, which reduces the burden on the system and increases its lifespan.
- Reduce the impact of your house, driveway, lawn, and other built areas of your property on the natural environment, including nearby lakes and streams.
- Give you the satisfaction of being a **watershed** steward by taking care of the environment and reducing your stormwater footprint.

Do-It-Yourself Stormwater Management

This section gives you everything you need to know to start managing stormwater on your property, including how to estimate your "stormwater footprint," estimate the volume of runoff from your property, test your soils, and determine the best locations for stormwater treatment. This section also describes stormwater "good housekeeping" practices to reduce stormwater pollution by simply changing the way you do certain things in and around your home, such as washing your car and watering your lawn.

Getting Started

Any change that you make on your property to reduce impervious surfaces, prevent erosion, and infiltrate stormwater makes a positive difference in your **watershed** and reduces your stormwater footprint. If you want to get more technical to specifically address the amount of runoff your property creates, you can use this section to calculate your runoff and do simple water and soil testing to better plan your site and size your LID practices.

Estimate Your "Stormwater Footprint"

Before you dive into planning your site, it helps to know how much stormwater and stormwater pollutants your property is contributing to the **watershed**. You can use the instructions in the NH Residential Loading Model in Appendix C of this guide to estimate the amount of phosphorus, nitrogen, and sediment that run off of your property. You can also use the model to see what LID practices will be most effective at reducing your stormwater footprint by selecting various LID practices for different areas of your property.

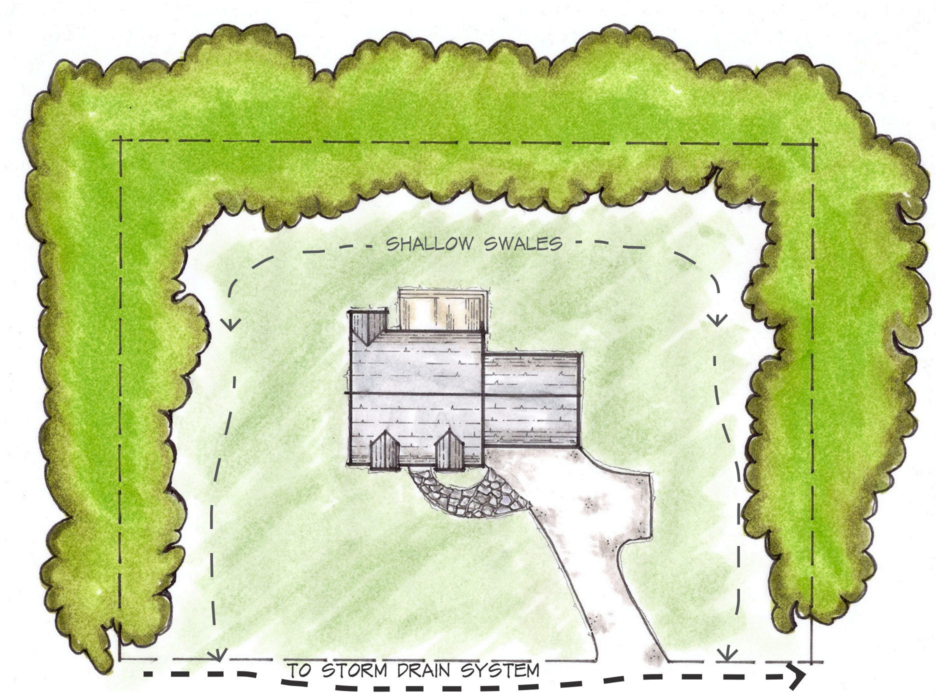
Estimate Your Runoff Volume

To manage stormwater and select the best LID practices for your property, you first need to know how much runoff comes from your property and where it flows. To do this, it helps to first make a sketch of your property to identify important features. You can use your tax map, survey (if you have one), or measure and make your own map. Then, follow the remaining steps to calculate your runoff and the volume of stormwater that you want your LID practices to capture and treat.

1. SKETCH YOUR PROPERTY

Make a map of your property including the following existing features (the **Site Sketch Grid** on page 62 can help you make your map):

- Impervious surfaces: roofs, driveways, walkways, sheds, and other areas
- Roof downspouts
- Lawn & landscaped areas
- Buffer areas
- Steep slopes
- Stormwater practices
- Streams or ponds
- Stormwater flow paths - best seen during a heavy rain (watch out for lightening)



Existing conditions site sketch.

2. CALCULATE THE TOTAL IMPERVIOUS AREA

Add up the areas of all the impervious surfaces (in square feet) that will contribute runoff to the future LID practice.

$$\mathbf{AREA_1 + AREA_2 + \ldots = AREA_{total}}$$

> Example: Roof runoff from half of your house (700 ft^2) and half of your garage (400 ft^2)is equivalent to...
>
> 700 ft^2 + 400 ft^2 = 1100 ft^2

3. CALCULATE THE STORMWATER CAPTURE TARGET

In New Hampshire, capturing and treating the first 1-inch of runoff from each rainfall event is roughly equivalent to capturing 90 percent of the annual stormwater runoff volume. The first inch of runoff is often called the "water quality volume." By capturing and treating the water quality volume, you remove the majority of stormwater pollutants.

To determine the volume of stormwater that a treatment practice needs to capture and treat in order to capture the first 1-inch of runoff, multiply the total area of impervious (from step 2) by 1-inch. Keep in mind that some storms produce greater than an inch of runoff. LID practices could be oversized to accommodate overflow or the practice could be designed to direct overflow to another treatment practice or a designated pervious area.

$$(\text{AREA}_{total}\ \text{ft}^2) \times (1\ \text{inch} / 12) = \text{STORMWATER CAPTURE TARGET (in ft}^3)$$

Example: To capture the first inch of runoff from 1,100 ft^2 of impervious surface a LID practice would need to be sized to capture...

$$(1{,}100\ \text{ft}^2) \times (1\ \text{inch}/12) = 92\ \text{ft}^3\ (688\ \text{gal})$$

NOTE: 1 ft^3 is equivalent to 7.48 gallons

Choose a Location for your LID Practices

After you know the amount of stormwater runoff to manage on your property, it's time to select the best locations on your property for LID practices to go. Using the sketch of your property that you created, you can identify the following.

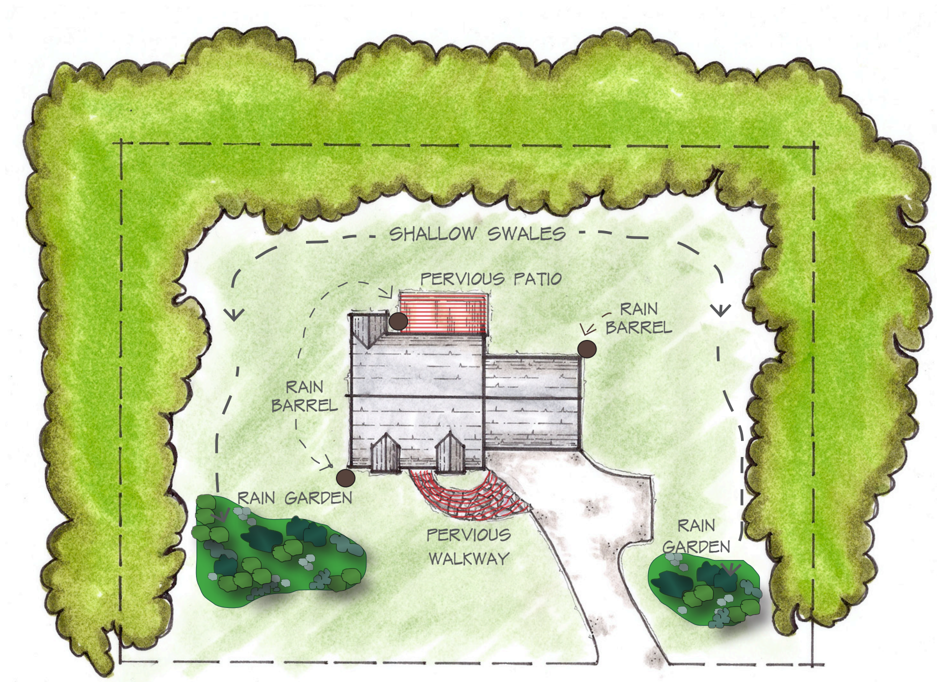
Natural Drainage: Observe the natural drainage patterns on your property after a storm. Notice the paths where the water runs, and where water tends to pool. An LID practice should be placed in a low lying area or along the natural flow path.

Vulnerable Areas: Avoid placing LID practices in vulnerable areas such as next to your foundation or over your leach field. Following the general tips below will help you avoid vulnerable areas.

- ✓ Place LID practices at least 10 feet away from the building to prevent seepage into the basement.
- ✓ Do not place over a septic tank or leach field.

- ✓ Do not place near a drinking water well.
- ✓ Avoid disturbing tree roots as the tree may be injured by digging and may not tolerate additional soil moisture.
- ✓ Make sure LID practices meet all property setbacks. You can verify setbacks with your town.

Call Before You Dig: Before you start any excavation project, it is your responsibility to locate any underground utilities on your property. Check for private wiring or underground utilities such as driveway lights and sheds with electricity. Call Dig Safe® at 1-888-dig-safe at least three days before digging to avoid underground pipes and utilities.



Future conditions site sketch.

Water Table and Soil Testing

The water table is the level underground where water has fully saturated the soil and is the source of groundwater. If there are any low points on your property that tend to be wet or have very moist soil even when it has not rained, this typically means there is a high water table or slowly draining soils.

Knowing the type of soil on your property can help you choose what LID practice to use. It is important that the bottom or your LID practice is at least 1-foot above the high water table. This will make sure it functions correctly and that there is enough time for the soil to treat the stormwater before coming into contact with groundwater. Sandy soils have the fastest infiltration and clay soils have the slowest. Since clay soils take longer to drain, they may require you to construct a larger LID practice than if there were sandy soils. You can do a simple perc test or a soil ribbon test (described below) to identify if the water table and soil type on your property.

SIMPLE PERC TEST

To conduct a simple perc test, use the following steps.

d. Using a shovel or a post hole digger, dig a 1 - 3 foot deep hole and use a watering can or bucket to fill it with water.
e. Fill the hole with water to moisten the soil an allow it to drain completely (NOTE: if the hole fills with water on its own or if water is still in the hole after 24 hours, choose a new location).
f. Fill the hole with water a second time and place a ruler or yard stick in the hole. Note the water level and time. After 15 minutes, check the water level again and note the new water level. Multiply the change in water level by 4 to get the number of inches of infiltration in an hour.

SOIL RIBBON TEST

Estimate your soil type by performing a ribbon test using the following steps:

a. Grab a handful of moist soil and roll it into a ball in your hand.
b. Place the ball of soils between your thumb and the side of you forefinger and gently push the soil forward with your thumb, squeezing it upwards to form a ribbon about a 1/4 inch thick.
c. Try to keep the ribbon uniform in thickness and width. Repeat the motion to lengthen the ribbon until it breaks under its own weight. Measure the ribbon with a ruler or measuring tape and compare it to the following table.

Example soil ribbon test.
photo: North Dakota State University

Soil Type	Ribbon Length (inches)	Min. absorption rate (inches/hour)
sand	soil does not form a ribbon at all	8 in/hr
silt	a weak ribbon <1.5 inches is formed before breaking	1 in/hr
clay	a ribbon >1.5 inches is formed	0.04 in/hr

Maintenance of LID Practices

As with any stormwater system, regular maintenance is essential to maximize performance and water quality benefits of LID practices. The general maintenance steps described below should be followed to properly maintain the treatment practices described in this guide.

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.

PLANTS: For practices with vegetation, new plants need to be watered frequently until their roots are established. Frequent weeding may be necessary in the first few years before plants become established. Check vegetation for signs of stress, disease and die-off and replace plants as necessary.

MULCH: For practices with vegetation, initially, 2″ - 3″ of mulch should be used to maintain soil moisture. Check periodically and after rain events and replenish mulch if needed. Once the vegetation in the treatment practices is established (2-3 years), mulch is not necessary, unless it is preferred for appearance.

OTHER MATERIALS: For practices with stone and other materials, periodically remove accumulated sediment, debris, and weeds from the surface. Practices lined with geo-textile fabric can clog over time. Check for ponding or slowly draining water. This can be a sign of clogging. If clogged, remove and wash the stone to clean out the accumulated sediment and debris.

Do-It-Yourself Fact Sheets

The fact sheets contained in this section give you everything you need to build these stormwater management practices at home.

Dripline Infiltration Trench - Page 21

Dripline infiltration trenches collect stormwater from your roof and store it until it soaks into the ground. They help control stormwater from running off your property.

Driveway Infiltration Trench - Page 23

Driveway infiltration trenches collect stormwater from your driveway and store it until it soaks into the ground. They help control stormwater from running off your property.

Dry Well - Page 25

Dry wells collect and infiltrate roof runoff at gutter downspouts, roof valleys, and other places where large amounts of water flow off of a roof. They help to reduce erosion and can reduce ponding and sitting water.

Infiltration Steps - Page 27

Infiltration steps slow down and infiltrate runoff on moderate slopes of 45° or less to help reduce erosion and define walking paths.

Pervious Walkways & Patios - Page 31

Pervious pavers have stone reservoirs under them that collect and infiltrate the rain and snow that accumulate on them. They help to reduce the stormwater runoff from your property.

Rain Barrel - Page 35

Rain barrels capture rainwater from your roof and store it for later use to water lawns, gardens, and indoor plants. They help to reduce the stormwater runoff from your property and also conserve water.

Rain Garden - Page 37

Rain gardens are bowl-shaped gardens that use soil, mulch, and plants to capture, absorb, and treat stormwater. They help to reduce stormwater runoff from your property and recharge groundwater.

Vegetated Swale - Page 41

A vegetated swale is a shallow channel that slows stormwater runoff and directs it to an area where it can infiltrate. Swales are typically used next to roads, sidewalks, and driveways. The plants in the swale help remove pollutants from stormwater and trap sediment, and the root system helps prevent erosion.

Water Bar - Page 43

A water bar intercepts water traveling down walkways, paths, gravel driveways, and other areas to divert water into stable vegetated areas. They helps prevent erosion.

What Stormwater Practice is Best for Your Property?

Use the following table to help decide which stormwater management practice is best suited for your property.

	Infiltration Trenches	Dry Well	Rain Garden	Pervious Walkway	Vegetated Swale	Infiltration Steps	Rain Barrel	Water Bar
Space Required min surface area: min width: min length: min depth:	 8 to 32 ft^2 1 to 4 ft 4 to 8 ft 8 inches	 8 to 32 ft^2 2 to 4 ft 4 to 8 ft 3 ft	 50 to 200 ft^2 5 to 10 ft 10 to 20 ft 3 to 8 inches	as needed to accommo-date walkway or patio area	bottom width: 2 ft. minimum 6 ft maximum	as needed to accomodate slope	not a factor - near downspouts	as needed
% Nutrient Removal Total Phosphorus: Total Nitrogen:	 60 55	 60 55	 34 65	 65 60	 20 20	 60 55	 0 0	 0 0
% Runoff Volume Reduction	90	90	80	75	60	90	40	0
Slopes	usually not a limitation, but a design consideration. Should locate down-slope of buildings and foundations			5% or less	swale side slopes: 3:1 or flatter longitudinal slope: 1.0% min	usually not a limitation, but a design consideration		
Water Table/ Bedrock	1 to 4 ft clearance				usually not a factor			
Proximity to foundations	minimum distance of 10 ft down-slope from buildings and foundations - unless dripline infiltration trench						not a factor	
Maintenance All LID practices should be inspected seasonally and after major storm events.	moderate - Inspect for signs of erosion or clogging. Remove any vegetation growing in the trench.	low - Inspect for signs of clogging such as ponding. Remove any vegetation growing over the dry well.	low - Inspect for signs of erosion where water enters the garden. Remove accumulated sediment. Replace mulch and vegetation as needed.	moderate to high - Inspect for signs of clogging such as ponding. Pressure wash and replace pea stone as needed to maintain infiltration.	low - Inspect for erosion. Remove accumulated sediment and replace vegetation as needed.	moderate - Inspect for signs of erosion or clogging. Remove any vegetation growing in the steps.	low - Empty barrel after each rain event or, at a minimum, when barrel is full.	

Adapted from Low-Impact Development: An Integrated Design Approach. Price George's County, Maryland. June 1999 and the NH Stormwater Manual. December 2008.

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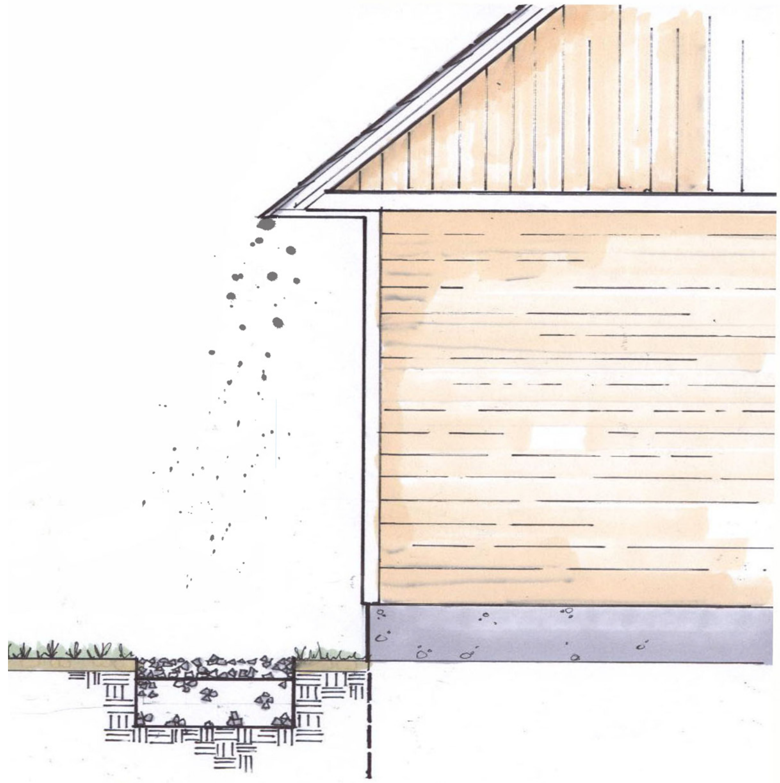
Dripline Infiltration Trench

A dripline infiltration trench collects and infiltrates stormwater from your roof until it soaks into the ground. It helps control stormwater from running off your property.



Sizing and Design

STEP 1. Measure the distance from the side of your house to the edge of your roofline. If you cannot reach the roofline, align your body under the edge of your roofline and measure the distance from your body to the house. This is your reference line.

STEP 2. Mark the reference line on the ground along the perimeter of your house where you will be installing the dripline trench.

STEP 3. Measure 12″ from the reference line away from your house and mark this along the perimeter. This the outside boundary line for excavation

STEP 4. Measure 6″ from the reference in toward your house and mark this along the perimeter. This is the inside boundary line for excavation.

EQUIPMENT & MATERIALS

- Measuring tape
- Shovel
- Crushed stone ($^1/_2$″ to $1^1/_2$″ diameter)
- Non-woven geotextile fabric (or landscape weed fabric for smaller projects)

OPTIONAL

- Perforated PVC or other plastic piping
- String or spray paint

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 house so that water will drain away from the foundation.

STEP 2. To extend the life of the trench, line the sides with non-woven geotextile fabric.

STEP 3.

For Well Drained Soils: Fill the bottom 5 inches of trench with $^1/_2$″ to $1^1/_2$″ crushed stone. Fold a piece of non-woven geotextile fabric over the stone layer and fill the remaining three inches with additional stone (Figure 1).

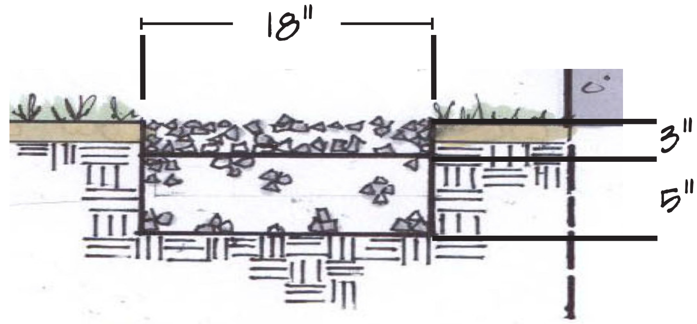


Figure 1. Profile for well drained soils.

For Slowly Draining Soils: Fill the bottom 1″ - 2″ of the trench with crushed stone. Lay a 4″ perforated pipe with the holes facing up along the trench. The end of the pipe should either outlet to a vegetated area with a **splash guard** to prevent erosion or to another treatment practice such as a dry well or a rain garden. The pipe should be sloped toward the outlet so the water easily flows out of the pipe. Cover the pipe with non-woven geotextile fabric and fill the remainder of the trench with stone (Figure 2).

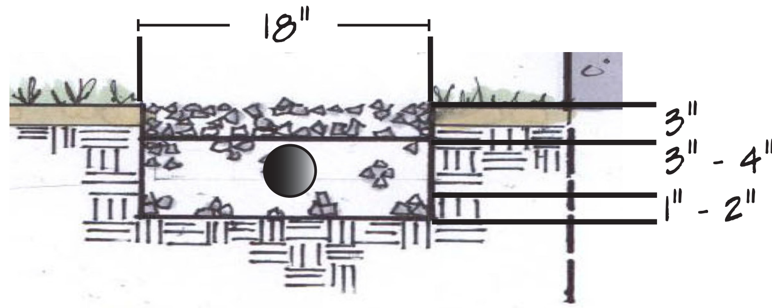


Figure 2. Profile for slowly draining soils.

Splash guard - prevents erosion at the end of pipes and gutter downspouts. You can purchase plastic or concrete splash guards at hardware stores or you can simply use a flat stone.

NOTE. *Dripline trenches work best in sand and gravel soils that can quickly infiltrate large volumes of water. If your property sits on poorly draining soils, you can install a perforated PVC (or other plastic) pipe in the trench as described here.*

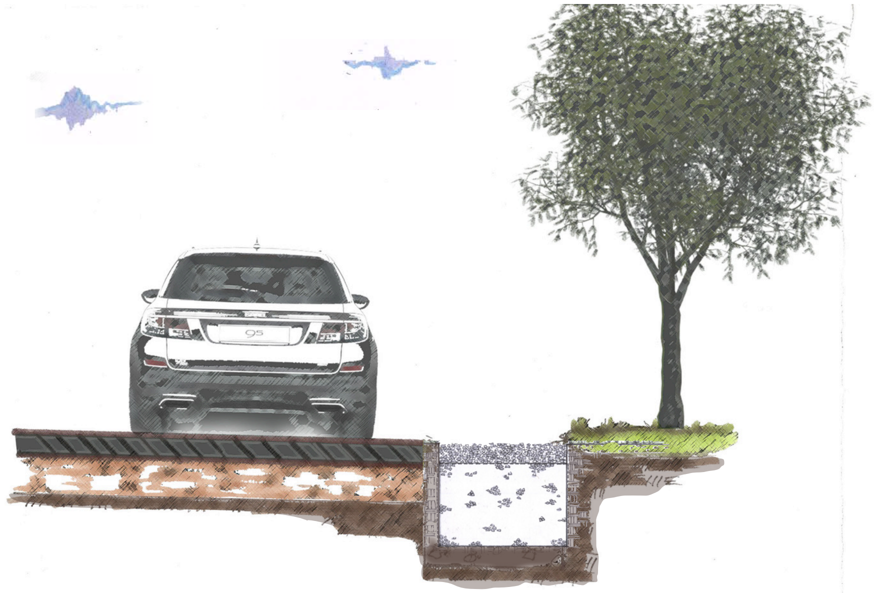
STEP 4. OPTIONAL: As material allows, spread a layer of stone all the way to the edge of your foundation. This creates a cleaner appearance and reduces the need for vegetation between the trench and your foundation.

DESIGN REFERENCE

Maine Department of Environmental Protection. *Conservation Practices for Homeowners*. Fact Sheet Series. May 2006.

Driveway Infiltration Trench

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



EQUIPMENT & MATERIALS

- Measuring tape
- Shovel
- Crushed stone ($^1/_2$" to $1^1/_2$")
- Non-woven geotextile fabric (or landscape weed fabric for smaller projects)

OPTIONAL

- Perforated PVC or other plastic piping
- String or spray paint

Sizing and Design

STEP 1. Look at 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. Decide the width of the trench you want to install. They should be between 12" and 18", as space allows.

STEP 3. Mark your desired trench width (12" - 18") along the edge of your driveway where you will be installing the trench. This is the boundary line for excavation.

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, if possible so that water will drain away from the driveway.

STEP 2. To extend the life of the trench, line the sides with non-woven geotextile fabric.

STEP 3.

For Well Drained Soils: Fill the bottom 5″ of trench with 1/2″ to 1 1/2″ crushed stone. Fold a piece of non-woven geotextile fabric over the stone layer and fill the remaining 3″ with additional stone (Figure 1).

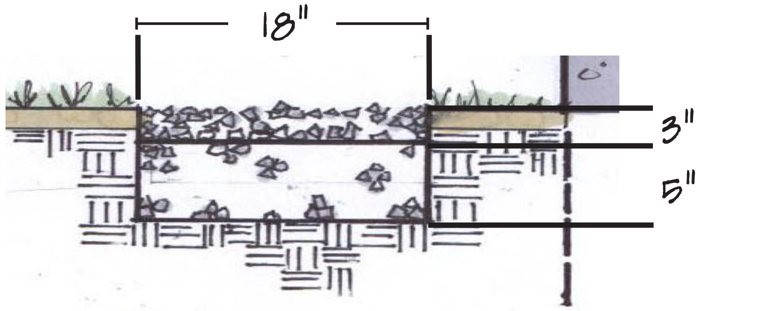


Figure 1. Profile for well drained soils.

For Slowly Draining Soils: Fill the bottom 1″ - 2″ of the trench with crushed stone. Lay a 4″ perforated pipe with the holes facing up along the trench. The end of the pipe should either outlet to a vegetated area with a **splash guard** to prevent erosion or to another treatment practice such as a dry well or a rain garden. The pipe should be sloped toward the outlet so the water easily flows out of the pipe. Cover the pipe with non-woven geotextile fabric and fill the remainder of the trench with stone (Figure 2).

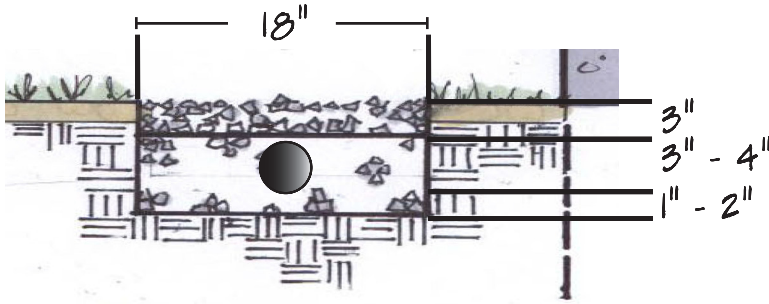


Figure 2. Profile for slowly draining soils.

NOTE. *Driveway trenches work best in sand and gravel soils that can quickly infiltrate large volumes of water. If your property sits on poorly draining soils, you can install a perforated PVC (or other plastic) pipe in the trench as described here.*

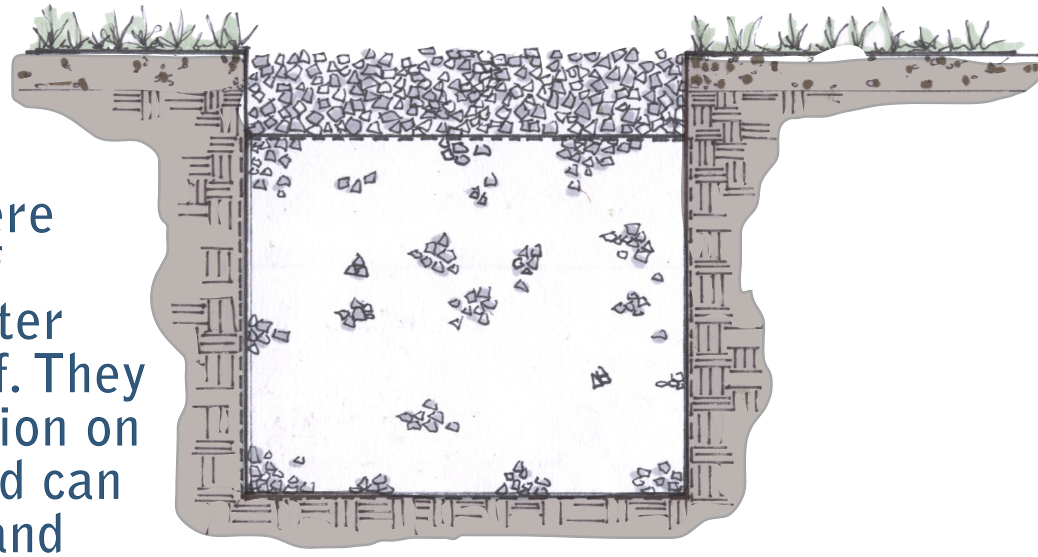
Design References

Maine Department of Environmental Protection. *Conservation Practices for Homeowners*. Fact Sheet Series. May 2006.

Riversides. *Toronto Homeowners' Guide to Rainfall*. http://www.riversides.org/rainguide.

Dry Well

Dry wells collect and infiltrate roof runoff at gutter downspouts, roof valleys, and other places where large amounts of concentrated water flow off of a roof. They help reduce erosion on your property and can reduce ponding and sitting water.



EQUIPMENT & MATERIALS

- Measuring tape
- Shovel
- Crushed stone ($^1/_2$″ to $1^1/_2$″ diameter)
- Non-woven geotextile fabric (or landscape weed fabric for smaller projects)

OPTIONAL
- Perforated PVC or other plastic piping
- Splash guard
- Gutter downspout extension

Sizing and Design

STEP 1. Determine the best placement for your dry well. This is usually where large amounts of concentrated runoff flow, such as off of a roof valley or at the end of your roof gutter downspout. It is best to observe runoff during a rain storm.

STEP 2. Follow the steps to **Estimate Your Runoff Volume** (page 11) and your **Stormwater Capture Target** (page 13) to determine how large to make your dry well. A typical dry well measures about 3′ x 3′ x 3′.

STEP 3. Clearly mark the boundary of your dry well to identify where you will dig.

Installation

STEP 1. Dig down 3′ within the dry well boundary you marked in step 3 above.

STEP 2. Slope the bottom of the dry well away from your house so that water drains away from the foundation.

STEP 3. Extend the life of the dry well by lining the sides with non-woven geotextile fabric.

STEP 4. Fill the dry well hole with 1/2″ to 1-1/2″ diameter crushed stone to within 3″ of the ground surface.

STEP 5. Fold a flap of filter fabric over the top of the dry well.

STEP 6. Cover the filter fabric with additional crushed stone until it is even with the ground surface.

STEP 7. Connect your runoff to the dry well. There are a number of ways to direct runoff to the dry well.

a. If the dry well is designed to absorb water from a roof valley, no special piping is needed. The drywell should be placed under the roof valley so that runoff can simply run down the valley and land on the surface of the dry well.

b. If the dry well is designed to absorb water from a roof downspout, you can either extend the downspout to direct runoff to surface of the dry well, or you can extend the downspout, wrap the end of the dowspout in filter fabric, and bury the end of the downspout in the drywell. Burying the downspout allow you to cover and seed over the surface of the dry well to make it less noticeable; however, this makes it more difficult to determine if your drywell is working properly. Be sure to inspect your dry well for signs that it is clogged or failing such as ponding at the surface of the drywell or water backing up in your gutters (if your downspout is buried). Parts for extending your dry well can be purchased at your local home improvement store.

Design Reference

Maine Department of Environmental Protection. *Conservation Practices for Homeowners*. Fact Sheet Series. May 2006.

Infiltration Steps

Infiltration steps slow down and infiltrate runoff on moderate slopes of 45° or less to help reduce erosion and define walking paths.

They are typically built with timbers and crushed stone or pea stone, but can be modified by using granite edging and pervious pavers.

Sizing and Design

STEP 1. Measure the overall rise and run of your steps in inches (figure 1).

STEP 2. Determine the number of steps that you will need.

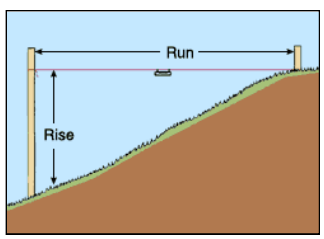


Figure 1

Divide the rise in your slope (measured in step 1) by the height of the timber (6″ unless you are using different sized timbers) and round to the nearest whole number. This is the number of steps you will need.

RISE / TIMBER HEIGHT = NUMBER OF STEPS

STEP 3. Determine the depth (tread) of the steps by dividing the run of the slope by the number of steps (figured in step 2). A comfortable step tread is at least 15″.

RUN / NUMBER OF STEPS = DEPTH OF STEP TREAD

EQUIPMENT & MATERIALS

- Measuring tape or ruler
- Hammer
- 4 wooden stakes
- String or spray paint
- shovel
- $^{3}/_{4}$″ crushed stone or pea stone
- Non-woven geotextile fabric
- 6″ x 6″ pressure treated timbers
- 18″ long pieces of $^{1}/_{2}$″ diameter steel rebar
- Level
- Power drill with $^{1}/_{2}$″ drill bit
- 12″ galvanized spikes

Infiltration Steps

STEP 4. Determine the width of the steps. A comfortable width is usually 4′, but depending on the topography, trees, or other site conditions, a wider or narrower step may be desired.

STEP 5. Determine your material needs. Once you know the number of steps that you need, their width and tread depth, you can determine the length of timber and the amount of steel rebar that you will need. If you are using side timbers, be sure to 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. If you are using side timbers, you will need 6 pieces of 18″ long $^{1}/_{2}$″ diameter steel rebar for each step. If you are not using side timbers, you will need two pieces for each step.

NOTE. *Infiltration steps may not require side timbers, especially if the steps are in an eroded pathway where the surrounding land is higher. In this case, extend the timbers into the adjacent banks so water will not go around the steps.*

Use the following equations to determine the length (in feet) of timber material you will need:

(STEP WIDTH + TREAD DEPTH + TREAD DEPTH) = TIMBER LENGTH PER STEP

(TIMBER LENGTH PER STEP x # OF STEPS) = TOTAL TIMBER LENGTH

Installation

STEP 1. Stake out the perimeter of the stairway by driving a stake into the ground at each corner of the stairway and stretching string between them (figure 2).

STEP 2. Determine the areas that need to be excavated for each step. Using a measuring tape and starting from the string at the bottom of the slope, measure and mark the depth of the each step until you reach the string at the top of the slope. Use spray paint, sand, or flour to mark the depth of each step (figure 2).

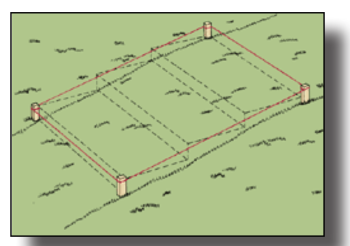


Figure 2

STEP 3. Excavate the first step. Starting at the bottom, dig a trench for the first riser timber (this will be more like a shallow groove in the ground). Next, if using side timbers, dig trenches for the side timbers, which should be long enough to extend 6″ passed the next step's riser. Check the make sure the trenches are level (figure 3).

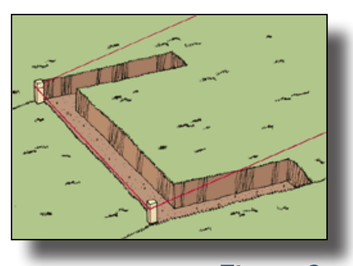


Figure 3

STEP 4. Prepare materials by cutting 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 step depth for the side timbers (remember that each step should extend 6″ past the next step's riser.) Drill $^1/_2$″ diameter holes approximately 6″ from the ends of each timber (figure 4).

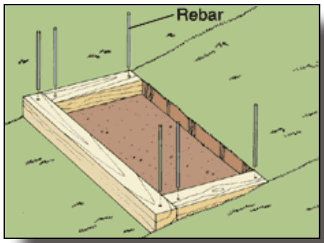


Figure 4

NOTE. *If you do not have your own saw, most home improvement stores have a cutting station that you can use yourself, or they will cut it for you if you give them the lengths you need.*

STEP 5. Position the timbers in the step and remove or add soil as needed to level them (figure 4).

STEP 6. Anchor the timbers by driving the 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 4).

STEP 7. 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 4).

STEP 8. To build the next step, measure from the front of the first riser timber and mark the step depth on the side timbers with a pencil. Align the front of the second step riser timber with the pencil lines on the side timbers of the step below. Secure the riser timber to the side timbers using 12″ galvanized spikes (figure 5).

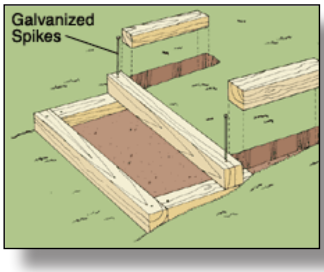


Figure 5

NOTE. *To make it easier to drive the galvanized spikes into the timber, you can pre-drill holes to about 5″ deep into the timber.*

STEP 9. Excavate for the side timbers and set the side timbers. Anchor the side timbers by driving the steel rebar through the drilled holes on the end of each timber into the ground (figure 5).

STEP 10. Shovel out the soil inside the step to create a surface roughly level with the bottom of the timbers the same as in step 7.

STEP 11. Repeat steps 8 through 10 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 12. Lay down geotextile 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 (figure 6).

b. Fill each step with $^3/_4$″ crushed stone or pea stone until it is about 1″ below the top of the timber.

c. Seed and/or mulch bare soil adjacent to the steps.

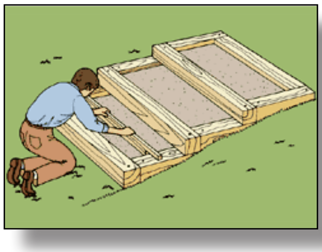


Figure 6

To Reftrofit Existing Steps

Existing steps can be retrofit to improve infiltration by removing several inches of soil from behind each step and following step 12.

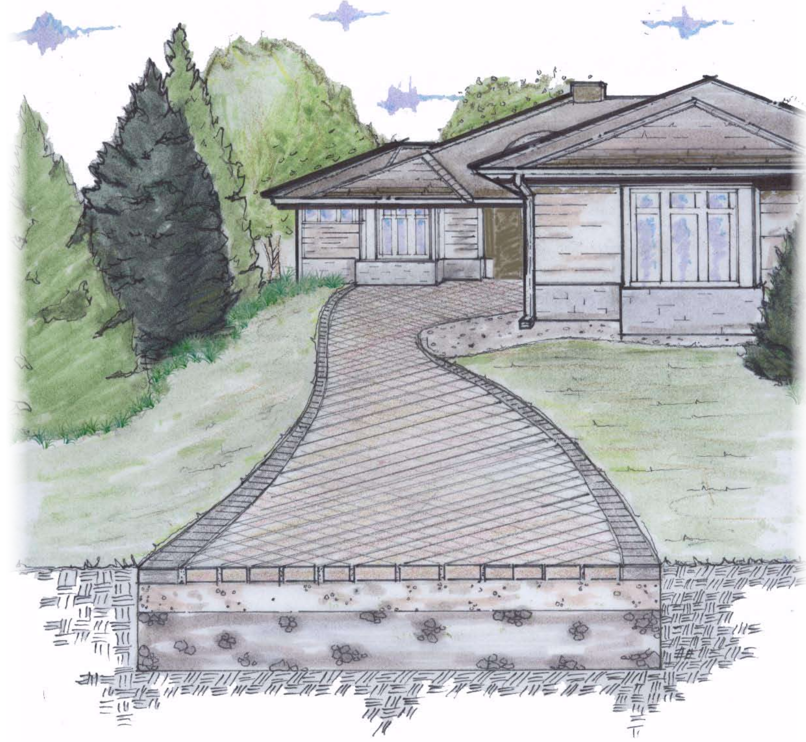
NOTE. *If the timbers are not firmly secured, drill $^1/_2$″ diameter holes, 6″ from the ends of each timber. Drive $^1/_2$″ diameter, 18″ long steel rebar through the holes with a sledge hammer. For gentle slopes, wooden stakes or large rocks can also secure the timbers.*

Design Reference

Maine Department of Environmental Protection. *Conservation Practices for Homeowners*. Fact Sheet Series. May 2006.

Figures used with permission from the Maine Department of Environmental Protection.

Pervious Walkways & Patios



Pervious pavers look like traditional brick, stone, or concrete pavers, but have spaces between them and a stone reservoir under them to absorb and store rain and snowmelt. This helps reduce the amount of runoff from your property and makes an impervious surface pervious.

EQUIPMENT & MATERIALS

- Measuring tape or ruler
- Shovel
- $1\frac{1}{2}$" crushed stone
- $\frac{3}{8}$" pea stone
- Non-woven geotextile fabric (or landscape weed fabric for smaller projects)
- Pervious pavers

OPTIONAL

- Perforated PVC or other plastic piping

NOTE. *Manufactured pervious pavers come with instructions for the type and depth of sub-base material. If the information in this fact sheet differs from the manufacturer's instructions, follow the manufacturer's instructions.*

Sizing and Design

STEP 1. Determine the areas that you will be installing pervious pavers.

Pervious pavers are best for areas with slopes of less than 2%. They should have a minimum of 2′ between the bottom of the gravel base and bedrock or the water table. Do a **Simple Perc Test** (page 14) to determine if pervious pavers will work on your property.

STEP 2. Material needs.

a. Calculate the area of the new or existing walkway, patio, or driveway that you will be installing with pervious pavers.

b. Determine the square footage of pavers you will need by multiplying the length (in feet) and width (in feet) of the area to be paved.

   If the area you are paving is not a simple square or rectangle, sketch the area where the pavers will be installed on a piece of paper, write down the corresponding measurements, and bring it to your local landscape supply yard or store where you will be purchasing the pavers. They will be able to help you determine how many pavers you need.

c. Sub-base material (figure 1) is the gravel and pea stone layers that go under the pavers. This material provides a reservoir for stormwater before it soaks into the ground underneath. You should have a minimum depth of 12″ of 1½″ diameter crushed stone and 6″ of 3/8″ peastone for your sub-base. Use the following equations to determine the amount of sub-base materials you will need:

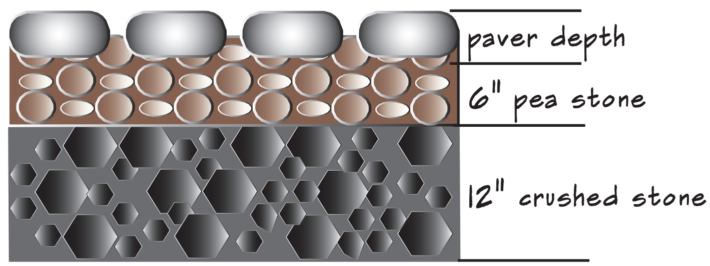


Figure 1. Pervious walkway profile.

(PAVEMENT AREA (SQ. FT.) x 1 FT.) x 0.037 = YARDS OF 1-1/2″ CRUSHED STONE

(PAVEMENT AREA (SQ. FT.) x 0.5 FT.) x 0.037 = YARDS OF 3/8″ PEA STONE

Installation

STEP 1. Prepare the installation site. Remove any existing walkway or patio material. This may require renting a jackhammer or other equipment such as a backhoe. Mark the location of the walkway or patio with either landscaping paint or place a string line on either side.

STEP 2. Excavate the site approximately 20-inches deep, depending on the type of paver you're using. Smooth the area you've excavated with a rake.

STEP 3. Lay the sub base material and pavers.

a. Spread the crushed gravel over the excavated dirt. The depth of the gravel should be 12″ or per manufacturer's instructions.
b. Place a layer of non-woven geotextile fabric over the crushed gravel.
c. Spread the pea stone over the fabric. The depth of the pea stone should be 6″ or per manufacturer's instructions.
d. Install the pavers on top of the pea stone and use a level to make sure they are installed uniformly. Most pervious pavers have tabs on the edges to create proper spacing between them.
e. Once the pavers are installed, spread more pea stone over the top and use a push broom to work the pea stone into the space between the pavers.

Design Reference

Low Impact Development Center. Permeable Paver Specification. 1995.

NH Department of Environmental Services. Permeable Pavement Demonstration Brochure. 2010.

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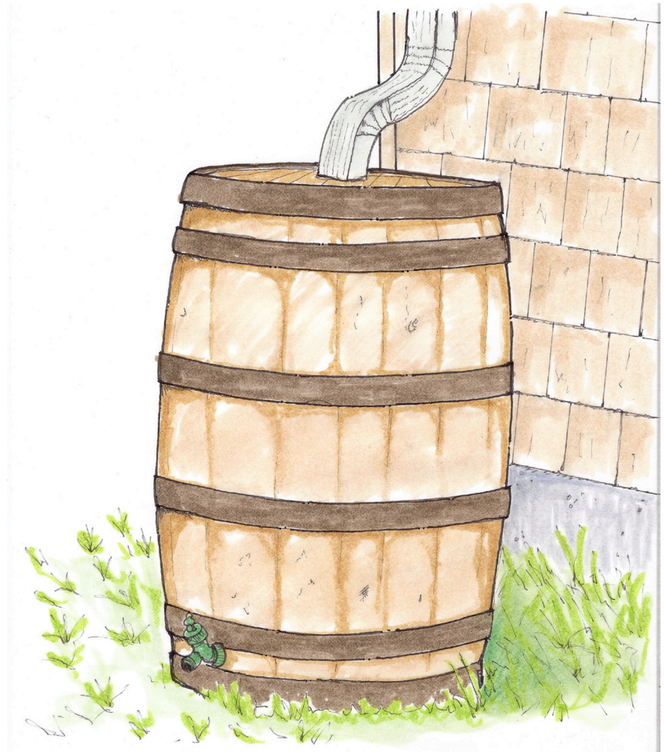
Rain Barrel

Rain barrels capture rainwater from your roof and store it for later use. This reduces stormwater runoff from your property and allows you to use captured water for lawns, gardens, and indoor plants.

Rain barrels must be emptied between rain events so they don't overflow and are able to capture runoff from the next storm.



Sizing and Design

STEP 1. Observe your roof runoff. Note where you have existing roof gutter downspouts or valleys that drain large amounts of water.

STEP 2. Use the **Stormwater Capture Target** (page 13) that you calculated in the Getting Started section to determine how many rain barrels you need. This will help you decide whether you need to establish an area to direct your rain barrel overflow.

Installation

STEP 1. 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 surface.

EQUIPMENT & MATERIALS

- Pre-made or home-made rainbarrel (food grade container)
- Shovel
- Cinder blocks

OPTIONAL

- Soaker hose for overflow
- Crushed stone
- Mulch
- Splash guard

NOTE. *You may need to cut your gutter downspout so the water flows onto the screen on top of the barrel.*

STEP 2. Elevate your rain barrel by placing it on cinder blocks or other sturdy base.

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

STEP 3. Attach additional rain barrels in a series, if you have more than one, or direct the overflow hose to an area that can receive overflow water such as a garden or dry well. Using a **splash guard** under the overflow hose will help prevent soil erosion during larger storm events.

Build Your Own Rain Barrel

Pre-made rain barrels are available in many sizes and styles and range in price from $50 to over $200. To save money, you can use the instructions at: http://www.portlandonline.com/shared/cfm/image.cfm?id=182095 to make your own rain barrel (City of Portland Environmental Services How to Manage Stormwater Rain Barrels fact sheet).

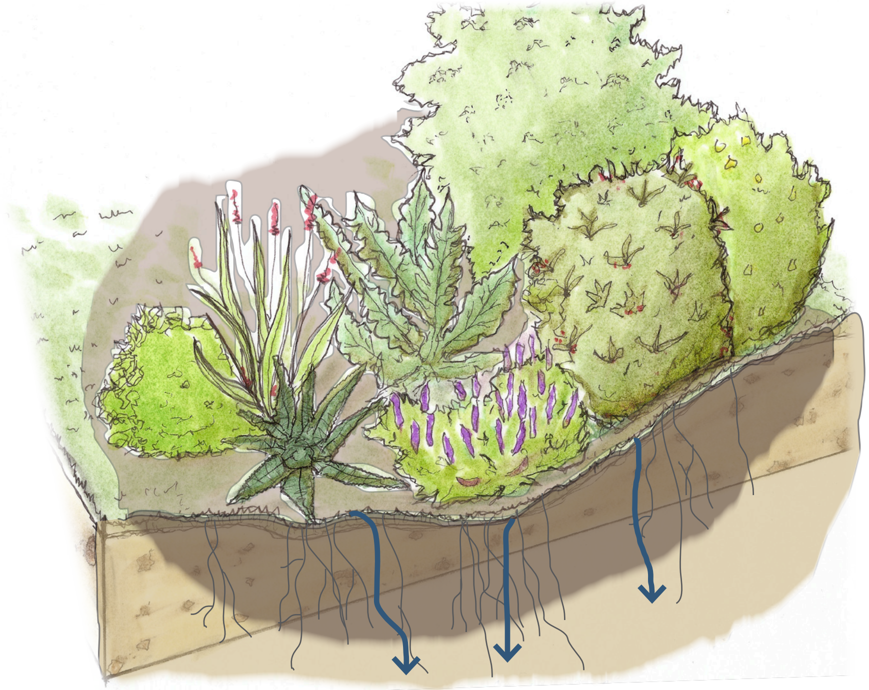
Design References

RiverSides Stewardship Alliance. *Toronto Homeowner's Guide to Rainfall*. 2005

Vermont Department of Environmental Conservation. *Low Impact Development Guide for Residential and Small Sites*. December 2010.

Rain Garden

A rain garden is a bowl-shaped garden that uses soil, mulch, and plants to capture, absorb, and treat stormwater. This helps to reduce the amount of stormwater coming from your property and to recharge groundwater.



Sizing and Design

STEP 1. Calculate the drainage area using the information in the **Estimate Your Runoff Volume** (page 11) section of this Guide.

STEP 2. Determine the soil type and suitability for a rain garden using the information in the **Water Table and Soil Testing** (page 14) section of this Guide.

STEP 3. Calculate the slope to determine the rain garden's depth.

a. Place one stake at the uphill end of the rain garden and another at the downhill end as illustrated in Figure 1.

b. Level the string between the two stakes.

c. Measure the total length of the string and the height of the string at the downhill stake in inches.

d. Divide the height by the length and then multiply the result by 100. This is the slope.

e. Use Table 1 to determine the recommended rain garden depth.

EQUIPMENT & MATERIALS

- Calculator
- Measuring tape or ruler
- Stakes (2)
- String or yarn
- Shovel
- Level
- Compost
- Mulch
- Plants

OPTIONAL

- PVC or other plastic piping
- Landscaping stones or edging

Table 1	
Slope	Depth
< 4%	3 - 5 in
5 - 7%	6 - 7 in
8 - 12%	8+ in

Table 2			
Soil Type	Rain Garden Depth (from Table 1)		
	3-5 in	6-7 in	8+ in
Sand	0.19	0.15	0.08
Silt	0.34	0.25	0.16
Clay	0.43	0.32	0.20

STEP 4. Determine the rain garden's size.

a. Use Table 2 to determine the rain garden size factor.

b. Multiply the size factor by the drainage area. This is the recommended rain garden size.

SIZE FACTOR x DRAINAGE AREA (square feet) = RAIN GARDEN SIZE (square feet)

STEP 5. Design your Rain Garden.

a. Your rain garden can be any shape, but MUST have a level bottom.

b. Stabilize the area where water will enter your rain garden with stone or gravel to slow the flow and prevent erosion. Place hardy flood tolerant plants where the stormwater enters the garden.

c. Select plants that are able to tolerate extreme moisture fluctuations typical of a rain garden. Plants must be able to tolerate both wet and dry conditions and survive the freezing winter conditions. See the **Native Plant List** on page 51 of this guide for a list of recommended plants.

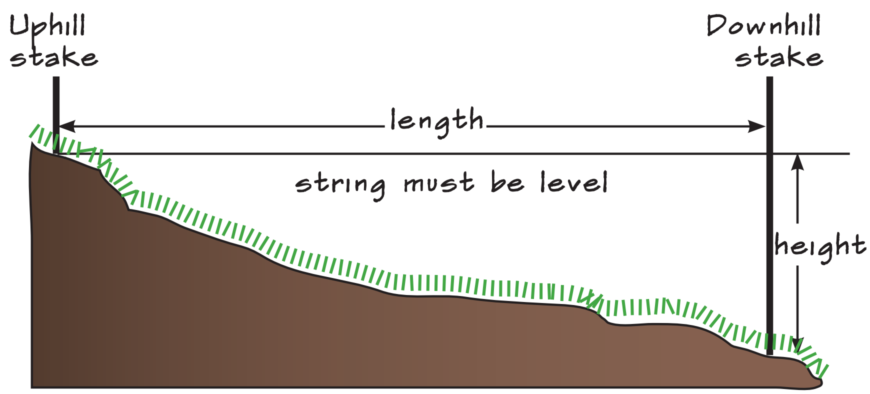


Figure 1. Determine the slope of the landscape before digging.

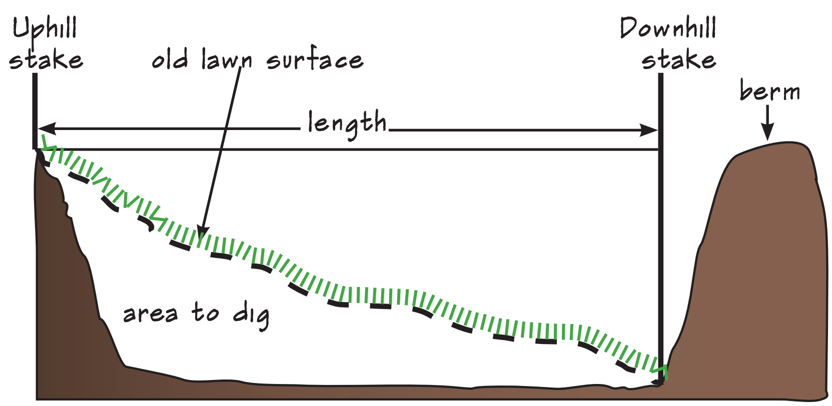


Figure 2. Where to dig and put the soil.

Installation

STEP 1. Define the borders by using string or spray paint to outline the shape of the rain garden.

STEP 2. Remove the grass within the rain garden area. You can either dig through the lawn or lay a tarp or sheet of black plastic within the rain garden area for several weeks to kill the grass. Herbicides are not recommended because they could kill newly planted rain garden plants.

STEP 3. Dig the rain garden.

a. Prepare the perimeter of the garden:

   On a Slope: If the rain garden is on a slope, a berm or low wall is needed on the downside of the rain garden to hold the water in the garden (Figure 2). Create a berm while digging the rain garden by piling the soil around the downside garden edges. The berm should be the same height as the uphill side of the garden to make the entire perimeter of the garden level. After shaping the berm, compact the soil and cover with sod, mulch, or other stabilizing ground cover.

   On Level Ground: If the rain garden is on level ground, no berm is necessary and the excavated soil can be removed or used somewhere else on your property. Landscaping stone or edging can be used to help hold water in the garden.

b. Dig the rain garden bed (bottom) 4″ - 6″ deeper than determined earlier to make room for compost and mulch. Avoid compacting the soils on the bottom of the garden. When the entire rain garden area has been dug out, lay a 2 x 4 board in the garden and place a carpenter's level on it. Dig or add soil to level out the bottom. Once level, rake the soil.

c. Apply at least 2″ of compost to the rain garden and mix into the native soils to help retain moisture and improve plant growth.

NOTE. *There is no need to add fertilizer to your rain garden soil. Adding fertilizer will add unnecessary nutrients and will reduce the ability for the rain garden to effectively treat stormwater.*

STEP 4. Place plants in the garden according to your planting plan. When removing the plants from their pots, loosen the root ball with your fingers to encourage root growth. Water generously after planting.

STEP 5. Apply a 2″-3″ layer of mulch over the entire rain garden to help retain moisture in the soil and to prevent weeds. A cubic yard of mulch will cover approximately a 100 square-foot-area with about 3 inches of mulch.

Design References

Winooski Natural Resources Conservation District. *The Vermont Rain Garden Manual "Gardening to Absorb the Storm"*. 2009

Wisconsin Department of Natural Resources. *Rain Gardens: A How-to Manual for Homeowners.* 2003.

Figures adapted from Wisconsin Department of Natural Resources. *Rain Gardens: A How-to Manual for Homeowners.* 2003.

Vegetated Swale

A vegetated swale is a shallow channel that slows stormwater runoff and directs it to an area where it can infiltrate. Swales receive drainage from roads, sidewalks, and driveways. They use plants to help trap sediment, remove pollutants from stormwater, and prevent erosion.

Sizing and Design

STEP 1: Determine the best location, shape, and size for your swale. Swales are often located close to roads or driveways. The swale should be located in a place where it will receive runoff at one end and have enough slope to it that the runoff will naturally flow through the swale to the other end to outlet. A slope of 1″ for every foot in length is enough to move the runoff.

STEP 2: Select plants for the swale using the **Native Plant List** on page 51 of this guide. Hardy groundcovers and grasses that produce uniform, dense cover, and can withstand flood and drought conditions are best. If the swale is to be located close to a road or in an area where you will store snow, choose salt-tolerant plants.

EQUIPMENT & MATERIALS

- Measuring tape
- Shovel
- Grass sod or other vegetation - native grasses, sedges, and seedlings. Drought & flood tolerant plants are best suited.
- Soil mix (depending on existing soil type)

OPTIONAL
- Downspout extension
- Splash guard
- Crushed stone (for check dams)

Installation

STEP 1: Dig out the shape of the swale to match your design. The deepest part of the swale in the center should be approximately 3′ deep. The width of the swale will be dependent on how much space you have on your site. A swale can be any size or length, but most are shaped like a trapezoid with the sides being three times wider than the width of the base. The slope of the sides should be between 1% and 4% (figure 1).

NOTE: Be careful not to compact the soil when digging, because this will reduce the ability of the swale to infiltrate runoff.

For clay soils or other poorly infiltrating soils, you may want to dig down another $1^1/_2$' below the bottom of the swale and create a sandy loam by mixing sand in with the existing soil, then refill the hole. This will improve infiltration.

STEP 2: Dig the swale at a slight slope downhill to move water through the swale. Dispose of any excess soil in a place where it will not runoff the property. For steeper slopes, check dams should be used to slow down the flow of runoff and reduce the potential for erosion. Check dams are small dams, usually made of

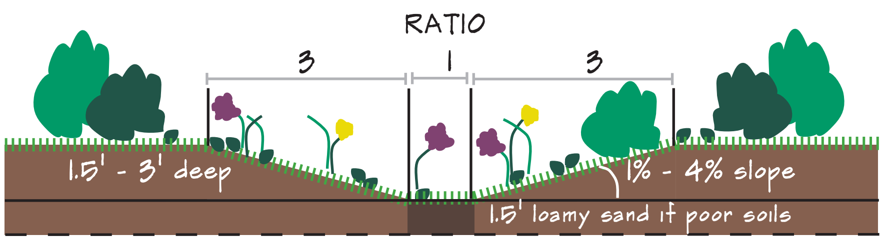


Figure 1. Profile of vegetated swale.

crushed stone, that are built across a swale. They are used to slow down the speed of the stormwater as it flows through the swale.

STEP 3: At the inflow end of the swale, where runoff enters, you may want to use a splash guard or pile stones or gravel to reduce erosion from fast moving runoff.

STEP 4: Plant the swale with seedlings, seeds, or sod. You can use the **Native Plant List** on page 51 of this guide or your local nursery can help you select native plants that are drought and flood tolerant, and tolerant of sun or shade conditions on your property. Runoff should not be directed to a swale until the vegetation is well established. Temporary mulch check dams can be used to slow the flow of runoff in the swale until the groundcover has matured and will not be damaged by runoff.

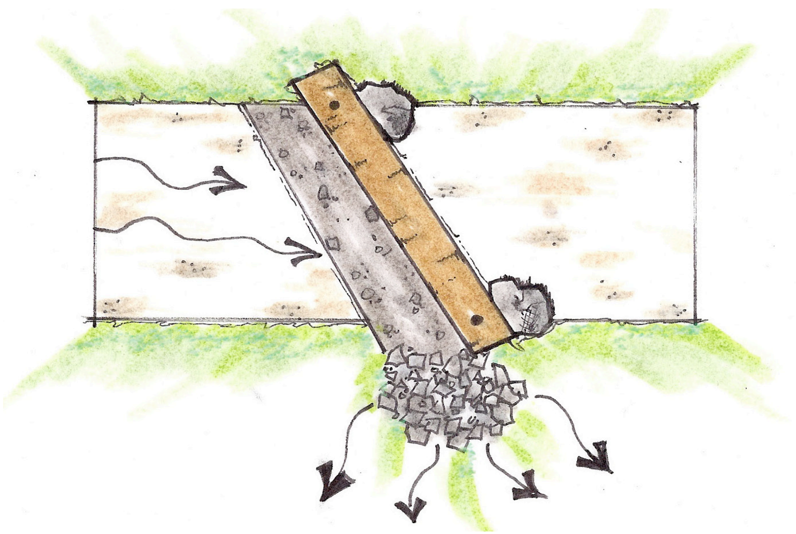
Design References

RiverSides Stewardship Alliance. *Toronto Homeowner's Guide to Rainfall*. 2005

Vermont Department of Environmental Conservation. *Low Impact Development Guide for Residential and Small Sites*. December 2010.

Water Bar

A water bar intercepts water traveling down moderately steep walkways, paths, gravel driveways, and other areas to divert water into stable vegetated areas. This helps to prevent erosion.



EQUIPMENT & MATERIALS

- Measuring tape
- Shovel
- Saw
- 6″ x 6″ or 8″ x 8″ pressure treated or cedar timbers or other rot-resistant logs
- 18″ long pieces of $^{1}/_{2}$″ rebar (2 for each water bar)
- $^{3}/_{4}$″ crushed stone
- Mulch

Sizing and Design

STEP 1. Determine how many water bars.

a. You will need to calculate the slope of your path (figure 1) using the following equation:

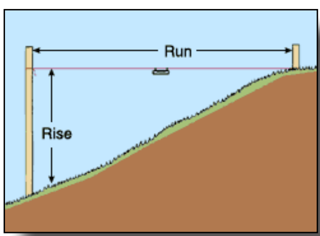


Figure 1..

(RISE / RUN) x 100 = % SLOPE

b. Compare your % slope to the waterbar spacing in table 1 to determine how far apart the water bars should be.

c. Divide the length of your path (along the ground surface) by the spacing between water bars from table 1 to get the number of water bars that you will need.

LENGTH OF PATH / WATER BAR SPACING = # WATER BARS

NOTE: If your path has known problem areas (e.g., areas erode or wash out frequently), place the water bars to specifically target these problem areas instead of using the spacing in table 1.

Table 1

% Slope	Spacing between water bars (in feet)
2	250
5	130
10	80
15	50
25+	40

Water Bar

STEP 2. Determine material needs. Measure the width of your path. The timbers should extend 6″ off both sides of the path. To determine the length of timbers you will need, use the following equation:

NUMBER OF WATER BARS + (PATH WIDTH + 1) = TIMBER LENGTH IN FEET

Installation

STEP 1. Dig a trench for the wood timber or log that is at approximately a 30º angle across the path. The trench should be deep enough so the top of the timber or log will be almost flush with the trail on it's downhill side once in place. Store soil and rocks excavated from the trench on the trail below the water bar to be used later to backfill the trench.

STEP 2. Prepare materials by cutting the timbers or logs to the appropriate length. For each water bar, cut one timber as long as the path width plus 1′ (remember that each timber should extend 6″ on each side). Drill $^1/_2$″ diameter holes approximately 6″ from the ends of each timber.

NOTE. *If you do not have your own saw, most home improvement stores have a cutting station that you can use yourself, or they will cut it for you at the lengths you need.*

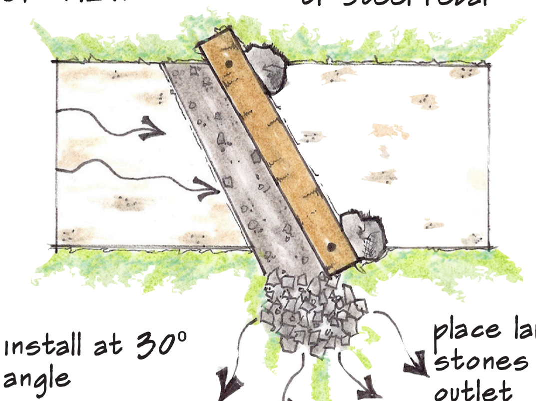


Figure 1. Top view of waterbar.

STEP 3. Install the timber or log by placing it snug against the downhill side of the trench. The timber should be level and have no high points or voids under it.

STEP 4. Secure the timber with rebar stakes making sure that the rebar is pounded down to be flush or slightly recessed with the top of the timber to avoid any sharp edges.

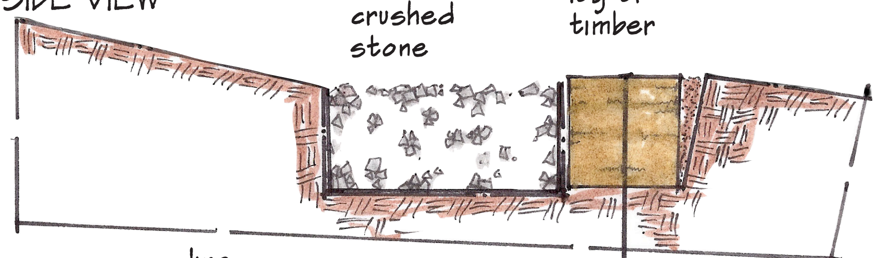


Figure 2. Side view of waterbar.

STEP 5. Back Fill around the water bar.

a. Dig a 12″ wide and 6″ deep trench along the uphill side of the timber.
b. Fill the trench with crushed stone, leaving a few inches of the timber exposed.

c. At the outlet of the waterbar, place an apron of crushed stone to prevent erosion.
d. Pack soil and gravel up against the downhill side of the timber so that the top of it is flush with the path.
e. Cover all disturbed soil with seed and mulch or leaf litter.

Design Reference

Maine Department of Environmental Protection. *Conservation Practices for Homeowners*. Fact Sheet Series. May 2006.

Figure used with permission from the Maine Department of Environmental Protection.

Good Housekeeping

The following good housekeeping practices help reduce the volume of stormwater created and help prevent pollutants from coming in contact with stormwater.

AUTOMOBILE MAINTENANCE

- Keep your vehicles (and any other motors) serviced regularly by a qualified mechanic.
- Clean up fluid leaks with cat litter and put an absorbent rag or carpet remnant under the leak to absorb the fluid until it is fixed.

CARWASH

- Take your vehicle to a local car wash that recycles and reuses the wash water and uses non-toxic cleaners.
- If you have to wash your vehicle at home, park your car on a grassy or pervious area, use a non-toxic soap, and minimize the amount of water that you use by running the hose only when you need it.

"GREEN" YARD CARE & LANDSCAPING

- Reduce the square footage of your lawn area by planting low-maintenance ground-covers, trees, flowers, and shrubs to help water infiltrate into the ground and prevent soil erosion.
- For new lawns, use 6" - 12" of topsoils to encourage deeper root growth.
- Choose native grasses and ground coverings as alternatives to conventional turf lawns on some or all of your property. Native plants have evolved and originated in your area and generally require less water, herbicides, pesticides, fertilizers, and trimming.
- Test your soil to see what it really needs before you apply fertilizer or lime (contact your county UNH Cooperative Extension office for information on soil testing).
- When fertilizer is necessary, use a slow-release fertilizer to avoid excess nutrients running into the water.
- If you have an automated irrigation system, make sure that it has a rain gauge or soil moisture sensor to prevent watering when it isn't necessary - like when it is raining or immediately following a rain shower.
- Aerate your lawn to help the soil breathe and promote stronger root systems.
- Raise and keep your lawn mower at a height of 7.5 cm (3 inches).

- Leave mulched grass clippings on your lawn to naturally fertilize and prevent evaporation to reduce the amount you need to water.
- Maintain natural vegetation and buffers around your property.
- Sweep up the yard waste and other materials from your driveway using a regular broom or, if that is too difficult, use a shop vacuum to collect the material.

REDUCE IMPERVIOUS COVER

- Limit the amount of impervious surface created on your property.
- Replace impervious surfaces with natural, native ground cover or materials that allow rain water to seep into the ground such as gravel, brick, stepping stones, wood chips, or other porous surfaces.
- Direct runoff from impervious areas to pervious ones. For example, direct the downspout from your roof gutter away from your driveway and instead into a vegetated area such as a swale or garden area.

SEPTIC SYSTEM MAINTENANCE

- Know the location of your septic tank and leach field area.
- Have your tank inspected yearly. If the sludge and surface scum combined are as thick as $^1/_3$ the liquid depth of your tank, have it pumped out by a licensed septage hauler.
- Keep bulky items like diapers, sanitary pads, cigarettes, and paper towels out of the system as they will cause clogging.
- Keep toxic materials like paint thinners, pesticides, and bleach out of your system. The chemicals could kill the good bacteria that live in your septic tank that keep it functioning.
- Do not use septic tank additives. They could be harmful to the bacteria.
- Repair leaking faucets and fixtures promptly to reduce the amount of water the system has to treat.
- Avoid putting food waste and grease into the system or using a garbage disposal. Food waste in your system would require more frequent pumping and can leach nutrients into the soils surrounding your leach field.
- Keep deep-rooted trees and bushes away from the leach field.
- Keep vehicles, equipment, and heavy foot traffic away from the leach field to avoid compacting the soils.
- Use alternative cleaning products, such as baking soda and borax, to avoid chlorine and strong acids that could kill the good bacteria in the septic system.

WINTER WALKWAY AND DRIVEWAY MAINTENANCE

- Reduce the amount of salt that you apply to your driveway and walkways.
- Use only sand to provide traction.
- If you have multiple entries to your home, designate one of them as the "winter entrance" and only maintain the walkway that serves that door.

PET WASTE

- Take the time to "scoop the poop" and dispose of it properly.
- Pick up pet waste. Flush it down the toilet, put it in the trash, or bury it in the yard at least 5" deep and away from vegetable gardens and waterways.
- Do not put pet waste into storm drains.
- For more information, see DES Scoop the Poop Campaign.

Glossary

Hydrology (hydrologic function) — the way water moves over the land and through the ground.

Infiltrate — when rain and snowmelt soak into the soil.

Impervious cover (impervious surface) — hard surfaces that cover the ground and prevent rain and melting snow from soaking into the soil, such as the roofs of houses and buildings, roads, and parking lots.

Low impact development — a stormwater management and land development strategy used at the lot and subdivision scale that uses thoughtful land use planning and on-site natural features with small-scale stormwater controls to try to match the way the stormwater traveled over and through the landscaping before development.

Phosphorus — an essential nutrient for life that is the limiting nutrient in fresh water lakes and ponds. This means that when there is too much phosphorus in a waterbody, the plants and algae grow and can become a nuisance for boating and swimming. Too much phosphorus can also increase the likelihood of toxic algae blooms that risk the health of humans and animals. When the plants and algae die, they decompose and use up the oxygen in the waterbody, leaving less available for the fish and other aquatic organisms who depend on it. TOO MUCH PHOPHORUS = TOO MANY PLANTS = NOT ENOUGH DISSOLVED OXYGEN.

Splash guard — prevents erosion at the end of pipes and gutter downspouts. You can purchase plastic or concrete splash guards at hardware stores or you can simply use a flat stone.

Stormwater — Water from rain or melting snow that does not soak into the ground.

Stormwater pollution — stormwater that has become a problem because there is too much of it and it is causing flooding or erosion or because it contains contaminants such as sediment, nutrients, metals, or other substances that lower water quality.

Surface water quality impairments — when a waterbody does not meet one of its designated uses, such as fishing, swimming, or it does not support aquatic life, it gets reported in the New Hampshire 305(b) Surface Water Quality Report and the 303(d) List of Impaired Waters. This report is updated by DES every two years and is submitted to the United States Environmental Protection Agency. Waterbodies that are listed as impaired need to be restored.

Watershed — a geographic area to which all water drains to a given stream, lake, wetland, estuary, or ocean; similar to a funnel. Our landscape is made up of many interconnected watersheds. The boundary between each is defined by the line that connects the highest elevations around the waterbodies.

References

Andreoletti, Jessica. *The Vermont Rain Garden Manual "Gardening to Absorb the Storm"* Winooski Natural Resources Conservation District, 2008.

Bannerman, R.E. Considine, and J. Horwatich, *Rain Garden: A How-to Manual for Homeowners,* UWEX Publications GWQ 037. University of Wisconsin-Extension, 2003.

Charles River Watershed Association, *Rain Garden Fact Sheet,* Low Impact Development Stormwater Best Management Practices, September 2008.

Hinman, Curtis, *Low Impact Development Technical Guidance Manual for Puget Sound*, Puget Sound Action Team and Washington State University, January 2005.

Maine Department of Environmental Protection. *Conservation Practices for Homeowners.* Fact Sheet Series. May 2006.

New Hampshire Department of Environmental Services. *Best Management Practices to Control Nonpoint Source Pollution: A Guide for Citizens and Town Officials.* WD-03-42. January 2004.

New Hampshire Department of Environmental Services. *Low Impact Development and Stormwater Management.* Environmental Fact Sheet WD-WMB-17. 2010

New Hampshire Department of Environmental Services. *New Hampshire Stormwater Manual,* Volume 1 and Volume 2, 2008.

Price George's County, Maryland Department of Environmental Resources Programs and Planning Division. *Low-Impact Development: An Integrated Design Approach* . June 1999.

Riversides. *Toronto Homeowners' Guide to Rainfall.* http://www.riversides.org/rainguide.

Vermont Department of Conservation. *Vermont Low Impact Development Guide for Residential and Small Sites.* December 2010.

Appendix A
Native Plant List

Plants, shrubs, and trees used in vegetated stormwater management practices should be able to tolerate both flood and drought conditions and should be hardy enough to tolerate stormwater pollutants. Plants that are native to New Hampshire are best suited for these conditions and will prevent the introduction of exotic, invasive plants to the state. The plant species listed here are from the University of New Hampshire Cooperative Extension's 2007 publication titled, *Integrated Landscaping: Following Nature's Lead* and are suitable for stormwater treatment landscaping.

TREES

Black Gum - *Nyssa sylvatica*

Red Maple - *Acer rubrum*

Black Spruce - *Picea mariana*

River Birch - *Betula nigra*

Shadblow Serviceberry - *Amelanchier canadensis*

Pagoda Dogwood - *Cornus alternifolia*

SHRUBS/VINES

Sweet Gale - *Myrica gale*

Speckled Alder - *Alnus incaba subsp. rugosa*

Meadowsweet - *Spirea alba var. latifolia*

Steeplebush - *Spirea tomentosa*

Spicebush - *Lindera benzoin*

Silky Dogwood - *Cornus amomum*

Winterberry Holly (male) - *Ilex verticillata*

Black Chokeberry - *Aronia melanocarpa*

Red Chokeberry - *Aronia arbutifolia*

Red Sprite Winterberry Holly - *Ilex verticillata 'Red Sprite'*

Diablo Common Ninebark - *Physocarpus opulifolius 'Diable'*

Pinkshell Azalea - *Rhododendron vaseyi*

Swamp Rose - *Rosa palustris*

Inkberry - Ilex glabra

GROUNDCOVER/GRASSES

Creeping Phlox - *Phlox stolonifera*

Bunchberry - *Cornus canadensis*

Sheep Laurel - *Kalmia angustifolia*

False Hellebore - *Veratrum viride*

PERENNIALS

Blue Flag Iris - *Iris versicolor*

Cardinal Flower - *Lobelia cardinalis*

Joe Pye Weed - *Eupatorium macalatum*

Swamp Milkweed - *Ascelpias incarnate*

Bluebead lily - *Clintonia borealis*

Jack-in-the-Pulpit - *Arisaema triphyluum*

Whorled Aster - *Aster acumiatus*

Marsh Marigold - *Caltha palustris*

Turtlehead - *Cheloni lyonii*

Bottle gentian - *Gentiana clausa*

Blasing Star Gayfeather - *Liatris spicata*

New York Ironweed - *Veronia noveboracensis*

Appendix B
State and Federal Regulations to Protect Water Quality

The state of New Hampshire uses the following programs and permits to protect water quality:

ALTERATION OF TERRAIN LAWS protect surface waters, drinking water supplies and groundwater by controlling soil erosion and managing stormwater runoff from developed areas that propose to disturb 100,000 square feet of terrain (50,000 square feet if any portion of the project is within the protected shoreland) or, for smaller projects, the General Permit by Rule applies.

MORE INFORMATION:
(603)-271-3434 or http://des.nh.gov/organization/divisions/water/aot/index/htm

SHORELAND PROTECTION LAWS protects surface waters through the Shoreland Permit by managing the disturbance of shoreland areas to maintain naturally vegetated shoreland buffers that protect against the potentially harmful effects of stormwater runoff. It applies to all fourth order and greater streams, designated rivers, tidal waters, and lakes, ponds and impoundments over 10 acres in size.

MORE INFORMATION:
(603)-271-2147 or http://des.nh.gov/organizations/water/wetlands/cspa/index.htm

WETLANDS LAWS protect surface waters by requiring avoidance and minimization of potential impacts to state surface waters, banks of lakes, ponds, or rivers, and tidal or non-tidal wetlands.

MORE INFORMATION:
(603)-271-2147 or http://des.nh.gov/organizations/water/wetlands/index.htm

SECTION 401 WATER QUALITY CERTIFICATION protects water quality by making sure that the state water quality standards are met in nearby lakes, ponds, streams, rivers, and other surface waters, during and after construction of large projects, such as the development of a large subdivision, shopping center, or for wastewater discharges.

MORE INFORMATION:
(603)-271-8872 or http://des.nh.gov/organization/divisions/water/wmb/section401/index.htm

The United States Environmental Protection Agency (EPA) regulates stormwater under the Federal Clean Water Act. Specifically, the National Pollutant Discharge Elimination System Program uses the following "Phase II" permits to regulate stormwater.

MUNICIPAL SEPARATE STORM SEWER SYSTEM (MS4) GENERAL PERMIT protects water quality by making sure that discharges from municipal stormwater drainage systems meet minimum requirements.

MORE INFORMATION:
(603)-271-2984 or http://des.nh.gov/organization/divisions/water/stormwater/ms4.htm

MULTI-SECTOR GENERAL PERMIT protects water quality by making sure that discharges from industrial activities, such as material handling and storage, meet minimum requirements.

MORE INFORMATION:
(603)-271-2984 or http://des.nh.gov/organization/divisions/water/stormwater/industrial.htm

CONSTRUCTION GENERAL PERMIT protects water quality by making sure that discharges from construction activity that disturbs over 1 acre of land, meets minimum requirements.

MORE INFORMATION:
(603)-271-2984 or http://des.nh.gov/organization/divisions/water/stormwater/construction.htm

Appendix C

NH Residential Loading Model Instructions

The New Hampshire Department of Environmental Services has created a modeling tool for homeowners to estimate their nutrient footprint called *The New Hampshire Residential Loading Model* available for download on the DES website.

This model is based on the Center for Watershed Protection's Runoff Reduction Method. It is designed to estimate the loading of nutrients, specifically phosphorus and nitrogen, as well as sediment from your property. This model can be used in a number of ways including:

1. To calculate your phosphorus or nitrogen footprint, which is how much phosphorus or nitrogen your property contributes to the watershed in which you live.
2. To calculate the benefit of installing LID practices on your property.
3. To compare the pre- and post-development conditions of your property with or without the use of LID practices. For example, to estimate the impact that building a garage on your property would have on nutrient loading.
4. To determine if your property meets a targeted nutrient goal or nutrient reduction for your watershed.

Instructions for Using the Model

The step-by-step instructions below will guide you through the model. You will need Microsoft Excel 2002 or newer to use the model.

TIPS FOR NAVIGATING THE MODEL

ENTER WORKSHEETS IN ORDER: In order for the model to work correctly, the worksheet tabs at the bottom of the screen ("Site Conditions", "Existing BMPs", etc.) must be completed in order from left to right. Each worksheet contains instructions on how to enter information. You will find that by either hovering over, or clicking on, a given cell, instructions and hints will be displayed.

ENTER ONLY IN DATA INPUT CELLS: Throughout the spreadsheet only certain cells are "unlocked" and can be modified. You should only type values in the data input cells. It is suggested that you do not perform a copy & paste as you may mistakenly paste a formula.

KEY:	data input cells	read only cells
	0	0.00

SQUARE FEET to ACRE CONVERSION: Throughout the spreadsheet, "Square Feet" is the unit of area that must be entered (1 acre = 43, 560 square feet). The model has a conversion box to help you convert from square feet to acres or acres to square feet.

EXAMPLE:

QUICK CONVERSION:	square feet	acres
square feet to acres:	15,000	0.3444
	acres	square feet
acres to square feet:	0.5	21,780

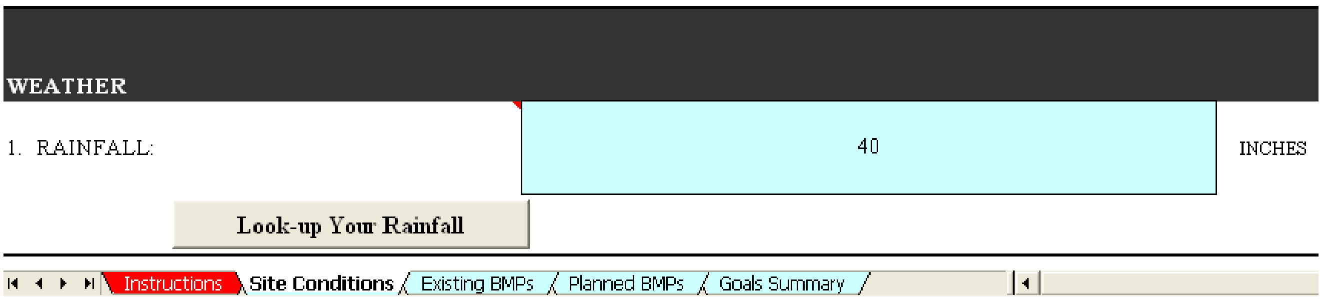
Instructions / Site Conditions / Existing BMPs / Planned BMPs / Goals Su

GENERAL INSTRUCTIONS

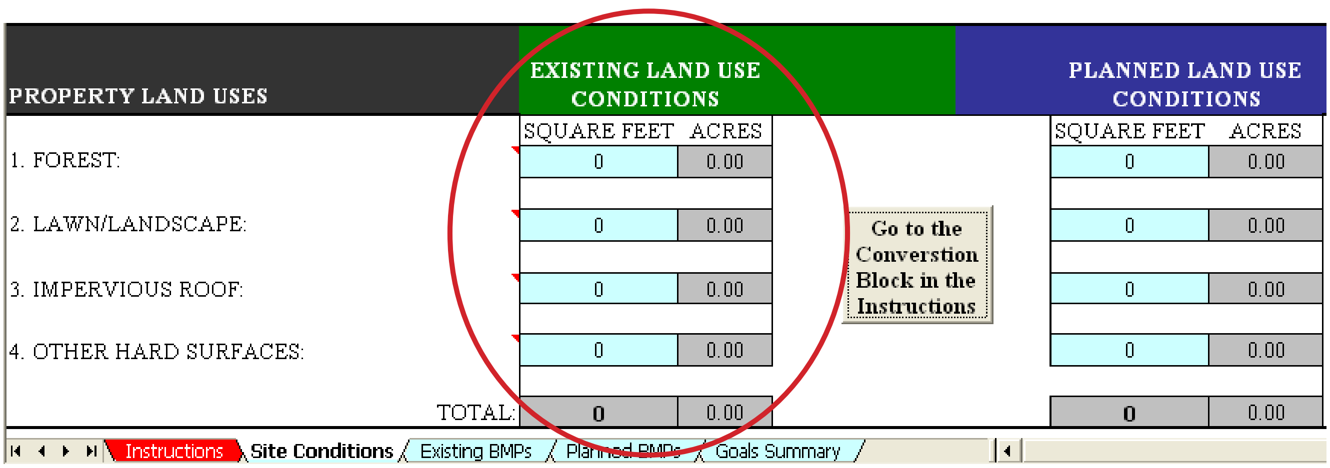
1. Open the spreadsheet and save under a new name.
2. **INSTRUCTIONS WORKSHEET:** Completely read through the instructions on the "Instructions" worksheet before working your way through the remainder of the worksheets. Worksheets should be completed in the following order:
    1. Instructions
    2. Site Conditions
    3. Pre Dev BMPs
    4. Post Dev BMPs
    5. Goal Summary

3. **SITE CONDITIONS WORKSHEET:** This worksheet gathers all of the basic information for your property. It asks you to estimate the annual average rainfall, land uses, and fertilizer usage for the existing condition (before land use changes) and an anticipated future condition (after land use changes). All of the "data input cells" should be populated even if many of the cells contain a zero (0). This information is automatically carried forward to the other worksheets. Follow steps a - d below to complete the worksheet.

   a. **Weather:** Enter the average annual rainfall in inches in the appropriate cell. Use the look-up link in the Site Conditions worksheet to find the weather station nearest your property and use that rainfall value.



   b. **Property Land Uses (Existing Land Use Conditions):** Enter the square footage of Forest, Lawn/Landscape, Impervious Roof, and Other Hard Surface areas that currently exist on your property into the appropriate cells in the "Existing Land Use Conditions" column. Find data in your town assessor's office, on-line, or by measuring them directly.



   c. **Property Land Uses (Planned Land Use Conditions):** Enter the square footage of Forest, Lawn/Landscape, Impervious Roof, and Other Hard Surface areas that you are proposing to change on your property in the appropriate cells in the "Planned Land Use Conditions" column.

   NOTE: If you are not proposing any changes to the land use conditions *of your property, simply enter the same square footage values from the "Existing Land Use Conditions" column into the corresponding cells in the "Planned Land Use Conditions" column.*

PROPERTY LAND USES	EXISTING LAND USE CONDITIONS			PLANNED LAND USE CONDITIONS	
	SQUARE FEET	ACRES		SQUARE FEET	ACRES
1. FOREST:	0	0.00		0	0.00
2. LAWN/LANDSCAPE:	0	0.00	Go to the Converstion Block in the Instructions	0	0.00
3. IMPERVIOUS ROOF:	0	0.00		0	0.00
4. OTHER HARD SURFACES:	0	0.00		0	0.00
TOTAL:	0	0.00		0	0.00

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d. **Fertilizer Use:** Enter the pounds per acre per year (lbs/ac/yr) of phosphorus and nitrogen fertilizers that you currently apply to your property in the "Existing Land Use Conditions" column. Enter the lbs/ac/yr of phosphorus and nitrogen fertilizers that you propose to apply to your property in the "Planned Land Use Conditions" column.

NOTE: The model uses default values for phosphorus (15 lbs/ac/yr) and nitrogen (150 lbs/ac/yr) automatically. If you know the amount of fertilizer you apply, replace the default values with the real application values. If you do not apply fertilizer and do not plan on using it in the future, replace these default values with zero (0).

FERTILIZER USE	EXISTING LAND USE CONDITIONS	PLANNED LAND USE CONDITIONS
PHOSPHORUS FERTILIZER USE (lbs/acre/year):	15	15
NITROGEN FERTILIZER USE (lbs/acre/year):	150	150

Help me calculate my application rate

Consider reducing your fertilizer use to help protect the health of New Hampshire's waters.

After you have entered values into all of the fields, the bottom of the worksheet will give you the Nutrient Runoff Concentration, Runoff Volume, and Runoff Nutrient Mass for the "Existing Land use Conditions" and "Planned Land Use Conditions".

NUTRIENT RUNOFF CONCENTRATION	EXISTING LAND USE CONDITIONS	PLANNED LAND USE CONDITIONS
TSS Event Mean Concentration (mg/L)	84.89	84.89
Phosphorus Event Mean Concentration (mg/L)	1.53	1.53
Nitrogen Event Mean Concentration (mg/L)	6.84	6.84

RUNOFF VOLUME	EXISTING LAND USE CONDITIONS	EXISTING LAND USE CONDITIONS WITH BMPS IN PLACE	PLANNED LAND USE CONDITIONS	PLANNED LAND USE CONDITIONS WITH BMPS IN PLACE
Treatable Stormwater Runoff Volume (cubic feet/year)	41,416	41,416	41,416	41,416

RUNOFF NUTRIENT MASS	EXISTING LAND USE CONDITIONS	EXISTING LAND USE CONDITIONS WITH BMPS IN PLACE	PLANNED LAND USE CONDITIONS	PLANNED LAND USE CONDITIONS WITH BMPS IN PLACE
"Total Suspended Solids (TSS) Footprint" (lbs/year)	219.49	219.49	219.49	219.49
"Phosphorus Footprint" (lbs/year)	3.95	3.95	3.95	3.95
"Nitrogen Footprint" (lbs/year)	17.69	17.69	17.69	17.69

Instructions / Site Conditions / Existing BMPs / Planned BMPs / Goals Summary

4. **EXISTING BMP WORKSHEET:** This worksheet gathers information on the BMPs that currently exist on your property. Not all of the data input cells in this worksheet need to be filled in because in some cases, there may be no existing BMPs. If your property has existing BMPs, follow steps a - c below to complete this worksheet.

   NOTE: If your property has no existing BMPs, skip to the "Planned BMPs" worksheet.

   Descriptions of the DIY practices listed in the model are included in this guide. Other BMPs included in the pick list are described in Volume 2 of the New Hampshire Stormwater Manual, available on the DES website at http://www.des.state.nh.us/organization/commissioner/pip/publications/wd/documents/wd-08-20b.pdf. Please note that all BMPs other than the do-it-yourself BMPs included in this guide are considered above the skill level of a typical homeowner and may require design and installation assistance from a professional.

PROPERTY STORMWATER EXISTING BMP CONDITIONS					
	BMP SET ONE	1. FOREST:	2. LAWN/LANDSCAPE:	3. IMPERVIOUS ROOF:	4. OTHER HARD SURFACES:
	Square Feet of landuse	87,120	39,204	2,000	2,000
	Acres of landuse	2.00	0.90	0.05	0.05
BMP SET ONE	BMP Applied? *(choose from the picklists)*		None	None	None
	Square Feet of landuse draining to BMP		0	0	0
	Acres of landuse draining to BMP		0.00	0.00	0.00
	Runoff Remaining for BMP in Series (Cubic feet/year)		*28,750*	*6,333*	*6,333*
	TSS Remaining for BMP in Series (lbs/year)		*143.58*	*7.51*	*68.40*
	TP Remaining for BMP in Series (lbs/year)		*3.69*	*0.04*	*0.22*
	TN Remaining for BMP in Series (lbs/year)		*16.27*	*0.59*	*0.83*
	Is there a second BMP applied downstream?		None	None	None
	BMP SET ONE TOTAL Runoff Reduction (Cubic feet/year)		**0**	**0**	**0**
	BMP SET ONE TOTAL TSS Reduction (lbs/year)		**0.00**	**0.00**	**0.00**
	BMP SET ONE TOTAL TP Reduction (lbs/year)		**0.00**	**0.00**	**0.00**
	BMP SET ONE TOTAL TN Reduction (lbs/year)		**0.00**	**0.00**	**0.00**

Instructions / Site Conditions / Existing BMPs / Planned BMPs / Goals Summary

a. **Determine Property Drainage Areas:** Determine the drainage areas on your property. Doing a sketch of your property is helpful to understand where runoff is coming from, how it flows across your property, and where it ends up. Your sketch should identify the roof, driveway, walkways and other impervious areas, lawn and landscaping, existing wooded areas, steep slopes, streams or ponds, the existing stormwater flow path, and any existing BMPs. See the **Getting Started** section on page 11 of this guide and the **Site Sketch Grid** on page 64 to help sketch your property.

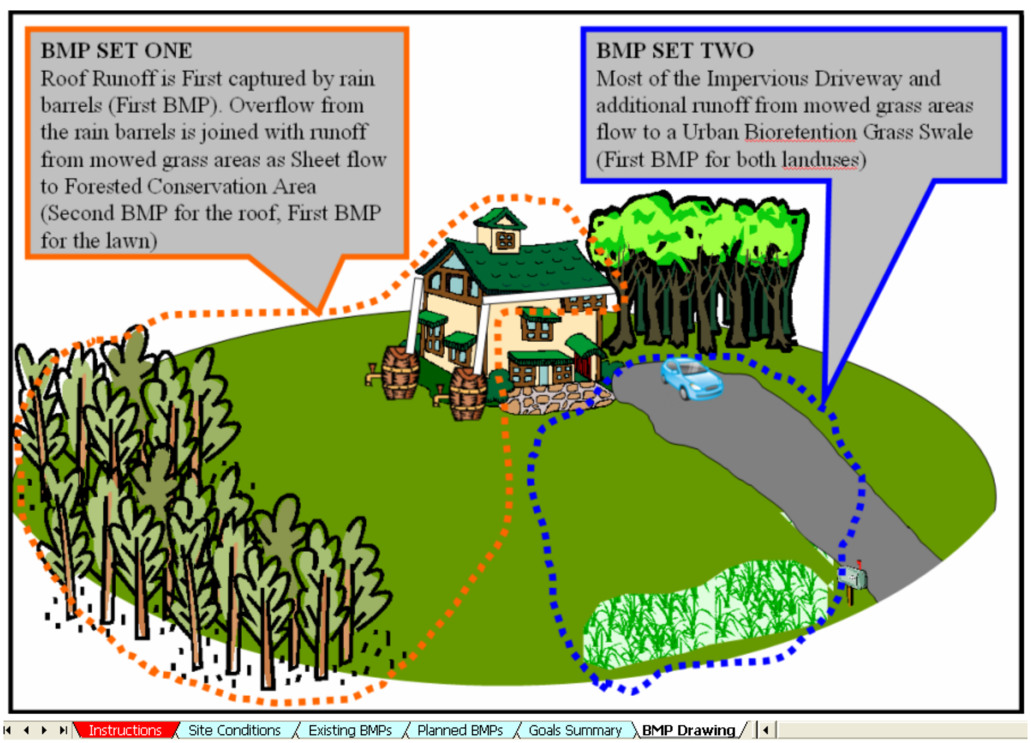
b. **BMP Sets:** This worksheet gives three blocks (BMP SETS) to model runoff for multiple drainage areas from each land use type (forest, lawn/ landscape/ impervious roof, other hard surfaces). If all of your roof runoff goes to a single BMP, you will only need to use BMP SET ONE to model the BMP for your roof runoff. If however, one side of your roof drains to one BMP and the other side drains to another, you should enter one roof side in BMP SET ONE and the other roof side into BMP SET TWO.

For each set, use the pick list in the row title "BMP Applied?" to select a BMP for each land use category (Forest, Lawn/Landscape, Impervious Roof, Other Hard Surfaces) that most accurately reflects the stormwater, management on your property. In the cell immediately below the BMP applied, enter the square footage of your property that is directed to that BMP for each land use. If there is no BMP for a particular land use, select "None" from the BMP pick list.

c. **BMPs In Series:** Do you have two or more BMPs in a row? If for example, you have roof runoff going to a "Rain Barrel" and any overflow goes to a "Rain Garden" you can model that "BMP in Series" by entering it as a "Second BMP applied downstream" within a single 'BMP SET'.

For each land use with a BMP in series, use the pick list in the row titled "Is there a second BMP applied downstream?" to select a BMP that most accurately reflects the stormwater management on your property. In the cell immediately below the BMP applied, enter the square footage of your property that is direc ted to that BMP for each land use.

NOTE: The cartoon drawing may help visualize the concepts of BMP sets and BMPs in series.



5. **PLANNED BMP WORKSHEET:** This worksheet gathers information on future BMPs that you plan on installing on your property. Not all of the "data input cells" in this worksheet need to be filled in because in some cases, there may be no additional BMPs planned. If you are planning additional BMPs for your property, go to step 4 above and follow a - c for the planning condition to complete this worksheet.

   NOTE: If you plan on keeping the existing BMPs that you entered in the "Existing BMP" worksheet, they will need to be re-entered into the "Planned BMP" worksheet to be accounted for in the future condition.

PROPERTY STORMWATER PLANNED BMP CONDITIONS

BMP SET ONE

BMP SET ONE	1. FOREST:	2. LAWN/LANDSCAPE:	3. IMPERVIOUS ROOF:	4. OTHER HARD SURFACES:
Square Feet of landuse	87,120	39,204	2,000	2,000
Acres of landuse	2.00	0.90	0.05	0.05
BMP Applied? *(choose from the picklists)*		None	None	None
Square Feet of landuse draining to BMP		0	0	0
Acres of landuse draining to BMP		0.00	0.00	0.00
Runoff Remaining for BMP in Series (Cubic feet/year)		*28,750*	*6,333*	*6,333*
TSS Remaining for BMP in Series (lbs/year)		*143.58*	*7.51*	*68.40*
TP Remaining for BMP in Series (lbs/year)		*3.69*	*0.04*	*0.22*
TN Remaining for BMP in Series (lbs/year)		*16.27*	*0.59*	*0.83*
Is there a second BMP applied downstream?		None	None	None
BMP SET ONE TOTAL Runoff Reduction (Cubic feet/year)		**0**	**0**	**0**
BMP SET ONE TOTAL TSS Reduction (lbs/year)		**0.00**	**0.00**	**0.00**
BMP SET ONE TOTAL TP Reduction (lbs/year)		**0.00**	**0.00**	**0.00**
BMP SET ONE TOTAL TN Reduction (lbs/year)		**0.00**	**0.00**	**0.00**

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6. **GOALS SUMMARY WORKSHEET:** This worksheet summarizes the change in runoff volumes and nutrient loading (footprint) between your property with existing BMPs and your property with planned BMPs. Three scenario options are provided. To complete this worksheet, follow steps a - c below.

   NOTE: You can model all of the parameters (runoff volume, total suspended solids, phosphorus, and nitrogen) using the same option, or you can model different option for each parameter.

   a. **Existing vs. Planned development option**: This is the default option. It is set up to show a comparison between the existing BMPs and pollutant loading and the planned BMPs and pollutant loading on your property The goal of this option is to have no increase in pollutant loading so that the planned pollutant loading be less than or equal to the existing pollutant loading.

      To set up the worksheet for this option, verify that "Yes" is selected in the data entry cells under the "Standard Existing-Planned Comparison" column for the parameters you wish to model under this option.

   b. **Percent reduction option:** If you want to see if your property meets a specific nutrient reduction (for example to reduce phosphorus loading by 10%), select "No" in the data entry cells under the "Standard Existing-Planned Comparison" column for the parameters you wish to model under this option.

      In the "Percent Reduction Needed" column, enter the percent reduction you are trying to achieve for runoff volume and each parameter being modeled in the appropriate cells.

   c. **Targeted footprint option:** If you want to see if your property meets a specific targeted footprint (for example X pounds of phosphorus per year), select "No" in the data entry cells under the "Standard Existing-Planned Comparison" column for the parameters you wish to model under this option.

      In the "Targeted Footprint" column, enter the target you are trying to achieve for each parameter being modeled in the appropriate cells. Notice the units of each parameter before entering.

RESULTS: Once you fill in the applicable data entry cells, the numeric results for your property are shown for each parameter in the "Existing Land Use Conditions" and "Planned Land Use Conditions" columns.

The column in between gives a message to tell you whether or not you have met your goal. If you have met your goal, congratulations! If you have not met your goal, you can go back to the "Site Conditions" and "Planned BMPs" worksheets and make adjustments to the number or type of BMPs being planned.

NOTE: Creating and modeling alternative scenarios can be done quickly by re-saving the file under a new name, and then modifying your input variables in the data entry cells.

RUNOFF VOLUME	Standard Existing-Planned Comparison	Percent Reduction Needed *(a value here overrides the 'Standard existing-planned comparison')*	Targeted Footprint cubic feet/acre/year *(a value here overrides 'Percent reduction needed')*	EXISTING LANDUSE CONDITIONS (includes BMPS if in place) (cubic feet/year)		PLANNED LANDUSE CONDITIONS (includes BMPs if in place) (cubic feet/year)	PLANNED LANDUSE CONDITIONS (includes BMPs if in place) (cubic feet/acre/year)
This is the annual treatable volume of stormwater runoff from your property. - For the existing condition, it is the volume of runoff from the un-developed portion that is to be developed and any existing developed portions of the lot. - For the planned condition it is the runoff from the developed portion of the lot.	YES			41,416	Congratulations, you reduced your Runoff Volume by 97% or 40208 cubic feet per year below your existing land use conditions Runoff Volume.	1,208	1,218

RUNOFF NUTRIENT MASS	Standard Existing-Planned Comparison	Percent Reduction Needed *(a value here overrides the 'Standard existing-planned comparison')*	Targeted Footprint lbs/acre/year *(a value here overrides 'Percent reduction needed')*	EXISTING LANDUSE CONDITIONS (includes BMPS if in place) (lbs/year)		PLANNED LANDUSE CONDITIONS (includes BMPs if in place) (lbs/year)	PLANNED LANDUSE CONDITIONS (includes BMPs if in place) (lbs/acre/year)
"Total Suspended Solids (TSS) Footprint" - This is the annual mass of Total Suspended Solids (TSS) in stormwater runoff for your property.	NO	25%		219.49	Congratulations, you reduced your Total Suspended Solids (TSS) Footprint by 96%. Your precent reduction in Total Suspended Solids (TSS) Footprint from your site has exceeded the target by 154.97 pounds of TSS per year.	9.65	9.73
"Phosphorus Footprint" - This is the annual mass of phosphorus in stormwater runoff for your property.	YES			3.95	Congratulations, you reduced your Phosphorus Footprint by 69% or 2.72 pounds of TP per year below your existing land use conditions Phosphorus Footprint.	1.23	1.24
"Nitrogen Footprint" - This is the annual mass of nitrogen in stormwater runoff for your property.	NO		10	17.69	Congratulations, you reduced your Nitrogen Footprint by 70%. Your targeted reduction for Nitrogen Footprint from your site was exceeded by 4.56 pounds of TN per year.	5.36	5.41

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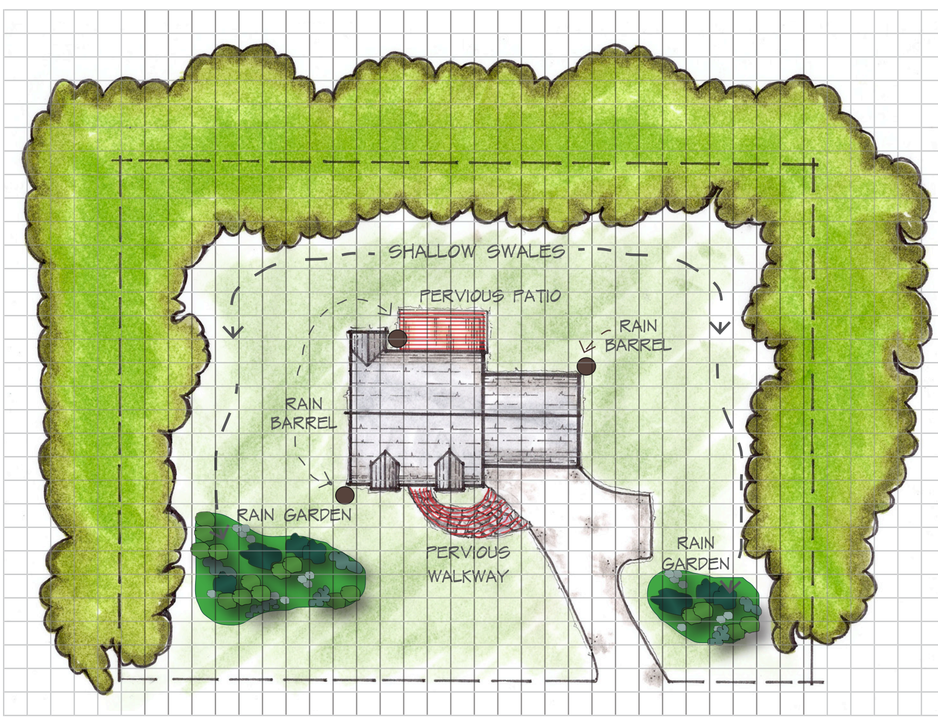
Appendix D

Site Sketch Grid

Use the grid on the following page to sketch your property and identify the property features listed below for the existing and the planned conditions.

- Impervious Roof
- Other Hard Surfaces (including driveways, walkways, decks, and patios)
- Lawn and Landscaped Areas
- Forest or other Undisturbed Areas
- Drainage Patterns (the way the water flows on your property)
- Best Management Practices (BMPs)

Approximations: For a 1/2 acre lot: 1 square = 5 ft. x 5 ft. (25 sq. ft.)
For a 1 acre lot: 1 square = 7 ft. x 7 ft. (50 sq. ft)
For a 2 acre lot: 1 square = 10 ft. x 10 ft. (100 sq. ft)



Example future conditions site sketch.

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