**ADMINISTRATIVE ORDER NUMBER 2020-010-OP**
**Respecting Stormwater Management Standards for Development Activities**

**WHEREAS** the Council of the Halifax Regional Municipality recognizes that that urban development and the hardening of natural land surfaces can have a negative impact on the quality of water bodies, and increased demand of the stormwater sewer system;

**AND WHEREAS** the Council of the Halifax Regional Municipality recognizes that using stormwater management best practices which consider retention and stormwater quality can reduce localized flooding and improve the quality of stormwater reaching waterbodies;

**AND WHEREAS** the Council of the Halifax Regional Municipality wants to minimize the potential negative impacts development may have on surrounding properties as well as the quality of water bodies within the Halifax Regional Municipality through best management practices;

**BE IT RESOLVED AS AN ADMINISTRATIVE ORDER** of the Council of the Halifax Regional Municipality under the authority of the *Halifax Regional Municipality Charter,* as follows:

**Short Title**
1. This Administrative Order may be known as the *Administrative Order on Stormwater Management.*

**Interpretation**
2. In this Administrative Order,

(a) "Engineer" means the Engineer of the Municipality and includes a person acting under the supervision and direction of the Engineer;

(b) “Municipality” means Halifax Regional Municipality;

(c) “stormwater best management practices (BMPs)” means state of the art methods or techniques used to manage the quantity and improve the quality of wet weather flow;

(d) “Stormwater Management Plan” means a combination of diagrams, documents, drawings, and specifications, prepared by a Professional Engineer licensed to practice in the Province of Nova Scotia, that clearly demonstrate how stormwater will be managed within the site;

**Purpose**
3. The purpose of this Administrative Order is to adopt the Halifax Stormwater Management Standards for Development Activities as set out in Appendix A, to provide direction to reduce the quantity and improve the quality of stormwater leaving a developed site by setting minimum standards for on-site stormwater management infrastructure.

**Application**
4. This policy applies to private properties being altered for the development of land, whether associated with a building permit, development permit, or no permit but intended for future development use in accordance with By-law G-200 *Respecting Grade Alteration and*

*Stormwater Management Associated with Land Development*, as described in the Halifax Stormwater Management Standards for Development Activities.

5. For greater certainty, this Administrative Order does not apply to development or alteration of:

(a) lots regulated under By-law L-400 *Respecting Lot Grading*, or

(b) individual low-density residential lots.

6. (1) Without limiting the generality of the foregoing, the latest editions of the following regulations shall be considered in the preparation of a Stormwater Management Plan:

(a) the Halifax Stormwater Management Standards for Development Activities

(b) the Halifax Water Design Specifications, as adopted by the Halifax Regional Water Commission;

(c) the Halifax Regional Subdivision By-law;

(d) the Nova Scotia Environment Erosion and Sediment Control Handbook for Construction Sites; and

(e) By-law T-600, the Trees By-law.

(2) In the case of a conflict with any of these documents, the more stringent standard for the item in question shall apply.

**Permit Requirements**

7. In addition to submission requirements as part of the applicable permit, applications must be accompanied by:

(a) applicable fees;

(b) detailed Stormwater Management Site Plan(s) as described in the Halifax Stormwater Management Standards for Development Activities; and

(c) Stormwater Management Report as described in the Halifax Stormwater Management Standards.

8. Detailed Stormwater Management Site Plans must be submitted in advance of anticipated construction and will be evaluated by the Municipality as part of the review process for a building permit, a development permit, or a grade alteration permit.

Done and passed in Council this 22nd day of September, 2020.

____________________________________
Mayor Mike Savage

____________________________________
Phoebe Rai, Acting Municipal Clerk

I, Phoebe Rai, Acting Municipal Clerk of the Halifax Regional Municipality, hereby certify that the above noted Administrative Order was passed at a meeting of Halifax Regional Council held on September 22, 2020.

____________________________________
Phoebe Rai, Acting Municipal Clerk

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|---|---|
| Notice of Motion: | July 21, 2020 |
| Approved: | September 22, 2020 |
| Effective Date: | September 26, 2020 |

APPENDIX A

# Halifax Stormwater Management Standards

## For development activities

**Halifax Regional Municipality**

**and Halifax Water**

July 2020

HALIFAX

# Table of Contents

# 1.0 Introduction

## 1.1 Stormwater Definition and Problem Statement

Stormwater is water from groundwater discharge, surface water, precipitation or melting snow and ice that flows across the landscape. Stormwater flows across a property (from rooftops, paved areas, graveled areas, bare soil, lawns, etc.) and gathers along streets, drains, open channels, and sewers in increasingly large amounts, until it eventually discharges into waterbodies. In areas served by combined sewer systems, stormwater flows with wastewater to a wastewater treatment facility, where it may lead to a combined sewer overflow.

As areas continue to urbanize, stormwater management is especially important due to decreases in natural surfaces and the increases of impervious surfaces like rooftops, sidewalks and asphalt. These surfaces compound the issues with stormwater because they change the permeability of the landscape, preventing stormwater from infiltrating into the ground.

Stormwater can pick up and carry pollutants (oil, grease, chemicals, dirt, sediment, nutrients, and pathogens). Without treatment, these pollutants can have a significant impact on downstream watersheds. Stormwater pollution can be significantly reduced with the use of applicable best management practices.

A properly designed and functioning stormwater system conveys the stormwater without damage to property, harm to personal health, significant inconvenience to the public, or detrimental environmental effects. However, some recent and historical storm events have caused damage and inconvenience to both public and private property. These storm events have caused problems that generally fall into the following categories:

- Private property flooding;
- Flooding and icing in the public right-of-way;
- Sewer system backups;
- Excessive stormwater in the wastewater system; and,
- Degradation in receiving water quality.

Scientific evidence indicates that climate change has already contributed to an increase in the severity and frequency of storm events, and will continue to do so. There is growing evidence to suggest that regulating site design features to promote control of stormwater at the source is more effective than public infrastructure at lessening effects.

## 1.2 Stormwater Legislation in Halifax

The Halifax Regional Municipality (HRM, Halifax) spans a geographic area of 5,600 square kilometres and has a population of approximately 400,000. Halifax was formed in 1996 through the amalgamation of four pre-existing municipalities. The amalgamation resulted in the inheritance of various policies and procedures relating to stormwater management (SWM).

In 2007 HRM conveyed the municipal wastewater and stormwater sewer systems, including ditches inside the service boundary, to the Halifax Regional Water Commission (Halifax Water). Since this time, there has been an increased awareness of the benefits of improving stormwater quality.

Before the adoption of this document, the stormwater management design requirement, adopted in 2002, was to balance pre-development flow with post-development flow over a development site. This requirement is based on the quantity, by limiting the stormwater flow rate leaving an overall site during prescribed precipitation events. However, it does not consider water quality impacts, nor does it manage stormwater throughout the site itself, but focuses on the ultimate outlet of the site.

Many major municipalities in North America have adopted stormwater management requirements that include stormwater runoff source control practices that aim to mimic the natural hydrology of the watershed, providing water quality benefits. This approach to stormwater management is commonly referred to as Low Impact Development (LID) practices, Stormwater Best Management Practices (BMPs), or Green Stormwater Infrastructure (GI). This document will refer to BMPs.

## 1.3 Purpose of Document

The Integrated Stormwater Management Policy Framework (ISMPF) was developed between HRM and Halifax Water and adopted by HRM Regional Council and the Halifax Water Board in January 2018. This document was developed between HRM and Halifax Water to support and implement the ISMPF by providing direction for mitigating the long-term impacts of development on natural waterbodies and downstream properties.

The primary goal of this document is to identify standards for stormwater management that, when followed, will reduce the quantity and improve the quality of stormwater leaving a site. This document describes the technical requirements to manage on-site stormwater quantity and quality for new development projects, including infill and redevelopment, (except low density residential developments, which are addressed by by-law L-400.)

This document guides the design and implementation of stormwater management practices on-site using BMPs. It also provides direction on stormwater management practices and approval requirements to HRM and Halifax Water, development community and property owners.

While this document presents a general framework of HRM and Halifax Water's expectations of approval requirements on water quantity and water quality targets for on-site stormwater management, HRM and Halifax Water also recognize that unique site-specific conditions may require alternative methods. As a result, HRM and Halifax Water may consider innovative approaches if it can be demonstrated that performance objectives are met.

## 1.4 Applicability

This document shall apply to private properties being altered for the development of land, whether associated with a building permit, development permit, or no permit but intended for future development use, in accordance with By-Law G-200 Respecting Grade Alteration and Stormwater Management Associated with Land Development.

Applies to:

- Multi-unit, Institutional, Commercial, and Industrial (MICI) developments outside the regional centre
- MICI developments within the regional centre with less than 80% lot coverage
- Clearing of land for future development use.

Does not apply to:

- Development or alteration of individual low-density residential lots, such as single family homes and duplexes (refer to by-law L-400)
- Development of major subdivisions that will have a master stormwater management plan in accordance with the Regional Subdivision By-law
- MICI developments in the regional centre with greater than 80% lot coverage (refer to Centre Plan)
- Infrastructure in the public ROW, as this is addressed in the HRM Municipal Design Guidelines.

Developments shall follow the requirements in this document, as well as all applicable regulations, established by the HRM Subdivision By-Law, HRM land use by-laws, HRM Municipal Design Guidelines, Halifax Water's Design Specifications & Supplementary Standard Specifications for Water, Wastewater & Stormwater Systems (Halifax Water Design Specifications), Halifax Water's Rules and Regulations, and any applicable Provincial and Federal regulations, regarding storm drainage for private properties. Where these standards differ, the stricter requirement shall govern.

# 2.0 Stormwater Management Requirements

The requirements described in this chapter are applicable as described in section 1.4 – Applicability. Private stormwater management facilities are to be contained within the property they service, apart from shared systems between private property owners. Any new direct connection to the Halifax Water stormwater system shall be in accordance with the latest edition of the Halifax Water Design Specifications. If an existing development wishes to comply with these standards, HRM and Halifax Water staff can provide direction on the process.

Each of the requirements is described in the following sections.

## 2.1 Stormwater Balance (Retention and Reuse)

The purpose of this requirement is to retain and manage stormwater on the development site to reduce stormwater runoff and erosion, enhance resiliency of infrastructure to extreme rainfall events, and to decrease localized flooding.

### 2.1.1 Stormwater Balance Requirements

*(a) Retain on site stormwater runoff generated from the first 10 mm depth of a rainfall event.*

Retaining stormwater onsite means that it does not leave the site. This requirement is not referring to “detention”, where stormwater is stored temporarily and later released. This requirement is for ideal conditions such as average temperatures. It is understood that some of the methods used may be less effective in winter.

A 10 mm depth typically represents a 10-minute design storm event with a 1:5-year return period (minor event), according to Environment Canada IDF curves for Halifax, without adjustment for climate change impacts. The result of this on-site retention is that stormwater runoff is actually reduced from pre-development flow rates.

*(b) Stormwater runoff generated after the first 10 mm of an event is to be balanced to ensure matching of the pre and post-development stormwater runoff conditions for the 1:5-year return design storm and the 1:100-year return design storm.*

This requirement may be achieved using detention, or the temporary storage of stormwater. Pre-development conditions can be considered the existing conditions before the project was initiated, or before the site was prepared for the project.

Consistent with the hierarchy approach (see section 3.2), new MICI development and re-development projects shall endeavour to apply BMP strategy and design techniques that are suitable and applicable to individual site conditions. Some of the HRM recommended BMPs for consideration are described in Section 5. Physical factors, such as soil infiltration rates, may suggest the use of some BMPs and preclude the use of others, or they may point to special design considerations.

### 2.1.2 Discharge Criteria to Halifax Water Infrastructure

The peak stormwater runoff rate to the stormwater system (minor system) from the development site during a 1:5-year return design storm event (in accordance with the HRM and Halifax Water Design Specifications) must not exceed the peak runoff rate from the site under pre-development conditions during the same storm event.

## 2.2 Stormwater Quality

The purpose of this requirement is to improve the quality of stormwater that leaves the development site, by decreasing pollutants from the stormwater runoff.

### 2.2.1 Stormwater Quality Requirements

*Average removal of 80% of Total Suspended Solids (TSS) on an annual loading basis from all stormwater runoff leaving the development site based on the post-development level of imperviousness.*

In addition to TSS, there are many other water quality parameters of concern, such as elevated concentrations of nutrients (total phosphorus, nitrates), metals (copper, zinc, lead) and toxic chemicals (pesticides), petroleum products, etc. TSS was selected as the indicative parameter because TSS is a common and easily measured water quality parameter, and many of these contaminants are included in measurements of TSS. It is acknowledged the percent reductions for some contaminants will not be 80%, and that TSS is used as a proxy parameter for this policy.

The use of an average removal (defined as %) is to account for the variability in characteristics of rainfall events. The efficiency of any proposed BMP should be judged by its long-term sustainability and on an annual basis, instead of on an event or seasonal basis. This requirement is for ideal conditions; It is understood that some of the methods used may be less effective in winter.

Some BMPs require pre-treatment (by other BMPs) to ensure proper operation and longevity. Pre-treatment is recommended for infiltration BMPs to reduce the potential for clogging and to avoid the deterioration of groundwater quality.

## 2.3 Erosion Control

### 2.3.1 Erosion Control Requirements

*The applicant is required to submit a temporary erosion and sediment control plan to demonstrate the erosion control measures for the site during construction.*

Erosion and sediment control plans and their implementation shall demonstrate a preventative approach rather than a reactive approach. This approach will prevent or minimize the initial sediment erosion and subsequent suspension in stormwater.

All erosion and sediment control BMPs shall be designed, constructed and maintained in all development sites at a minimum in accordance with the Nova Scotia Environment Erosion and Sediment Control Handbook for Construction Sites. NSE is in the process of updating the

Erosion and Sediment Control Handbook for Construction Sites. Therefore, if more modern BMPs are proposed that meet the intent of the NSE requirements, they will be considered by HRM.

# 3.0 Selection of Best Management Practices

## 3.1 Benefits of On-Site Stormwater Best Management Practices (BMPs)

Stormwater BMPs are measures used to mitigate impacts to quantity and quality of stormwater runoff resulting from development. BMPs with a focus on green infrastructure (GI) use vegetation, soils, and other elements to mimic the natural processes required to manage stormwater and create healthier urban environments. Conversely, “grey” stormwater infrastructure includes the traditional fabricated facilities, often made from concrete and other hard / manmade materials. On-site BMPs may include vegetation planting, green roofs, and other landscaping to increase infiltration and evapotranspiration from the site, and to increase the amount of permeable surface on-site.

Vegetation slows the flow of stormwater in several ways. It is a physical barrier, allowing some of the stormwater to evaporate, it also absorbs stormwater through leaves, bark and roots, using it for growth. Vegetation can capture and uptake nutrients from deposited sediments, which can include nutrients that degrade water quality such that it may not support fish and aquatic organisms, or may cause nuisance plant growth and algal blooms. Some forms of algae, especially blue-green algae (cyanobacteria) in freshwater environments, may produce toxins that are harmful to wildlife, domestic animals, pets, and humans. This can result in the use of lakes being prohibited for recreation as a safety precaution.

Vegetation die-off and decomposition will release nutrients back into the water column. Unless vegetation harvesting and removal occurs, vegetation uptake does not substantially reduce nutrient loads in stormwater systems. Maintenance of BMPs is importance to maintain designed performance and the intended results.

During a rain event, the initial stages of stormwater runoff generated by the first 25 mm of rain fall is sometimes called “the first flush”. This stormwater collects the most sediment from impervious surfaces (such as parking lots, driveways, walkways etc.), and carries them downstream, increasing the concentration of pollutants along the way. By retaining on-site an initial portion stormwater from a single rain event, the concentration of nutrients downstream is reduced, which can result in an improvement to downstream water quality. Retaining rainfall on-site also decreases the flow rate of stormwater leaving individual sites. This results in improved flood resilience for affected areas and reduces the demand on municipal infrastructure.

Section 5 of this document identifies effective BMPs for developments that:

- provide environmental protection through stormwater quality improvements;
- continue to function appropriately over time; and,
- require minimal operation and maintenance.

The BMPs recommended in this document are based on proven technology used across Canada. Generally, these are methods that attempt to replicate the natural characteristics and infiltration components of an undeveloped system to the extent possible, to limit runoff quantity and to reduce or prevent water quality degradation caused by typical development.

There is no single BMP that suits every development, and a single BMP may not satisfy all stormwater control objectives. Therefore, a combination of BMPs may be required to achieve the objectives.


**Figure 1 - Rain garden at NSCC Ivany campus in Dartmouth**

## 3.2 Hierarchy Approach

The Hierarchy Approach was adopted as part of the guiding principles used in establishing the objectives for this document.

The applicant shall demonstrate that the Stormwater Management Plan for the proposed development implements the hierarchy approach within the private stormwater management of the development site, as described below:

a. **Source Control** practices retain stormwater where it reaches the site (*i.e*. retain rain where it falls). Source controls at the lot level are the preferred method for controlling the impacts of stormwater.

b. **Conveyance Control** such as private vegetation swales and/or infiltration systems, can limit the flow as it moves across the site.

c. **End-of-Pipe Control**, considered the last treatment opportunity prior to leaving the sites, shall be implemented if source and conveyance controls are unable to achieve the necessary level of stormwater quality and quantity control targets.

Engineered solutions such as “grey infrastructure” will be considered if the above methods are unable to achieve the targets alone. These practices often require more ongoing maintenance than BMPs, and do not have the added benefits that vegetated “green” infrastructure offers.

Implementing the hierarchy approach on private development sites improves the overall downstream stormwater quality above and beyond the traditional approach of an end-of-pipe stormwater management facility. The use of stormwater BMPs upstream will decrease the requirements for end-of-pipe facilities. In general, end-of-pipe facilities are the least preferred approach, because of the construction and maintenance costs, and the potential disruption of land features. For these reasons, stormwater BMPs typically result in better Return on Investment results.

# 4.0 Administration

## 4.1 Application Requirements for New MICI Construction

Stormwater balance and quality requirements are applicable as described in section 1.4. The application will be reviewed by both HRM and Halifax Water for completeness and acceptability prior to approval[1].

The following documentation is to be provided in accordance with By-Law G-200 Respecting Grade Alteration and Stormwater Management Associated with Land Development:

### 4.1.1 Stormwater Management Site Plan

A *stormwater management site plan(s)*, prepared and stamped by a professional engineer, of the private stormwater management system and design calculations, confirming the stormwater management system for the development:

(a) retains on-site stormwater runoff generated from the first 10 mm depth of a rainfall event.

(b) balances stormwater runoff generated after the first 10 mm of an event, to ensure matching of the pre and post-development stormwater runoff conditions, identified in a table on the plan.

This plan may be combined with erosion control, servicing or grading plans where reasonable based on the complexity of the site.

### 4.1.2 Stormwater Management Report

*A Stormwater Management Report* prepared by a professional engineer that shall:

a) Confirm the average removal of a minimum of 80% of TSS on an annual loading basis from stormwater runoff leaving the development site based on the post-development level of imperviousness.

b) Provide design rationale and identify hierarchy of stormwater principles used in the design of the private stormwater management system.

c) Provide information on operation and maintenance activities, if required, to ensure quantity and quality requirements continue to be met through the life of the infrastructure.

This may be expressed through a letter, memo, or on construction notes in combination with the requirements in section 4.1.1. Confirmation of removal of 80% TSS is not intended to be demonstrated through testing, but may be expressed using rationale provided through research associated with the prescribed methods.

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[1] An application made in accordance with these standards does not preclude the requirements for (an) additional application(s) for approval from provincial or federal agencies, nor does HRM of Halifax Water guarantee the granting of such approvals.

### 4.1.3 Soil Analysis

In circumstances where native soil is proposed for infiltration purposes, a *geotechnical soil analysis* may be necessary to ensure the soil is of sufficient permeability to allot the water to infiltrate at an acceptable rate. Alternatively, soil amendments may be used to ensure the design infiltration is achieved. If soil analysis cannot be completed, or if the soil is not suitable for infiltration, consider bioretention cells with underdrains.

### 4.1.4 Erosion and Sediment Control Plan

An Erosion and Sediment Control Plan, prepared and stamped by a professional engineer, shall be submitted and implemented during construction, in accordance with the requirements described in section 2.3.

## 4.2 Construction Certification Requirements

Upon completion of works, a professional engineer shall provide a certification of compliance with the approved Stormwater Management Plan and Report, as described above.

In cases where changes are required during construction, the Stormwater Management Plan and Report must be updated and re-submitted, to ensure compliance with approval conditions.

## 4.3 Maintenance Requirements

Monitoring of operating conditions and maintenance inspections are required for most stormwater management facilities (BMPs). The property owner is responsible to maintain the designed performance of the private stormwater management system.

It is important that BMP designers consider maintenance activities in their design and provide specific details in the Stormwater Management Plan and Report. There are many factors, which affect sedimentation rates and maintenance requirements including: types of BMP, land use, upstream development, and wildlife. Typically, sediment removal is the main maintenance requirement for wet or dry ponds and for infiltration facilities. Accumulated sediment at pre-treatment inlets or within the facilities must be removed. Other maintenance requirements include periodic removal of debris, control of vegetation (grass cutting, weed control, etc.) and revegetating, where necessary.

# 5.0 Descriptions of Recommended Best Management Practices

There are a wide range of BMPs for different site challenges and purposes. There are many considerations when deciding on best practices for a particular site or network of sites. Some of the most common considerations include: available space, existing infrastructure, proximity of the water table and bedrock to the surface, soil infiltration rates, hydrology, demand for water re-use, available materials and resources, pollution sources, maintenance requirements, land owner/developer preferences, and allowable limits for discharge of pollutants to the stormwater system.

The following are options recommended by HRM and Halifax Water for stormwater management, however other options may be accepted.

## 5.1 Source Control

### 5.1.1 Rain Barrels and Cisterns

**Overview**

As a means of source control, rainwater can be harvested in rain barrels or cisterns for later reuse. *Rain barrels* and *cisterns* are storage containers that collect runoff from rooftops during storm events and can either release or re-use the rainwater during dry periods[2].

The harvested runoff can be reused for multiple non-potable purposes such as watering gardens, flushing toilets, and washing cars. In addition to reducing stormwater runoff, rainwater harvesting can help to reduce domestic water consumption and reduce water bills and costs associated with electricity from pumping water.

**Use**

Rain barrels are typically attached to downspouts and range in size from 190 L to 400 L and industrial or commercial cisterns can range from 750 L to 40,000 L. The design components of cisterns can include a drainage system, pre-treatment filter, storage container, and delivery mechanism such as an outflow spout.

As part of the Stormwater Management Plan submitted, applicants will be asked to provide a description of how they will reuse the harvested rainwater.

**Considerations**

- Frequency and volume of water stored.
- Stored water should be used completely or drained before next storm if storage space is limited.

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[2] The use of captured rainwater for reuse as potable water may require NSE approval for a public registered water system. Additionally, disinfection through chlorination, UV, ozone, etc. may be required if the intended use is potable water.

- The level of treatment required should be considered, such as filtering and sediment removal.
- The pathway of precipitation if the system is full, or if the opening is frozen or otherwise blocked.

### 5.1.2 Green Roofs

#### Overview

As a means of source control, a *green roof* is a roof surface that has been intentionally covered with layers of actively rooted, growing vegetation planted in a growing medium.

Green roofs help to store rain water and result in increased evapotranspiration. Additional benefits from green roofs include temperature regulation for the building resulting in reduced energy costs, habitat creation for butterflies and bees, noise reduction, and increased longevity of the roof structure.

#### Use

Green roofs typically include a waterproof membrane, drainage layer and conveyance system for overflow, growing medium (soil), and vegetation. There are two main types of green roofs:

a) extensive green roofs which use a shallow growing medium, are planted with mosses, grasses, low plants and shrubs, and can be added to existing buildings of varying roof slopes; and,

b) intensive green roofs often include a thicker growing medium with larger features such as trees and walkways.

Green roofs can be built with building roof slopes of up to 10%, with larger slopes requiring engineering techniques to reduce erosion.

A minimum of 150 mm of growing medium should be used, to optimize stormwater capture and ensure the long-term survival of plants on a roof in Halifax's climate. While 150 mm is the recommended minimum, deeper soil depths allow more stormwater to be retained, and provide more function in winter weather.

Plantings of grasses and forbs (or mixed species including grasses, forbs, and succulents) are recommended for Halifax. There is increased maintenance during the first 2 years while plants become established. It is recommended that a 2-year maintenance contract be established to ensure the success of the green roof system and to ensure all plants are thriving.

Designers should consider provisions for supplemental irrigation. It is recommended that one hose bib be provided for every 30 linear meters of green roof.

These considerations are necessary to ensure the long-term sustainability of green roofs. If green roofs are not adequately designed and maintained, they can fail (plants die).

Green roofs can be paired with subsurface retention systems such as cisterns to maximize benefits of keeping stormwater on site. Roof structural requirements must be incorporated into the building design to support the increased weight of the green roof system. In the case of renovations, the building should be assessed by a structural engineer to ensure the structure can support the added weight of the green roof system including vegetation, soil, and maximum retained water.

### Considerations

- The structural capability of the roof system
- Slope of the roof and erosion prevention techniques.
- Plant types used.
- How the system will function in colder months.
- Soil depths to support vegetation.

**Figure 2 - Green roof on Halifax Central Library**

**Figure 3 - Green Roof on Halifax Seaport Farmers Market**

## 5.1.3 Bioretention

### Overview

Bioretention cells are depressions that contain vegetation grown in an engineered soil mixture often placed above a gravel storage bed. They provide storage, infiltration, and evaporation of both direct rainfall and runoff captured from surrounding areas. Street planters, stormwater boulevards, and rain gardens are examples of bioretention cells.

### Use

*Bioretention cells* include a combination of sand/gravel and well-drained soil layers and are typically planted with native plants that can endure both moist and dry conditions between rain events. Native perennials, shrubs, and trees are often selected to reduce maintenance costs and create habitat.

*Rain gardens* are a type of bioretention cell consisting of just the engineered soil layer with no gravel bed below it, and typically have no walls. Rain garden sizes usually range between 4 – 28 $m^2$ (50 - 300 $ft^2$). The ground is typically excavated to ensure a flat bottom and the garden soil is level with the ground surface. Design should allow surface water to infiltrate within a 4-hour period after a 25mm (1”) rainfall.

Bioretention systems can capture sediments, while the plants absorb and use the nutrients. A bioretention system can reduce runoff by approximately 30% compared to a conventional lawn. These systems can be combined with other infiltration systems. A perforated pipe/underdrain or vegetated swale can help direct excess runoff downhill to a destination such as a catch basin.

Bioretention systems using ground infiltration should be built 3 m away from building foundations and 8 m away from any portion of a septic system. Planting under tree canopy should generally be avoided to minimize disturbance to tree roots and promote greater plant growth. It is recommended that they be built on slopes of less than 12% to avoid erosional challenges and deepening the bed more than necessary. Compared to other best practices, bioretention has relatively low cost of installation and maintenance, which mainly involves erosion control, weeding/thinning, and watering in the first 2 years.

### Considerations

- Available space
- Soil permeability and soil infiltration rate
- Proximity of groundwater table
- How the system will function in colder months
- The pathway of precipitation if the storage is full or otherwise blocked

**Figure 4 - A rain garden being constructed outside the George Dixon Center in Halifax, with the help of the Ecology Action Center**

## 5.1.4 Trees for Stormwater Management

### Overview

In addition to their immense social and aesthetic value, trees and urban forests provide quantifiable economic and ecological value to cities. Healthy trees can contribute significantly to stormwater management, with large capacity to transpire water, intercept rainfall, and treat water quality. Trees play a key role in mitigating the effects of water on our landscape. It is estimated that for every 5% increase in overall canopy cover, total city run-off is reduced by 2%. In HRM, it is estimated that trees provide about $2.1 million in stormwater reduction services annually.

The preservation of trees, or *forested buffers* left on-site can absorb significant amounts of rainfall. *Tree canopy* can capture and slow rainfall. Trees can also absorb rainfall in leaves, bark and roots. Canopy coverage from mature trees are an effective practice of stormwater management.

Trees survive best in a natural system such as forests or even *tree lawns*. However, in hardscape areas where there is limited space, *soil cells* can be used as an effective method of bioretention. *Tree trenches* are a shared planting pit that accommodates several trees and their roots systems, that may have a subsurface system for distributing runoff among a series of trees.

### Use

It is important that these tree systems have adequate soil volumes and drainage to grow to maturity. Tree species selected should be diverse, climate and region appropriate. Varying trees can provide food and habitat to different species of birds and wildlife and can increase resilience to different kinds of disease. Select tree species that provide adequate canopy for stormwater management and, if applicable, are tolerant of standing water and wet conditions.

For further guidance on tree planting in urbanized areas, designers can refer to the tree guidelines in the HRM Municipal Design Guidelines.

### Considerations

- Available space
- Tree species
- Adequate drainage
- The pathway of precipitation if / once the opening is frozen or otherwise blocked

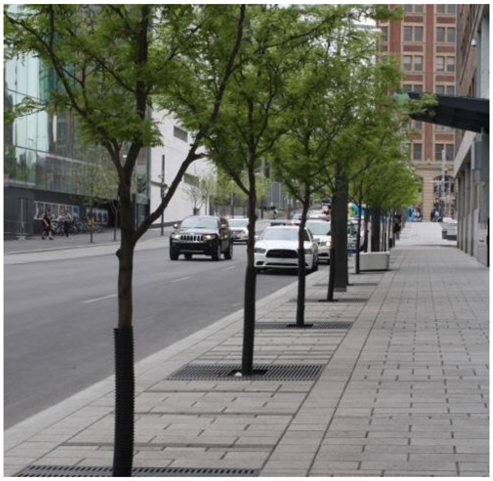

Figure 5 - Montreal - Soil cell

### 5.1.5 Permeable Pavement

#### Overview

In areas of new construction or where removal of pavement has occurred, permeable pavement can be installed to provide parking and walking areas which have higher permeability and infiltration capacity than conventional pavement. Permeable pavements typically include porous asphalt and concrete, vegetated grids, and inter-locking paving blocks, which sit above a storage layer. Rainfall passes through the pavement into the storage layer where it can infiltrate into the soil.

Permeable pavement can have higher cost than traditional pavement but are useful when other surface BMPs are not possible on the site. In the winter, they can reduce black ice, increase snow melt, and can be flexible enough to withstand minor heaving. These are suitable for private parking areas, and not suitable in the right-of-way or for heavy traffic.

In an Atlantic Canadian climate, important considerations for pavers include the ability of chosen materials to withstand freeze-thaw cycles and the impacts of de-icing strategies. Permeable pavements have been used successfully in Atlantic Canada through careful product selection and system design consideration.

Figure 6 - Permeable pavers in Dartmouth; water can infiltrate between the blocks to a gravel bed below.

Figure 7 – Porous asphalt in Halifax; water can infiltrate through the asphalt, but sediment may be trapped.

### Use

*Porous asphalt* or *porous concrete* have a porous binder, while *inter-locking paving blocks* have built-in spacing and a cement or plastic grid with vegetation growing in a sandy soil medium between the gridlines. Permeable pavements are typically underlain with layers of sand and gravel to provide support for traffic and increase storage and filtration. An underdrain should be used where the ground has low infiltration capacity. These options provide a stable surface for vehicle and foot traffic while enabling greater water flow into the ground, reducing runoff quantity and providing some filtration.

Chloride de-icing salt is a potential contaminant that has been known to mobilize heavy metals in soils; therefore, pre-treatment prior to infiltration or avoidance of de-icing salt hot spots may be necessary where groundwater contamination is a risk. Filter strips or berms installed on the edge of the paved area can help to reduce surface water runoff and introduction of sediment to the permeable pavement. Permeable pavements are to be avoided for sites that have high potential for oil spills (e.g. gas stations).

Porous concrete and asphalt require maintenance in the form of regular vacuuming to remove sediment build up from the pavement pours. Lower maintenance BMPs are recommended over porous pavements in Halifax. However, if a maintenance plan is in place, porous paving may be considered.

### Considerations

- Freeze-thaw cycles
- Location and proximity to salts and de-icing chemicals
- Depth of gravel bed below
- Ongoing maintenance

#### 5.1.6 Disconnection and Removal of Impervious Area

**Overview**

Disconnection of impervious surfaces such as rooftops, walkways and parking lots, (typically connected to the municipal system by downspouts or catch basins), can reduce stormwater volume by redirecting water to rain barrels and/or vegetated areas and by promoting infiltration and evapotranspiration.

For new MICI developments, it is not permitted to connect roof leaders to the municipal stormwater system, and it is encouraged for existing developments to disconnect. It is recommended that roof leader disconnection be paired with other BMPs.

**Use**

All disconnected roof leaders should be discharged a minimum of 2 m away from building foundations. Disconnected roof leaders must not be directed to adjacent properties or the right-of-way.

Removal of pavement from unused parking lots can help to increase permeability of surfaces. The restored area can be made into an open space with soil amendments to increase permeability and can be combined with other BMPs and tree planting to increase stormwater infiltration and uptake.

**Considerations**

- Area of impervious material being removed
- Site grading, slopes and erosion control
- Combination with other BMPs

### 5.2 Conveyance Control

#### 5.2.1 Biofiltration (Bioswales, Grass Swales, Vegetated Filter Strips)

**Overview**

While bioretention practices seek to hold water at the source for as long as possible, biofiltration practices filter the runoff while conveying it further downstream.

*Grass Swales* are typically shallow (0.5m) and are usually sodded with slopes around 1%, their purpose being to slow down water to allow infiltration. *Bioswales* are deeper and contain a variety of plants often selected for filtration and biodiversity and are typically used as a first stage treatment and infiltration. Bioswales may have gravel layers for added storage and infiltration. They can be used as pre-treatment of stormwater and direct water downhill to another BMP such as a rain garden, or permeable pavement area.

*Vegetated filter strips* are bands of dense vegetation through which runoff is directed. They are best for gently sloping areas, where channelized flow is not likely to form. Filter strips may treat runoff from roads, roof leaders, small parking lots and impervious surfaces, or can be used as pre-treatment. Vegetated filter strips should have slopes of not more than 10%, 1-5% is considered ideal. *Forested buffers*, or undeveloped land strips can also be used as vegetated filters.

**Figure 8 - Vegetated swale in Dartmouth**

### Use

Biofiltration practices should not be considered where the ground is not stabilized and should not be used where there are high sediment loads. They can be combined with an underdrain to increase drainage where the ground has low infiltration capacity.

*Bioswales* are typically excavated to a depth of 300 mm - 1 m (with thicker gravel layers enabling greater retention and infiltration of water. They are typically wider than grass swales, 4-6m. A slope of 5% or less is recommended to convey stormwater without eroding the channel. For slightly steeper slopes, check dams can be used to slow the water and promote sheet flow.

Maintenance of swales and infiltration trenches can include periodic trimming or mowing of vegetation, checking for clogging of the trench or underdrain, and replacing material lost through erosion.

### Considerations

- Sediment loads
- Available area
- Slope and erosion control
- The pathway of precipitation if/once the conveyance system is full or entrance to the conveyance system is frozen or otherwise blocked.

#### 5.2.2 Subsurface conveyance

#### Perforated Pipes and French Drains

##### Overview

*Perforated pipes* can be used to store excess stormwater, allowing the water to infiltrate slowly into the ground. They reduce surface water in undesirable locations by transmitting the excess water underground and downhill to a more suitable location such as a private catch basin. They can be used as an element in other BMPs, including bioswales, and rain gardens. They are useful for sites where infiltration conditions are poor.

*French drains* (or dry wells) are a specific BMP that includes *perforated pipes* as a design component. A French drain is a trench, lined with geotextile fabric, filled with clean gravel with a perforated pipe centered in the lower portion of the trench. The geotextile fabric and stone prevent particulate matter from clogging the holes in the pipe. French drains enable the infiltration and transmission of stormwater to lower lying areas and allow the ground surface to be free for other uses. The surface may be exposed gravel, or it may be topped with geotextile fabric, soil, and plant material.

Oversized piped sections, or subsurface detention chambers with orifice controls are also an acceptable method of temporarily storing and controlling the release of stormwater. These options can be placed below parking lots with no loss / consumption of land.

##### Use

Perforated pipe systems should include an observation well to enable regular maintenance and inspection and avoid blockage issues. It is recommended that these underdrain systems not be built on a slope greater than 15% and that the gravel bed have a slope of not more than 1% to promote infiltration. It is recommended that perforated pipes be installed after upstream construction has been completed and that pre-treatment be included to reduce particulates in stormwater outflows. Perforated pipes should be set back at least 4 meters from building foundations and must be below the local maximum frost penetration depth to avoid freezing during the winter.

Perforated pipes and French drains may not be connected directly to Halifax Water storm sewers. However oversized pipes with orifice control are typically acceptable. Refer to Halifax Water Design Specifications.

##### Considerations

- Soil material and infiltration rate
- Slope of ground and erosion control
- How the system will function in colder months.

### 5.3 End of Pipe

End-of-pipe solutions typically include naturalized stormwater ponds and constructed wetlands. End-of-pipe options are best used when upstream BMPs cannot achieve the requirements alone. Stormwater ponds can provide storage and can control the release of stormwater using orifices or weirs. These systems may offer some quality benefits by allowing sediment to settle out. However there are regular maintenance requirements to remove built-up sediment.

An applicant may choose to use a privately owned and maintained stormwater management pond on site. However, publicly owned naturalized stormwater ponds and constructed wetlands require consultation with public entities such as NSE and are outside the scope of this document.

## 5.4 Other

When the requirements for water balance and quality cannot be met with the BMPs above, additional practices can be used in combination with BMPs, such as oil and grit separators, catch basin inlet control devices, parking lot storage, or underground storage tanks. Refer to the Halifax Water Design Specifications for more information prior to the design, selection and installation of these facilities.

**Figure 9 - Green wall at NSCC Ivany campus in Dartmouth - an example of other innovative options**