City of Peterborough

To:	**Members of the General Committee**
From:	**W. H. Jackson,** **Commissioner of Infrastructure and Planning Services**
Meeting Date:	**August 20, 2018**
Subject:	**Report IPSEC18-014** **Low Impact Development Guidelines**

Purpose

A report to provide an overview of the upcoming Ministry of the Environment, Conservation and Parks “Low Impact Development Guidelines” and how these new guidelines will impact future infrastructure projects and land development in the City.

Recommendations

That Council approve the recommendations outlined in Report IPSEC18-014 dated August 20, 2018 of the Commissioner of Infrastructure and Planning Services as follows:

a) That the presentation on the proposed Low Impact Development Guidelines be received; and

b) That the City of Peterborough Engineering Design Standards be updated to incorporate portions of Low Impact Development practices as described in Appendices A and B of Report IPSIP18-014.

Budget and Financial Implications

There is no immediate budget or financial implications as a result of the adoption of these recommendations.

Implementation of the new low impact stormwater management strategies may increase the capital costs of some City projects and, as Low Impact Development (LID) projects become more prevalent in the City, additional operating/maintenance costs may also occur. All of these costs will be included in the individual capital budgets and future operating budgets as appropriate.

Background

At its meeting on August 28, 2017, the Planning Committee requested;

“That staff provide a report for Council consideration regarding the adoption of low impact design standards”.

Report IPSEC18-014 is being provided to the General Committee to address this request as well as provide additional information related to the upcoming Ministry of the Environment, Conservation and Parks (MOECP) LID Guidelines.

LID as defined by the U.S Environmental Protection Agency and by Credit Valley Conservation in their respective guidelines is:

“A stormwater management strategy that seeks to mitigate the impacts of increased runoff and stormwater pollution by managing runoff as close to its source as possible. LID comprises a set of site design strategies that minimize runoff, and distributed small scale structural practices that mimic natural or predevelopment hydrology through the processes of infiltration, evapotranspiration, harvesting, filtration and detention of stormwater. These practices can effectively remove nutrients, pathogens and metals from runoff, and they reduce the volume and intensity of stormwater flows.”

History of Stormwater Management

Stormwater Management (SWM), since its inception, has typically employed a conveyance (storm sewers) and an end of pipe (pond) solution for managing the increased amount of runoff that results from development and overall increases in hard surfaces. The storm sewers and ditches carry stormwater to a pond or watercourse. The pond or “Stormwater Facility” collects and holds back runoff, releasing it at a lower rate, before it enters a watercourse or water body. Prior to the 1990’s, most stormwater facilities were used for flood control ignoring, for the most part, water quality issues.

In 1994 Ontario adopted the Stormwater Management Practices Planning and Design Manual which considered water quality and flood control. With the adoption of the manual, Municipalities across Ontario began to see the construction of wet pond type SWM Facilities in most new subdivision and large-scale developments. An update to the manual was undertaken in 2003. This update introduced source control guidelines and lot level control whereby stormwater runoff is managed where it is generated, rather than being managed further downstream.

Unfortunately, the 2003 manual was not explicit in the requirements to implement source control and lot level control and common practice was to utilize the treatment (pipes and ponds) that was most economical and easiest for approvals. The approach has been an accepted approach by the Ministry over the past 20 years, as indicated by the issuance of Environmental Compliance Approvals (ECA).

Current and Future Approaches to Stormwater Management

The MOECP, in their 2015 Interpretation Bulletin regarding SWM indicated that:

“Too often, preservation of the natural hydrologic cycle is not sufficiently addressed in stormwater management plans submitted to the Ministry for an ECA”.

The Ministry further states that, “going forward, the Ministry expects that stormwater management plans will reflect the findings of watershed, sub watershed, and environmental management plans, and will employ LID in order to maintain the natural hydrologic cycle to the greatest extent possible”.

With these statements it is clear the MOECP is intending to not only enforce the process set forth in the 2003 manual but expand on their requirements. Reference to the hydrologic cycle means the movement, distribution, and quality of water including the water cycle, water resources and environmental watershed sustainability. This water cycle outlook will play a large role in how municipalities advance in treating stormwater.

LID has been gaining traction in Ontario over the past decade, primarily driven by concerns associated with climate change and the increased risks associated with weather extremes. The benefits of LID are well documented and recognized. The City has been awaiting revised guidelines from the Ministry outlining the requirement for LID as a primary form of stormwater management.

The **Provincial Policy Statement (PPS)** and the **Growth Plan for the Greater Golden Horseshoe (The Growth Plan)** represent the guiding principles for which future developments will proceed, and include a clear emphasis on environmental sustainability. Environmental sustainability as it relates to SWM is achieved through informed watershed planning, widespread adoption of LID and Green Infrastructure and traditional stormwater management techniques. It is widely recognized in the water resources engineering community that LID is a compliment to traditional stormwater infrastructure such as storm sewers and stormwater management ponds.

Watershed Planning

New policies contained in the latest **Growth Plan**, and legislated under the **Places to Grow Act** require municipalities to undertake watershed planning as a basis for identifying and protecting the water resource systems and to inform land use and infrastructure planning and decision making. Developing a Watershed Plan will prepare the City for future expansion and intensification in accordance with the requirements of the **Growth Plan** and **Places to Grow Act** and help guide the development community with a plan that balances the environment with the needs of our growing community.

The Watershed Plan will improve our approach to strategic adaptation planning and reduce climate risk by helping to shape future development and City infrastructure priorities in the City and surrounding areas. This approach will guarantee that climate adaptation priorities and climate risks related to watershed management are realized, validated and refined; creating a more resilient community.

To ensure the City is well positioned to develop the appropriate watershed plans, two steps will be taken:

- A $500,000 capital budget item will be included in the 2019 Draft Budget to allow for the hiring of outside consultant help in undertaking the Watershed Plan Project; and

- An application will be made to the Federation of Canadian Municipalities for a Climate Change Grant to partially fund the salary of a project manager for the Watershed Plan project. The staff grant will fund up to a maximum of $125,000 over a 24 month period with the remaining estimated salary and benefits of $48,000 annually coming from the capital budget allocated to watershed planning.

Watershed planning is the high level review that will assist in the implementation of LID aspects of stormwater management in future developments within the City.

LID Manual

Municipalities across Ontario and the MOECP have recognized the need for clear and consistent guidance for the successful adoption and implementation of LID. To help with this guidance, MOECP, Municipalities, Conservation Authorities and many other interest groups have drafted a Low Impact Development Stormwater Management Guidance Manual (LID Manual).

The LID Manual is in draft and has yet to be formally approved, but indications are that this could happen in 2018. If past practices of the MOECP are any indication, strict adherence to the contents of this manual will be required in order for an Environmental Compliance Approval (ECA) to be issued.

The LID Manual represents a significant shift in managing stormwater. Implementation of these SWM approaches will benefit the natural environment, and aid the City in its climate change adaptation. The LID manual and its companion document, the 2003 Stormwater Management Ponds Planning and Design Manual, collectively provide the guidance and SWM criteria necessary to implement a holistic treatment to stormwater management using the full spectrum of source, conveyance and end-of-pipe controls.

Highlights of the MOECP LID Guidance Manual

The LID Guidance Manual is meant to compliment past guidance documents with a focus on four objectives for Ontario:

- Defining stormwater volume control requirements;
- Presenting criteria to select appropriate water budget and water modeling tools;
- Establishing guidelines and processes for groundwater protection from infiltration based LID; and
- Presenting a process for which to reflect future climate scenarios and assess climate change risks and vulnerabilities.

The foundation of the LID Manual's guidance on SWM is to capture and retain 90% of all rain events. For Peterborough, this translates to the first 27mm of rain. While the first step in the hierarchy of SWM control, as defined in the manual, is to infiltrate water (Hierarchy 1), the manual does allow for other forms of SWM control when infiltration is not feasible. This includes capturing and releasing runoff at a controlled rate using LID and conventional controls (Hierarchy 2 and 3). In all cases the manual allows for some exceptions where sites are unable to meet the intended control targets.

LID technologies capable of controlling stormwater in accordance with Hierarchy 1 of the LID Manual are provided in Appendix A. Within Appendix A, Table 1 includes a decision matrix for selecting the most appropriate LID feature based on the type of development. Table 2 further refines this decision matrix by identifying which LID features provide the maximum benefit for addressing various stormwater related issues. The City's Engineering Design Standards will adopt principles and build on the guidance provided in the LID Manual, presenting a method for selecting appropriate LID features based on development type, and detailing and standardizing the design and construction of various LID's. Consideration for capital and operating budgets will be important factors in our design standards as it relates to public infrastructure.

The proposed volume control targets for Ontario represents a significant shift in the practice of stormwater management for municipalities providing many benefits such as:

- Mitigating downstream flooding;
- Mitigating erosion in receiving watercourses;
- Helping control water quality with the ability to remove more contaminates than traditional SWM practices;
- Preserving stream base flow and riparian ecosystems;
- Helping to recharge shallow and deep aquifers;
- Preserving natural temperatures in receiving watercourses;
- Being multifunctional; including landscaping and aesthetic benefits, providing native vegetation for animals, birds and insects, societal benefits, open space use, etc.; and
- Being resilient and adaptable to climate change.

Appendix B details common examples of LID practices that will be considered when implementing LID in the City Engineering Guidelines. Included is a brief description of the LID practice, limitations that may prohibit its use, and a high level cost/benefit description.

Financial Impact of LID Practices

The benefits of LID will likely come at a cost. The new LID Guidelines may result in a significant impact to the capital cost of many linear road reconstruction projects. An example of the potential cost increase is described below.

The project examined included full reconstruction and expansion of the road. The project was completed to improve drainage, storm water quality, efficiency, and safer pedestrian crossings and included the installation of curb, gutter, storm sewers, and oil and grit separators as well as, new traffic signals, an off-road bicycle facility, pedestrian sidewalks, signalized pedestrian crossings, new asphalt surface, and new multi-use trail. The total project cost was $6.1 million, including approximately $1.1 million of which was directly attributed to "Stormwater" related services. The works included installation of two Stormceptor Oil and Grit Separators. These units provide water quality control only, by removing oils and sediment prior to it being discharged downstream.

Under the proposed MOECP LID Guidelines, this project would have required additional or alternative SWM controls, including the use of LID features. A minimum of 14 Bioretention Cells (each approximately 40m long) could have been required in place of the oil and grit separators (OGS). The cost to install the Bioretention Cells is estimated at $580,000 versus $170,000 for the OGS units. In this example, constructing LID features would have added 6.5% to the projects capital budget.

When considering full lifecycle costs, the cost of the OGS units, over a 50 year period (including installation) would be $570,000, assuming a 2% annual construction cost index and a major rehabilitation after 25 years. The Bioretention Cells, are less expensive to maintain and construct individually, however because there needs to be significantly more of them, the initial installation and annual maintenance cost is estimated to be $1.3 million over 50 years, which also includes major rehabilitation after 25 years.

Other Non-Financial Challenges

There are other, non-financial aspects of LID that need to be understood as listed below:

- The City's standard Municipal Right-of-Way (ROW) layout may need to be modified. LID practices typically distributed within the ROW include Bioretention cells, grassed swales, tree boxes and perforated pipe systems. These features occupy valuable space and will compete with other ROW priorities such as sidewalks, multi-use trails, bike lanes, utilities and parking stalls which may require ROW widths to increase.

- Significant homeowner education and municipal enforcement will be needed to ensure the longevity of LID features installed on individual homeowner's property as part of subdivision approvals. LID typically installed on private residential property include rear yard swale/infiltration trenches, modified topsoil (to promote infiltration) and to some extent rain barrels and rain gardens. The long term reliance on these types of features is difficult without the appropriate oversight to ensure they are working and maintained as needed. Many other Municipalities are implementing stormwater fees and credits, or rebates, as an incentive to ensure homeowners maintain and protect these features. The alternative would involve by-law enforcement and fines for damaging an LID feature.

- The City of Peterborough has and continues to make significant investments in reducing the inflow and infiltration to the Sanitary System. The goal of this program is to reduce the number of sewer backups and eliminate by-passes of the Wastewater Treatment Plant. LID promotes infiltration of water into the ground and may negatively impact the existing sanitary system by introducing more water to the system. This is a common concern across Ontario and should be considered prior to implementing any LID project.

- Widespread implementation of LID within roadways and on private properties is a major cultural shift in the management of stormwater. Educating the City’s design staff, construction inspection staff and maintenance staff will be vital to ensure the initial and ongoing success of LID facilities in the City. It will also be important that consultants and contractors be qualified to design and construct LID facilities. Training is made available in Ontario through the Sustainable Technologies Evaluation Program (STEP). The City may choose in the future to have LID training and certification a requirement for working on capital projects.

Next Steps Related to LID Systems

The next steps listed below will need to occur to implement LID.

1. Remain engaged with the MOECP and other Municipalities on further advancements and changes to the Draft LID Manual. Discuss implications of LID Manual with all appropriate City Departments.
2. Adjust the City’s design standards as necessary to facilitate the addition of LID stormwater management techniques similar to those detailed in Appendix B; including development of a revised standard Right-of-Way that includes LID. Distribute to affected Departments and Utilities for comment, revise as necessary, and present to Council for approval when complete.
3. Begin Watershed Planning in 2019 for the City of Peterborough as required by **The Growth Plan for the Greater Golden Horseshoe (GPGGH).** Watershed Planning will further assist in the identification of priority LID areas and what significant features may be present in the watershed (sensitive to water quality, groundwater recharge, volume capture, etc.).
4. Investigate downsizing of existing storm water management infrastructure based on LID implementation, and the potential for cost savings. This includes reducing the size of stormwater management ponds and storm sewers.
5. Develop an enforcement mechanism and/or incentive program for the maintenance of LID located on private property. This may include a maintenance by-law and

restrictive covenant registered on title for property owners, ensuring the long term protection of LID. Alternatively, the City may decide to register easements over all LID located on private property (single family residences only), and retain the maintenance responsibility.

Summary

The MOECP LID Guidance Manual represents a major shift in how the City will manage stormwater. The manual will also have an impact on the development community, requiring all new development and re-development sites to implement various forms of Low Impact Development Stormwater Management techniques. Applying widespread LID practices will add to the upfront cost of most infrastructure projects, but it is a necessary shift to ensure the City is protecting water resources for future generations.

Submitted by,

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Appendix A – LID Applicability and Benefits
Appendix B - Common LID Practices

Appendix A: LID Applicability and Benefits

Table 1 below can be used to aid Developers and the City in selecting the most appropriate form of LID for various development types (subject to revisions). Table 2 includes a decision matrix for determining which types of LID are most beneficial for various hydrologic, water quality and energy related concerns. In selecting LID features, the City and Developers will consider the objectives and goals of a watershed or sub watershed plan and utilize Table 2 for identifying the most beneficial form of LID.

Table 1

LID Category	Development Type					
	Infill Redevelopment	**Industrial**	**Commercial and Multi Family**	**Residential**	**Parks and Open Space**	**Linear Road Reconstruction**
Stormwater Reuse/Harvesting	Medium	High	High	Medium	Low	Low
Grass Swales and Bioswales	Medium	Medium	Medium	High	High	High
Bioretention	High	Medium	High	High	High	High
Soakaways and Infiltration Chambers	High	High	High	Medium	High	Low
Perforated Pipe and Exfiltration	Medium	Medium	Medium	Low	Medium	High
Green Roofs	Low	Medium	Medium	Low	Low	Low
Permeable Pavement	Medium	Medium	High	Medium	High	Low
Absorbent Landscaping	Low	Low	Low	High	High	Low
Low	This LID type is usually not applicable. Site constraints and/or cost will limit the use of this LID					
Medium	This LID type is applicable in most cases, but not all. Costs and site constraints may be an issue					
High	This LID type is highly applicable in most or all cases. Costs are manageable in comparison to other methods of achieving design goal					

Table 2

LID Benefit	LID Category							
	Reuse / Harvesting	**Swales and Bioswales**	**Bioretention**	**Soakaways and Chambers**	**Perforated Pipe and Exfiltration**	**Green Roof**	**Permeable Pavement**	**Absorbent Landscaping**
Reduced Runoff	+	+	+	+	+	+	+	+
Reduced Flooding	<	+	+	+	+	+	+	+
Improved Water Quality	<	+	+	<	<	+	<	+
Increased Groundwater Recharge		+	+	+	+		+	+
Reduced Salt Application							+	<
Improved Air Quality		+	+			+		<
Reduced Urban Heat Island		+	+			+	<	+
Reduced Energy Use	+	+	+	<	<	+	+	<
Improved Aesthetics		+	+			+	<	+
Improved Habitat		+	+			+		+
Reduced Traditional Stormwater Infrastructure	+	+	+	+	+	+	+	+

+	Highly Beneficial
<	Possible Beneficial
(shaded)	Required elements to meet MOECP LID Guidelines

Appendix B: Common LID Practices

A. Stormwater Reuse/Harvesting

Rainwater harvesting is the process of intercepting, conveying and storing rainfall for future use. When harvested rainwater is used to irrigate landscaped areas, the water is either evapotranspired by vegetation or infiltrated into the soil, thereby helping to maintain a predevelopment water balance. Passive collection systems such as rain barrels are also considered under this category.

Limitations

- Systems have minimal water quality treatment capabilities;
- Rainwater re-use systems often require a potable water supplement since rainfall is not consistent enough to supply all irrigation or non-potable demands in a timely and economical manner;
- Installation MUST be done by experienced personnel to prevent any chance of cross contamination of the potable system;
- Due to installation on private property, control of operation and maintenance is typically beyond the jurisdiction of municipalities; and
- Rain barrels have limited volume and must be emptied between rainfalls to be effective, these concerns limit the ability to be used in a stormwater system design.

Cost/Benefit Summary

Medium – Rainwater harvesting systems would be beneficial at reducing runoff and may also improve water quality in a downstream receiver. They may have a high upfront cost, depending on the size and complexity of the system.

Clockwise from top left: typical plastic rain barrel; cast in place concrete cistern integrated within a parking garage (Source: TRCA); above-ground plastic cistern; underground pre-cast concrete cistern (Source: University of Guelph)

B. Grass Swales and Bioswales

Enhanced grass swales are vegetated open channels designed to convey, treat and attenuate stormwater runoff (also referred to as bioswales). Check dams and vegetation in the swale slows the water to allow sedimentation, filtration through the root zone and soil matrix, evapotranspiration, and infiltration into the underlying native soil.

Limitations

- Improper installation will prevent removal of sediment and pollutants. Slopes and vegetation density are critical;
- Individual swales can treat only small areas;
- They are less feasible along roadsides with many driveway crossings and where space is limited in the right-of-way;
- Phosphorus and bacteria removal capabilities may be limited depending on design and vegetation used;
- Maintenance requirements are higher than curb and gutter systems; and
- They may be subject to damage from off-street parking and snow removal when located along roadways.

Cost/Benefit Summary

High – Grass swales and bioswales are highly a beneficial SWM practice and are typically simple to implement and construct. Drainage features such as swales and ditches may already be a necessity in some projects, and the addition of an enhanced swale or bioswale would not add substantial cost.

Source: Seattle Public Utilities (left); Sue Donaldson (right)

C. Bioretention

As a stormwater filter and infiltration practice, bioretention temporarily stores, treats and infiltrates runoff. The primary component of a bioretention practice is the filter bed which is a mixture of sand, fines and organic material. Other important elements of bioretention include a mulch ground cover and plants adapted to the conditions of a stormwater practice. Bioretention is designed to capture small storm events or the water quality storage requirement.

Limitations

- Unlike stormwater ponds, bioretention cannot treat large drainage areas;
- They are susceptible to clogging by sediment. Therefore, pre-treatment may be required, especially in locations where anti-skid material has been applied to the contributing catchment;
- They may consume considerable space, between 5% to 20%, of the catchment area;
- Incorporation into parking lot design may reduce the number of parking stalls available; and
- Depending on the location and development type, construction costs can be relatively high compared to some conventional stormwater treatment practices.

Cost/Benefit Summary

High – Bioretention is a highly beneficial SWM practice and is typically simple to implement and construct. The upfront costs to construct bioretention are moderately more expensive than other surface LID features.


Left – York University (Source: TRCA); Right – Riverwood Park, Mississauga, Ontario (Source: CVC)

Left and Right - front yard rain gardens that takes runoff from the residential lot and street (Source: City of Maplewood, Minnesota)

D. Soakaways and Infiltration Chambers

On sites suitable for underground stormwater infiltration practices, there are a variety of facility design options to consider, such as soakaways, infiltration trenches and infiltration chambers.

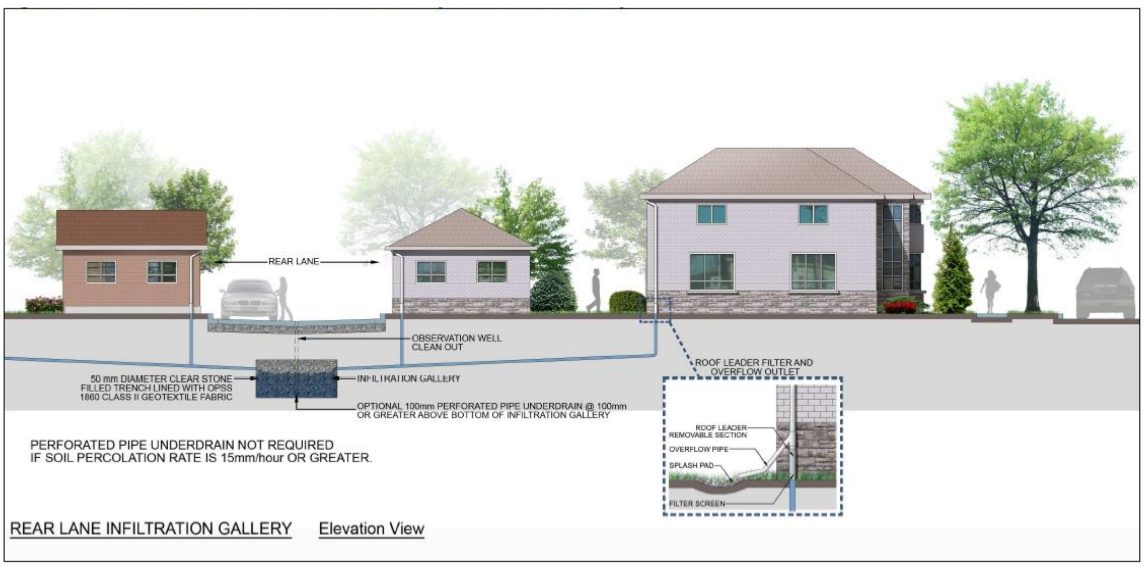
Soakaways are typically installed on residential or small commercial properties and are rectangular or circular excavations lined with a geotextile and filled with clean granular stone, they receive runoff from a perforated and allow it to infiltrate to native soils. Soakaway trenches are essentially the same, but are constructed as a linear feature. Chambers are also similar, but are typically made from large manufactured structures of plastic or concrete. Chambers are typically found under parking or landscaped areas that create large void spaces for temporary storage of stormwater runoff and allow it to infiltrate into the underlying native soil.

Limitations

- Are susceptible to clogging and should only accept clean roof drainage or include a pre-treatment device when accepting road/parking lot drainage;
- May not be feasible where groundwater is high or in areas where groundwater contamination is a concern;
- Biological processes that remove contaminants from stormwater are negligible; and
- Depending on the location and development type, construction costs can be relatively high compared to some conventional stormwater treatment practices.

Cost/Benefit Summary

Medium – Soakaways are a moderately beneficial SWM practice and are typically simple to implement and construct. Chambers are also a moderately beneficial SWM practice but may be complex to implement and construct. Soakaways have a low to moderate upfront cost, while Chambers are one of the most expensive forms of LID. The significant upfront cost of a Chamber is offset by the ability to retain useable land area above the structures.



. Perforated Pipe and Exfiltration System

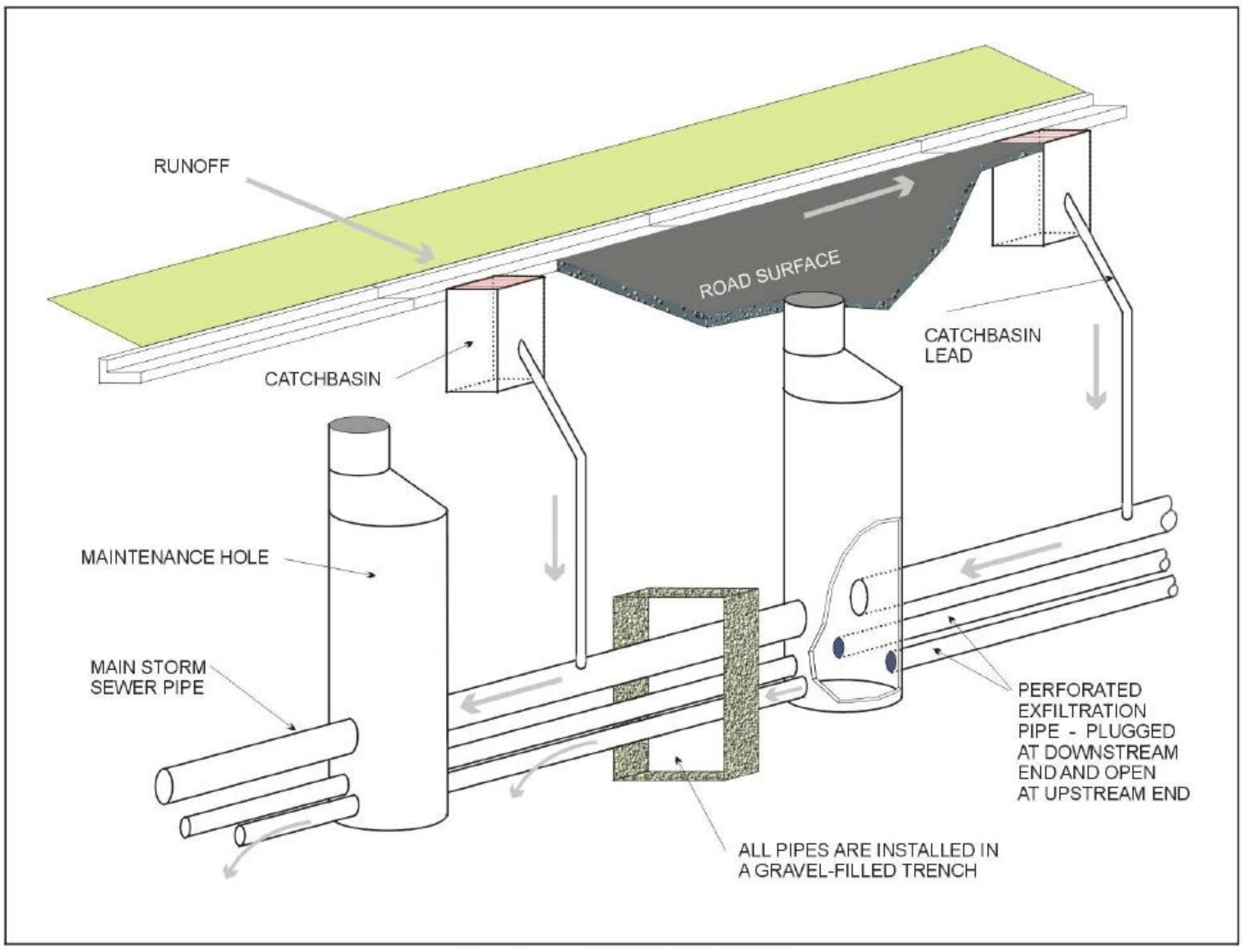
Perforated pipe systems can be thought of as long infiltration trenches or linear soakaways that are designed for both conveyance and infiltration of stormwater runoff. They are underground stormwater conveyance systems designed to attenuate runoff volume and thereby, reduce contaminant loads to receiving waters. Perforated pipe systems can be used in place of conventional storm sewer pipes, where topography, water table depth, and runoff quality conditions are suitable.

Limitations

- Are susceptible to clogging and must include a pre-treatment device when accepting road/parking lot drainage;
- May not be feasible where groundwater is high or in areas where groundwater contamination is a concern;
- Biological processes that remove contaminants from stormwater are negligible;
- Construction costs will be more expensive than a traditional storm sewer system; and
- Not practical when infiltration to the sanitary sewer is a concern.

Cost/Benefit Summary

Medium – Perforated pipe and exfiltration systems are a moderately beneficial SWM practice but may be complex to implement and construct. These systems would have a high upfront cost to construct, but would be a more practical expense when used to replace or complement a traditional storm sewer system.



Source: SWAMP, 2005

F. Green Roofs

Green roofs, also known as “living roofs” or “rooftop gardens”, consist of a thin layer of vegetation and growing medium installed on top of a conventional flat or sloped roof. Green roofs are touted for their benefits to cities, as they improve energy efficiency, reduce urban heat island effects, and create green space for passive recreation or aesthetic enjoyment. To a water resources manager, they are attractive for their water quality, water balance, and peak flow control benefits.

Limitations

- Costs to build green roofs are high compared to traditional roof treatments;
- Only direct rainfall is treated;
- Control of maintenance and operation is often beyond municipal jurisdiction; and
- Design and construction experience is currently limited in Canada, though rapidly becoming less so.

Cost/Benefit Summary

Low – Green Roofs are a low to moderately beneficial SWM practice and may be complex to implement and construct. These systems may be prohibitively expensive to construct during a redevelopment of an existing building. Green Roofs have the highest cost/benefit when used on new development sites in high density urban areas.

Clockwise from top left: Chicago City Hall (Source: Roofscapes, 2005); York University in Toronto, Jackman Public School in Toronto; and Earth Rangers Building in Vaughan (Source: TRCA)

G. Permeable Pavement

Permeable pavements, an alternative to traditional impervious pavement, allow stormwater to drain through them and into a stone reservoir where it is infiltrated into the underlying native soil or temporarily detained. They can be used for low traffic roads, parking lots, driveways, pedestrian plazas and walkways. Permeable pavement is ideal for sites with limited space for other surface SWM practices.

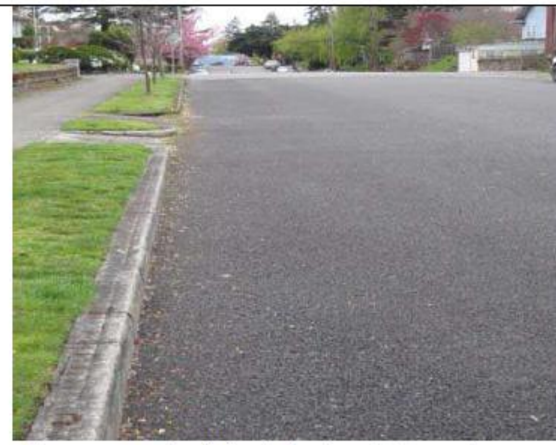
Limitations

- Maintenance requirements are high compared to other LID-BMP stormwater management facilities;
- Costs to build permeable pavements are high compared to other stormwater management facilities;
- A small drainage area is treated;
- They are susceptible to clogging where anti-skid material is applied;
- Performance is reduced if freezing occurs while the surface is saturated;
- They are unsuitable for use in areas where heavy sediment loads are expected or in active construction or excavation areas that are not fully stabilized; and
- They are unsuitable for use in areas with heavy vehicle traffic, unless specifically designed for heavy loads.

Medium – Permeable Pavement is a moderately beneficial SWM practice and may be complex to implement and construct. These systems may be prohibitively expensive to construct. Permeable Pavement has the highest cost/benefit when used on an infill development where space is limited for other forms of LID’s.

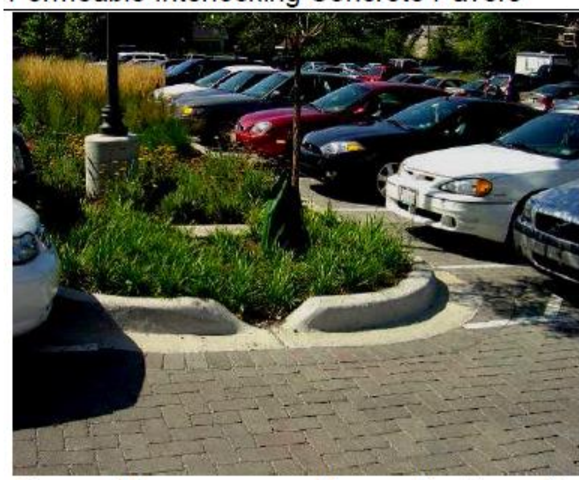
Porous Asphalt

Porous asphalt parking lot (Source: Villanova Urban Stormwater Partnership)



Porous asphalt installed curb to curb on a residential street (Source: City of Portland, Bureau of Environmental Services)

Permeable Interlocking Concrete Pavers



Permeable pavers used in combination with bioretention in a parking lot in Elmhurst, IL (Source: ICPI).

Permeable pavers in Hoboken, NJ used around trees which allow air and water to reach the roots (Source: Bruce Ferguson).

H. Absorbent Landscaping

Absorbent landscaping includes; disconnecting downspouts and directing to a grassed area, vegetated filter strips, and amended topsoil. Disconnected downspouts help to filter and infiltrate roof runoff before reaching the road or storm sewer system. Vegetated filter strips are gently sloping, densely vegetated areas that treat runoff as sheet flow from adjacent impervious areas. They function by slowing runoff velocity and filtering out suspended sediment and associated pollutants, and by providing some infiltration into underlying soils. Amending topsoil involves creating a specific mix of soil for residential properties in a subdivision that improves infiltration and filtration of runoff, amended topsoil depths are also increased to promote infiltration.

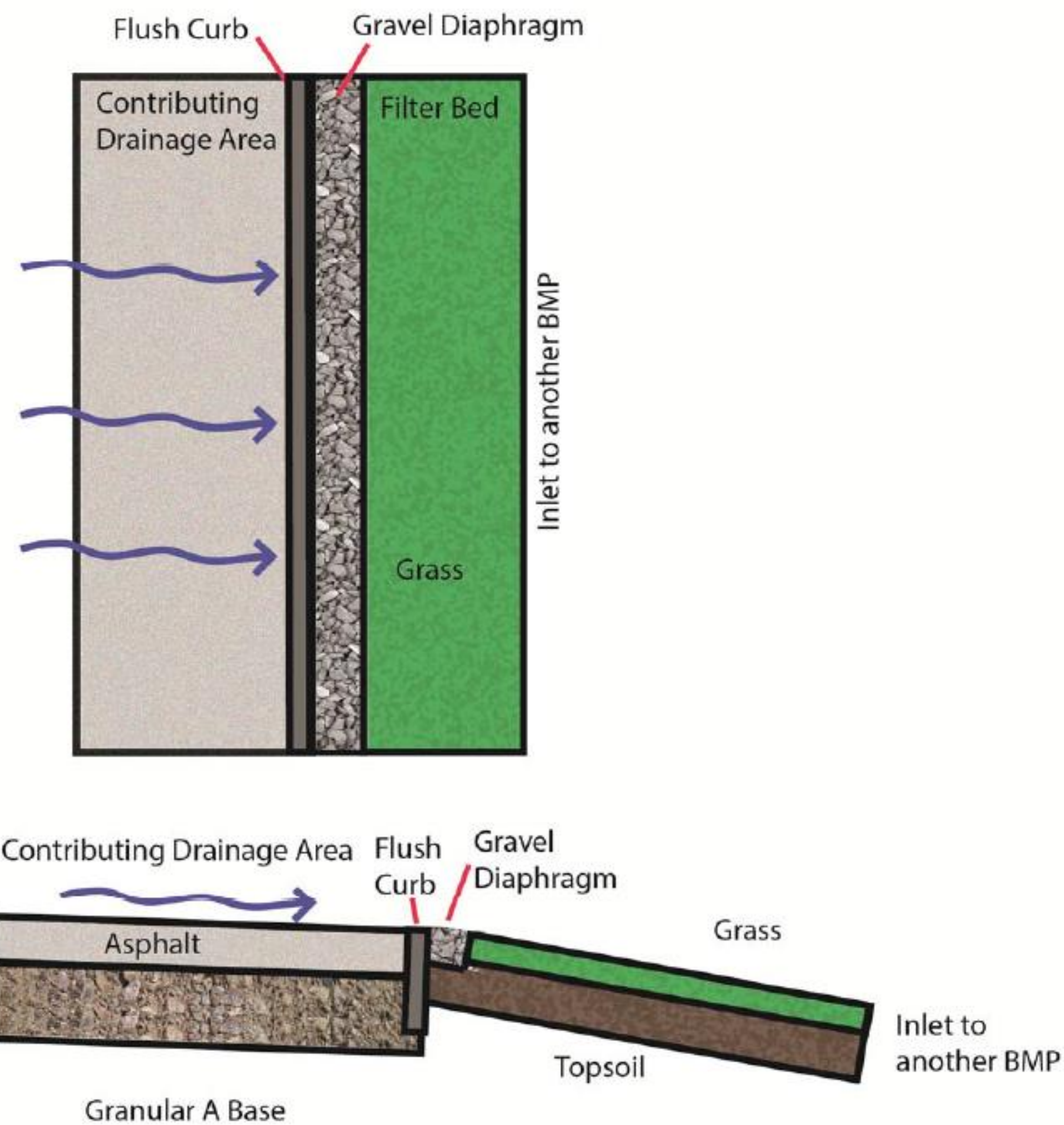
Limitations

- Are susceptible to compaction over time, limiting their ability to infiltrate;
- Topsoil amendments rely heavily on proper mix design and readily available soil stripped from a development may not be suitable;
- Site grading standards specifying minimum slopes limit the ability to infiltrate on lawns; and
- Quantifying their benefit in a site design is difficult; these systems are best used as a passive feature and not as a primary means of SWM.

Cost/Benefit Summary

High – Absorbent landscaping is a highly beneficial SWM practice that is relatively simple to implement and construct. Although its infiltration capabilities may be limited compared to other LID systems, absorbent landscaping is considered best practice to be implemented in tandem with other LID features. These systems have a low upfront cost and are best implemented in new development sites with sufficient green space.

Source: City of Surrey (left); Riversides (centre); David Elkin (right)


Flush Curb
Gravel Diaphragm
Contributing Drainage Area
Filter Bed
Inlet to another BMP
Grass
Contributing Drainage Area
Flush Curb
Gravel Diaphragm
Asphalt
Grass
Inlet to another BMP
Topsoil
Granular A Base