CITY OF VICTORIA STORMWATER UTILITY

Rainwater Management Standards

Do-It-Yourself for Your Home

JUNE 2015

CITY OF VICTORIA

FOR MORE INFORMATION:

City of Victoria
Public Works and Engineering Department

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Contents

Disclaimer:

If you are intending to undertake work on your own, it is recommended that you read through all relevant sections within the DIY Rainwater Management Standards before deciding to move forward. These standards have been developed for relatively simple rainwater management projects and for homeowners who have sufficient skills to do the work themselves, however in many cases the City recommends or requires working with a professional.

This manual will be updated on a regular basis as standards and regulatory requirements change or evolve. Where bylaws, policies, codes, standards, and other documents are referred to within this manual, the most recent edition or amendment applies.

If you are reviewing a printed copy of this document, please check with the City to ensure it is the most current version.

Part 1: Rainwater Management Overview

Approximately 660 mm of rain falls in Victoria every year. In urban settings like Victoria, the natural water cycle is broken when rainwater hits roofs, streets, sidewalks, parking lots and other impervious surfaces.

Rainwater turns into stormwater runoff once it hits paved surfaces. It picks up pollutants, debris and grit. Runoff is also created from activities like washing cars or watering lawns.

The City's stormwater system collects this water through catch basins and drains. Underground pipes then carry it to the nearest body of water: a creek, an inlet or, in most cases, the ocean. Stormwater has a large impact on water quality, specifically along shorelines and within our harbour.

The stormwater system works to reduce flooding by moving stormwater away from properties and roadways. Large objects and debris are separated in the stormwater system and some of the oil and grit are filtered out. Generally, the quality of the stormwater that enters the system is the same quality that eventually flows into waterways. If the stormwater runoff is polluted it impacts the aquatic and near-shore habitat, environment, and users of that space.

Why Manage Rainwater?

Rainwater management helps to maintain or restore natural water cycles and use rainwater as the resource that it is. The goal is to use rain gardens, green roofs, bioswales and other similar rainwater management methods to slow and clean the rainwater, either capturing it for use in irrigation or within buildings in 'purple pipe' or grey-water systems, or slowly diffusing it back to the natural water table through infiltration into the soil.

By managing rainwater more sustainably, we will:

- Have cleaner water that is discharged to our harbour and beaches,
- Reduce the peaks of runoff that can stress and overwhelm the existing stormwater system and reducing runoff volumes for climate change resiliency,
- Expand residents' understanding of the local water cycle and their interactions with it.

Rainwater Management Planning Tool

A Rainwater Management Planning Tool has been developed to help property owners visualize what rainwater management methods may be a good fit for their property. This tool will provide information about sizing, approximate installation costs and the potential Rainwater Rewards available. The Tool also displays a property's approximate Stormwater Utility bill. Try it out: **victoria.ca/stormwater**.

Rainwater Rewards

As part of the Stormwater Utility, the City of Victoria has developed a rainwater management incentive program called Rainwater Rewards. For low density residential property owners (with 1–4 units), Rainwater Rewards have two parts: one-time rebates to assist with up-front costs, and smaller on-going credits reducing the property's annual stormwater bill.

The value of the incentives vary depending on the amount of rainwater treated and by the effectiveness of the management method. To be eligible for the Rainwater Rewards program, design of the rainwater management method must be approved prior to construction and be compliant with the standards outlined in this document.

For up-to-date details on the Rainwater Rewards program, and how to apply, please go to the City of Victoria website at **victoria.ca/stormwater**.

Rainwater Management Design Target

When developing the design standards for the rainwater management methods, a rainwater management target was identified: to manage 32 mm of rainfall in a 24-hour period. This means that 32 mm of rain on impervious surfaces must be captured and treated in order to meet the requirements of the City's Rainwater Rewards Program. This target is based guidance from Fisheries and Oceans Canada, to manage approximately 90% of Victoria's average annual rainfall.

How To Use This Document

The Rainwater Management Design Standards is a planning and design document that provides property owners, land developers, or their representatives with the information necessary to properly meet the requirements of the City of Victoria's Rainwater Rewards program.

These Rainwater Management Standards also provide guidance on selecting appropriate rainwater management methods for a site and designing the method so that it meets the City's rainwater management target and can be approved under the Rainwater Rewards program. See Appendix A - Rainwater Rewards Pre-Approval Guide for the information on what is required for approval. Checklists for each rainwater management method have also been developed to help achieve this, and are located in Appendix B.

This document is for low density residential homeowners (with four units or less) who wish to take a Do-It-Yourself (DIY) approach to constructing rainwater management methods. This document walks through the steps for planning, site assessment, design, construction and maintenance.

The following sections will assist you in determining if your property is appropriate for a DIY approach. Please carefully review Part 2, including Table 2 Site Feasibility for Rainwater Management Methods, Table 4, Checklist: Can This Project Be DIY; and Part 4 that outlines pre-approvals, inspections, and documentation required for approval under the Rainwater Rewards program.

The City of Victoria has prepared a separate Professional version of the Rainwater Management Standards for Qualified Designers and Professionals that allows for variation, where the DIY version does not. If a homeowner would like to deviate from these standards, they must hire a Qualified Designer or Professional to apply the *Rainwater Management Standards Professional Edition*.

Rainwater Rewards Process

The overall design process is shown below. These steps are the same, no matter who is doing the design.

Table 1: Rainwater Rewards Process	
Site Assessment	• Use the Site Assessment Checklist in Section 2.2. • Identify and measure impervious areas such as pavement and roof area. • Locate discharge points, roof leaders, building sump, storm drain connection, etc. VicMap and its Rainwater Management Planning Tool are a great place to start. • Review terrain for high and low points, direction of water flow. • Note any issues or hazards to be avoided, e.g. trees, unstable soils, steep slopes, bedrock, underground services (pipes or cables) or structures, or boggy areas.
Review the Site Selection Considerations	• Are there ground surface areas where runoff could be routed to methods for water quality treatment? • Can your terrain and landscape accommodate a rainwater management method? • Is there impervious surface that can be converted to permeable paving? Can additional roof or surface area discharge to it? • Is there space for a cistern (above or below ground) where roof water can be directed to it? Do you have a use for collected rainwater? • Could an infiltration chamber be located below yard or pavement where rain garden or swale on the surface cannot be accommodated?
Talk to the City	• Contact the City of Victoria Stormwater Specialist to review your rainwater management ideas and property layout, **stormwater@victoria.ca**; 250.361.0443. • Ask about: zoning restrictions, permitting, inspections, Rainwater Rewards.
Create a Rainwater Management Design for your Property	• Refer to Appendix A - Rainwater Rewards Pre-Approval Guide. • Select method(s) and location(s) for site. • Choose standard DIY design or a professional for design, see Table 4: Can this Project be DIY. • If DIY, create a design specific for your property based on the Rainwater Management Standards - Do-It-Yourself for Your Home. • If using a contractor, talk to them about construction constraints. • Notify home insurance company of plans and discuss any concerns. • Size method according to City of Victoria standards. • If not using standard design, Qualified Professional can develop site-specific design based on parameters in City of Victoria's Rainwater Management Standards Professional Edition.
Pre-Approval	• Submit design and completed steps from Appendix A: Rainwater Rewards Pre-Approval Guide to City and obtain all necessary permits and/or approvals prior to construction, including eligibility for the Rainwater Rewards Program.
Construction	• Refer to Appendix B: Installation Checklists. • Construct in accordance with requirements outlined in this document and construction best management practices. • Obtain city inspections/approvals as required. • Submit final documents for Rainwater Rewards approval.
Maintenance	Plan your regular maintenance, including: • landscaping maintenance; • cleaning of sumps; • vacuuming or pressure washing of pervious paving; • checking piping, valves or other parts if possible; and • checking for signs of failure during small rain events.
Rainwater Rewards	• Receive credit and rebate!

Introduction to Rainwater Management Methods

Rain Barrels and Cisterns

Rain barrels and cisterns can be used to collect rainwater for reuse. The larger the storage system is, the more water can be re-used and kept out of the stormwater system. The water collected is not safe for human consumption (non-potable), but can be used to water gardens and lawns or indoors in toilets. In Victoria, most of the rain falls in the spring and autumn, but watering needs are the highest in the summer. It is beneficial to have a larger storage capacity if the stored water is to be used for irrigation of landscape or garden areas.

- Rain Barrels: A rain barrel is a specialized container, connected to the downspout from a building that is designed to collect and store rainwater for reuse.
- Cisterns: Cisterns or holding tanks collect rainwater and have a larger storage capacity than rain barrels. They can be elevated above ground, placed at ground level or buried underground. Cisterns can be connected to an irrigation system or ‘purple pipe’ system for indoor use.

Infiltration Chambers

Infiltration chambers are underground tanks or chambers with permeable bottoms that are designed to slowly release water into the ground over time. They primarily act to slowly return rainwater to the natural water table. This water is not reused.

Rain Gardens

A rain garden is a shallow depression that uses soil and plants to manage runoff from hard areas such as roofs, parking lots and driveways. Rain gardens mimic nature by absorbing and filtering stormwater runoff. A rain garden fills up with water and forms a temporary “pond” of stormwater. It naturally filters out the pollutants in the stormwater as the water soaks down through the soil of the rain garden.

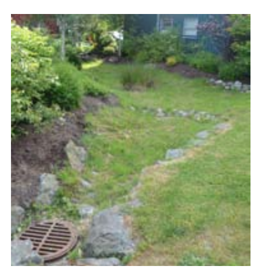
The plants and a layer of absorbent soil can hold and evaporate a significant amount of rainwater as well as allow the stored water to slowly seep into the ground. A rain garden can enhance the look of a home or business as it is a landscape feature as well as a rainwater management method.

Permeable Paving

Permeable paving is hard surfacing specifically designed to allow rain to flow through the surface and into the soil below. To increase the volume of runoff that can be directed to the pavers, they can be installed with a drainage pipe and rock reservoir underneath. Permeable paving can be used instead of standard asphalt and concrete for surfacing sidewalks, patios, driveways, or parking areas. It can add character to your site while maintaining access and durability for vehicles and foot traffic.

Bioswales

Bioswales must be designed and built by a professional. Bioswales are sloped channels that are designed to clean and slow the runoff coming from a roof or driveway. There are a number of different types of bioswales, including grassed channels, dry swales and wet swales. They all use absorbent soil and plants to absorb, filter and infiltrate runoff. As with rain gardens bioswale plantings often include native plants or plants that are drought resistant and can also handle large amounts of water. A bioswale helps to move stormwater from one area to another, while also slowing and cleaning the stormwater.



Images top to bottom: rain barrel, cistern, infiltration chamber, rain garden, permeable paving, bioswale




Part 2: Rainwater Management Planning and Site Selection

2.1: Planning for Rainwater Management

Selection of Rainwater Management Methods

As noted in Part 1, the Do-It-Yourself (DIY) rainwater management methods for low density residential properties currently accepted by the City for Rainwater Rewards Program include:

- Rain barrels;
- Cisterns;
- Rain gardens;
- Infiltration chambers;
- Permeable paving;

Bioswales can be considered, however they must be designed and installed by a professional.

This section discusses the uses of each of these types of rainwater management methods and gives information to help select the methods that could be appropriate and beneficial to a particular site.

Once the appropriate methods are selected and locations chosen for a site, detailed sizing and design information may be found in Part 3. It is possible that sizing requirements for specific methods will restrict their use on some sites. If this is the case for a selected method, you can return to the selection stage to choose another method. Alternately, a professional may be consulted to design an appropriate method or methods for the site.

Please note that all rainwater management methods must have an overflow connection to the municipal stormwater system. A backflow preventer may be required on the overflow pipe in accordance with the City's Plumbing Bylaw, when your rainwater management method is below the crown of the road

Rain Barrel Site and Selection Considerations

- Rain barrels are only approved for low density residential lots in the City of Victoria. Due to their limited impact, other sites may use them as educational installations but they will not qualify for rainwater management credit on their own.
- A typical residential rain barrel design includes an opening in the sealed lid to accept downspout flow, an overflow pipe for when the barrel is full, and a spigot at or near the bottom to attach a hose or faucet. A screen at the opening controls mosquitoes and other insects. Rain barrels can be connected in series to store more rainwater.
- Locate rain barrels on a flat surface next to or near roof downspouts.
- Only collect roof water for reuse. Do not reuse water from parking or pedestrian areas, surface water runoff, or bodies of standing water.

- Roof material can impact the end use of the water collected in your rain barrel or cistern. Currently, no water quality standards for roofing types exist, and few roofing products carry water quality test information. Individual roof products vary. It is important to be mindful that any chemical treatment to your roof, such as moss inhibitors, could be harmful to plants.

Cistern Site and Selection Considerations

- Cisterns must be located where roof water can be directed to the tank. Only collect roof water for reuse. Do not reuse water from parking or pedestrian areas, surface water runoff, or bodies of standing water.
- Flat, stable surfaces must be provided to support the tank and designed for the weight of the tank when full of water. Underground cisterns require flat, stable subgrade, but no constructed base other than crushed rock.
- A cistern is possible in areas where infiltration methods may not be feasible such as steep or hazardous slopes, bedrock, high water table, or contaminated soils.
- An elevated cistern requires design by a qualified professional.
- Cisterns must be connected to the municipal stormwater system for overflow or to a properly designed rainwater management method with an overflow connection to the stormwater system.
- A cistern should only be used where there is a use for the water, enabling the tank to be emptied. This may include irrigation of landscaping or re-use for toilet flushing where there is a consistent demand through the wet season of the year.
- If using the rain water within a building, a professional is required to design and install the required "purple pipe" system.
- Cisterns must meet the setback requirements that apply to the main building within that particular zone. For example, in the R1-B zone (single family dwelling), a cistern can be located as follows:
  - 7.5m (minimum) from the front or rear property line
  - 1.5m from the side yard property line
- Collectively, the total surface area of the buildings, cistern and other structures on a property must not exceed the maximum site coverage permitted in the zone. For example, in the R1-B zone (single family dwelling), the maximum total site coverage is 40%.
- Rain barrels (1,200 litres or less) do not have setback requirements or site coverage limits.
- Cisterns may not be located on a required parking space. Please check Schedule C of the Zoning Bylaw to determine the required parking for a particular zone. For example, in the R1-B zone (single family dwelling), there must be at least 1 space per dwelling unit.
- Cisterns should be located in an area to minimize any potential negative visual impacts. Other ways to lessen these impacts, such as screening, can be utilized. Screening guidelines are located in Appendix B.
- Roof material can impact the end use of the water collected in your rain barrel or cistern. Currently, no water quality standards for roofing types exist, and few roofing products carry water quality test information. Individual roof products vary. It is important to be mindful that any chemical treatment of a roof, such as moss inhibitors, could be harmful to plants.

Rain Garden Site and Selection Considerations

- Where surface space is available, rain gardens provide the best stormwater treatment value of the methods presented here, and can increase the value of property due to the aesthetic value of the landscaping.
- Rain gardens are utilized for volume capture and stormwater treatment. Treatment is provided by the soil layer and volume capture by infiltration from the rock reservoir.
- A rain garden will provide increased volume capture when compared to other methods, due to the surface ponding and plant uptake of moisture.
- The rain garden must be planted with species adapted to periods of flooding as well as summer drought conditions. Covering the bottom of the rain garden with only river rock/gravel is not acceptable.
- Where space is extremely tight, a straight-sided rain garden, sometimes called a "planter-style" rain garden may be used. This is more expensive as the vertical sides must be formed and supported by a concrete curb or wall. This type of rain garden must be designed by a professional.

- If required, a rain garden can be constructed as a non-infiltration (also called a “flow-through”) facility. This type of rain garden must be designed by a professional.
- Rain gardens can be any shape, including irregular or “organic” shapes.
- Rain gardens should be located where runoff from impervious areas can be directed to them either by overland flow or by pipe. If possible, ground-level impervious areas that are used by vehicle traffic such as driveways and parking lots should be directed to rain gardens in preference over roof areas if the rain garden cannot be large enough to accommodate runoff from both roof and ground surface areas.
- Rain gardens are generally trapezoidal in cross-section, and the flat bottom area or “base area” is used as the measure of the rain garden’s size. The area required for side slopes is additional to the base area and the total area including base area and side slopes must be considered for fitting a rain garden into a site.
- The base area of a rain garden should be flat, so it may be difficult to fit a rain garden on a sloped site. A series of “stepped” rain gardens with weirs between them may be used on mild slopes (< 10%).
- Rain gardens should be situated to minimize crossing utilities as the underground trenches can become conduits for infiltrated water. If it is necessary to cross a utility trench, low-permeability trench dams must be used.
- In order to allow ponding in the rain garden, the outlet or overflow should be raised above the bottom of the rain garden. Plantings or rocks may be used to improve the look of the outlet.
- Rain gardens should be located or designed to not have foot traffic through the rain garden, if possible.
- Rain garden plantings require care and watering until they are established, generally the first one to two years post installation. Irrigation water must be available for this, even when the plantings are intended to be drought tolerant.

Infiltration Chamber Site and Selection Considerations

- Infiltration chambers should be used where infiltration is desired and possible but surface area for rain gardens is restricted, not available, or not wanted. Typically, infiltration chambers are located below lawn or pavement areas.
- Infiltration chambers may not be located below buildings.
- Infiltration chambers are best used to infiltrate roof runoff, which is generally cleaner than ground surface runoff.
- Inflow to the infiltration chamber is generally through a sump to pre-clean the rainwater before entering the infiltration chamber, reducing the maintenance and extending the lifespan of the system. This may be a standard household sump.
- Inflow may also be through a lawn basin, which is a grate-topped sump located in a grassed area.
- The perforated underdrain pipe below the surface must be connected to the municipal stormwater system.
- Infiltration chambers are easier to fit within a site than rain gardens as they do not take up surface area and can be buried underground, however, they tend to require a larger footprint than rain gardens and are more expensive to construct.

Permeable Paving Site and Selection Considerations

- Different types of permeable paving have different considerations, including ease of construction and cost of installation. For DIY projects, interlocking permeable pavers are usually the first choice as they are widely available and installation is similar to other block pavers.
- Permeable paving may be used for any ground surface location that would otherwise be paved with traditional asphalt or concrete. Some types of permeable paving, particularly open-grid systems where a structural grid is filled with gravel or grass, should only be used where there is light vehicle or moderate foot traffic. Traditional gravel driving surfaces, and conventional installations of concrete unit pavers are not considered permeable.
- Only low density residential driveways may use planting/driving strips where two strips of traditional impervious concrete are placed to support vehicle wheels and surrounded by grass.
- Manufacturers’ instructions for use and installation should be followed for all types of permeable paving and should be considered when choosing a permeable paving option.
- To maximize accessibility for people using mobility aids, sidewalks or other areas using permeable paving should be permeable concrete or asphalt, or interlocking permeable pavers with gaps between blocks of less than 1 cm (0.5 cm preferred).
- When permeable pavers are installed with an underdrain, runoff from additional impervious area may be directed to permeable paving areas. Runoff from ground surface impervious area should flow on the pavement surface (sheet flow) to the adjacent permeable paving area so that runoff and pollutants are spread over the area and not concentrated in a small section.

- Runoff from roofs may be connected directly to the perforated pipe underdrain below the permeable paving, or may be discharged to the permeable paving surface in a safe location where the discharge is directed away from the building and will not cause a safety hazard in freezing conditions.
- The overflow connection to the municipal stormwater system will be below the permeable paving and connected to the perforated pipe underdrain. It is not necessary to have a surface overflow.
- Permeable paving should be situated to minimize crossing utilities as the underground trenches can become conduits for infiltrated water. If it is necessary to cross a utility trench, low-permeability trench dams must be used.
- Unless designed specifically as a permeable paver, other types of concrete unit pavers will not be eligible for rainwater management incentives.

Table 2: Site Feasibility for Rainwater Management Methods

	Land Use								Suitable for Difficult Sites			Allowable Water Source					Effectiveness		Land Use	
Rainwater Management Method	Low Density (DIY)	Low Density (Professional)	Multifamily Strata	Civic/Institutional	Commercial/Industrial	Parking Lot	Suitable for Retrofit	Limited Land Availability	Steep Slopes	High Water Table	Shallow Soils Over Bedrock	Roof Water	Parking Areas	Pedestrian Areas	Overland Flow – Ground Surface	Piped Flow – Ground Surface	Flow Control	Water Quality	Low Density (DIY)	Low Density (Professional)
Rain Garden	●	●	●	●	●	●	●	○	■	■	■	●	●	●	●	●	●	●	○	○
Rain Garden Raised Planter	■	■	●	●	●	■	●	○	■	■	■	●	●	●	■	●	●	●	○	○
Bioswale	■	■	●	●	●	●	●	○	■	■	■	●	●	●	●	●	●	●	○	○
Permeable Pavement	●	●	●	●	●	●	●	○	■	○	○	○	○	○	○	○	●	●	○	■
Green Roof	■	■	●	●	●	■	■	●	●	●	●	■	■	■	■	■	●	○	■	■
Infiltration Chamber	●	●	●	●	●	■	●	●	○	■	■	●	○	●	■	●	●	○	○	■
Cistern	●	●	●	●	●	■	○	○	●	●	●	●	○	●	■	●	■	■	■	■
Rain Barrels	●	●	■	■	■	■	●	●	●	●	●	●	■	■	■	■	■	■	■	■

Application and Suitability

- ● Most Appropriate
- ○ May be used if opportunities exist
- ■ Not Appropriate/Applicable

Effectiveness

- ● High
- ○ Medium
- ■ Low

Strategies for Rainwater Management in Constrained Sites

Strategies to Accommodate Methods in Limited Space

- Land is a significant cost in the City of Victoria. Integrating rainwater management methods into the overall design of a project when there is an opportunity to do so as part of a larger project or re-development effort makes the best use of limited space on a site and budget.
- Use required landscape areas for rainwater management – make rain gardens at the site edge and in courtyards, rather than mounded landscape areas.
- Drain small paved areas into small rainwater management methods rather than try to fit a single large method on-site.
- Install permeable paving. Permeable paving of several types is highly suitable for parking areas and patios.
- Place an infiltration chamber or cistern underground, or under paved or lawn areas.
- Allow surface storage. Temporary ponding on the surface of rain gardens is approximately three times more efficient than underground storage in a drain rock reservoir due to the volume of space taken up by the rock.
- Some methods can be designed as flow-through planters that provide filtration but not infiltration, including rain gardens and bioswales. These types of facilities can use less space than traditional rain garden designs. Note: these must be designed and installed under the supervision of a professional to qualify for Rainwater Rewards.

Develop raised planters as rain planters (flow through planters) for on-slab construction. Note: These systems are not outlined in this document, must be designed and installed under the supervision of a professional to qualify for Rainwater Rewards.

Strategies When Infiltration is Undesirable

- For areas where infiltrated water could cause geotechnical concerns, or to avoid disturbing areas where contaminated soils are known to be, use cisterns that re-use rainwater for irrigation or indoor “purple pipe” systems.
- Some methods can be designed as flow-through facilities that provide filtration but not infiltration, including rain gardens and bioswales. Note: these must be designed and installed under the supervision of a professional to qualify for the Rainwater Rewards program.
- For pavement areas sloping toward the building, use permeable pavement or intercept runoff using a catch basin or a linear drain and pipe runoff to a downslope facility to prevent impacts to foundation drains.

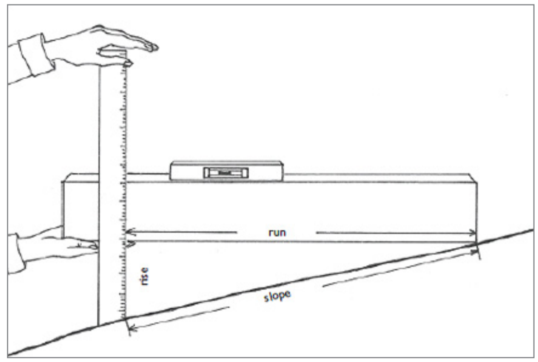
2.2: Site Assessment

The goal of a site assessment is to identify opportunities and information used to select, plan, design, and construct rainwater management methods.

A site assessment may involve estimating, measuring and testing to better understand conditions on site; for example:

- Estimating site slope – this requires a measurement of elevation drop (rise) over the length of the slope and measurement of the distance (run) for that drop (SEE FIGURE 1). Slope = rise ÷ run x 100%; and
- Measuring areas of impervious (hardscape) and pervious (landscape) surfaces – this may be done with tape measure or with a scaled site plan (if available) or by using the Rainwater Management Planning Tool available online at **victoria.ca/stormwate**r; (SEE FIGURE 2)
- Testing soil infiltration capacity – see below.

Figure 1: How to Measure a Slope

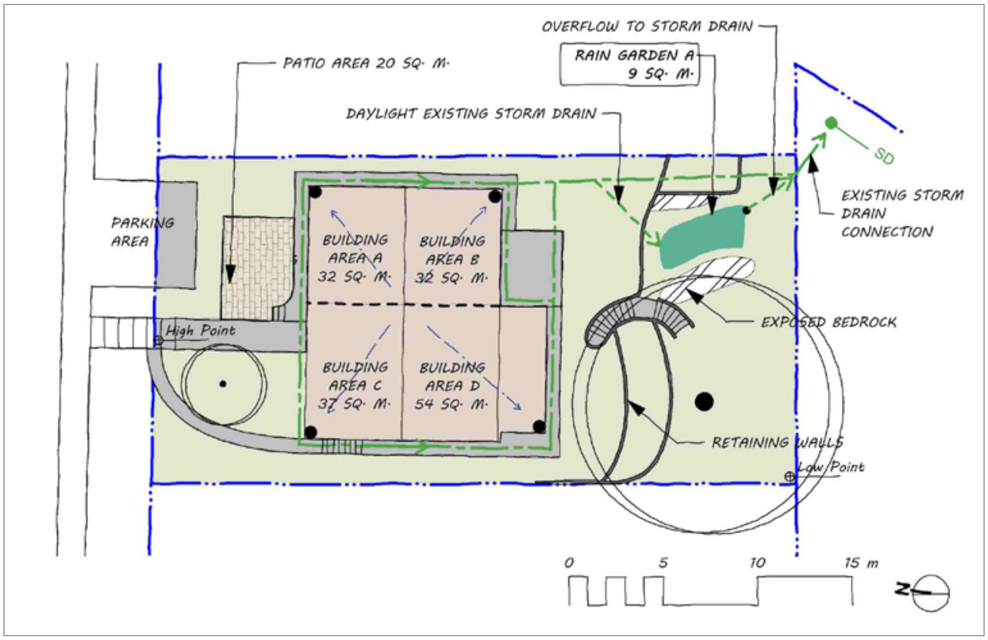


Site Assessment Checklist

The following is a list of site features that should be identified to help assess the site and the suitability of different methods. A good starting point is to locate your property on the Rainwater Management Planning Tool or VicMap and print off a map to sketch on.

- ☐ Identify the project site's high and low elevation points and note the general flow path of water across your site;
- ☐ Identify soil characteristics (e.g. well or poorly draining, sandy or clayey), rock outcrops, and terrain breaks, including retaining walls;
- ☐ Determine downspout and storm drain connection locations;
- ☐ Determine roof outline, delineate roof areas feeding each downspout, and note water flow direction across roof areas;
- ☐ Delineate all driveway, patio, parking, sidewalk and other impervious (hardscape) areas and identify drainage paths and discharge points of the hardscape areas;
- ☐ Note wet areas; and locations known to collect water (typically in the winter months);
- ☐ Note surface discharge to or from adjacent lots and if any water flows onto your site from a neighbour's property during rainy periods;
- ☐ Note location of municipal stormwater main nearest to property (usually fronting) using VicMap;
- ☐ Note the location of all utilities (may include underground pipes such as water, sewer, and gas, and cables and overhead wires) and other underground infrastructure from VicMap or by calling BC OneCall;
- ☐ Note existing tree locations to avoid, including protected or significant trees (see City of Victoria's Tree Preservation Bylaw);
- ☐ Location of steep slopes (>15%)
- ☐ Location of shoreline/natural boundary edges and associated setback requirements;
- ☐ Location of any Statutory rights of way from property survey and/or VicMap; and
- ☐ Landscaping and other features that may influence the selection and design of on-site rainwater management.
- ☐ Identify any setbacks required based on the property's land use zone.

Figure 2: Site Assessment Example



Subsurface Soil Infiltration

Low density residential properties can assume an infiltration rate of 2 mm/hr. If desired, a percolation test may be performed by a homeowner or by a professional. Whoever does the test must document the test, the conditions under which it was performed, and the results for submission to the City. The percolation test procedure is outlined in Appendix D.

Site Constraints and Considerations

Site constraints are identified at the site assessment stage. Some constraints prohibit proceeding with certain types of rainwater management methods and other constraints can be addressed or overcome with proper planning and design strategies. This may require involvement of a professional.

Example: The management of rainwater runoff must carefully consider site conditions as well as adjacent off site conditions, particularly where slope instability might be cause for concern or where the water table is high. Recharging shallow groundwater near bluffs and steep slopes may increase slope instability, or recharging groundwater where water table is too near the surface could be a limiting factor for application of rainwater management methods on some sites. For this reason, rain gardens and others methods may not be appropriate without additional expert help to address site constraints.

Figure 3 illustrates three different site conditions and basic scenarios where additional professional input will be required to select and design appropriate rainwater management methods.

Note: This document does not explicitly define or deal with geotechnical hazards or contaminated sites. The recommended setbacks are intended to reduce the risks where hazards are known, but geotechnical or hydrogeotechnical expertise is required to identify, assess, and properly mitigate these hazards. If there is any geotechnical concern for rainwater management implementation, a geotechnical professional must be consulted.

Trees

Placing rainwater management methods within a tree's root zone, or removing a tree to accommodate a method should be avoided. In certain cases where protected or significant trees are involved, the tree and its root zone must not be impacted.

Required: Consult the City of Victoria's Tree Preservation Bylaw, or the Stormwater Specialist if your rainwater management design may impact a tree.

Hazardous Slopes

The implementation of rainwater management methods that encourage infiltration is prohibited in hazardous areas of potential slope instability. Infiltration from methods may further reduce the stability of these hazardous slopes.

Required: Adequate setback for infiltration from the top of these slopes should be delineated by a qualified professional engineer. A minimum setback of 150 m is required in the absence of better information. It should be communicated to the engineer how much volume of water is expected to be infiltrated by the on-site rainwater management methods as the small infiltration volumes from methods are generally lower hazard than may be expected by the engineer.

Steep Slopes

Existing or proposed steep slopes can be a constraint to infiltration. Designers must consider the stability of the slope, and the interaction of deep and shallow groundwater interflow on the stability of slope. The definition of "steep" may vary, but for infiltration designs, slopes of 5% to 15% can make it more challenging to fit infiltration into a constrained site. Slopes greater than 15% are generally considered "steep" and infiltration methods up-gradient of steep slopes require professional design and construction.

Required: infiltration methods within 100 m of steep slopes, or that direct surface or groundwater at a steep slope area are prohibited unless reviewed and deemed acceptable by an engineer with geotechnical or hydrogeological expertise. This may require looking for steep slopes several lots away from the property in question.

Overflows

Required: All rainwater management methods must be designed with an overflow connection to ensure the facility overflows to the municipal stormwater system, and does not discharge to or through adjacent sites. A backflow preventer may be required on the overflow pipe in accordance with the City's Plumbing Bylaw (Bylaw No. 04-067). Engineered rock pits are also an option to direct overflow where no stormwater main fronts the property.

Groundwater Protection

It is important to consider the potential impact of rainwater management methods on groundwater contamination and the potential influences on existing water wells in the vicinity.

Required: A hydrogeologist must be consulted for any site where drinking water wells are located within 30 m of proposed infiltration facilities to confirm that infiltrated water does not put groundwater resources at risk. There should be very few of these in the City of Victoria as potable water is supplied by the City water system.

Utility Trenches

Trench dams are to be used as barriers between the infiltration reservoir and utility piping (usually service lines to the building) in order to prevent infiltrated water from short-circuiting through the high permeability material used in utility trenches and potentially causing damage downslope.

Required: Infiltration methods that intersect utility trenches must have low permeability trench dams to separate the two and inhibit flows.

Contaminated Soils and Pollution Hot Spots

Infiltration should not be undertaken directly from land uses that present a high risk of pollution such as automotive service yards. These land uses should employ spill control facilities (such as oil/water separators and oil interceptors) that may drain to rainwater management methods if enough protections are put in place.

Contaminated sites are also restricted for infiltration. No infiltration methods should be installed on sites with contaminated soils. A minimum setback of 30 m should be used for installation of infiltration methods up-gradient of a contaminated site or landfill. If a large infiltration rainwater management method is anticipated for the up-gradient site a larger setback distance may be needed, to be determined by a professional.

Required: For sites that are known to be contaminated, rainwater management methods should be considered on an individual-case basis and professionals must be consulted.

High or Seasonable High Water Table

Infiltration methods should not be used where there is known to be a high water table, even if only seasonally, as the methods need to be able to drain into surrounding subsurface soils during the wet season. If only a portion of a site is known to have a seasonally high water table, there may be other areas on the site that are more suitable for an infiltration method.

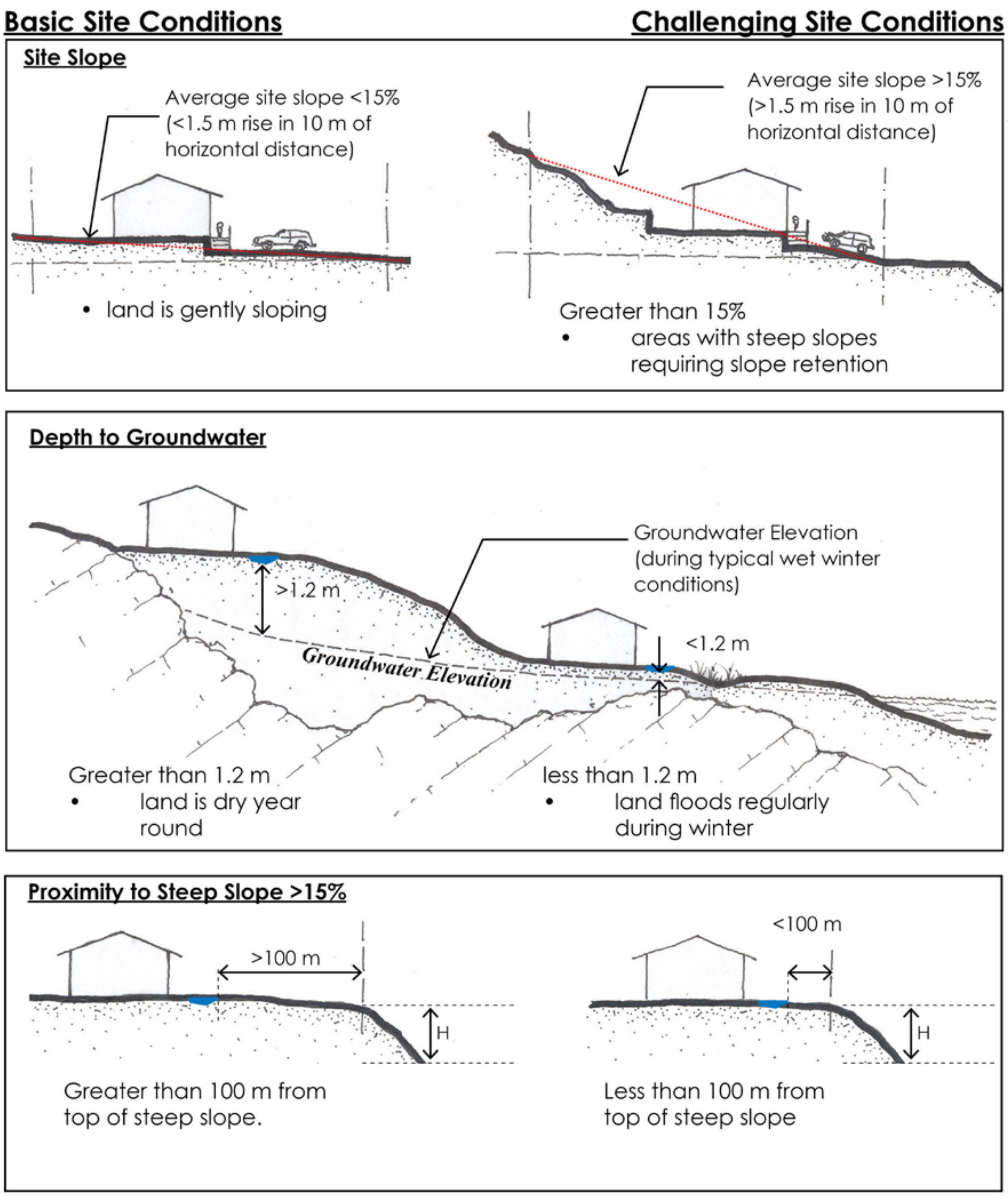
Required: The infiltration facility must have a minimum of 600mm of separation between the bottom of the infiltration reservoir and the top of the high water table.

Shallow or Surface Bedrock

Infiltration requires subsurface soil layers to be able to drain water so it is not recommended to install infiltration methods in areas where there is surface or shallow bedrock or cemented soil layers.

Required: The infiltration method must have a minimum of 600 mm of soil below the bottom of the infiltration reservoir.

Figure 3: Site Conditions



Entrances and Parking

Required: Ensure rainwater management method is not blocking access/egress to rear yard or exits/entrances, or blocking or displacing parking spaces or driveways.

Table 3: Setback and Minimum Values Summary

	Setback or Minimum Required
Infiltration setback from building foundation	5 m
Infiltration setback from steep (> 15%) slope	30 m minimum
Vertical and horizontal clearance from utilities	1.5 m
RMM setback from natural boundary/shoreline	10 m
Infiltration setback from drinking water well/spring	30 m minimum OR as directed by a hydrogeologist
Infiltration setback up-gradient from landfill or contaminated site	30 m
Rainwater Management Method near a protected or significant tree (see the City's Tree Preservation Bylaw)	Outside protected root zone
Vertical separation from bottom of infiltration RMM to high water table	0.6 m for catchments < 900 m^2 1.0 m for catchments > 900 m^2 OR as directed by qualified professional

2.3: DIY and Professional Design

Professional Design Qualifications and Requirements

In many circumstances site constraints and project complexity will warrant use of a Qualified Designer or a Qualified Professional in order to meet rainwater management objectives and the City of Victoria Rainwater Management Standards. The term "professional" used in this document includes both Qualified Designers and Qualified Professionals.

"Qualified Designer" means an individual who demonstrates to the satisfaction of the Director of Engineering and Public Works for the City that he or she has the training and experience necessary to design and oversee the installation of a rainwater management method.

"Qualified Professional" means an applied scientist or technologist, acting alone or together with another qualified professional, if:

(i) The individual is registered in good standing in British Columbia with an appropriate professional organization constituted under an Act, acting under that association's code of ethics and subject to disciplinary action by that association,

(ii) The individual's area of expertise is recognized by the individual's professional organization as one that is acceptable for the purpose of performing a professional service for design of rainwater management methods, and

(iii) The individual is acting within the individual's area of expertise.

Qualified Professionals include but are not limited to:

- **Landscape Architects** – registered or licensed to practice as a qualified landscape architect under a recognized professional association (within BC the BCSLA and CSLA); and
- **Professional Engineers** – registered or licensed to practice as a professional engineer, under the Engineers and Geoscientists Act (APEGBC).

When is Do-It-Yourself appropriate?

The City of Victoria has developed two levels of design and construction for rainwater management methods based on how complex a site is and the level of complexity in the method utilized. The following outlines the two levels for rainwater management methods based on the complexity of the site and systems:

- DIY PROJECTS – Low density residential (1– 4 units) projects that use standard rainwater management methods outlined in this document and meet all of the requirements in Table 4 Can This Project be DIY can be developed and submitted by the home owner or a representative such as a Qualified Designer or Qualified Professional.
- PROFESSIONAL PROJECTS – any project with challenging site constraints, complex rainwater management method designs, or property types other than low density residential must be completed by a Qualified Designer/ Qualified Professional, collectively referred to in this document as professionals.

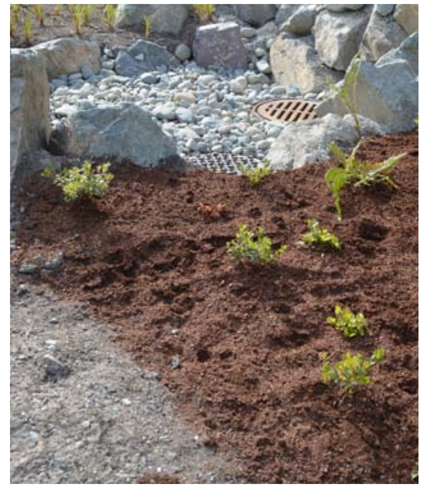
Projects with impervious surface areas greater than 300 sq.m. (including roof, driveway, etc.) must be designed by a professional.

See Table 4 on the next page to determine if the project is eligible for DIY.

Table 4: Can this Project be DIY Checklist

		DIY Allowed	Professional Only
Land Use		☐ Low Density Residential (1 – 4 Dwelling Units) ☐ Impervious surface area < 300 m^2	☐ Multi-family Residential (5+ Dwelling Units) ☐ Civic and Institutional ☐ Commercial and Industrial ☐ Impervious surface area ≥ 300 m^2
Site Conditions	Depth to Groundwater	☐ Greater than 1.2 m (land is dry year round)	☐ less than 1.2 m (land floods regularly during winter)
Site Conditions	Proximity to Hazardous Slopes	☐ Method is greater than 150 m from top of known hazardous slope	☐ Method is less than 150 m from top of known hazardous slope
Site Conditions	Proximity to Steep Slopes	☐ Method is greater than 100 m from top of steep slope (>15%)	☐ Method is less than 100 m from top of steep slope (>15%)
Site Conditions	Bedrock on Site	☐ No known or visible bedrock	☐ Visible or known bedrock
Site Conditions	Contaminated Soils	☐ No known contaminated soils or buried oil tanks or ☐ Rain Barrel or Cistern is planned	☐ Known contaminated soils or buried oil tanks
Site Conditions	Available Stormwater Main	☐ Stormwater main fronting or adjacent to property (VicMap)	☐ No stormwater main fronting or adjacent to property
Type of Rainwater Management Method to be installed		☐ Rain garden (slopes <5%) ☐ Infiltration chamber (rock) ☐ Permeable concrete unit paving (slopes <8%) ☐ Rain barrel ☐ Cistern at grade (plumbed for gravity irrigation)	☐ Methods requiring advanced design, e.g.: green roof (intensive and extensive), rain planters, cisterns below or above grade or plumbed for indoor use/irrigation , infiltration chamber (open), bioswale, permeable concrete unit paving (slope >8%)
Who can prepare the design?		If **all** of the conditions in the above column apply to your site, and only Standard Methods are used, the project can be designed by the • Home Owner or • Qualified Designer or • Qualified Professional	If **any** of the conditions in the column above apply to your site, the plans must be designed by a • Qualified Designer or Qualified Professional
Who can build the project?		The project can be built by the • Home Owner or • Contractor/Professional	If **any** of the conditions in the column above apply to your site, the project **must** be built by a • Contractor/Professional
Documentation Requirements		• Concept Plan of Site and Methods • Sizing Calculation Sheet • Standard DIY Design to be used	• Concept Plan of site and methods • Construction Details and Plans • Sizing Calculation Sheet





Part 3: Permitting and Approvals

The City of Victoria is committed to helping property owners implement rainwater management on their properties because rainwater management provides multiple benefits. The City has a role in overseeing how rainwater management is implemented in order to ensure that the rainwater management methods installed will function correctly and provide the expected benefits. In addition, the City has worked to reduce permitting and approval requirements to the greatest extent possible.

When a rainwater management project is undertaken with the intent of being approved for Rainwater Rewards, all associated permits required for the project will be streamlined through the Rainwater Rewards application to help simplify the process for the applicant. Alternatively, when the rainwater management work is part of a larger project requiring Building and/or Development Permits, those standard permitting processes will apply.

To achieve this, all rainwater management method designs must be submitted to the Stormwater Specialist for pre-approval before any site preparation or construction. Doing this will help to ensure the design:

- meets the requirements laid out in this document and Rainwater Rewards eligibility can be identified
- is distributed for review to applicable departments in the City (plumbing, zoning, electrical) prior to construction
- will be eligible for exemptions from development permit, heritage and zoning restrictions

Once reviews are complete, pre-approval will be granted, or a deficiency list will be provided to identify shortcomings that would prevent Rainwater Rewards, or other departments' approval. When design deficiencies are rectified (if applicable), the design can be resubmitted for pre-approval.

When pre-approval is received, site work can start. The Stormwater Specialist will help identify and coordinate required inspections and documentation to ensure all requirements can be met. These requirements will vary depending on project location and complexity, but some of the components are generally identified below.

As a general guide to help ensure installation requirements are met, refer to the Insallation Checklists in Appendix B.

Rainwater Rewards Program Application

The latest information on the Rainwater Rewards program can be found on the City of Victoria's website: **victoria.ca/stormwater**.

To submit an application, you need to submit the following documentation along with the application form. The application form may be filled out online on the City's website.

When pre-approval is received, site work can start. The Stormwater Specialist will help identify and coordinate required inspections and documentation to ensure all requirements can be met. These requirements will vary depending on project location and complexity, but some of the components are generally identified below.

Inspections

Possible inspection times:

- prior to breaking ground
- prior to back filling
- at completion

Possible inspection items:

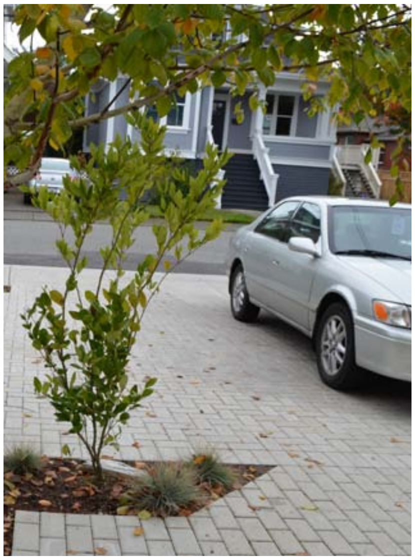
- overflow connections
- drip valves
- trench depths
- appropriate material specification
- growing medium composition
- piping size, orientation and grades
- pumps
- site coverage
- setbacks

Documentation

Potential documentation requirements for Rainwater Rewards approval:

- finalized design drawing of rainwater management method
- material and labour receipts and invoices
- photographs before and after construction, at key construction phases,
- finalized as-built drawing of actual construction
- calculation sheets showing impervious area being directed to the rainwater management method, and the sizing of the method. If the design was done by a professional, include the professional's drawings and sizing calculations
- maintenance and landscaping plan for the rainwater management method

If your rainwater management method was built prior to 2015, you must provide as much of the above documentation for the rainwater management method as possible and may need to have a post-construction inspection by the City. If sufficient documentation is provided and/or inspection approved, you will be able to apply for an ongoing 10% credit off your annual stormwater utility bill, but not for a rebate.



Part 4: DIY Design and Sizing Approach

The following rainwater management methods included in the Rainwater Rewards program have been designed primarily to provide water quality treatment for 90% of the average annual rainfall runoff that is directed through them. The secondary design objective is to reduce the volume of runoff that enters the City's stormwater system by encouraging infiltration, evaporation and reuse of the rainwater. To achieve this, rainwater management methods must be designed to meet the City's rainwater management target to treat and/or capture 32 mm of rainfall in a 24 hour period.

This document provides sizing and design requirements for rainwater management methods to qualify for Rainwater Rewards.

This document is intended to help low density residential homeowners to design, build, and maintain their own rainwater management methods.

If the project is determined to be inappropriate for DIY based on the checklist in Table 4 or discussions with City staff, a professional must be hired. If the professional determines that the project could meet the target by methods other than those described here, they must use the Professional Rainwater Management Standards, which offer some flexibility and are intended to help professionals ensure the rainwater management methods will qualify for the Rainwater Rewards program.

Both Rainwater Management Standard documents provide design information that will help achieve the City of Victoria's rainwater management goals and reduce the stormwater impacts on downstream receiving waters.

Do-It-Yourself Standards

This section includes step-by-step requirements for design, construction and maintenance of each rainwater management method accepted under the City's Rainwater Rewards program for low density residential properties. For a property owner to design and build their own rainwater management method, all of the requirements in Table 4 must be met, and they must use one of the standard designs found here.

Each of these standard designs is described in detail and includes all the basic information needed for the sizing and construction.

While all of these designs are ready and intended for DIY, homeowners should recognize that:

- This entire document should be read and understood prior to any work on the project.
- The City's online Rainwater Management Planning Tool can help determine what incentives a rainwater management method may qualify for and to help visualize the sizing.
- City permits may be required for installation of rainwater management methods. These will be identified when the plan is submitted for approval before work starts.
- City staff can answer questions regarding your project – if there is anything you don't understand, ask, don't guess!

The DIY standards have been developed to simplify the design and construction requirements, and reduce costs as much as possible. The DIY standards may also be simplified in certain respects to improve ease of construction and reduce costs. If all steps outlined in this document are followed, in most cases a homeowner should not need to hire a professional.

Low density residential property owners who wish to make changes to the standard designs require approval by the City and may be required to work with a professional.

Property owners always have the option of engaging a professional to design a rainwater management method for a low density residential lot. In some cases that may be necessary due to particular issues and constraints of the property or method (see Part 2). They may also use a contractor to build their rainwater management method.

Whether or not a rainwater management method is designed or constructed by a homeowner or by professionals, the documentation of the design and construction required by the City to apply for permits and rainwater management incentives will be the same. It is important to be aware of the documentation required at the beginning of a project, as it may be impossible to go back and obtain photos or other documentation once construction is complete.

Though terminology has been kept simple in this section, a glossary has been developed (Part 6). If further clarification of any terminology is needed, please contact City staff.

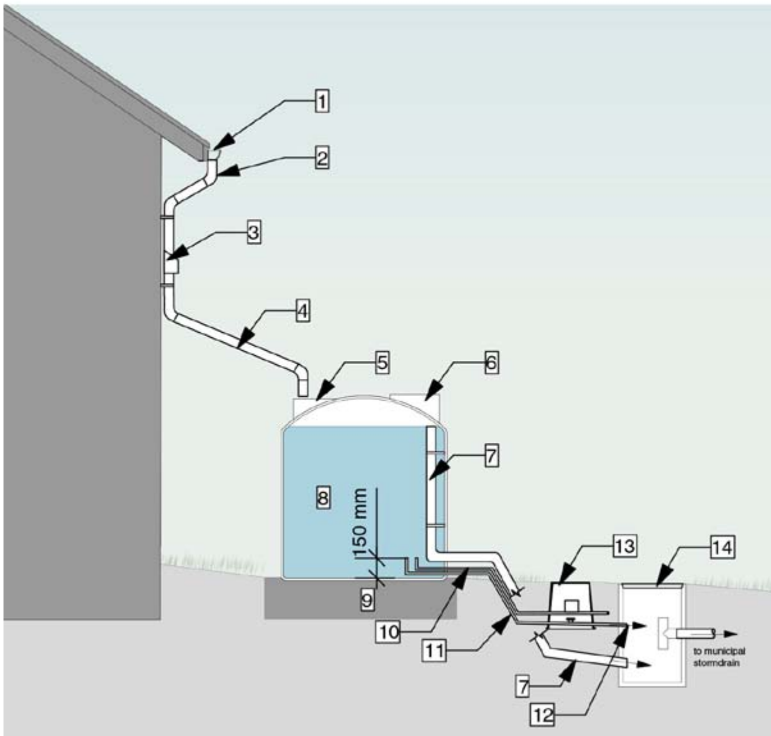
Installation checklists were also developed as a general guide to help achieve compliance with these standards, and can be found in Appendix B.

Rain Barrels and Cisterns

Rain barrels and cisterns collect rainwater for reuse. They provide some flow control and volume reduction benefits but do little to treat runoff. A cistern has more storage capacity than a rain barrel.

The collected water can be used to water gardens and lawns but not for consumption, since it is non-potable. The rain barrel or cistern should be installed so the cistern stores water for irrigation during the dry months (May to September). During the wet months (October to April) a valve is opened so that the rain barrel or cistern slowly releases the captured water between rain events or storms.

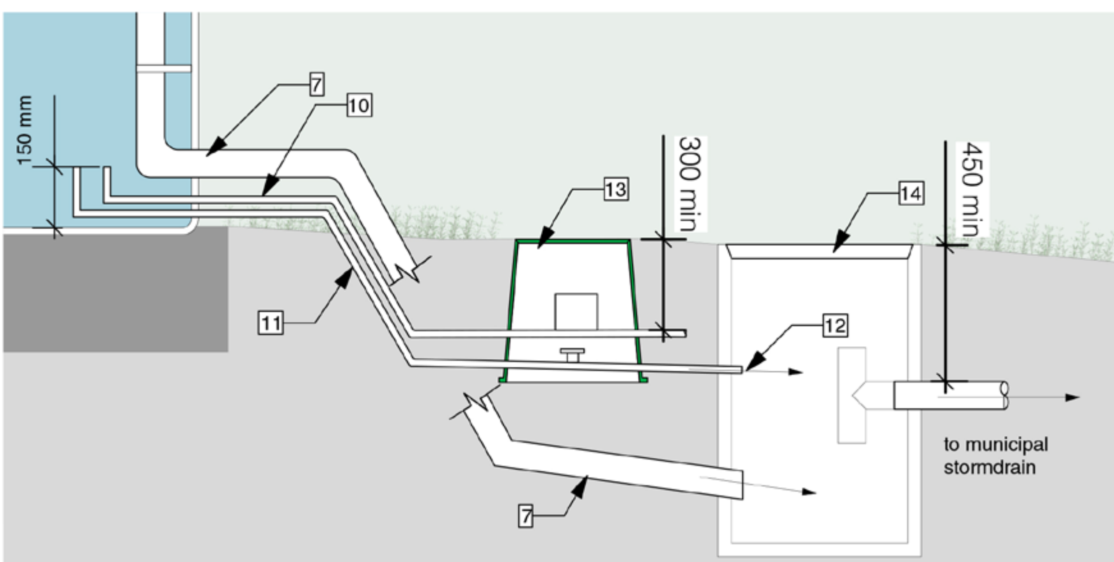
Figure 4: Cistern/Rain Barrel – Downspout Connection



Above Ground Cistern Materials

1. Gutter
2. Building rainwater leader/downspout
3. Inline debris removal device
4. Diversion pipe to rain barrel/cistern
5. Rain barrel/cistern fill opening
6. Self-venting lid
7. Overflow to sump
8. Cistern / rain barrel
9. Compacted base
10. 25 mm diameter to irrigation system. Pump and filter (not shown) installed on either interior or exterior of rain barrel/cistern.*
11. 25 mm diameter winter drain pipe, with valve.
12. Orifice with screw on adapter at end of winter drain pipe
13. Irrigation valve box
14. Sump**

Figure 5: Cistern – Pipe Connections



** An irrigation system is not required if the homeowner chooses to install a hose bib for hand watering.*

***Sump is shown as a location to bring the winter drain and the overflow together prior to connection to the municipal stormwater system and allow for access and cleanout of the piping. A sump is not required if the homeowner chooses to use a below ground tee connection instead.*

Sizing Factor

Provide 25 litres of rainwater storage per 1 square metre of roof area being directed to cistern/rain barrel. If plumbed for irrigation the rain barrel and/or cistern must be connected to 2 square metres of watered area per 1 square metre of roof area being directed to cistern/rain barrel.

Estimated Installation Cost

Approximately $1000 per cubic metre water stored. Estimated installation costs include materials and installation for the standard design. These estimates are intended only as a guideline as the actual costs can vary greatly – costs per cubic metre are typically higher on small installations and lower on large installations.

General Design Requirements

1. a. Siting requirements for rain barrels and cisterns approved under the Rainwater Rewards Program:

   Cisterns must meet the setback requirements that apply to the main building within that particular zone. For example, in the R1-B zone (single family dwelling), a cistern can be located as follows:

   i. 7.5m minimum from the front or rear property line

   ii. 1.5m minimum from the side yard property line

   b. Collectively, the total surface area of the buildings, cistern and other structures on a property must not exceed the maximum site coverage permitted in the zone. For example, in the R1-B zone (single family dwelling), the maximum total site coverage is 40%.

   c. Cisterns may not be located on a required parking space. Please check Schedule C of the Zoning Bylaw to determine the required parking for a particular zone. For example, in the R1-B zone (single family dwelling), there must be at least 1 space per dwelling unit.

   d. Rooftop cisterns less than 9000 litres are excluded from height regulations.

   e. Rain barrels (less than 1,200 litres) do not have setback requirements or site coverage limits.

2. One or more debris removal devices should be used in the catchment system to remove debris (normally particles larger than 200 – 500 microns).

3. Overflow required, minimum 50 mm diameter pipe, with connection to municipal stormwater system.

   a. Protect from debris and sediment with strainer or grate.

   b. A backflow preventer may be required in accordance with the City's Plumbing Bylaw (No. 04-067).

4. Rain barrels and cisterns should be:

   a. Installed on a level compacted base, according to manufacturer's recommendation.

   b. Dark-colored, UV-resistant, polyethylene or fibreglass preferred to reduce algal growth.

   c. Inlet / fill opening to be screened to keep debris out of the tank.

   d. All pipe openings to be sealed with waterproof seal, grommet or barb fitting.

5. Gravel base for a cistern should be compacted using vibratory equipment such as a walk-behind vibratory plate compactor. Gravel base for a rain barrel may be compacted by hand using a hand-held plate tamper. Compacted base is generally constructed with clean crushed rock materials, but may be other materials such as concrete. Base must be constructed in accordance with cistern/rain barrel manufacturer's recommendations.

6. All solid pipe to be PVC sewer pipe minimum CSA rated ≤ 35 SDR (Standard Dimension Ratio).

7. Irrigation supply to be minimum 25 mm diameter and must have positive slope with provision to prevent freezing.

   a. Pump and filter for irrigation system to be installed on either interior or exterior of rain barrel or cistern as per manufacturer's specifications.

8. Winter drain pipe to be max 25 mm diameter, installed level to flow control sump;
   a. Winter drain pipe to be connected to valve. Valve may be manual valve controlling flow to flow control sump (shown) or garden hose faucet, if draining to rainwater management method, or other safe location.
   b. Winter drain pipe to have 10 mm orifice with screw adapter installed at outlet to flow control sump.
9. Underground valves, pumps, and filters to be accessible through irrigation valve box with a minimum of 50 mm clearance between box and valves. Install 100 mm compacted base under box.
10. Sump shall be concrete, plastic, or other non-degradable box with strength suitable to withstand surface loads.
    a. Sump should be rated for appropriate vehicle loads (H-20) on driveways or any other driveable surface.
    b. There is no loading requirement for walkways/grass areas.
11. Outlet pipe shall be PVC sewer pipe minimum CSA rated ≤ 35 SDR (Standard Dimension Ratio). 100 mm diameter minimum complete with PVC backflow preventer valve (if required) as per City Plumbing Code. Outlet pipe must have minimum 1% grade and follow the Plumbing Code.
12. All rain barrel and cistern hose bibs must be identified with signage indicating for “non-potable usage only”.

Cistern Screening Considerations

Where cisterns will be visible to neighbours or the street, consider ways to soften their appearance through landscaping or other design features. Cisterns should complement the overall design and character of your property while retaining functionality. You will need to be able to access your cistern for routine maintenance.

1. Consider screening cisterns with plants or bushes, such native, drought tolerant species, vines or food plants (e.g. hops, berries).
2. Cisterns can be screened with trellis panels, wooden panels or wrought iron panels.
3. Cisterns can be integrated into a building by locating them under decks or behind existing out-buildings such as sheds or garages.
4. There are examples of cisterns that have been finished with galvanized metal, concrete, masonry or wood cladding, and complement the style and character of the property.
5. Consider incorporating elements that complement the character of the property, such as metalwork into the cistern.

More cistern screening guidance, examples and ideas are available in Appendix C.

Design and Installation

The following steps detail installation of a rain barrel or cistern, for low density residential use:

1. Complete Site Assessment Checklist in Section 2.
2. Determine the size of roof and hardscape areas that will flow to rain barrel/cistern. Determine the size of the landscape that will be irrigated with rain barrel/cistern water.
3. Submit completed design as part of the Rainwater Rewards Application for pre-approval before starting work to confirm design meets Rainwater Rewards program requirements. Once pre-approval is granted, work can start.
4. Install a sump with an overflow pipe and connect with 100 mm diameter pipe to municipal storm drain system.
5. Ensure that the rain barrel/cistern is located so that the downspouts can be directed to it, and to ensure it can be connected to the sump.
6. Select a flat location for installation of the rain barrel/cistern. If the proposed location is within a softscape area, a compacted base area must be installed. Refer to manufacturer's recommendations for appropriate depth and materials for compacted base.
7. Place the rain barrel/cistern, as per manufacturer's recommendations.
8. Create openings in side of rain barrel/cistern, as needed for overflow, irrigation connection, and winter drain pipe. Seal all openings with waterproof seals, grommets, or fittings.
9. Install overflow pipe, with top of pipe set at desired maximum fill level, and connect to sump.
10. Install either a 25 mm diameter pipe connection for irrigation system or a hose bib for hand watering, 150mm from bottom.
11. For winter drain that is connected to sump:
    a. Install 25 mm diameter winter drain pipe with valve below finished grade, preferably in same access location as irrigation valve components, and connect to flow control sump. Install orifice with screw on adapter at the end of the winter drain pipe.

12. For winter drain directed towards safe location or rainwater management method:
    a. Install 25 mm diameter winter drain pipe and faucet or hose bib. Connect garden hose and direct to safe location or rainwater management method area.
13. Install appropriately sized valve box for access to valve, before backfilling underground pipes. Valve box to rest on 100 mm depth compacted gravel base.
14. Backfill overflow connection, overflow pipes, and irrigation pipes (if installed).
15. Connect the downspout to rain barrel/cistern. Ensure that the downspout has an in-line debris removal device installed.

Construction Tips

1. Cisterns/rain barrels should not be installed:
    a. In a concave area where water could collect around the base, or in the path of surface water runoff; or
    b. In an area prone to high winds, without the tank being anchored and/or strapped down in accordance with manufacturer's instructions.
2. Rain Barrels in Series – If you plan to connect multiple rain barrels at one roof leader/downspout, they should be installed in series. The first barrel (only the first barrel) should be directly connected to the roof leader and the last barrel should be installed with the discharge pipes and overflow to the storm drain. The barrels should be connected to each other via a pipe that is installed at the bottom of each barrel so they each drain into the next one.

Maintenance

- Keep the drainage pathway to the cistern/rain barrel clear. Remove leaves and other debris from the roof gutter, clean out sump in the case of the cisterns and the inlet screen in case of the rain barrel.
- Clean gutters annually. Fine-mesh gutter covers or frequent cleaning will reduce the sediment and debris deposited into the cistern/rain barrel.
- Install a debris removal device that is sized to handle peak water flow from the roof areas it drains, to reduce maintenance.
- Cleaning of cistern recommended every three to five years, for non-potable outdoor and indoor use. This requires draining the cistern and scrubbing to remove dirt and algae on the surfaces, as well as on valves and piping that can be accessed and cleaned. Use only mild, biodegradable soaps, not strong chemicals or detergents as they can harm plants.

Rain Garden

A rain garden is a shallow depression that uses soil and plants to slow and clean rainwater.

Two types of rain gardens available for DIY are depicted here – those with, and those without rock reservoir. Both types function in a very similar way.

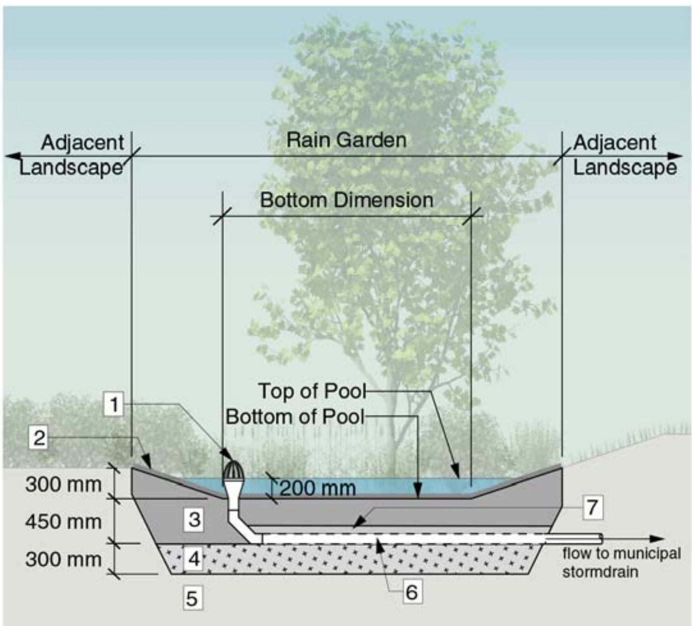
Rain Garden Without Reservoir

Essential Components

1. Concave surface
2. Rainwater input
3. Living plants
4. Growing Medium
5. Drain or outlet (porous base & overflow)

A rain garden without reservoir provides volume capture and rainwater treatment, provided by soil layers, surface ponding, and plant uptake. Trees can be planted in all rain gardens without rock reservoirs. The bottom of the rain garden must be planted. Covering the bottom of the rain garden with rock is NOT acceptable (planting is essential for the rain garden to function properly). The bottom of a rain garden without a reservoir is scarified/mechanically loosened, instead of being filled with sand or rock as is the case with rain gardens with a reservoir (next section).

Figure 6: Rain Garden Without Reservoir Detail



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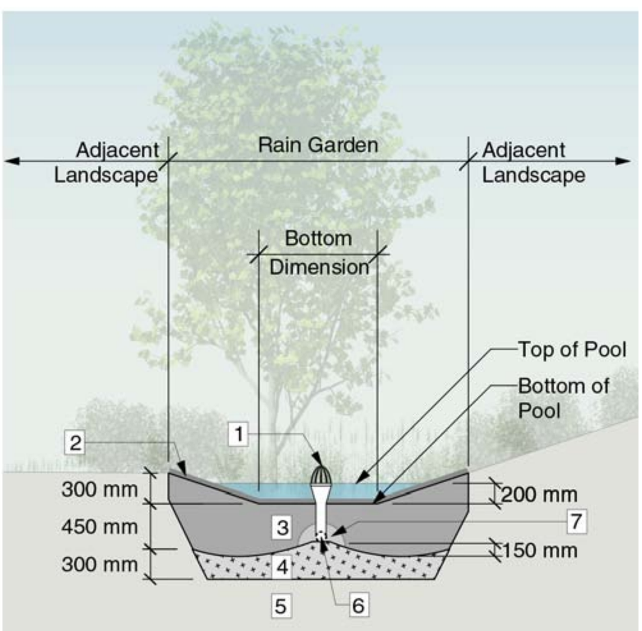


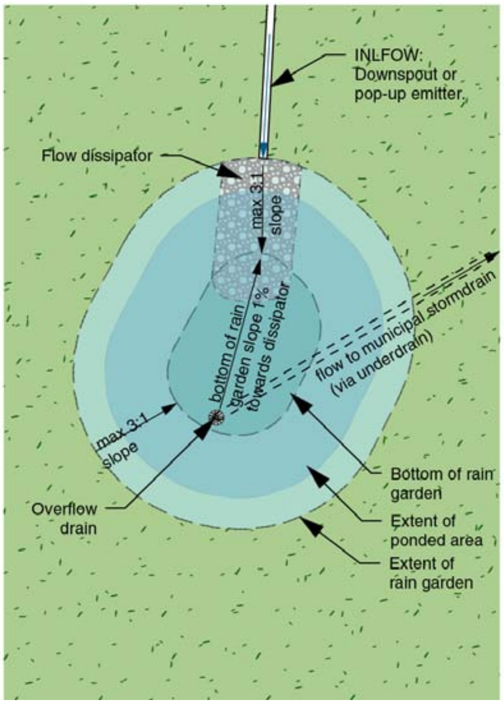
Cross Section

Rain Garden Materials

1. Overflow drain, 200 mm domed grate and adapter
2. Composted mulch, 50 – 70 mm depth
3. Bio-retention growing medium, 450 mm depth
4. Scarified/tilled subgrade, 300 mm depth
5. Existing subgrade/native material
6. 100 mm diameter (min) perforated pipe
7. 25 mm diameter drain rock, 100 mm depth

Note: Flow dissipator inlet options and pop-up emitter details are located at the end of this section.

Figure 7: Rain Garden Plan



Sizing Factor

The size factor for the rain garden without reservoir is 5%, based on the construction details included in this section. An impervious area of 100 m^2 would require a rain garden area* of 5 m^2** to manage the runoff.

*For sizing purposes, the rain garden area is calculated using the length and width of the bottom (the flat area) of the rain garden.

**Allow for an additional 0.9 m buffer around the calculated base area to determine the total footprint of the rain garden with 3:1 side slopes.

Estimated Installation Cost

Approximately $200 per square metre. Estimated installation costs include materials and installation for the standard design. These estimates are intended only as a guideline as the actual costs can vary greatly – costs per square metre are typically higher on small installations and lower on large installations.

General Design Requirements

1. Dimensions:
   a. Depth of basin (from top of growing medium to overflow elevation): 200 mm.
   b. Bottom of rain garden (flat area) width: minimum 1.0 m. (1.0 m – 3.0 m, preferable).
   c. Length to width ratio of 2 to 1 is preferred.
   d. Side slopes of rain garden: The steepest slope allowed is 3 horizontal units to 1 vertical units (3:1). Slope of 4:1 is preferred.
2. Service trench crossing: Any service trench crossings must have impervious backfill barriers (trench dams) properly installed, using compacted impervious materials, for entire trench width and extend to 200 mm above the top of the service trench, refer to figure 15, page 37.
3. Inflow:
   a. Inflow should enter as overland flow and as sheet flow if possible.
   b. For a piped inlet to rain garden, install flow dissipater such as a rock pad to transition from inlet to growing medium.

4. Overflow drain, with connection to municipal stormwater system is required.
   a. Protect from debris and sediment with domed grate.
   b. Allow a minimum 100 mm freeboard between the inlet elevation (top of pool) and the maximum ponded elevation (overflow elevation of adjacent landscape).
5. Mulch to be leaf mold, compost, shredded garden waste, well composted bark or mild, well composted manures.
6. Bioretention growing medium, 450 mm depth:
   a. Must be obtained from a supplier to meet the following specifications:

Table 5: Bioretention Growing Medium Specs	
Particle Size Classes	Percent Dry Weight of Mineral Fraction
Coarse Gravel (particles greater than 19mm and less than 40mm)	0 to 1%
All Gravels (particles greater than 2mm and less than 40mm)	10 to 25%
Sand, Silt, Clay & Organic components measured from remaining non gravel portion of sample (% dry weight)	
Sand* (particles greater than 0.05mm and less than 2mm)	60 to 70%
Combined Silts and Clays (particles less than 0.05mm)	10 to 20%
Organics (particles less than 2mm)	15 to 20%

   b. Install growing medium in 200 mm lifts (layers) and compact with lawn roller. Do not over compact or this will decrease ability to infiltrate water.

   *Note: Growing medium to be manufactured with '2 mm minus' sand to reduce gravel content in the soil. 2 mm minus sand is available from most local quarries upon request
7. Scarified subgrade to 300 mm depth.
8. Perforated pipe to be 100 mm diameter PVC with minimum 2 rows of 5 mm (1/2 inch) holes.
9. Outlet pipe shall be PVC sewer pipe minimum CSA rated ≤ 35 SDR (Standard Dimension Ratio). 100 mm diameter minimum complete with PVC backflow preventer valve (if required) as per City Plumbing Code. Pipe must have minimum 1% grade and follow the Plumbing Code.

Plant List

Latin name (common name)

Edge or bottom of Rain Garden Tree Species:

- *Acer circinatum*[1] (Vine Maple)
- *Acer rubrum* (Red Maple)
- *Cercidiphyllum japonicum* (Katsura)
- *Cercis canadensis* (Eastern Redbud)
- *Chamaecyparis nootkatensis* 'Pendula' (Nootka False Cypress)
- *Nyssa sylvatica* (Tupelo)

Edge of Rain Garden Species:

- *Cistus x corbariensis** (White Rockrose)
- *Gaultheria shallon**[1] (Salal)
- *Lonicera pileata** (Box-leaf Honeysuckle)
- *Mahonia aquifolium**[1] (Oregon Grape)
- *Myrica californica**[1] (Pacific Wax Myrtle)
- *Rosa nutkana**[1] (Nootka Rose)
- *Polystichum munitum**[1] (Sword Fern)
- *Symphoricarpos alba*[1] (Snowberry)
- *Vaccinium ovatum**[1] (Evergreen Huckleberry)
- *Viburnum davidii** (David's Viburnum)

Bottom of Rain Garden Species:

- *Carex obnupta**[1] (Slough Sedge) shade only
- *Carex stipata**[1] (Awl Fruited Sedge) sun/shade
- *Cornus sericea* 'Kelseyii' (Dwarf Red Dogwood)
- *Iris setosa**[1] (Dwarf Arctic Iris) sun/shade
- *Juncus* 'Carmen's Grey* (Carmen's Grey Rush) sun/part shade
- *Miscanthus sinensis* 'Adagio'* (Dwarf Maiden Grass) sun/part shade
- *Myrica gale**[1] (Bog Myrtle)
- *Schizostylis coccinea* 'Oregon Sunset'* (Crimson Flag) sun/shade

Consult with local nursery for more suggestions.

*Generally considered to be deer resistant shrub/grass/perennial species

[1]Species native to the Pacific Northwest coast.

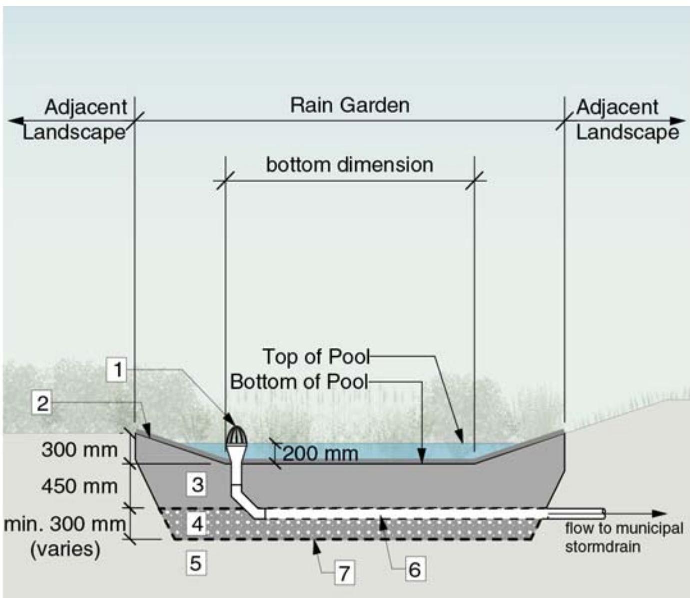
Rain Garden With Reservoir

Essential Components

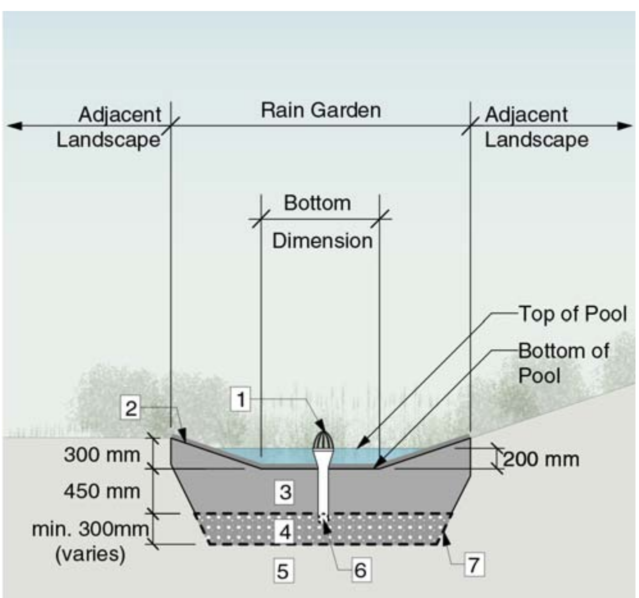
1. Concave surface
2. Rainwater input
3. Living plants
4. Growing medium
5. Reservoir
6. Drain or outlet (overflow & porous base)

A rain garden with reservoir provides volume capture and rainwater treatment, provided by soil layer, surface ponding, and plant uptake. Additional volume capture and infiltration capacity is provided by a reservoir layer. The reservoir can be constructed with sand or rock. Trees cannot be planted in rain gardens with reservoirs. The bottom of a rain garden with a reservoir is filled with sand or rock, instead of being scarified/mechanically loosened as is the case with rain gardens without a reservoir (previous section).

Figure 8: Rain Garden with Reservoir Detail



Profile



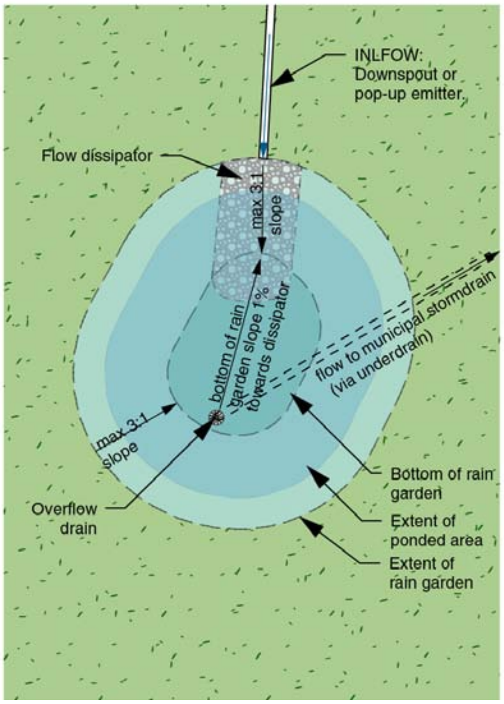
Cross Section

Rain Garden Materials

1. Overflow drain, 200 mm domed grate and adapter
2. Composted mulch, 50 – 70 mm depth
3. Bio-retention growing medium, 450 mm depth
4. Reservoir base
5. Existing subgrade/native material
6. 100 mm diameter (min) perforated pipe
7. Non-woven geotextile on bottom, sides, and top drain rock

Note: Flow dissipator inlet options and pop-up emitter details are located at the end of this section.

Figure 9: Rain Garden Plan



Sizing Factor

The size factor for the Rain Garden with Reservoir is 5%, based on the construction details included on this page. An impervious area of 100 m² would require a rain garden area* 5 m²** to manage the runoff.

*For sizing purposes, the rain garden area is calculated using the length and width of the bottom (the flat area) of the rain garden.

**Allow for an additional 0.9 m buffer around the calculated base area to determine the total footprint of the rain garden with 3:1 side slopes.

Estimated Installation Cost

Approximately $200 per square metre. Estimated installation costs include materials and installation for the standard design. These estimates are intended only as a guideline as the actual costs can vary greatly – costs per square metre are typically higher on small installations and lower on large installations.

General Design Requirements

1. Dimensions:
   a. Depth of basin (from top of growing medium to overflow elevation): 200 mm.
   b. Bottom of rain garden (flat area) width: minimum 1.0 m. (1.0 m – 3.0 m, preferable).
   c. Length to width ratio of 2 to 1 is preferred.
   d. Side slopes of rain garden: The steepest slope allowed is 3 horizontal units to 1 vertical units (3:1). Slope of 4:1 is preferred.
2. Service trench crossing: Any service trench crossings must have impervious backfill barriers (trench dams) properly installed, using compacted impervious materials, for entire trench width and extend to 200 mm above the top of the service trench, refer to figure 15, page 37.
3. Overland (surface) flow that is spread across the areas draining to it is preferred. (Grade the impervious area and softscape areas conveying water, towards the rain garden).
4. At point-source inlets (ex. pipe outlets, curb inlets) install flow dissipater to transition from inlets to growing medium.
5. Overflow drain, with connection to municipal stormdrain, is required.
   a. Protect from debris and sediment with domed grate.
   b. Allow 100 mm freeboard between the inlet elevation and the maximum ponded elevation (overflow elevation).
6. Mulch to be leaf mold, compost, shredded garden waste, well composted bark or mild, well composted manures.

7. Bioretention growing medium, 450 mm depth:

   a. Must be obtained from a supplier to meet the following specifications:

Table 6: Bioretention Growing Medium Specs

Properties		Proportions
	Particle Size Classes	Gravel component measured from total sample (% dry weight)
Gravel Component of Growing Medium	Coarse Gravel (particles greater than 19mm and less than 40mm)	0 to 1%
	All Gravels (particles greater than 2mm and less than 40mm)	10 to 25%
Texture	Sand, Silt, Clay & Organic components measured from remaining non gravel portion of sample (% dry weight)	
	Sand (particles greater than 0.05mm and less than 2mm)	60 to 70%
	Combined Silts and Clays (particles less than 0.05mm)	10 to 20%
Organic Content	Organics (particles less than 2mm)	15 to 20%

   b. Install growing medium in 200 mm lifts and compact with lawn roller. Do not over compact or this will decrease ability to infiltrate water.

   *Note: Growing medium to be manufactured with ‘2 mm minus’ sand to reduce gravel content in the soil. 2 mm minus sand is available from most local quarries upon request.

8. Perforated pipe to be 100 mm diameter PVC with minimum 2 rows of 5 mm (1/2 inch) holes.

Plant List

(Trees cannot be planted in rain gardens with rock reservoirs.)

Latin name (common name)

Edge of Rain Garden Species:

- *Cistus x corbariensis** (White Rockrose)
- *Gaultheria shallon**[1] (Salal)
- *Lonicera pileata** (Box-leaf Honeysuckle)
- *Mahonia aquifolium**[1] (Oregon Grape)
- *Myrica californica**[1] (Pacific Wax Myrtle)
- *Rosa nutkana**[1] (Nootka Rose)
- *Polystichum munitum**[1] (Sword Fern)
- *Symphoricarpos alba*[1] (Snowberry)
- *Vaccinium ovatum**[1] (Evergreen Huckleberry)
- *Viburnum davidii** (David’s Viburnum)

Bottom of Rain Garden Species:

- *Carex obnupta**[1] (Slough Sedge) shade only
- *Carex stipata**[1] (Awl Fruited Sedge) sun/shade
- *Cornus sericea* ‘Kelseyii’*[1] (Dwarf Red Dogwood)
- *Iris setosa**[1] (Dwarf Arctic Iris) sun/shade
- *Juncus* ‘Carmen’s Grey*(Carmen’s Grey Rush) sun/part shade
- *Miscanthus sinensis* ‘Adagio’* (Dwarf Maiden Grass) sun / part shade
- *Myrica gale**[1] (Bog Myrtle)
- *Schizostylis coccinea* ‘Oregon Sunset’* (Crimson Flag) sun/shade

Consult with local nursery for more suggestions.

*Generally considered to be deer resistant shrub/grass/ perennial species

[1]Species native to the Pacific Northwest coast.

9. Reservoir:

   a. Drain Rock to be 25 mm diameter washed rock, installed in maximum 300 mm lifts/layers compacted to eliminate voids between the geotextile and surrounding soils.

   b. Sand to be hard, granular sharp sand well washed and free of impurities, chemicals or organic matter.

10. Outlet pipe shall be PVC sewer pipe minimum CSA rated ≤ 35 SDR (Standard Dimension Ratio). 100 mm diameter minimum complete with PVC backflow preventer valve (if required) as per City Plumbing Code. Pipe must have a minimum 1% grade and follow the Plumbing Code.

Steps to Building a Rain Garden With or Without Reservoir

The following steps detail installation of both types of rain garden:

1. Complete Site Assessment. Refer to Site Assessment Checklist in Section 2.
2. Determine the size of roof and hardscape areas that will contribute to possible rain garden locations.
3. Determine how the water will flow downhill into the rain garden. Water can flow into the rain garden by overland flow (preferred) or through a pipe.
4. Ensure that the rain garden site is located so that the overflow drain can be connected to municipal storm drain system, and can be drained by gravity (minimum 1% slope towards drain system).
5. Design – Refer to rain garden without reservoir and rain garden with reservoir design sections above.
6. Sizing – Confirm that the bottom of the rain garden is 5% of the total impervious area that flows to into it. The bottom of the rain garden is the flat surface area, and needs to be at least 300 mm (1 foot) below the level of the surrounding landscape to allow for 200 mm ponding and 100 mm freeboard. The edges of the rain garden should slope down to the bottom of the rain garden at a maximum 3 horizontal to 1 vertical slope, so the bottom of the rain garden will be offset at least 900 mm from the perimeter of the rain garden area.
7. Layout the size and shape of the rain garden's total area on the ground using string, a garden hose, or spray paint. Measure to get the size you need and adjust the shape. Don't forget to consider aesthetics! Rain gardens are attractive and can enhance or become a feature of your landscape.
8. Submit completed design as part of the Rainwater Rewards Application for pre-approval before starting work to confirm the design meets program requirements. Once pre-approval is granted, work can start.

9a. Rain garden without reservoir

   i. Excavate 800 mm of native soil from the rain garden area (200 for ponding + 100 for freeboard + 450 for growing medium + 50 for mulch). The bottom of the rain garden must be flat and the full 800 mm depth. The side slopes of the rain garden excavation can be at a maximum 2:1 slope (2 units vertical for every 1 unit horizontal).

   ii. Scarify the bottom of the rain garden to a depth of 300 mm below the base of excavation, to reduce compaction and encourage infiltration. You can scarify the subsoil with a rototiller or cultivator.

9b. Rain garden with reservoir

   i. Excavate 1100 mm of native soil from the rain garden area (200 for ponding + 100 for freeboard + 300 mm rock reservoir + 450 mm for growing medium + 50 for mulch). The bottom of the rain garden must be flat and the full 1100 mm depth. The side slopes of the rain garden excavation can be at a maximum 2:1 slope (2 units vertical for every 1 unit horizontal).

   ii. Scarify the bottom of the rain garden to a depth of 300 mm, to reduce compaction and encourage infiltration. You can scarify the subsoil with a rototiller or cultivator.

   iii. Place woven geotextile on the bottom and sides of the excavated area. Overlap pieces of geotextile 600 mm, if necessary. The geotextile should be long enough to wrap the top of the rock reservoir.

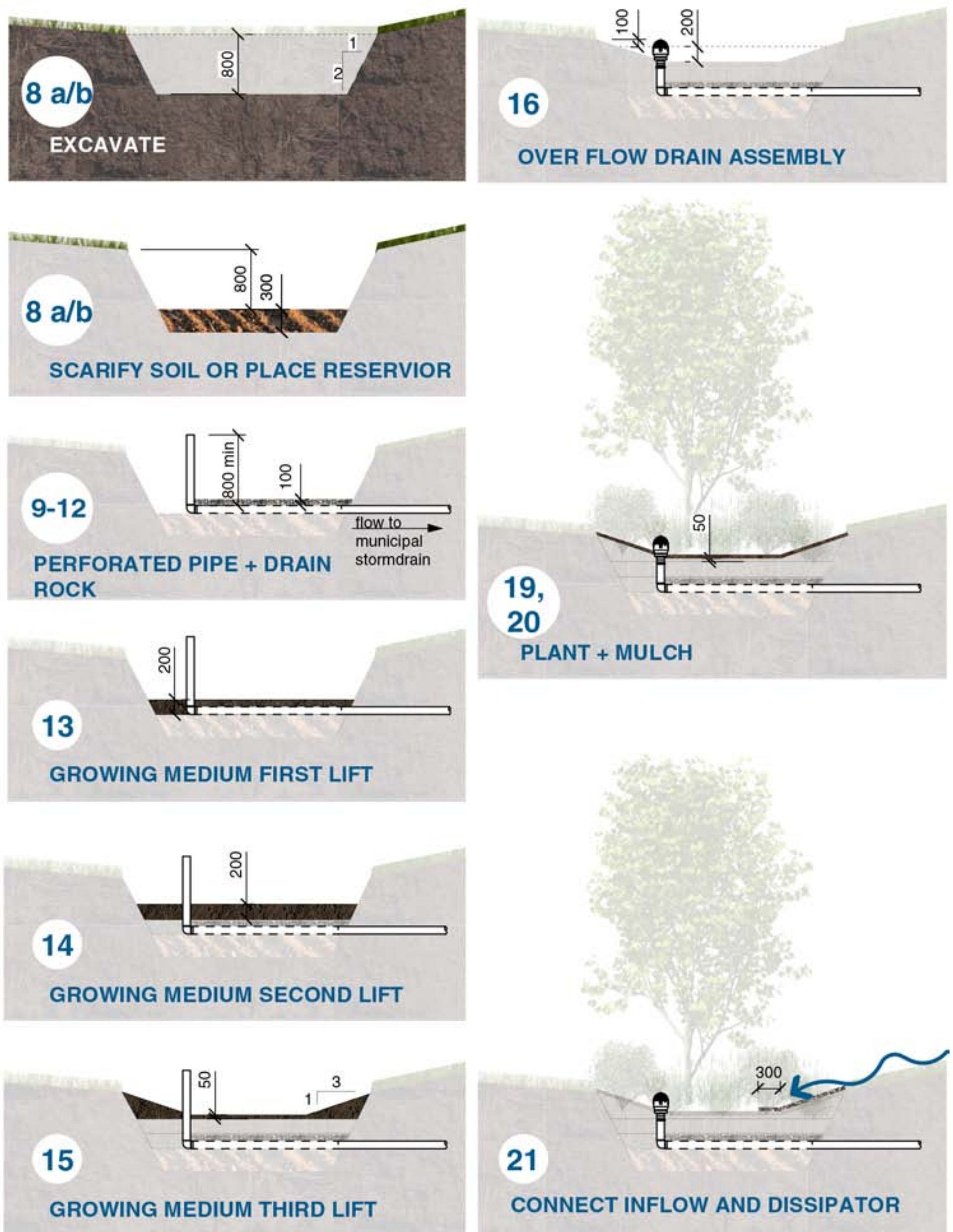
   iv. Place the drain rock in 100 mm lifts (100 mm depth layers). After placing each lift, moisten by sprinkling with water and compact with mechanical tamper.

   v. Place woven geotextile on the top of the drain rock. Overlap pieces of geotextile 600 mm, if necessary.

10. Place the 100 mm diameter perforated pipe (underdrain) with holes facing down along the bottom of rain garden, usually along the length of the rain garden. The scarified soil should be mounded along the alignment of the underdrain, so that the bottom of the pipe is 150 mm above the bottom of the rain garden.

11. Connect the downstream end of the perforated pipe with a solid pipe, to the building sump or to the municipal stormwater system using a backwater valve when the overflow elevation is lower than the crown of the road, as per City of Victoria's Plumbing Code.

Figure 10: Illustrated Rain Garden Steps



12. The other end of the perforated pipe will be connected to the overflow drain assembly with a 90 degree pipe connector, referred to as an 'elbow joint'. Connect a pipe that is at least 800 mm long to the elbow joint. This will become the overflow pipe and will keep sediment and rock out of the underdrain, while drain rock and growing medium is installed over the perforated pipe.
13. Place 100 mm of drain rock to cover the perforated pipe on the top and the sides, to prevent the soil/growing medium from clogging the perforations in the pipe (Note: do not use fabric covered pipe, or cover pipe with fabric).
14. Place 200 mm of growing medium in the rain garden area and lightly compact the growing medium with a weighted lawn roller, or by walking on it. The growing medium should be firm enough that deep footprints are not created when walked on.
15. Place another 200 mm of growing medium and lightly compact using the same method.
16. Repeat with the final 50 mm of growing medium. The finished grade of the growing medium should slope up the edges of the rain garden (maximum 3 horizontal to 1 vertical slope). The bottom of the rain garden should slope at a 1% grade towards the inlet. To check the slope, use a flat piece of wood (ex. 2" x 4") and a level. There should be 10 mm (1 cm) of drop for every 1 m of rain garden length.
17. Install overflow drain assembly. Trim the overflow pipe to the correct height to accommodate the drain. Ensure the inlet (top of drain pipe – NOT the top of grate) is 100 mm below the crest of the rain garden edges, and 200 mm above the bottom of the rain garden. Protect the overflow from growing medium with a plastic or fabric bag/ cover while the remaining work is completed (remove cover when complete).
18. Install automatic irrigation system (permit and inspection required), if desired. Rain gardens normally need to be watered regularly for 1 to 2 years to establish the plants. After the plants are established, regular watering is optional.
19. Select a mix of shrubs, grasses/rushes/sedges, and trees from the plant list, or consult with your local nursery for suggestions. Mulch all grass/sedge areas with 50–70 mm of compost mulch prior to planting.
20. Plant and water well. The bottom of the rain garden must be planted. Covering the bottom of the rain garden with rock is NOT acceptable (planting is essential for the rain garden to function properly). Place shrubs and grasses with space for ½ to ¾ the plants diameter at maturity (mature spread) between plants.
21. Install 50–70 mm of compost mulch on the surface of the rain garden, in shrub and tree areas.
22. Layout and install the overland flow path, or pipe alignment to direct runoff into the rain garden. Overland flow paths must go downhill, with the rain garden being the lowest point, relative to the surfaces it will be managing. Water always runs straight downhill! If runoff is piped to the rain garden, the bottom of the pipe must be no lower than the top of pool (overflow point) so that the pipe does not backwater and must have a flow dissipater (see following page for details). Do not connect rain water flow path/pipe until after rain garden is completed, to avoid messy, saturated soils.

Design Considerations

1. Inclusion of sediment traps at drain inlets helps reduce maintenance requirements.
2. Trees should not be planted over the rock reservoir area. Substitute rock with sand and do not install filter fabric if planting a tree is desired.
3. Rain gardens can take many shapes to suit the site and aesthetic qualities desired.

Construction Tips

1. Subgrade must be free of water, mud, and soft clay prior to installation of growing medium.
2. Divert water away from rain garden until installation of rain garden, including plant material, is fully complete.
3. Install growing medium in 200 mm lifts and lightly compact with lawn roller.

Maintenance

Both types of rain gardens must be protected from foot traffic as well as vehicles and other loads, especially during wet conditions. This is to prevent compaction and preserve the infiltration capacity of the soil.

General Maintenance Guidelines During Establishment Period (first one to two years):

- Water the rain garden regularly for the first one to two years, until plants are well established.
  - Water deeply, but not frequently, every week or as needed. The top 150 to 300 mm of soil should be moist.
  - Use soaker hoses or irrigation system if possible; if not, use slow-release watering devices such as tree bags to water trees and shrubs
- Every other week during spring and summer (growing season):
  - Weed control – remove weeds by hand as needed and dig or pull weeds out by the roots before they go to seed to control their spread.
- On a monthly basis during spring and summer (growing season):
  - Check irrigation coverage and adjust as needed to ensure all plants are getting the water they need; and
  - Remove debris, including garbage, broken branches and dead vegetation, and any excess accumulation of sediment.
- Every other week during fall and winter (rainy season):
  - Inspection and debris removal from inflow and overflow (leaf fall in planting areas need not be cleared); and
  - Inspection and correct of erosion problems. Armor erosion areas with small stones.
- Bi-annual (spring and fall):
  - Check mulch depth and add mulch or coarse compost by hand as required. Mulch depth should be uniform 50 – 75 mm depth;

Do not mound mulch against woody trunks; and

- Add compost and cultivate into the soil.

General Maintenance Guidelines After Establishment Period:

- Water plants during drought conditions or as needed to maintain plant cover
- Monthly inspection for:
  - Weeds and debris (sediment and vegetative litter); and
  - Erosion and ponding problems.
- If you notice excessive ponding (more than 48 hrs), investigate cause. Look for clogs and check connections and grades.
  - Clean sump and pipes of sediment and debris;
  - Remove leaves clogging the outlet or matted in the bottom of the rain garden or bioswale;
  - Assess if fine sediment is clogging the growing medium and remove and replace if required; and
  - Assess if water is coming into the rain garden from unexpected sources, either the catchment area has increased or another area has been routed to the rain garden that was not part of the original design – if so and the extra water is having an adverse impact on the plants and soil the extra water must be diverted to the stormwater system.
- If you notice erosion on the slopes of the rain garden or bioswale:
  - Investigate the source of flows to that area and whether the flow is entering as it should or is concentrating somewhere that it should not outside the rain garden or bioswale. Correct as needed.
  - If erosion is caused by flow that is too fast, consider ways of slowing the flow or using rocks to protect the soil where the erosion is occurring.

Annual Maintenance Recommended:

- Soil test to determine nutrient requirements in spring (fertilization regime);
- Pruning of rain garden rushes (Juncus species) just below seed heads in November/December; and
- Pruning of trees to direct growth or correct structural problems during winter (dead, damaged, or diseased branches can be removed as needed throughout the year).

Figure 11: Downspout to Flow Dissipator

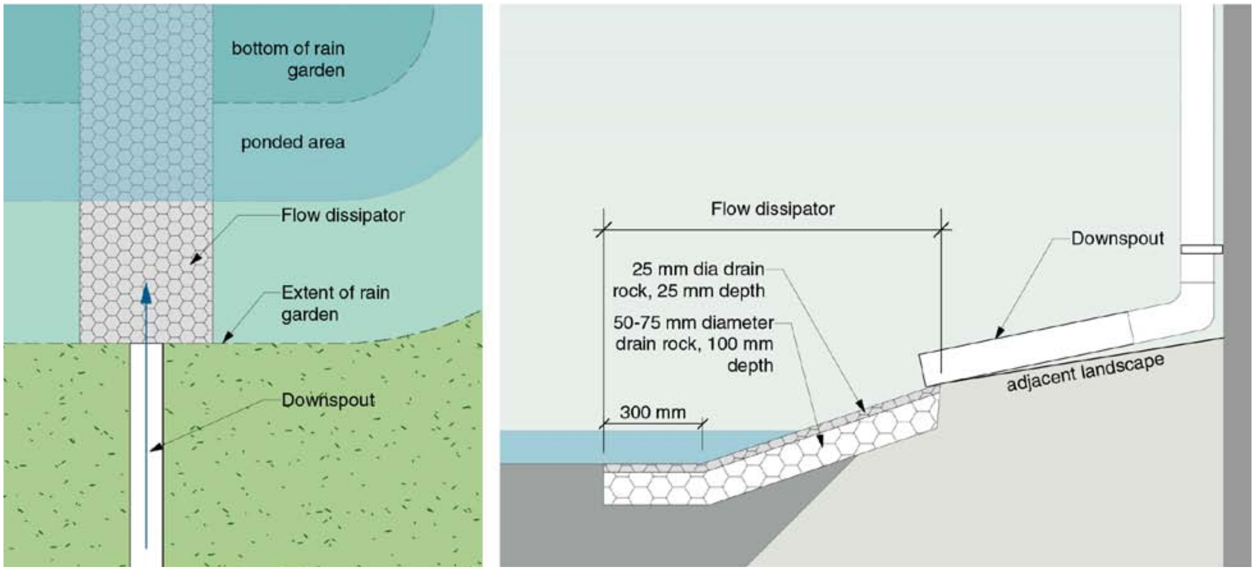


Figure 12: Pop-Up Emitter to Flow Dissipator

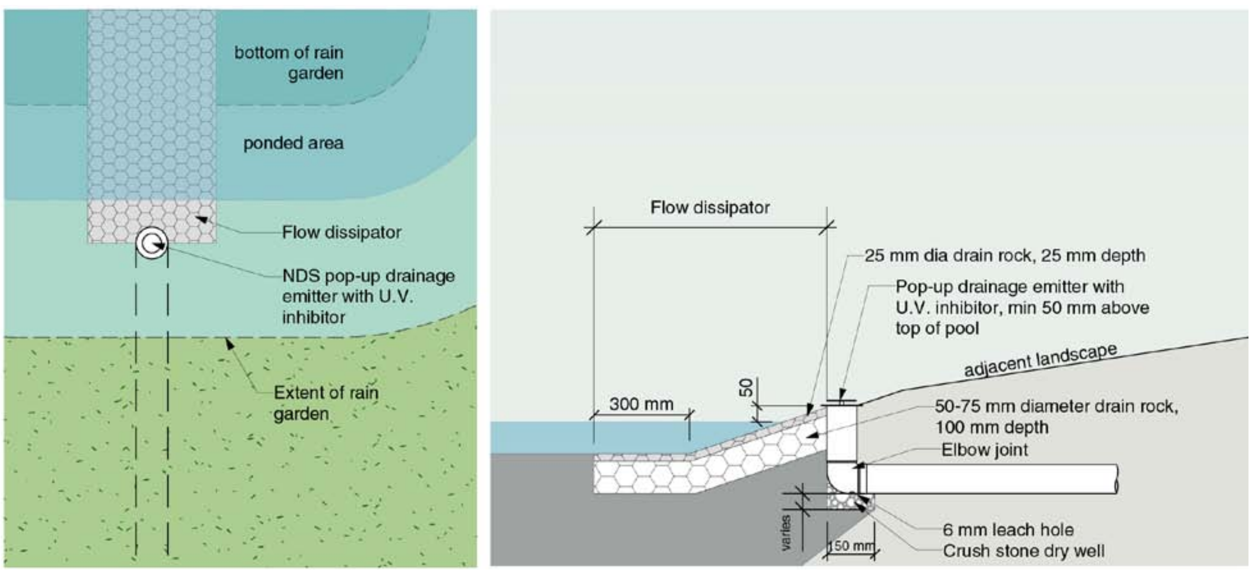
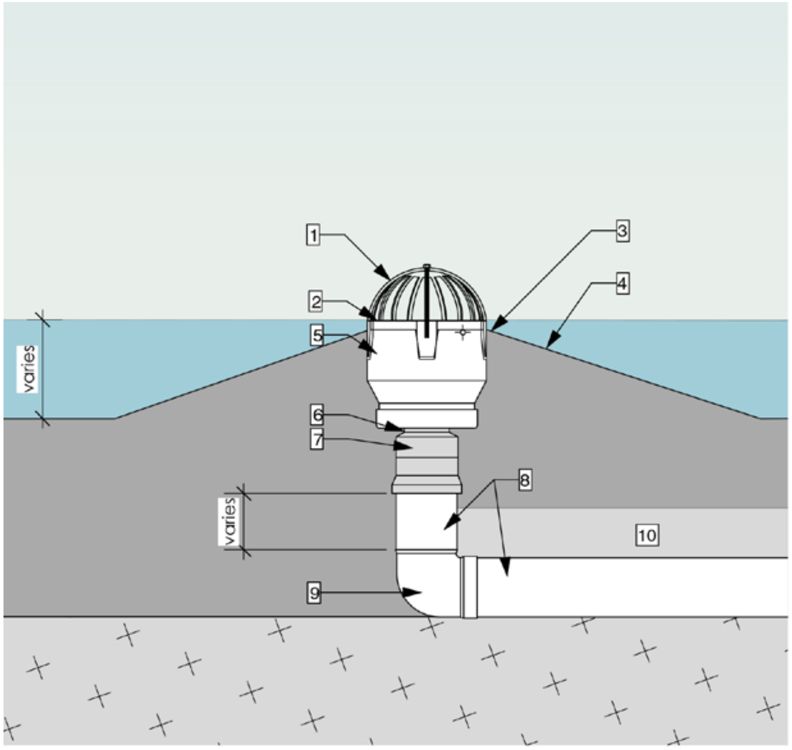
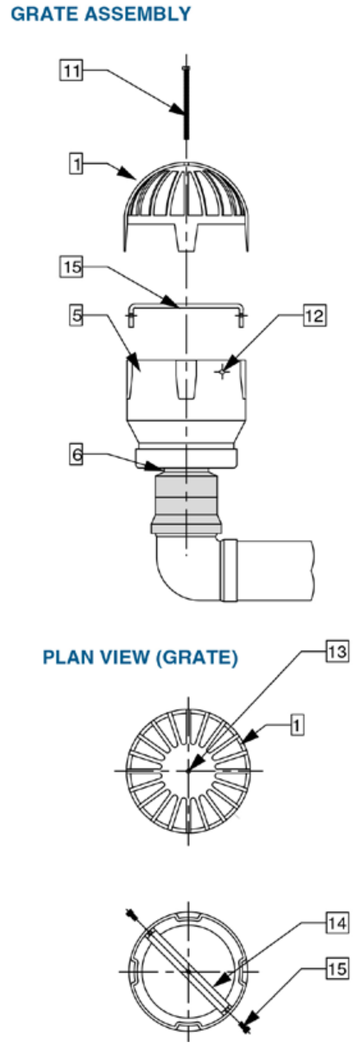


Figure 13: Overflow Assembly with Domed Grate





Materials

1. 200 mm locking dome grate, ductile iron
2. Drain invert elevation
3. Finished grade, growing medium
4. Max 3:1 slope
5. In line drain
6. Watertight joint
7. Adapter to fit 4" PVC pipe
8. 100 mm dia pipe
9. Elbow joint
10. 25 mm dia drain rock
11. Hex bolt, zinc-plated steel
12. Drill hole through 2 places for fasteners
13. Drill hole through for hex bolt
14. 200 mm ductile iron grate lock bar
15. Socket head cap screw (allen head), black steel. 2 places

Infiltration Chamber

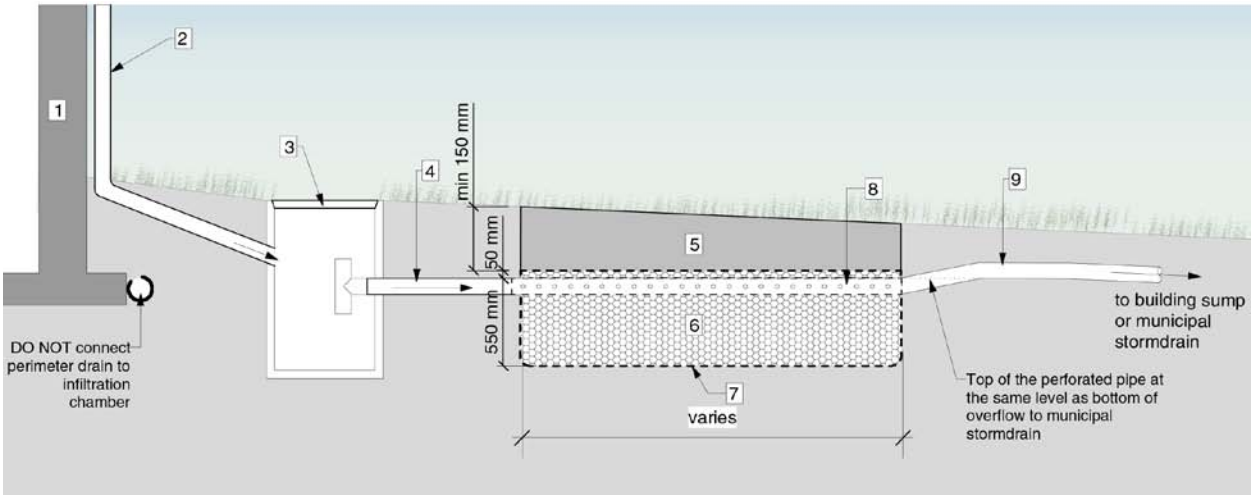
Infiltration chambers are underground tanks or chambers with permeable bottoms that are designed to slowly release water into the ground over time, returning rainwater to the natural water table. The water is not reused.

There are two types of infiltration chambers: rock-filled, and open. Only rock-filled infiltration chambers are available for DIY design and construction, due to the complexity of the open infiltration chamber.

Rock Infiltration Chamber

A rock infiltration chamber/trench is an underground water storage facility constructed with course aggregate. Water fills the pore spaces between the aggregate, and the facility will typically be designed to infiltrate water into the surrounding soil.

Figure 14: Rock Infiltration Chamber Detail



Materials

1. Structural wall
2. Building rainwater leader/downspout
3. Infiltration chamber sump
4. Solid pipe to infiltration chamber
5. Growing medium
6. Drain rock, 550 mm depth
7. Non-woven geotextile on bottom, sides, and top of drain rock
8. 100 mm diameter (min) perforated pipe
9. Solid overflow pipe complete with PVC backflow preventer valve (if required) as per City Plumbing Code.

Sizing Factor

The size factor for rock infiltration chamber is 13%. An impervious area of 100 m2 would require 13 m2 of rock infiltration chamber to manage the runoff.

Estimated Installation Cost

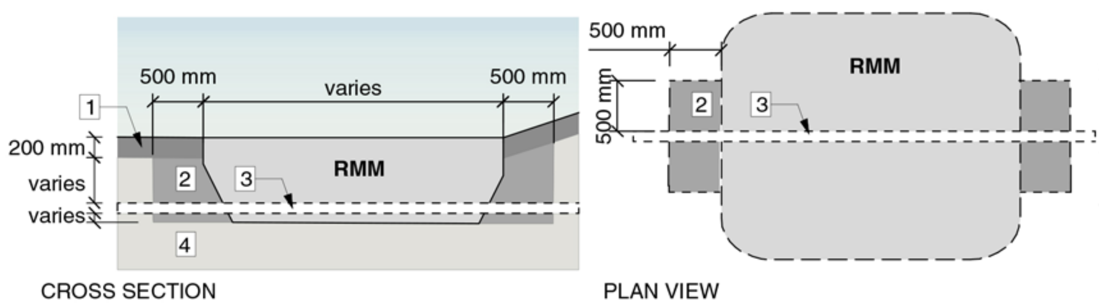
Approximately $3250 per cubic metre of water stored OR approximately $625 per square metre infiltration chamber. Estimated installation costs include materials and installation for the standard design. These estimates are intended only as a guideline as actual costs can vary greatly – costs per cubic metre are typically higher on small installations and lower on large installations.

General Design Requirements

1. Minimum depth of 600 mm is required from base of infiltration chamber to water table or solid bedrock.
2. Service trench crossing: Any service trench crossings must have impervious backfill barriers (trench dams) properly installed, using compacted impervious materials, for entire trench width and extend to 200 mm above the top of the service trench.
3. Maximum of three chambers are allowed for DIY applications.
4. Sump shall be concrete, plastic, or other non-degradable box with strength suitable to withstand surface loads.
5. Solid pipe to be CSA B182. Grade pipe at minimum 1% slope.
6. Perforated pipe to be 100 mm diameter PVC with minimum 2 rows of 5 mm (1/2 inch) holes. Grade perforated pipe at minimum 1% slope.
7. Geotextile to be installed with 600 mm minimum overlap at all joints.

8. Drain rock, minimum 550 mm depth to be angular or round stone containing no fines. Many stone sizes may be acceptable as long as the minimum porosity of the trench is 0.35.
9. Outlet pipe connected to the stormwater system shall be PVC sewer pipe minimum CSA rated ≤ 35 SDR (Standard Dimension Ratio). 100 mm diameter minimum complete with PVC backflow preventer valve (if required) as per City Plumbing Code. Outlet pipe must have a minimum 1% grade and follow the Plumbing Code.

Figure 15: Service Trench Crossing



Materials
1. Growing medium, min 200 mm depth
2. Compacted impervious backfill (glacial till or clay) for entire service trench width
3. Underground pipe crossing (water, gas, sewer, etc.)
4. Native subgrade

Steps to Installing a Rock Infiltration Chamber

The following steps detail installation of a rock infiltration chamber:

1. Complete Site Assessment. Refer to Site Assessment Checklist in Section 2.
2. Determine the size of roof and hardscape areas that will contribute to possible infiltration chambers. Roof runoff can be piped from the building sump to the infiltration chamber directly. Runoff from paved surfaces must be pre-treated by an upstream oil/grit separator before entering an infiltration chamber, to remove pollutants and can be connected by surface or underdrain.
3. Ensure that the infiltration chamber is located so that the overflow drain can be connected to a municipal stormwater system. Alternately, the infiltration chamber can be connected to an existing building sump that is connected to the municipal stormwater system.
4. Install building sump that can be connected to downspout, if not already installed.
5. Excavate soil to a minimum depth of 750 mm.
   a. If you are connecting to an existing building sump that is connected to the municipal stormwater system, the depth of the infiltration chamber may be dependent on the elevation of the overflow pipe from the building sump. The top of the perforated pipe should be at the same level as the bottom of the building sump overflow pipe, or overflow pipe to the municipal stormwater system.
6. Scarify the native soil so that the surface is loose and friable.
7. a. Place woven geotextile on the bottom and sides of the excavated area. Overlap pieces of geotextile 600 mm, if necessary. The geotextile should be long enough to wrap the top of the infiltration chamber.
   b. Install observation well pipe to level of proposed finished grade.
   c. Place and spread 100 mm of drain rock, without wrinkling or folding the geotextile. Compact with mechanical tamper.
   d. Place and spread the remaining drain rock to a depth that is equal to the total depth minus 100 mm (to allow for installation of 100 mm diameter perforated pipe). Place the drain rock in 100 mm lifts (100 mm depth layers). After placing each lift, moisten by sprinkling with water and compact with mechanical tamper.
   e. Install 100 mm diameter perforated pipe, and connect to one end to the building sump. At the sump, the perforated pipe should connect to a 100 mm PVC Tee with an orifice in the bottom.

f. Connect the other end of the perforated pipe to the municipal stormwater system, with 100 mm diameter solid pipe. The top of the infiltration chamber overflow drain pipe should be at the same level as the bottom of the pipe connected to the municipal stormwater system.

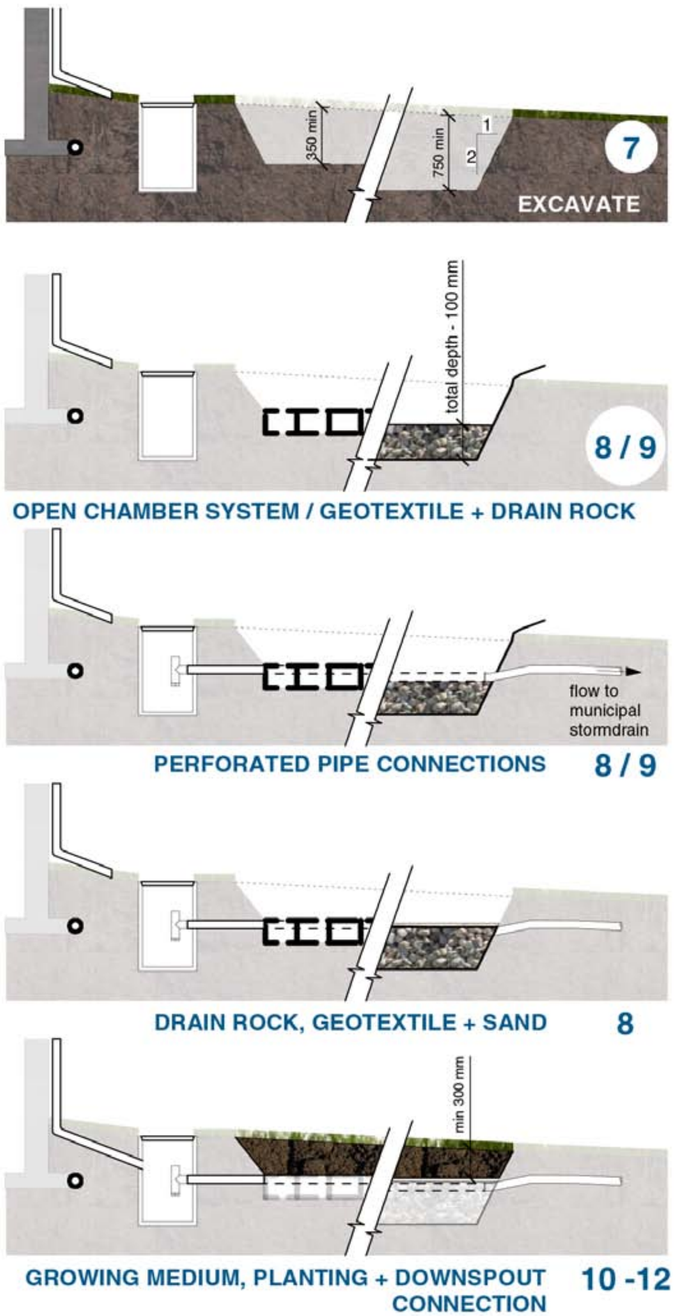
g. Place and spread a final 100 mm of the drain rock. Compact with mechanical tamper.

h. Place woven geotextile on the top of the drain rock. Overlap pieces of geotextile 600 mm, if necessary.

i. Place 50 mm depth of sand over geotextile.

9. Connect downspout to sump, if it is not already connected.
10. Connect building sump to municipal stormwater system, if it is not already connected. A backflow preventer may be required.
11. Place a minimum of 150 mm of growing medium as cover, and plant as desired.

Figure 16: Illustrated Infiltration Chamber Steps



Maintenance

- Inspect sumps annually and clean as required. Sediment should be removed from the sump bottom and floatables removed from the water surface.
- If the infiltration chamber has an observation port, check periodically every few years during dry weather to be sure that water is not remaining in the chamber for more than 4 days after a rain event.
- If the water is not draining from the chamber then the infiltration surface is clogged. There is no repair for this except removal of the existing chamber, rehabilitation of the subsurface soils (if possible) and replacement of the chamber.

Permeable Paving

Pervious/permeable paving is a permeable paving system constructed with specialized impervious modular pavers. The pavers are designed to have gapped joints between pavers which are filled with porous joint stabilizer. Water percolates between the pavers to the base material and reservoir below. Not all unit pavers are permeable; only pavers designed specifically to be permeable will be eligible for rainwater management incentives.

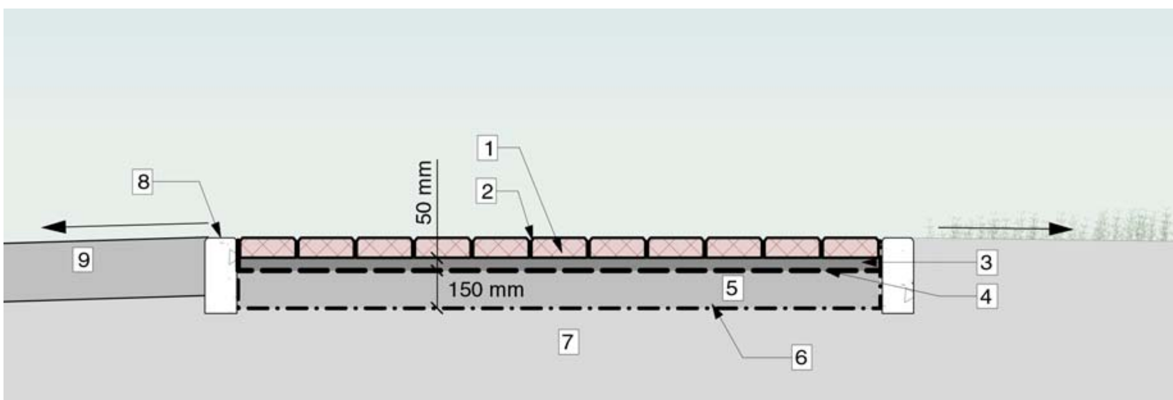
Two types of permeable unit pavers are depicted here: with, and without underdrain.

If considering other permeable paving options such as permeable asphalt or concrete, a professional must be used.

Permeable Unit Pavers Without Reservoir

Permeable unit paving areas do not require a rock reservoir and underdrain system if no additional runoff is directed to the area. Rainwater that falls on the pavers percolates through the joints and infiltrates into the soil/subgrade below.

Figure 17: Permeable Paver Without Reservoir Detail



Permeable Unit Paving Materials

1. Permeable unit paving stone
2. Joint stabilizer
3. Open-graded paver bedding course, 50 mm depth
4. Non-woven geotextile
5. Open-graded base, 150 mm depth
6. Woven geotextile
7. Existing subgrade/native material
8. Curb/edge restraint
9. Impervious paving

Sizing Factor

Permeable unit paving areas without a rock reservoir can manage only the rain that falls directly on them, no sizing calculations are required.

Estimated Installation Cost

Approximately $200 per square metre. Estimated installation costs include materials and installation for the standard design. These estimates are intended only as a guideline as actual costs can vary greatly – costs per square metre are typically higher on small installations and lower on large installations.

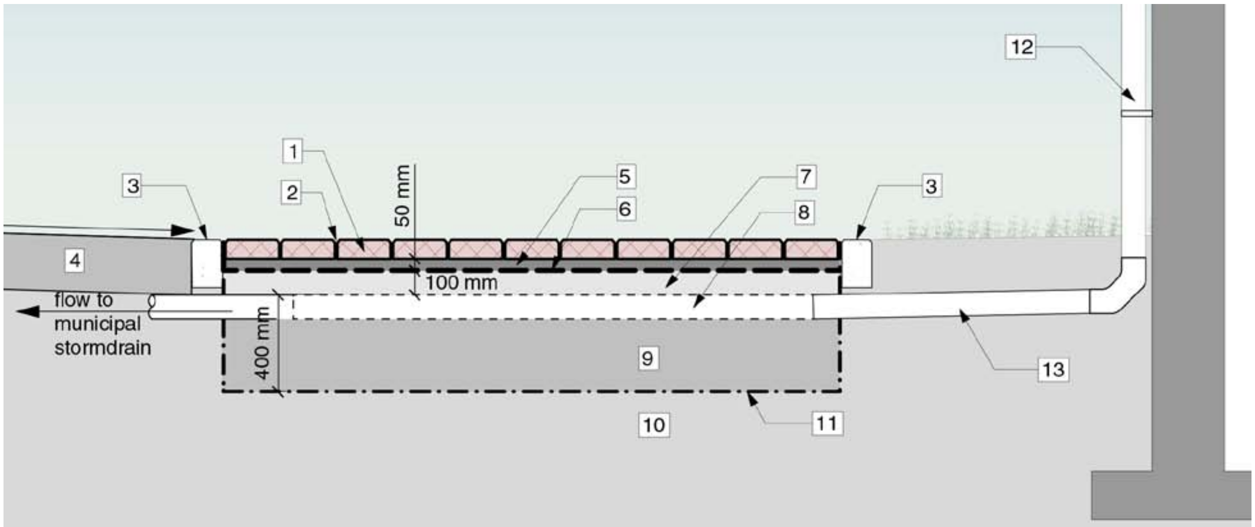
General Design Requirements

1. Minimum depth of 600 mm is required from the bottom of the permeable paving excavation to water table or solid bedrock.
2. Provide edge restraint to contain pavers on all edges. Most manufacturers have a recommended edge restraint system.
3. Pavers:
   a. Permeable Interlocking Concrete Pavers meeting CSA A231.2, designed and tested by the manufacturer for use as part of a permeable paving system with an initial infiltration rate >280 mm/hr and a maintained >28 mm/hr infiltration rate over the pavement life.
   b. Install pavers to manufacturer's instructions.
   c. Pavers to be 80 mm thick for all drivable surfaces.
   d. Permeable Paving surface slope should be 1% minimum to avoid ponding on the surface.
4. Joint Stabilizer:
   a. As per manufacturer's recommendations.
5. Aggregates:
   a. Subbase and bedding materials must be clear crushed open-graded aggregates. Percentage of angular and sub-angular particles greater than 90%. Do not use rounded river gravel.
6. Paver bedding course, 50 mm depth:
   a. Shall be open-graded crush 5 mm aggregate (or ASTM No. 8 – no sand).
7. Open-Graded base, 150 mm depth:
   a. Shall be clean crushed stone graded from 5 mm to 20 mm, installed in lifts no deeper than 100 mm.
8. Non-woven geotextile to be installed between Open-Graded base and paver bedding course
   a. Non-woven geotextile: synthetic material, that conforms to manufacturer's recommendations, with 600 mm minimum overlap at all joints.
9. Open-Graded base shall be lined with woven geotextile filter cloth on bottom and sides.
   a. Woven geotextile: synthetic material, that conforms to manufacturer's recommendations.
10. Subgrade should not require compaction if it is excavated into existing consolidated (i.e. "settled") ground. If fill is being used below permeable pavers it must be compacted in accordance with City requirements for paving subgrade prior to installation of any of the permeable paver system elements.
11. Service trench crossing: Any service trench crossings must have impervious backfill barriers (trench dams) properly installed, using compacted impervious materials, for entire trench width and extend to 200 mm above the top of the service trench, refer to figure 15, page 37.

Permeable Paving with Rock Reservoir

Permeable paving areas designed and built with a rock reservoir include an underdrain system and can manage runoff from other impervious paving and roof surfaces, provided they are properly maintained. Runoff percolates through the paving system and infiltrates the reservoir before entering the subgrade below, and the underdrain carries overflow to the municipal stormwater system.

Figure 18: Permeable Paver With Reservoir Detail



Permeable Paving With Rock Reservoir Materials

1. Permeable paving stone
2. Joint stabilizer
3. Curb/edge restraint
4. Impervious paving
5. Open-graded paver bedding course, 50 mm depth
6. Non-woven geotextile
7. Open-graded base, 150 mm depth
8. Perforated drain pipe, 100 mm dia min.
9. Open-graded rock reservoir, 400 mm depth
10. Exostomg singrade/native material
11. Woven geotextile on bottom and sides of reservoir
12. Downspout
13. Piped downspout connection

Sizing Factor

The size factor for permeable paving with rock reservoir is 20%, based on the above reservoir design. For example, an impervious area of 100 m^2 would require 20 m^2 of permeable unit paving with rock reservoir to manage the runoff.

Estimated Installation Cost

Approximately $300 per square metre. Estimated installation costs include materials and installation for the standard design. These estimates are intended only as a guideline as actual costs can vary greatly – costs per square metre are typically higher on small installations and lower on large installations.

General Design Requirements

1. Minimum depth of 600 mm is required from the bottom of the permeable paving excavation to water table or solid bedrock.
2. Provide edge restraint to contain pavers on all edges. Most manufacturers have a recommended edge restraint system.
3. Pavers:
   a. Permeable interlocking concrete pavers meeting CSA A231.2, designed and tested by the manufacturer for use as part of a permeable paving system with an initial infiltration rate >280 mm/hr and a maintained >28 mm/hr infiltration rate over the pavement life.
   b. Install pavers to manufacturer's instructions.
   c. Pavers to be 80 mm thick for all driveable surfaces.
   d. Permeable paving surface slope should be 1% minimum to avoid ponding on the surface.

4. Joint Stabilizer:
   a. As per manufacturer's recommendations for the selected pavers.
5. Aggregates:
   a. Base and bedding materials must be clear crushed open-graded aggregates. Percentage of angular and sub-angular particles greater than 90%. Do not use rounded river gravel.
6. Paver bedding course, 50 mm depth:
   a. Shall be open-graded crush 5 mm aggregate (or ASTM No. 8 – no sand).
7. Open-Graded base, 100 mm depth:
   a. Shall be clean crushed stone graded from 10 mm to 6 mm, installed in lifts/layers no deeper than 100 mm and compacted.
8. Open-Graded Reservoir, 400 mm depth:
   a. Shall be clean crushed stone graded from 5 mm to 20 m, installed in lifts/layers no deeper than 150 mm and compacted.
9. Non-woven geotextile to be installed between Open-Graded base and paver bedding course
   a. Non-woven geotextile: synthetic material, that conforms to manufacturer's recommendations.
10. Open-Graded Reservoir shall be lined with woven geotextile filter cloth on bottom and sides.
    a. Woven geotextile: synthetic material, that conforms to manufacturer's recommendations.
11. Perforated pipe to be 100 mm diameter PVC with minimum 2 rows of 1/2 inch holes.
12. Outlet pipe shall be PVC sewer pipe minimum CSA rated ≤ 35 SDR (Standard Dimension Ratio). 100 mm diameter minimum complete with PVC backflow preventer valve (if required) as per City Plumbing Code. Pipe must have minimum 1% grade and follow the Plumbing Code.
13. Subgrade should not require compaction if it is excavated into existing consolidated (i.e. "settled") ground. If fill is being used below permeable pavers it must be compacted in accordance with City requirements for paving subgrade prior to installation of any of the permeable paver system elements.
14. Service trench crossing: Any service trench crossings must have impervious backfill barriers (trench dams) properly installed, using compacted impervious materials, for entire trench width and extend to 200 mm above the top of the service trench, refer to Figure 15 on page 37.

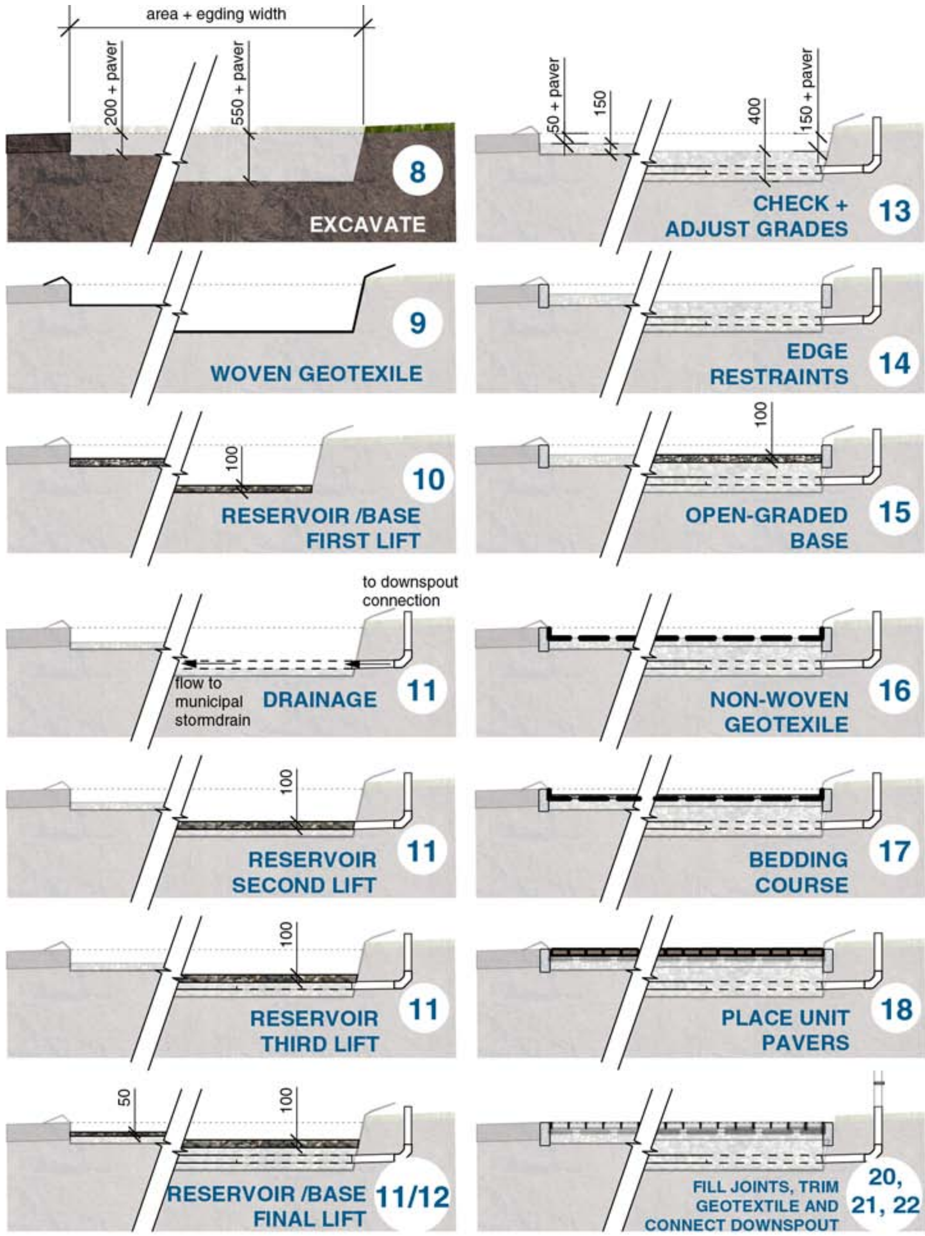
Steps to Installing Permeable Unit Paving

The following steps detail installation of Permeable Paving with and without rock reservoir:

1. Complete Site Assessment. Refer to Site Assessment Checklist in Section 2.
2. If you are planning to direct runoff from roof or other impervious hardscape areas to the Permeable Paving area, you must construct it with a rock reservoir. Determine the size of roof and hardscape areas that will contribute to permeable unit paving locations.
3. If you are planning to construct permeable paving without a rock reservoir, you may not discharge runoff from roof or impervious hardscape areas to the pervious paving.
4. Water flowing from a roof downspout must flow into the permeable paving reservoir through a pipe or be discharged at the surface in a safe location. Runoff from an adjacent impervious hardscape area can flow to the pervious paving area on the surface.
5. Ensure that the permeable paving with rock reservoir area is located so that the overflow drain can be connected to municipal storm drain system.
6. Sizing – For pervious paving with a rock reservoir, confirm that the permeable paving area is 20% of the total impervious area that flows to into it. Without the rock reservoir, the permeable unit paving manages only the rainwater that falls on the pervious paving area.
7. If you are installing new paving (in an area where no paving currently exists), layout the size and shape of the permeable paving area using a string line and stakes. You will need to leave room for a curb or edge restraint around all edges that are not currently paved.

8. Remove old paving area and/or existing soil, and excavate to a depth of 550 mm + the height of the paving stone, if installing a rock reservoir. For permeable unit paving without reservoir, excavate to a depth of 200 mm + the height of the paving stone. Ensure the finished grade of the new paving will meet the level of adjacent hardscape and softscape areas. The slope of the pervious paving area should not exceed 8%.
9. Place woven geotextile on the bottom and sides of the excavated area. Overlap pieces of geotextile 300 mm, if necessary. The geotextile should be long enough to exceed the finished grade of the paving, and can be cut flush once pavers are installed.
10. Place and spread 100 mm of open-graded base or reservoir, without wrinkling or folding the geotextile. Compact with mechanical tamper.
11. For rock reservoir installation only:
    a. Place the 100 mm diameter perforated pipe.
    b. Connect one end of the perforated pipe, with a solid pipe to the municipal stormwater system.
    c. Place and spread another 100 mm of open-graded reservoir. Compact with mechanical tamper.
    d. Repeat with another 100 mm of open-graded sub-base, using the same method.
    e. Repeat with the final 100 mm of open-graded reservoir, using the same method.
12. For installation without rock reservoir:
    a. Place and spread the final 50 mm of open-graded sub-base. Compact with mechanical tamper.
13. The compacted base must be uniform. Check, and adjust as needed, to ensure that the elevation of the compacted base is:
    a. 150 mm + the height of the paving stone, below the proposed finished grade, if installing a rock reservoir OR
    b. 50 mm + the height of the paving stone, below the proposed finished grade, if installing without reservoir.
14. Install edge restraints around perimeter of permeable unit paving area. Construct wood forms, mix, pour concrete and level.
15. For rock reservoir installation only:
    a. Place and spread 100 mm of the open-graded base. Moisten by sprinkling with water and compact with mechanical tamper.
16. Place non-woven geotextile over compacted open-graded base. Overlap pieces of geotextile 300 mm, if necessary.
17. Place and spread 50 mm of the open-graded bedding course. Compact with mechanical tamper. Use a screed board (2" x 4") to smooth the bedding layer to the level of the completed surface. Avoid walking on the screeded surface.
18. Hand place stones in desired pattern, beginning in one corner. Spaces between pavers should be as per manufacturer's recommendations.
19. Once all stones are laid, sweep surface and compact the entire surface in both directions with tamper, or as per manufacturer's recommendations.
20. Apply joint stabilizer to the surface, and sweep into joints. Tamp the entire surface again, and apply and sweep more joint stabilizer to completely fill all joints.
21. Trim excess geotextile.
22. Connect downspout to pipe, or layout and install the overland flow path of the inflow for runoff to enter the pervious paving.

Figure 19: Illustrated Permeable Paver Steps



Construction Tips

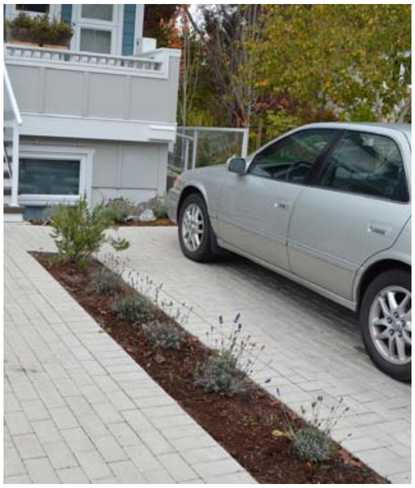
1. Install permeable pavement after all building and landscaping has been completed. Where this is impractical, protect permeable paving from sediment during construction to reduce clogging.

Maintenance

Successful maintenance for permeable paving includes regular removal of sediment, debris and excess moss for the surface of the permeable paving to prevent clogging of the surface pores that allow water to drain through.

- For small areas: sweep surface semi-annually or vacuum with a shop vac. Take care not to dislodge and remove small aggregate from between permeable paver block or from within paver grids.
- For large areas: vacuum sweep pervious paving when ponding on the surface is observed, or once every year.
- Remove excess moss during the summer when it is dry by using a stiff broom or, for large areas, a power washer with rotating brushes.
- Remove accumulations of organic debris and leaf litter in the fall or as needed.
- Underdrain sump or building sump (if any – will not be present for permeable pavement that has no underdrain) should be inspected and cleaned annually or as required.

- Winter care:
  - Snow should not be stockpiled on permeable pavement.
  - Snow removal should be done by hand whenever possible to avoid damage to the surface of the permeable paving; alternatively plow blades should be raised on skids or rollers; environmentally friendly chemical de-icers, e.g. salt or molasses based may be used in moderation.
  - Sand and cinders should not be used on permeable paving , but if they are accidentally applied, the sediment should be swept or vacuumed up as soon as possible.
- If surface appears clogged and ponding is present, there are several options to remediate the surface:
  - Perform annual sweeping and/or vacuuming and see if that removes the problem;
  - Pressure wash the surface with a hand-held pressure washer, then vacuum sweep the surface; and
  - Use a power washer with rotating brushes to clean the surface, then sweep or vacuum to remove sediment.
- Clean up harmful material spills immediately to prevent contamination of runoff going to the stormwater system and the aggregate layers and soil below the pavement.
- Adjacent landscaping areas must be stabilized so that soil is not eroding and depositing on the permeable pavement.
- Landscaping materials including soil, sand, compose mulch and fertilizer must not be stockpiled on permeable pavement.
- If surface is broken or paver blocks or grids become uneven and the surface is no longer flat, the surface may become a trip hazard:
  - Try to determine causes of damage. Causes may include heavy vehicles or higher vehicle speeds than intended by design; dislodging by maintenance or other vehicles; movement of base courses that were not fully compacted or inappropriately sized; or disruption from tree roots.
  - Remove causes of damage as needed.
  - Remove and re-set uneven portion of paving. Take care that and material clogged with fines is removed, and the area and new materials are protected from sediment during the repair process.
  - If the area is very small relative to the overall size of the facility, impervious asphalt or concrete may be used to replace permeable asphalt or concrete pavement sections. If the area is large enough to affect the overall performance of the facility, the area must be replaced with the same permeable surface to maintain the function of the facility.

Part 5: General Maintenance Tips for Rainwater Management

Maintenance of rainwater management methods is generally not onerous when they are properly designed and installed. The recurring maintenance tasks required for methods are listed below.

The maintenance requirements listed in each method's section in Part 3 are important to keep rainwater management facilities functioning properly, and also to remain eligible for the incentive program.

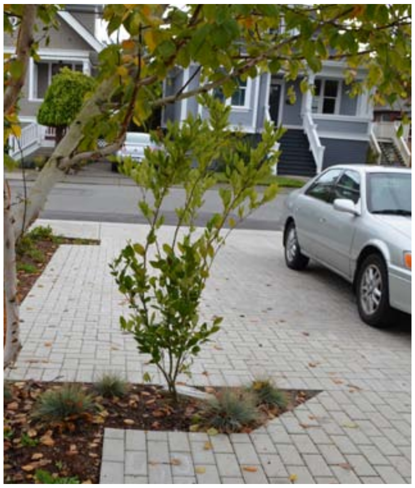
Before maintenance activities commence, the persons doing maintenance must be familiar with the rainwater management methods they are maintaining, including:

- Basic structure and function of the methods;
- Design, as-built drawings or other knowledge of the intended appearance of the methods;
- Understanding of the maintenance items required; and
- Understanding of basic indicators of functional problems that may require remediation, rather than just routine maintenance.

This information should be communicated by the property owner to those who will be maintaining the rainwater management methods, whether they are paid maintenance staff or the owner's friends or family.

Please refer to the Maintenance sections in Part 3 for specific maintenance requirements for each rainwater management method.

The "Low Impact Development Technical Guidance Manual for Puget Sound" is available online at: **www.psp.wa.gov/stormwater.php** This document has photos of "good" and "poor" maintenance of many rainwater management methods in "Appendix 4 – Maintenance of Low Impact Development Facilities" and is a good visual reference if needed.



Part 6: Glossary of Terms

Definitions of technical and common terms for rainwater management design and construction

Amended soil – A soil that has an amendment such as sand or compost added to increase the infiltration capacity and/or water retention capabilities.

Bioretention – growing medium

Bioswale – A shallow landscaped channel with or without a reservoir beneath, which captures stormwater runoff and allows it to soak into the soil and subsurface ground below. Similar to a rain garden, but provides conveyance of water across a site similar to a ditch.

Cistern – A rainwater storage tank with 1,200 litres minimum capacity that allows rainwater to be used.

Compaction – The process in which a stress (force) applied to a soil causes densification as air is displaced from the void spaces between the soil grains. Compaction is often achieved with a roller or mechanical tamper

Conveyance – A way to transport water from one point to another; conveyance methods include pipes, ditches, and channels.

Freeboard – The vertical distance between the design water surface elevation (overflow elevation) and the top of the rainwater management method.

Friable – A word used to describe soil that is easily crumbled or broken apart.

Geotextile – Can be woven or non-woven, also known as filter cloth or fabric that when used properly, will reinforce and filter without clogging. To be Amoco 4545 or equivalent.

Glazing of soil – Process by which rainfall or water or surface traffic make the surface of soil smoothed and less pervious, so that the infiltration of water through the surface is reduced.

Growing medium – Soil mixture made up of sand, loam, and compost; used in rainwater management methods to support vegetation and to filter runoff.

Hardscape – The impervious areas of a site that are not roof; includes driveway or parking areas, walkways, patios, or any other impervious surface that sheds water; contrasts to 'landscape' areas of the lot that are covered with soil and vegetation.

Hydraulic conductivity – or saturated hydraulic conductivity – A property of saturated soil that enables water to move through it; often equated to or used as a measure of infiltration rate.

Impervious – A surface that does not allow water to pass though; includes surfaces such as roofs and driveways.

Infiltration – The downward entry of water through a soil surface and into the soil. Infiltration is often expressed as a rate (millimetres per hour), which is determined though an infiltration test.

Inlet – A way for entering; an opening or pipe to allow water into a rainwater management method.

Invert – The lowest point on the inside of a pipe, or the bottom elevation of a channel or rain garden.

Loam – A rich soil consisting of sand and clay and decaying organic matter.

Low density residential – A land use category comprising one to four dwelling units on a single lot.

Outlet – A place or opening though which something is let out; an opening or pipe to allow water to leave a rainwater management method.

Overland flow – Overland flow is another term for surface runoff. Rainwater can be directed to rainwater management methods via overland flow on paved surfaces or grassed areas.

Perforated pipe – Pipe with holes or slots in the pipe.

Permeability – The ease with which water penetrates or passes through a layer of soil or porous medium; can also be referred to as perviousness and is related to the size and continuity of the void spaces in soils.

Permeable/Pervious/Porous pavement or paving – (these terms are often used interchangeably in the literature) a hardened surface that allows water to percolate through to the underlying subgrade soils, or to a reservoir where water is stored and either infiltrated to the underlying subgrade or removed by an underdrain. The surface component can be:

- Porous asphalt or concrete, where fines are not included in the mix, providing a high void ratio that allows water to pass through.
- A structural load-bearing matrix made of concrete with large voids that are filled with permeable material, usually gravel or soil; the latter often have grass. Also known as gravel or grass pavers.
- Permeable unit pavers made of impervious concrete blocks with gapped joints that allow water to percolate between the pavers; also called modular pavement or pervious interlocking concrete pavement.

Porosity – Similar to void ratio, this is the portion of a volume of material such as soil or rock that is empty spaces between particles; usually expressed as a percentage of the total volume.

Professional – a term used in this document to collectively refer to Qualified Designers and Qualified Professionals as a group.

Qualified Designer – means an individual who demonstrates to the satisfaction of the Director of Engineering that he or she has the training and experience necessary to design and oversee the installation of a rainwater management method.

Qualified Professional – means an applied scientist or technologist, acting alone or together with another Qualified Professional, if:

> the individual is registered in good standing in BC with an appropriate professional organization constituted under an Act, acting under that association's code of ethics and subject to disciplinary action by that association; the individual's area of expertise is recognized by the individual's professional organization as one that is acceptable for the purpose of performing a professional service for the design of rainwater management methods; and the individual is acting within the individual's area of expertise.

Rain Barrel – a rainwater storage tank or combination of tanks with 350 litres minimum capacity that allows rainwater to be used.

Rain garden – A shallow landscape depression with an amended soil mix and plants that is designed to capture stormwater runoff or rainwater from nearby contributing impervious areas and allows the water to soak into the soil and the subsurface ground below.

Scarified subgrade – Subgrade of which the surface has been loosened or broken up.

Scarify – To scarify is to loosen, break or roughen the surface of soil. Can be done with a rototiller (small areas) or a cultivator (large areas).

Screed – to smooth a surface or layer so it is even.

Sheet flow – Similar to overland flow, but where the flow is widespread and not constricted.

Sizing Factor – A sizing multiplier that allows simple sizing for rainwater management methods based on the area of impervious surface that is generating runoff.

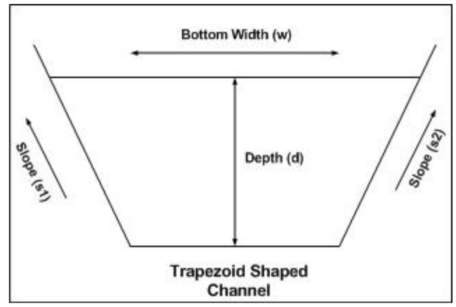
Softscape – refers to the elements of a landscape that comprise live, horticultural elements. Softscaping can include, flowers, plants, shrubs, trees, flower beds, etc.

Subgrade – The underlying ground beneath any constructed feature; often called native soil as it is material that was in place before an excavation or construction started. Typically this is the bottom of an excavation for construction and is the underlying base for the construction which goes on top.

Subsurface – Below the surface, underground.

Sump – similar to a catch basin where runoff is directed to control and clean the flow.

Trapezoidal shape – A four sided shape that has two sides that are parallel and two sides that are not parallel. In stormwater, a trapezoidal channel has a base that is narrower than the parallel top.



Trapezoidal shape

Underdrain – plastic pipes with holes drilled though one side, installed either on the top of the rock trench or bottom of an infiltration rainwater management method with no rock trench, which are used to collect and remove excess runoff.

Unit paving – Also referred to as pavers or paving stones, unit paving uses concrete blocks to create a surface for roads, driveways, patios and other outdoor platforms

Void ratio – Similar to porosity, this is the fraction of the volume of the void (or 'empty') spaces in the soil over the total volume of soil; value is between 0 and 1.

Appendix A – Rainwater Rewards Pre-Approval Guide

This guide has been provided to assist applicants in the process for pre-approval for the Rainwater Rewards program. For more information, please refer to Table 1: Rainwater Rewards Process.

Please follow the steps below (for site assessment, method selection, sizing calculation and design drawing) and submit with your Rainwater Rewards application.

To qualify for the Rainwater Rewards credits and/or rebates you must receive pre-approval before starting any work. For more information, please contact the City's stormwater specialist at **stormwater@victoria.ca** or

250.361.0443.

All references to the City of Victoria's Rainwater Management Standards – DIY For Your Home are available at **victoria.ca/stormwater**.

1. Site Assessment

Please complete the site assessment checklist found on page 10 of the Rainwater Management Standards-DIY for Your Home. Complete a site assessment drawing (see Figure 1: Site Assessment Example), using an aerial photo of the property from VicMap (or similar), or a scaled hand drawing.

2. Choosing a Rainwater Management Method

To choose an appropriate rainwater management method for your site, please review Part 2: Rainwater Management Planning and Site Selection. Consider the following:

- Site and Selection Considerations
- Table 2: Site Feasibility for Rainwater Management Methods.

3. Can my Project be Do-It-Yourself?

If you are considering taking a "do-it-yourself" approach to designing and installing your rainwater management method, please complete the checklist found on page 16 - Table 4: Can my project be DIY Checklist, to ensure that DIY is an option for your project. If you do need to work with a professional, please ensure their design follows the steps outlined inthe Rainwater Management Standards-Professional Edition.

4. Sizing Calculation for Do-It-Yourself Project

Each rainwater management method has its own sizing calculation (except for permeable paving without underdrain). You need the following information to calculate the sizing and to apply for Rainwater Rewards.

- Total roof area
- Roof area to be treated
- Total surface impervious area
- Surface impervious area to be treated

(Roof area to be treated + Surface impervious area to be treated = Total impervious area to be treated)

Ensure you consider site setback requirements (page 14, Table 3: Site Setback and Minimum Values summary) - Ensure zoning setback requirements are met for installation of cisterns.

Sizing Calculations for each rainwater management method can be found in Part 4: DIY Design and Sizing Approach.

i.e. Rain Garden Sizing:

Total impervious area to be treated x 5% = rain garden base area

Total rain garden footprint = rain garden base area + 0.9 m buffer (for 3:1 side slopes)

5. Design Drawing

Please provide a plan drawing with dimensions outlining where the rainwater management method will be located. Tip: you can use your site assessment drawing as a starting point.

6. Submit for Pre-Approval

Please submit to following completed documents for pre-approval for the Rainwater Rewards program:

- Rainwater Rewards Application form
- Table 4: Can my Project be DIY Checklist
- Sizing calculations
- Design drawing

Appendix B – Installation Checklists

How to use these Checklists

When you are constructing your rainwater management methods, it is necessary to follow the steps outlined in the City of Victoria's Rainwater Management Standards. These checklists are specific for the Do-It-Yourself for Homeowners edition, and are intended to highlight the key installation details that must be met. Please ensure you have received pre-approval for the Rainwater Rewards program prior to starting construction. Once construction is completed, please submit photos and any invoices to **stormwater@victoria.ca** to receive your credit and/or rebate.

Rain Barrel Installation Checklist	Completed	Photo
General		
Ensure all manufacturers' installation requirements are met		NA
Ensure all manufacturer's installation requirements are met		NA
Ensure installed rain barrel is secured for safety if applicable		NA
Subgrade		
Ensure subgrade is level and able to support the weight of the full rain barrel, using sufficient support (concrete, crushed rock, etc.) if subgrade is soft		
Piping, Overflow and Connection to City Stormwater System		
Confirm overflow connection to City stormwater system is installed correctly		
Confirm roof downspouts are correctly connected to rain barrel(s)		
Confirm correct grades used on all piping		
Confirm rain barrels in series are properly connected together (if applicable)		
Confirm seasonal slow release valve is correctly installed		
Materials		
Ensure rain barrel(s) has/have a total capacity of at least 350L and multiple barrels are connected in sequence		NA
Ensure correct piping used		NA

Cistern Installation Checklist	Completed	Photo
General		
Ensure all manufacturers' installation requirements are met		NA
Ensure Rainwater Management Standards document is followed throughout design, installation, and maintenance processes		NA
Ensure installed cistern is secured for safety if applicable		NA
Subgrade		
Ensure subgrade is level and able to support the weight of the full cistern, using sufficient support (concrete, crushed rock, etc.) if subgrade is soft		
Confirm underground cistern location and elevation is correct related to inlet and outlet piping		
Piping, Overflow and Connection to City Stormwater System		
Ensure tanks in series are properly connected together (if applicable)		
Confirm roof rainwater downspouts are correctly connected to cistern		
Confirm overflow connection to City stormwater system is correctly installed		
Confirm seasonal slow release drain valve is correctly installed		
Overall Site		
Ensure zoning setbacks are met		NA
Ensure supporting structure of elevated cistern is built to the professionally-designed specification		NA
Materials		
Ensure cistern is correct capacity and product type for intended use		NA

Rain Garden Installation Checklist	Completed	Photo
General		
Ensure Rainwater Management Standards document is followed throughout design, installation, and maintenance processes		NA
Subgrade		
Subgrade excavated to correct depth and levelled		
Base area scarified as a final step prior to subsequent installations (rock trench, perforated pipe, growing medium, etc.) to minimize compaction of base area		
Rock Trench Layer (if applicable)		
Confirm length, width, and depth of trench are correct		
Confirm that rock trench base is on scarified native soil/subgrade		
Confirm placement and overlaps of filter fabric in rock trench complete with proper placement of rock/sand sections		
Growing Medium		
Ensure growing medium is placed in rain garden 200mm at a time		NA
Confirm placement of growing medium is to correct thickness and compacted per specifications (not over-compacted)		NA
Piping, Overflow and Connection to City Stormwater System		
Confirm placement and elevation of inlet, building drainage sump (if applicable), underdrain, and overflow connection to City stormwater system		
Confirm roof rainwater downspouts directed to rain garden are adequately dissipated to not cause erosion/damage		
Confirm overflow connection to City stormwater system is installed correctly		
Service Trench Crossing		
Confirm that any service trench crossings have had impervious backfill barriers properly installed		
Overall Site		
Ensure final lot grading meets plan for directing surface flows to rain garden		NA
Confirm rain garden side slopes are angled correctly		
Materials:		
Confirm PVC piping, concrete products, and drainage grates meet specifications		NA
Confirm geotextile filter cloth meets specifications		NA
If using a rock trench, confirm rock has proper gradation, is clean and free of all fines		NA
Growing medium to have written confirmation of mixture requirements		NA
Ensure sand is clean- washed fill sand		NA

Infiltration Chamber Installation Checklist	Completed	Photo
General		
Ensure all manufacturers' installation requirements are met		NA
Ensure Rainwater Management Standards document is followed throughout design, installation, and maintenance processes		NA
Subgrade		
Subgrade excavated to correct depth and levelled		
Base area scarified as a final step prior to subsequent installations (perforated pipe, drainage rock, etc.) to minimize compaction of base area		
Confirm infiltration chamber location and elevation is correct to incoming and outlet piping		
Rock/Drainage Layer		
Confirm rock trench size and volume are correct if applicable		NA
Confirm that rock trench base is on scarified native soil		
Confirm placement and overlaps of filter fabric in rock trench complete with proper placement of rock/sand/chamber sections		
Piping, Overflow and Connection to City Stormwater System		
Confirm placement and elevation of inlet, building drainage sump (if applicable), perforated pipe, and overflow connection to City stormwater system		
Confirm roof rainwater downspouts are correctly connected to sump, perforated pipe, flow control manhole, etc. if applicable		
Confirm overflow connection to City stormwater system is installed correctly		
Service Trench Crossing		
Confirm that any service trench crossings have had impervious backfill barriers properly installed		
Overall Site		
Ensure final lot grading meets plan for directing surface flows to on-site drainage sump and/or infiltration chamber		NA
Materials		
Confirm PVC piping, concrete products, etc. meet specifications		NA
Confirm geotextile filter cloth meet specifications		NA
Confirm stone for rock trench has proper gradation, is clean and free of all fines if applicable		NA
Growing medium to have written confirmation of mixture requirements		NA
Ensure infiltration chamber products are correct capacity and product type for intended use		NA

Permeable Paving Installation Checklist	Completed	Photo
General		
Ensure Rainwater Management Standards document is followed throughout design, installation, and maintenance processes		NA
Ensure permeable paving is installed to the manufacturer's instructions		NA
Subgrade		
Subgrade excavated to correct depth, levelled and compacted as required		
Rock/Drainage Layer		
Confirm rock trench size and thickness are correct if applicable		NA
Confirm placement and overlaps of filter fabric in rock trench complete with proper placement of rock/sand sections if applicable		
Confirm gravels for permeable pavers including optional reinforcing grids are placed and compacted properly		
Piping, Overflow and Connection to City Stormwater System		
Confirm placement of building drainage sump (if applicable), and connections to underdrain		
Confirm overflow connection to City stormwater system is installed correctly		
Service Trench Crossing		
Confirm that any service trench crossings have had impervious backfill barriers properly installed		
Overall Site		
Ensure final lot grading meets plan for directing surface flows to on-site drainage sump and/or permeable paving		NA
Materials		
Confirm pavers used are specifically designed and certified as permeable		
Confirm PVC piping, and concrete products meet specifications		NA
Confirm permeable pavement materials including pavers and reinforcing grids (if needed) meet specifications		NA
Confirm geotextile filter cloth meets specifications		NA
Ensure gravel base and permeable paving gravels meet specifications		NA
Ensure sand is clean-washed fill sand if applicable		NA

Appendix C – Cistern Screening Guidelines

City of Victoria Rainwater Management Standards

Screening Guidelines for Cisterns

What is a Cistern?

- Cisterns are holding tanks that collect rainwater for later use.
- Under the Rainwater Rewards Program, rainwater harvesting tanks with at least 1,200 litres (264 imp. gallons) capacity are considered cisterns. The top surface area must be less than 15m^2 (161 ft^2) in area.
- They can be placed at ground level, buried underground, on a platform or rooftop.

Purpose of the Screening Guidelines

Cisterns play an important role in rainwater management by collecting rainwater and keeping this water out of the stormwater system. However, cisterns can be big and bulky, and could be considered visually intrusive in certain cases. Some careful thought about the cistern's location and appearance is important.

To help achieve this, these guidelines provide information on locating cisterns, as well as well as suggestions for screening cisterns.

These guidelines promote:

- Cisterns that are both functional and complement the style and character of your property
- Cisterns that minimize visual impacts on neighbours and views from the street.

Siting

Here are some cistern siting considerations relating to appearance and zoning. For all cistern siting requirements, please refer to section 2.1 of the City of Victoria's *Rainwater Management Standards*,

- Cisterns must meet the setback requirements that apply to the main building within that particular zone. For example, in the R1-B zone (single family dwelling), a cistern can be located as follows:
  - 7.5m (minimum) from the front or rear property line
  - 1.5m from the side yard property line
- Collectively, the total surface area of the buildings, cistern and other structures on a property must not exceed the maximum site coverage permitted in the zone. For example, in the R1-B zone (single family dwelling), the maximum total site coverage is 40%.
- Rain barrels (1,200 litres or less) do not have setback requirements or site coverage limits.
- Cisterns may not be located on a required parking space. Please check Schedule C of the Zoning Bylaw to determine the required parking for a particular zone. For example, in the R1-B zone (single family dwelling), there must be at least 1 space per dwelling unit.

Slim cistern

Appearance

- Think about where the cistern will be located and the style of cistern that will work best for your property.
- Cisterns come in many different shapes and sizes. Some fit snugly against a building; others are designed to be out in the open.

Round cistern

Tips for Screening

Where cisterns will be visible to neighbours or the street, consider ways to soften their appearance through landscaping or other design features. Cisterns should complement the overall design and character of your property while retaining functionality. You will need to be able to access your cistern for routine maintenance.

Consider screening cisterns with plants or bushes, such native, drought tolerant species, vines or food plants (e.g. hops, berries).

- Plantings can soften the appearance of a cistern
- Cisterns can be screened with trellis panels, wooden panels or wrought iron panels
- Cisterns can be integrated into a building by locating them under decks or behind existing out-buildings such as sheds or garages.
- There are examples of cisterns that have been finished with galvanized metal, concrete, masonry or wood cladding, and complement the style and character of the property.

Cistern with plantings

Wood panels adding character and screening

Screening complementing the style of a traditional residence

Cistern located under a porch

Use of wood cladding

A metal cistern that complements the contemporary character of a building

Cistern that fits into a commercial area

Rooftop Cisterns

Placement and Appearance

- Place cisterns in the centre of roofs where possible, to minimize visibility from adjacent properties and the street. A structural engineer is needed to ensure the roof or platform can support the cistern.
- Where rooftop cisterns are visible from the street or adjacent buildings, think about ways to enhance the design and softening the visual impact through design features mentioned above.

The appearance of rooftop cisterns can be softened with landscaping and careful choice of materials.

The appearance of rooftop cisterns can be softened with landscaping and careful choice of materials.

Height Limits

- Rooftop cisterns and their supporting structures are treated as mechanical features and as such, are excluded from height calculations for the Zoning Bylaw, provided they don't exceed 9,000 litres (1,980 imp. gallons).

Development Permits

- On a property that contains an existing building, new cisterns under 9,000 litres (1,980 imp. gallons) that have been approved under the Rainwater Rewards Program will not require a Development Permit. New cisterns 9,000 litres (1,980 gallons) and over will require a Development Permit.
- When a cistern is installed as part of a new building construction in an area that requires a Development Permit, the design of cisterns will be reviewed as part of the overall design guidelines applicable for the site.
- Single family dwellings do not normally require Development Permits.

Cistern that complements the industrial character of a development

Cistern that complements the industrial character of a development

Photo Credits:

http://www.google.ca/imgres?imgurl=http://www.rwh.in/rainwatr/cistern.jpg&imgrefurl=http://www.rwh.in/&h=768&w=1024&tbnid=ULy477QQ6Ci1aM:&zoom=1&docid=r-nrW_khQ9L_QM&ei=-OYaVfLwKor3oATa5IKoDw&tbm=isch&ved=0CH0QMyhCMEI

http://ecourbanllc.com/wp-content/uploads/2013/10/EcoProduct-1300-Gallon-Cistern-Square-cropped-300x300.jpg

https://www.google.ca/url?sa=i&rct=j&q=&esrc=s&source=images&cd=&cad=rja&uact=8&ved=0CAcQjRw&url=https%3A%2F%2Fwww.pinterest.com%2Fklvm7788%2Fbackyard-design-ideas%2F&ei=tegaVd_uBYbUoASvxoKgDw&bvm=bv.89744112,d.cGU&psig=AFQjCNGXJE-ftsePcANATrRswMISHIjKrQ&ust=1427913241995263

http://gardenmentors.com/wp-content/uploads/2009/10/2009_10_cistern2.jpg

https://s-media-cache-ak0.pinimg.com/474x/b8/6d/92/b86d925b757cce2d5165a93eedb78528.jpg

http://www.siteselection.com/ssinsider/snapshot/images/Cistern_18321_2.jpg

http://rainbank.info/design

Appendix D – Percolation Test Procedure

City of Victoria Rainwater Management Standards

Introduction

The following procedure was adapted from the Province of British Columbia's Sewerage System Standard Practice Manual, Version 3 (2014). Although the Province's procedure was developed for septic system installations, the procedure can also be used for rainwater management method installations.

The entire document is available for reference at:

http://www2.gov.bc.ca/gov/topic.page?id=C2F3DBA2AF8C4B9DAB7FC2C3A87D63E3

The results from the Percolation Test Procedure below may be used by a property owner, Qualified Designer, or Qualified Professional to inform the suitability of the rainwater management method in that location, or by a Qualified Professional to alter the design within the limits defined in the City of Victoria's *Rainwater Management Standards Professional Edition*.

Percoaltion Test Procedure

Use the following instructions to conduct a percolation test. This is the procedure for a percolation test in BC.

1. Perc test holes should be made at points and elevations selected as typical in the area of the proposed infiltration rainwater management method.
2. Typically, test holes are to be dug at each end of the area of the absorption field and near the centerline. Testing of the receiving area may also be necessary. Further holes could be needed, depending upon the nature of the soil, the results of the first tests and the size of the proposed dispersal area.
3. Test holes should be 30 cm (12") square or 36 cm (14") round and excavated to the proposed depth of the rainwater management method (or as instructed by the designer). It is generally easiest to dig a larger hole part way down, then dig a 18 to 20 cm (7 to 8") deep accurately sized test hole in the base of the larger hole.
4. To make the percolation test more accurate, any smeared soil should be removed from the walls of the test holes. This is best achieved by digging the hole approximately 5cm undersized (2") and then enlarging the hole to the accurate size as follows: using a rigid knife, insert the blade into the top side of the hole opposite you approximately 2.5cm (1") deep, holding the blade with its cutting edge vertical. Pull the blade away to break out a chunk of soil, repeat about an inch (2.5cm) apart around the hole, then repeat for another "ring" below until reaching the base. The result will be a hole with a ragged inner surface which looks like a freshly broken clod of soil.
5. The base of the hole should be cleaned of debris and be approximately flat. To achieve this, use a metal scoop or similar. It should also be picked to present a natural surface. Note that a picking action (use a pointed tool) is needed, not a scratching action (which just produces smears that are indented).
6. Place 5 cm (2") of clean fine gravel in the bottom of the hole. If the sidewalls are likely to collapse, use a paper basket to support the sidewalls (see note below). Place a piece of white plastic or similar provided with clear marks at 5" and 6" from the bottom of the test hole prior to adding the gravel. For greater accuracy a float and pointer arrangement can be set up.
7. If the soil contains considerable amounts of silt or clay, and certainly for any soil with "clay" as part of the texture description, the test holes should be pre-soaked before proceeding with the test. Pre-soaking is accomplished by keeping the hole filled with water for 4 hours or more. The water should be add carefully and slowly to avoid disturbing the soil (including the sidewall soils). The test should be carried out immediately after pre-soaking;
8. To undertake the test, fill the test hole (the accurately sized test hole) with water. The water should be added carefully and slowly to avoid disturbing the soil (including the sidewall soils). When the water level is 5" or less from the bottom of the hole, refill the hole to the top. No recording of time needs be done for these two fillings.
9. When the water level after the second filling (procedure (8)) is 5" or less from the bottom of the hole, add enough water to bring the depth of water to 6" or slightly more. Note that these measurements are from the base of the soil bottom (using the marker installed in step (6)), not the gravel layer.
10. Observe the water level until it drops to the 6" depth, at precisely 6", commence timing, when the water level reaches the 5" depth, stop timing, record the time in minutes.

11. Repeat procedures (9) and (10) until the last 2 rates of fall do not vary more than 2 minutes per inch or by more than 10% (whichever is less).
12. Report slowest rate for each hole.
13. Backfill the holes with the excavated soil and flag and label their locations so you can pick them up for the plan.

If a test hole is discarded due to flow in a root channel or similar, record the information and make a replacement test. If there is a large variation (greater than or equal to 50%) between tests in the same soil layer, increase the number of tests.

Paper basket to protect hole

If sidewalls of the hole are likely to collapse, one option is to make a paper basket to protect and support the sidewalls as follows:

1. Cut the bottom out of a large paper bag (grocery bag) and cut the bag open along a side.
2. Lay bag on a soft surface. Punch holes in the bag about 5 to 7.5 cm (2 to 3 inches) apart using a pencil or similar.
3. Roll into a tube, with the short dimension being the axis of the tube, and place in the test hole.
4. Open the tube until the paper is in contact with the sidewalls of the test hole, then roll the top of the tube over to stiffen it.
5. After placing the tube in the hole, place the plastic marker and add the base gravel layer.

Percolation rate for design

Select the percolation rate to be used for the rainwater management method. This will be the median (middle) value from all the tests conducted.

Percolation test form

Location (address):							File #:	
Date:		Tested by:						
Weather:								
Test number	Depth of base of hole from surface (cm)	Timings, mins per inch for water to drop from 6" to 5" from base of hole.						Lowest rate (min per inch)
		#1	#2	#3	#4	#5	#6	
1								
2								
3								
4								
5								
6								
7								
8								
							Percolation rate:	
Notes:								

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