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Rain Gardens: Improve Stormwater Management in Your Yard

Stormwater refers to rain and melted snow and ice. Stormwater runoff from your roof, driveway and other hard surfaces in your yard is typically directed towards the street and into the municipal storm sewer system. This stormwater runoff, which has picked up harmful substances such as road salt, heavy metals and oils, ends up in streams, lakes or other water bodies, where it can harm water quality and aquatic habitat. Meanwhile, water used for lawns and gardens is drawn from the local drinking water supply.

There are several ways that you can reduce runoff and better use stormwater in your yard while ensuring proper drainage. One relatively easy and attractive method is a rain garden (see Figure 1).

A rain garden is a planted or stone-covered bed specifically designed to receive stormwater and allow it to be slowly absorbed into the soil (infiltration). This *About Your House* provides information on designing and building a rain garden, as well as tips for improving stormwater management in your yard.

LET NATURE INSPIRE YOU

In the natural hydrologic cycle, stormwater slowly infiltrates into the soil. There, it is naturally filtered and cleansed of some pollutants, is used by plants and replenishes the water table. Stormwater also falls directly into water bodies or gradually reaches them over land or through the shallow water table (see Figure 2).

In contrast, stormwater runoff in settled areas usually flows quickly from hard surfaces, such as roofs and driveways, into sewers that eventually empty into water bodies. The increased volume and frequency of high flows can cause erosion and related sedimentation

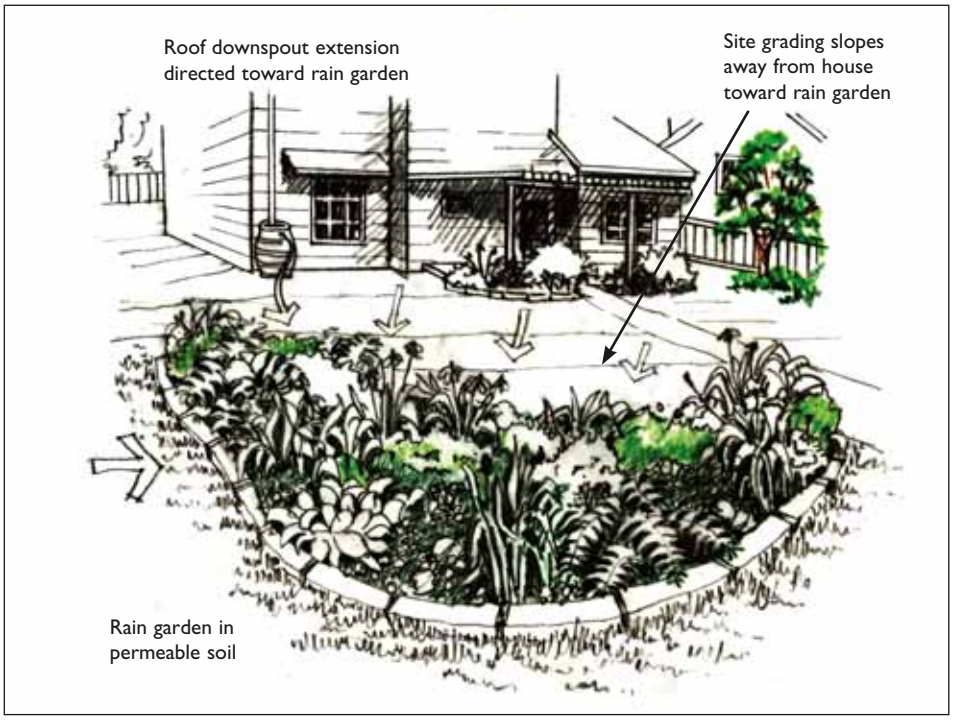

Figure 1 Rain garden

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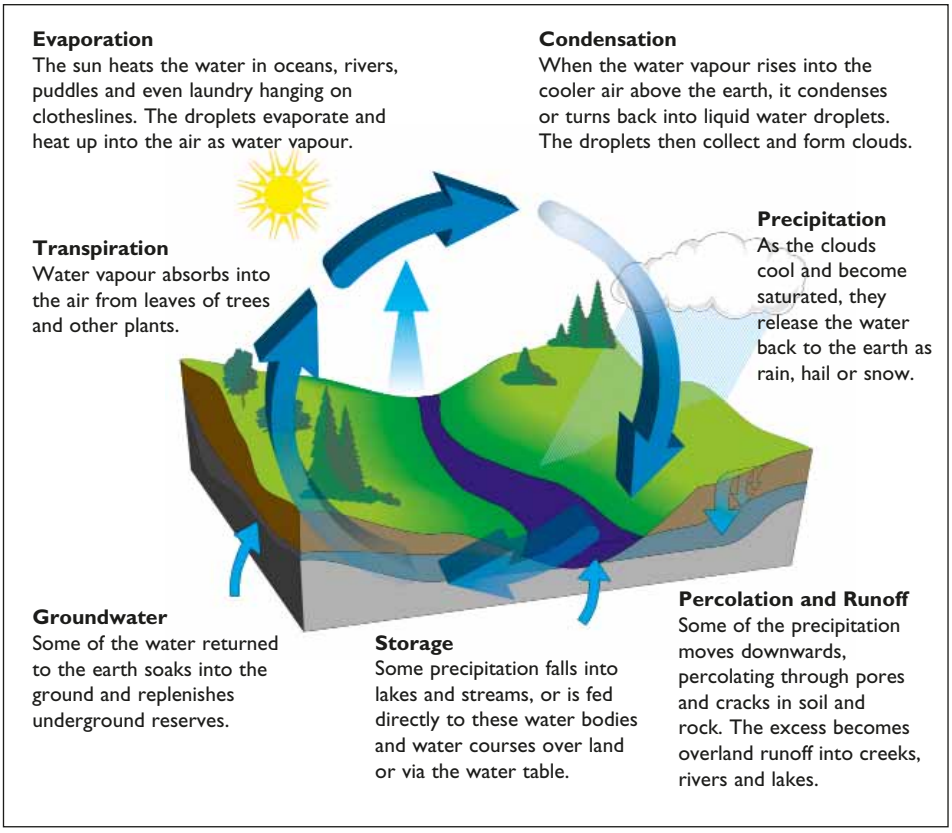

Figure 2 Hydrologic cycle

in receiving lakes and rivers. Along the way, the water also picks up polluting substances, such as de-icing salt, grease, oil, animal wastes, excess sediments, pesticides and fertilizers. In areas with combined storm and sanitary sewers, the system can sometimes become overloaded, so that untreated sanitary sewage overflows into natural water bodies. All of these factors can harm water quality, habitat for aquatic species and the stability of shorelines and riverbanks. They also increase municipal costs to convey and treat stormwater.

There is a growing trend towards designing municipal stormwater systems to work with natural processes. These systems involve the use of wetlands and other methods that allow water to soak into the ground, filter pollutants and slow the flow of water before it enters water bodies.

Rain gardens are one way that you can reduce runoff and let stormwater soak slowly into the ground in your home landscape, just as it does in nature. Rain gardens are shallow depressions or low-lying areas that are designed to capture and absorb stormwater fairly quickly and dry out between rainfalls. When planted, they can also provide habitat for birds, butterflies and other fauna.

STEPS IN DESIGNING A RAIN GARDEN

Rain gardens are relatively easy and inexpensive to design and build, but there are a few considerations to ensure that they function effectively. The two most critical technical considerations are:

1. Water must infiltrate and not stand in the bed for more than two days.
2. Water should not create drainage problems on your property or neighbouring ones.

Beyond that, rain gardens can be naturalistic or more manicured, can include a variety of plants, and can be in various shapes.

Find a suitable location

Observe the drainage area and paths along which stormwater naturally runs in your yard. Place the rain garden at a low point or at a location somewhere along the natural flow path. If your yard is relatively flat and evenly drained, you can create a depression anywhere, following the guidelines below.

To ensure that water will not simply run over the lower edge, rain gardens need to be as level as possible. If possible, avoid slopes

greater than 12 per cent, as they will make it more difficult to create a level garden. If you have no other choice, you can cut and fill a steeper area, as described in the "How to Install a Rain Garden" section on page 6, but you will need to ensure that the sides are adequately stabilized.

To avoid creating moisture problems, you will need to direct stormwater away from vulnerable areas, such as your house foundation, septic beds or neighbouring homes. Place your rain garden at least 4 m (13 ft.) away from such areas. Also avoid placing rain gardens over underground utility pipes or wires.

Rain gardens do not work well on clay soil because drainage in clay is slow. Look for a spot with soil that is sandy, gravelly, loam or a mix that can include up to 10 per cent clay. If your soil has a higher clay percentage, you can add sand, fine gravel and/or organic matter to improve permeability.

Drain water away from your house

Ensure that stormwater is directed away from your house foundation. Follow the tips in Chapter 4 of CMHC's *Landscape Guide for Canadian Homes*. The Guide also describes drainage considerations around your main activity areas and neighbouring properties.

How to measure a slope

Slope is the ratio of the length of the rise (the vertical change) to the length of the run (the horizontal change). Here is a simple way to measure slope:

- Place a carpenter's level on a 2x4 wooden board situated on the ground along the slope you want to measure and lift the lower end until the board is level (see Figure 3).
- To determine the rise, measure the distance from the ground to the bottom edge of the board at the end of the slope.
- The run is the length of the board from the end to where you measured the rise.
- Divide the rise by the run to obtain the per cent of the slope. For example, if the rise is 5 cm and the run is 2.5 m, the slope is 0.05 m ÷ 2.5 m = 2%.

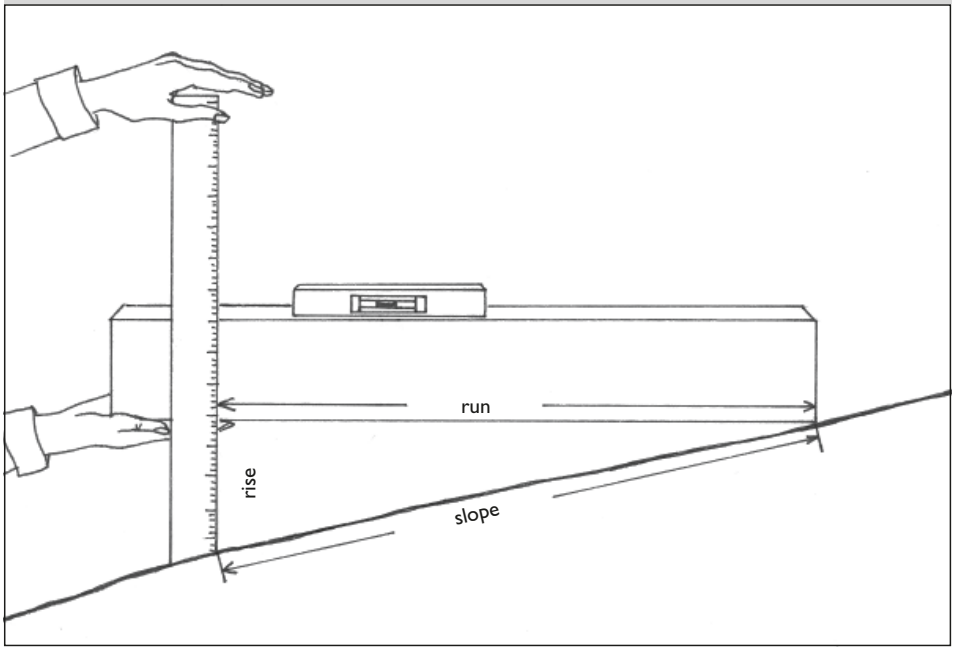

Figure 3 How to measure a slope

Compacted soils are also relatively impermeable, so you will need to loosen them before building a rain garden. Ensure that the soil is permeable to a depth of between 0.6–1.2 m (2–4 ft.) below the rain garden. Refer to *Get to Know Your Soil* in CMHC's *About Your House* series for tips on analyzing and amending your soil.

The surface of the depression should be at least 1 m (3 ft. 3 in.) above the seasonally high shallow groundwater table. To determine where the shallow water table is, in dry weather dig a small test pit and see if it fills with water. Or, you can ask if your municipality has information about your neighbourhood's shallow water

table. If the shallow water table is close to the surface, find a location on higher ground or abandon the idea of a rain garden.

Along with catching water from other areas in your yard, rain gardens are often designed to capture roof runoff via a downspout extension, a swale or an underground pipe. If you want your rain garden to capture roof runoff, look for a convenient location.

Locating your rain garden in full sun or partial shade will let you choose the widest selection of plants. You can consider a shady area if you select plants that are tolerant of shade. If your preferred location has trees that can tolerate occasional flooding, a woodland rain garden is an option.

An existing depression in your yard could function as a natural rain garden. If needed, you can make some enhancements, such as replanting with suitable plants or adjusting depth or size so it can hold more water. If the depression tends to hold water for more than two days, you will also need to improve the soil's drainage capacity as discussed above, or find another location with better drainage.

Determine depth and size

Determining the ideal depth and size for a rain garden is not an exact science, and various authors suggest different methods. Your rain garden will likely function well if you make a reasonably accurate estimate of the two most critical factors—the amount of stormwater that will be captured (inflow) and how quickly it will be absorbed. The depth and sizing method described below is based on these two factors.

The depression will need to be shallow enough to ensure that water will not stand for more than two days, but deep enough to hold the anticipated amount of water. A general guideline for depth is 7.5 cm (3 in.) in soils with relatively low infiltration rates (for example, loam) and up to 15 cm (6 in.) in soils with high infiltration rates (for example, sandy or gravelly soils). To ensure that there is adequate space in shallower depressions, the size of the garden will be adjusted for various soils, as discussed below.

To determine the size, follow these three steps.

1. Determine inflow

i. Estimate the area in square metres of the section of your roof that will drain into the downspout, plus the area in square metres of other hard surfaces, such as driveways or patios, that will drain into the rain garden. Next, estimate the area of lawn that will drain into the garden and multiply that figure by 20 per cent.[1] The size of the roof area plus other hard surface areas plus 20 per cent of the lawn area draining into the rain garden is the total drainage area (in square metres). For example, the total drainage area might be 170 m^2.

ii. Estimate the amount of precipitation that will flow into your rain garden over a 24-hour period. Some municipalities set rainfall capture targets, so check with your municipality's public works department. If there isn't a municipal target, set your own based on average local precipitation. Your municipality may have precipitation data for your region; if it doesn't, this information can be obtained from Environment Canada. An example of a target is 25 mm over 24 hours. Targets will vary from region to region and can be as low as 5 mm over 24 hours.

iii. Multiply the drainage area in square metres (Step i) times the rainfall capture target in metres (Step ii). For example, a rain garden that will capture 25 mm of rain over 24 hours from 170 m^2 of drainage area must hold 170 m^2 x 0.025 m = 4.25 m^3 of water over 24 hours.

[1] Note that if your lawn is well aerated it will absorb almost all stormwater. Nevertheless, even a well-aerated lawn is not likely to absorb all water from an average to heavy rainfall.

Soil infiltration rate

Knowing the permeability of your soil is essential when installing a rain garden. Sandy soils are highly permeable with a minimum water absorption rate of 210 mm per hour. The minimum absorption rate for sandy loam is 25 mm per hour. For loam, the minimum absorption rate is 15 mm per hour. In clay soils, absorption rates can be as low as 1 mm per hour. You can test the permeability of your soil by digging a small test pit, filling it with a known quantity of water and observing the time it takes for the water to be absorbed.

2. Determine the infiltration rate of your soil

For example, if the rate is 15 mm per hour, it will absorb 360 mm of water over 24 hours. Convert the figure to metres (in this case, 0.36 m). See text box above.

3. Calculate the area

Divide the estimated inflow (Step 1) by the infiltration rate (Step 2). Using the example above, the rain garden would need an area of $4.25\ m^3 \div 0.36\ m = 11.8\ m^2$.

Rain gardens are designed for average annual precipitation levels. Occasionally, there will be a heavy rainfall and, less often—once every 25 to 100 years—an extremely heavy rainfall. Occasional overflow of your rain garden will most often be accommodated by your own yard and the municipal storm system. If there is any possibility that overflow could cause drainage problems in neighbouring areas, include an overflow system. This can be as simple as an in-ground perforated pipe or shallow swale that is directed towards a less vulnerable area, or an area that drains into the municipal storm system. You can also reduce the frequency of overflow by slightly increasing the size of the rain garden or the depth of permeable soil, or both.

Although following the steps for sizing will give you the optimum size, you can change the size to better suit your yard, your budget or maintenance. You can reduce the size by increasing the depth of permeable soil, decreasing the area that contributes to inflow, or creating more than one rain garden.

Determine the shape

To capture as much stormwater as possible, a rain garden should be at least 1.5 times longer than it is wide (length is defined here as the face at a right angle to the slope). The 11.8 m^2 rain garden in the example above should measure approximately 4.2 m x 2.8 m. Again, if site conditions do not allow for the optimum size, you can adjust as needed.

Many people prefer the appearance of soft, round edges to hard, square edges, and kidney or oval shapes, but you can create any shape that suits your taste and your yard.

Select plants and stones

Select perennials, shrubs, grasses or ferns, or all, that can tolerate both wet and dry conditions. Choose plants that are adapted to your region and your specific soil and sunlight conditions. Native plants are well adapted to local conditions and are therefore generally preferred for rain gardens. Non-native plants can also be used, but avoid invasive species (see "References and Resources" on page 8).

For an attractive garden that will bloom for much of the season, also bear in mind plant heights, colour and bloom time. See the plant list in CMHC's *Landscape Guide for Canadian Homes* for help choosing plants.

You can install herbaceous plants (species that are not woody), like perennials, as plugs, potted plants or seeds. Plugs or potted plants will create an instant garden and are easier to grow and more predictable than seeds. Seeds don't cost as much, but it can take up to three years for the garden to fully fill in. A seed mix can be customized for your conditions, or you can use a shoreline or wet-dry meadow/prairie mix if your local native seed supplier offers it. You can plant shrubs from pots, as bare root seedlings and, in some cases, as cuttings.

Photo by: Glen Pleasance

Figure 4 This dry riverbed rain garden is covered with river stone and the sides are covered with woodchip mulch, tall grasses, perennials and shrubs.

Or, you can line the bottom of the rain garden with loose, hard materials, such as pebbles or river stone. A stone-lined rain garden will mimic a stony stream bed, adding a unique feature to your yard (see Figures 4 and 5). You can also include plants in a stone-lined rain garden. To add esthetic appeal, edge the pond with materials such as brick or stone. You can also add a focal element, such as a large rock or a sculpture.

HOW TO INSTALL A RAIN GARDEN

The best time to build a rain garden if you are working with plugs or potted plants is mid-spring, after the thaw, when the soil is most likely to be moist and fairly easy to dig. Plants will benefit from spring rains. Although you can build a rain garden in summer, you may need to water the plants far more often until they are established.

If you are seeding the bed, the best time to install your rain garden is mid-spring or late fall. Seeding in late fall allows the natural, freeze-thaw cycles to work. They help many native seeds germinate without pre-treatment. Ask your seed supplier if any pre-treatment of native seed is required for spring sowing. Shrubs can be planted in either spring or fall, depending on the species.

Begin by laying out the shape and size of the bed with a rope or garden hose. Remove existing lawn with a sod cutter, garden spade or edging tool, being sure to remove all pieces of root. If you have enough lead time, you can smother grass or other plants with heavy black plastic anchored down with rocks and left on for at least two months during the previous growing season. Remove the plastic before digging the bed.

Call before you dig

Before digging any test pits or depressions in your yard, locate buried wires and pipes. Call your local service providers for assistance.

Dig the bed to the required depth, as described earlier in the "Determine depth and size" section. Remove any remaining roots of former plants or lawn. If you need to improve the drainage of the soil beneath the surface, continue to dig and add other amendments, such as sand, fine gravel or organic matter, to a depth of 0.6–1.2 m (2–4 ft.). A small backhoe can be helpful if you need to dig beneath the surface. To help the new plantings establish themselves, add compost and work it into the top few inches of soil.

If you dig into a slight slope, use a carpenter's level to help you keep the bed level. Soil from the higher side of the slope can be used as fill for the lower side. On a slope, you will also need to build a low berm along the lower side of the slope edge to retain the water (see Figure 5). The berm can be constructed with soil that you removed from the upper side and covered with a variety of plants or lawn. Gently slope both sides of the berm and compact it by stomping on it. Sod, seed or plant the berm immediately and temporarily cover with a straw mat or straw mulch to prevent erosion.

If needed, dig and install an overflow pipe or swale on the lower side of the garden. You can place your downspout extension in the garden. To prevent erosion in the garden, place a small bed of pea gravel or decorative pebbles, or a concrete splash pad, under the extension (see Figure 6). Or, the downspout can discharge onto a lawn area that drains into the rain garden.

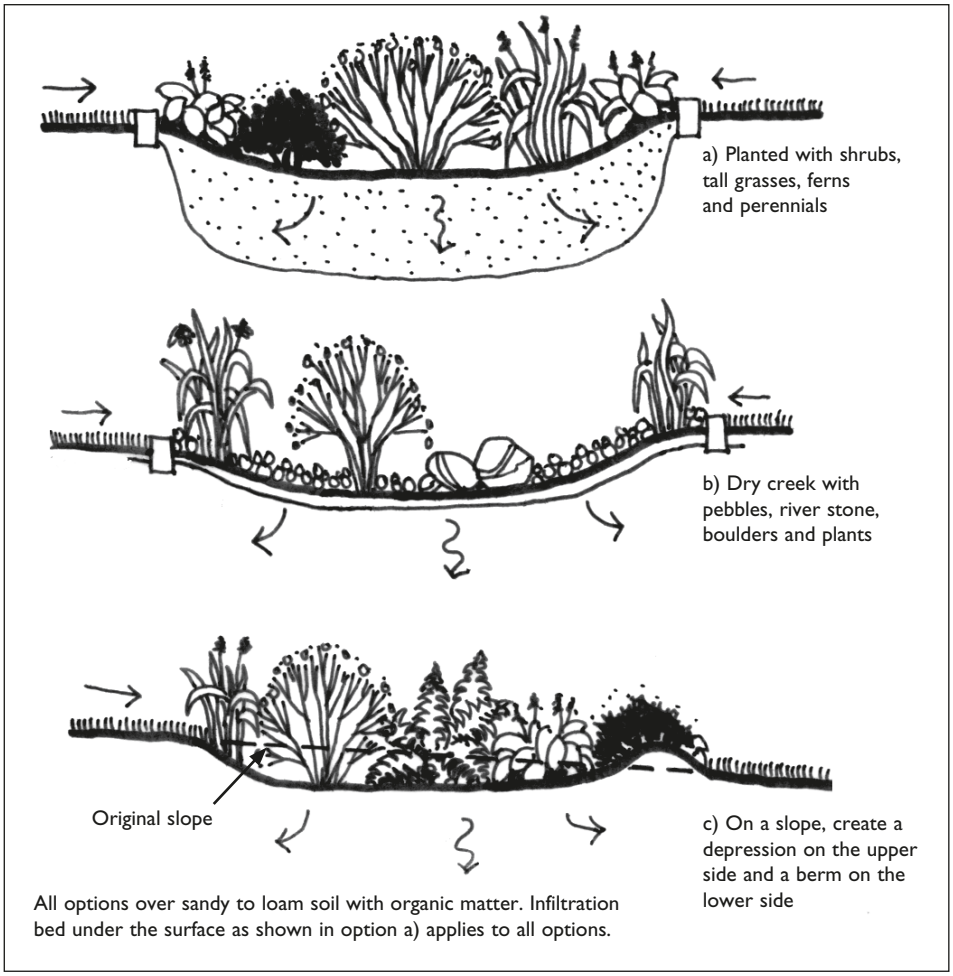

Figure 5 Rain garden variations

Rake the bed so that it is fairly smooth. Use standard planting or seeding methods. See CMHC's *Landscape Guide for Canadian Homes* for advice and tips.

If you are covering with stone, place a layer of filter fabric on the surface, then place the stone. To plant among the stones, slit the fabric.

HOW TO MAINTAIN A RAIN GARDEN

Keep the soil moist during the first growing season. If there is little or no rain, you will need to water with a one-hour trickle at least once a week for the first three weeks. Subsequently, water during hot, dry weather. Plants grown from fall seeding will also need to be watered in drought conditions the following season. If you have selected plants that are suited to the soil and

Figure 6 You can run a roof downspout extension directly into your rain garden. To prevent erosion, install a small bed of pebbles or a concrete splash pad under the end of the extension.

moisture conditions, plants in the rain garden should not need to be watered once they are established.

For the first two or three years, you will need to remove weeds regularly. Some desirable native plants may migrate to the site, so try to identify the species before you remove them. You can hand-pull weeds, being careful not to disturb new plantings. Pull weeds when they are immature, before they go to seed. Weeds are easier to pull when the soil is moist. Once the garden has filled in and a root mass has formed, you won't have to weed as often.

Once the rain garden is established, you can occasionally add compost. Plants that are adapted to sandy or gravelly soil tend to prefer nutrient-poor conditions, so compost should be added only if it appears necessary. To control insects and disease, it is best to use low-impact manual or non-synthetic controls whenever possible. For more information on maintenance, refer to "References and Resources" or to CMHC's *Landscape Guide for Canadian Homes*.

Aerate the soil occasionally to ensure it does not become compacted. If over time you find that water is standing in the bed too long, the easiest solution is to make the garden larger or create a second rain garden to catch some of the water. You can also make the depression deeper or further amend soils to improve permeability, but both of these options will require removing and transplanting plants.

Once established, your rain garden should provide many years of enjoyment with little maintenance. You can derive added satisfaction from knowing you are contributing to a healthier natural environment.

REFERENCES AND RESOURCES

Books and articles

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Minimize impermeable surfaces

Minimizing the amount of impermeable surface area on your property is another way to reduce stormwater runoff and allow water to soak into the ground. You can start by limiting the number and size of hard surfaces to only those needed for your household's regular activities (see Figure 7). You can also combine various uses on hard surfaces. For example, a driveway or patio can double as a footpath.

You can also use porous paving materials that allow infiltration. Where possible, use loose materials, such as decorative pebbles or crushed brick. Where you need a firmer surface, consider using precast concrete pavers with wide gaps. They are designed specifically for stormwater infiltration. Also fill gaps between patio stones or pavers with sand or fine gravel instead of concrete. On driveways, you can install two strips of paving spaced for the wheels of your car or other vehicles, and plant grass or a low groundcover in the spaces between the strips.

Figure 7 To reduce runoff and beautify the property, the homeowners reduced the size of their driveway by more than 60 per cent by replacing it with plantings. They changed the material on the remaining driveway from asphalt to precast concrete pavers.

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Websites

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Canadian Food Inspection Agency—Invasive Species
http://www.inspection.gc.ca/english/plaveg/invenv/invenve.shtml

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Printed in Canada
Produced by CMHC 20-05-11
Revised 2005, 2011

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