Low Impact Development Public Lands Retrofits:

Optimizing Parks, Public Buildings, Schools and Places of Worship through Low Impact Development

Public Lands

CREDIT VALLEY CONSERVATION

Welcome to the Credit Valley Conservation Be A Leader Grey to Green Series

As the Chair of Credit Valley Conservation, and City Councillor for Mississauga, I have first hand experience with pressures our communities face with aging infrastructure, changing climate, a growing population, and fiscal crisis. It's growing more difficult to find the resources to meet growing needs.

Municipal infrastructure is regularly overwhelmed and ineffective. Time and time again—especially this past summer—we're reminded that existing systems cannot manage intense storms and are failing to protect the environment.

But there is a solution, and it's not as expensive as you might think. In fact, the low impact development (LID) approach easily ties into existing systems, our public lands, road right-of-ways, commercial and institutional properties and residential homes all present opportunities. Properly maintained LID features promise a quick return on investment and many other benefits. With LID, you can:

- **Protect assets and defer larger investments.** LID barriers can slow the flow to storm sewers during intense rain events, giving them more time to process stormwater. In this way, LID helps meet asset management requirements, reduces damage to existing systems, and extends the useful life of infrastructure.
- **Save money. Smaller, more frequent events cause costly damage.** LID practices encourage infiltration and can help reduce the amount of erosion, and pollutants to creeks, rivers, and streams that leads to regular and often expensive maintenance and lost revenues from beach closures.
- **Increase tax revenue.** Free space in growing cities is at a premium. The cost of land can be as much as four times the cost of new infrastructure. LID practices require minimal land expropriation, and often fit into existing urban infrastructure, leaving more land available for development and tax revenue.
- **Build resiliency and protect the environment.** One technology alone isn't enough to ensure resiliency. Adding LID measures to a treatment train can reduce the frequency of flood-related residential damage due to overwhelmed existing systems. LID can also reduce the flow of contaminated stormwater to surface waters, which can harm aquatic environments, and increase the cost of treatment at the drinking water level.

If you see opportunities for LID in your municipality, we encourage you to review the business case (Chapter 1) and pass along this user-friendly guide to your clients, municipality's staff, property managers, land developers and infrastructure teams.

On behalf of all of us at Credit Valley Conservation, we hope this Guide can help create vibrant, healthy, sustainable communities!

Pat Mullin

Councillor, City of Mississauga and Region of Peel
Chair, Credit Valley Conservation

P.S. This guide is a living document. We invite you to share your experiences with LID for future editions, and reach out to the CVC team for further guidance and collaboration. Please visit our website for access to all the Grey to Green guides: http://www.creditvalleyca.ca/low-impact-development/low-impact-development-support/stormwatermanagement-lid-guidance-documents/

Acknowledgements

Project Team

Chris Despins
Kyle Vander Linden
Christine Zimmer
Aaron Knutson
Robb Lukes
Phil James
Tyler Babony
Julie McManus

Technical Advisory Committee

John Nemeth, Region of Peel
Dan Labrecque, Region of Peel
Stefan Szczepanski, City of Mississauga
Andy Wickens, City of Mississauga
Muneef Ahmad, City of Mississauga
Irina Polo, City of Mississauga
Meghan Stewart, City of Hamilton
Tony Dulisse, Town of Orangeville
Patrick Cheung, City of Toronto
Carole Berry, Unitarian Congregation in Mississauga
Jennifer Reid, Diocese of Toronto
Harold Reinthaler, Schaeffers Consulting Engineers

Comments or questions on this document should be directed to:

Christine Zimmer
Senior Manager, Protection and Restoration
Credit Valley Conservation
1255 Old Derry Road
Mississauga, Ontario L5N 6R4
905-670-1615 x. 229
czimmer@creditvalleyca.ca

Phil James
Manager, Protection and Restoration
Credit Valley Conservation
1255 Old Derry Road
Mississauga, Ontario L5N 6R4
905-670-1615 x. 234
pjames@creditvalleyca.ca

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Welcome to the Grey to Green Public Land Retrofit Guide

LID

low impact development is a green infrastructure approach to stormwater management that uses simple, cost-effective landscaped features and other techniques to infiltrate and evaporate rainfall where it falls.

Who should read this guide?

The Grey to Green Public Lands Retrofit Guide supports properties managed by municipalities as well others that, while privately owned, are considered by many to be part of the public realm in our communities. Read this guide if you are responsible for one of the following public lands:

- Municipal facilities
- Parks
- Schools
- Places of worship

Why should I read this guide?

LID practices provide several benefits to the community: they can reduce risk of flooding, create beautiful green spaces, provide water quality improvements and help you meet your organization's sustainability targets. Establishing an LID feature on your site demonstrates your commitment to improve your community and your local environment.

This guide provides you with the information, guidance, case studies and tools you need to do the following:

- Understand why implementing an LID makes sense for your property
- Know what LID options are available and how to select the right option for your property
- Implement an LID retrofit, including both small- and large-scale projects
- Operate and maintain your LID practice

How should I read this guide?

This guide includes information, guidance, case studies and tools that are general and apply to all types of public lands as well as content applicable specifically to your public land type. To help draw attention to the information that is important to you, this guide uses the following colour-coded icons:

Parks

Municipal Facilities

Schools

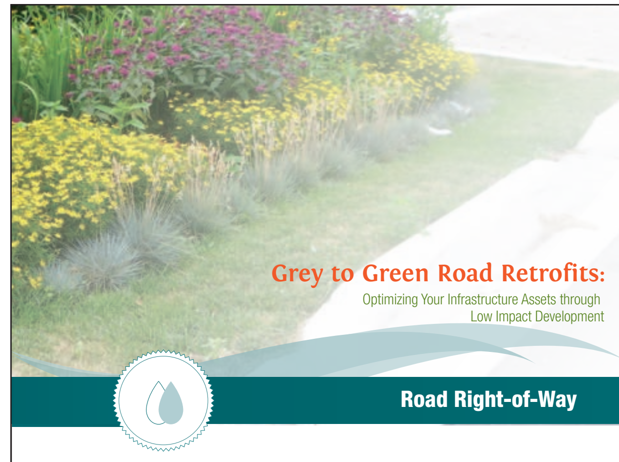
Places of Worship

Where should I go for more information?

For more information on the design, construction and lifecycle activities of LID features as well as case studies of public lands that have implemented LID on their property please visit Credit Valley Conservation's Be a Leader website at

bealeader.ca

Check out the entire suite of the Grey to Green Retrofit Guides:



1.0 The Business Case for Grey to Green Public Lands Retrofits

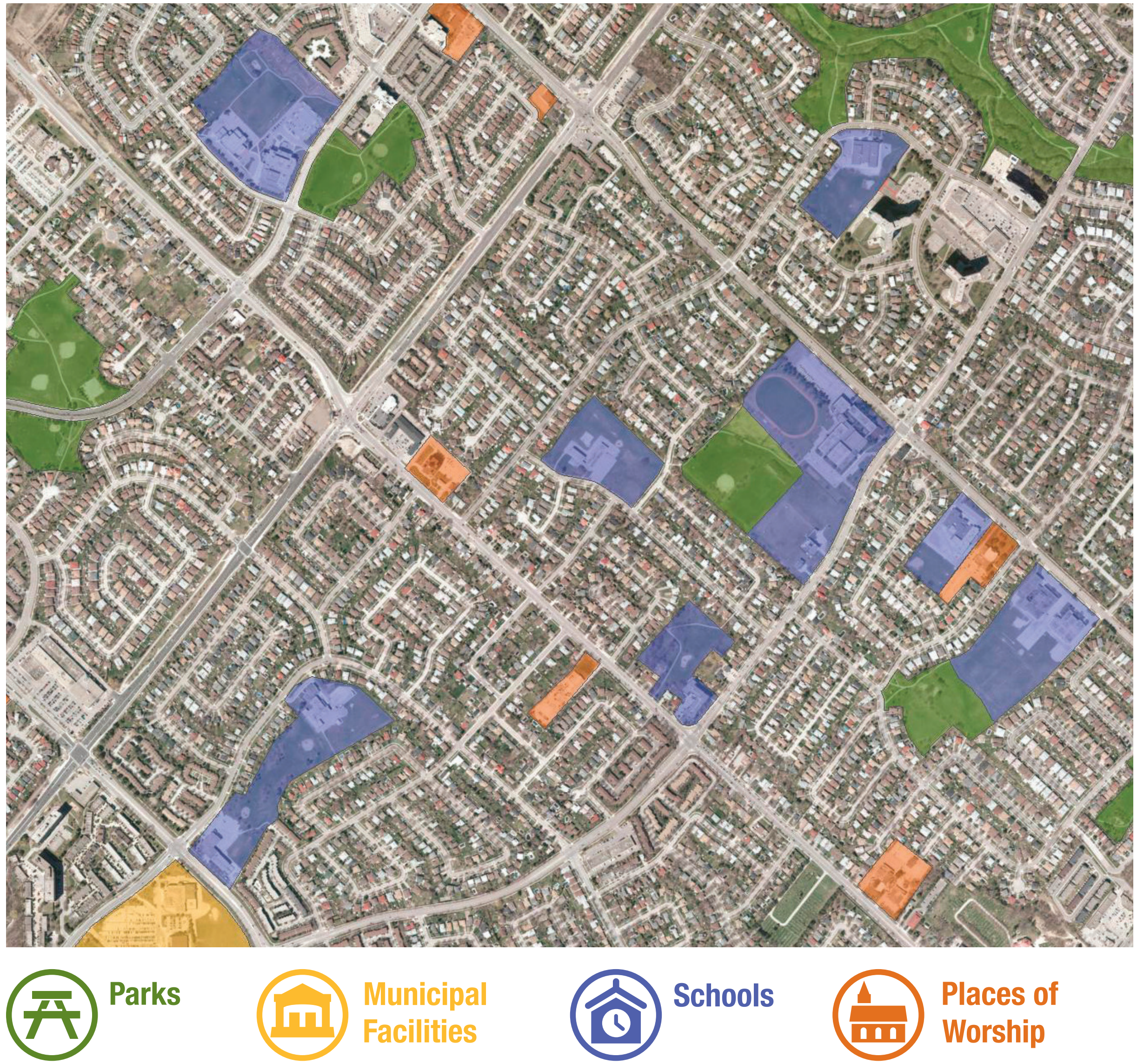
Source: Alex Mozo

Look at this aerial photo of an urban area in Ontario. What do you see?

Look a little closer, and notice the highlighted areas. These areas are parks, municipal facilities, schools, and places of worship. These public lands hold much of the green space in our communities. Green spaces are ideal for implementing green infrastructure, including low impact development (LID).

Incorporating LID on your public lands site will build your community's stormwater management capacity while reducing your risk and liability associated with extreme weather events. They also provide great opportunities to educate the public and surrounding businesses on stormwater issues.

LID can help you improve your community, enrich areas through beautifully landscaped features and demonstrate your leadership and commitment to the environment.



1.1 Background

When rainfall flows over natural areas, it soaks into the ground and is absorbed by plants. These processes ensure the water reaching streams, rivers and lakes is cool and clear. Before your property was developed, its green surfaces helped this important natural process to occur. These green surfaces also prevented erosion because plant roots helped to stabilize soils.

Natural conditions begin to change when land is developed. Hard surfaces like roofs, roads, sidewalks and parking lots prevent rain from soaking into the ground and being taken up by plants. This generates increased stormwater (rainwater) flows, referred to as runoff. To manage this runoff, stormwater management systems are constructed to convey it through urban sewer systems and eventually empties the water to streams, rivers, and lakes. Pollutants in the runoff contaminate these bodies of water and cause a number of other negative impacts.

Using the principles of LID to re-establish natural processes, public lands properties can help to reverse the impacts of urban development. Small changes made on multiple sites can add up to significant impacts. These changes ensure water resources remain drinkable, swimmable and fishable for future generations.

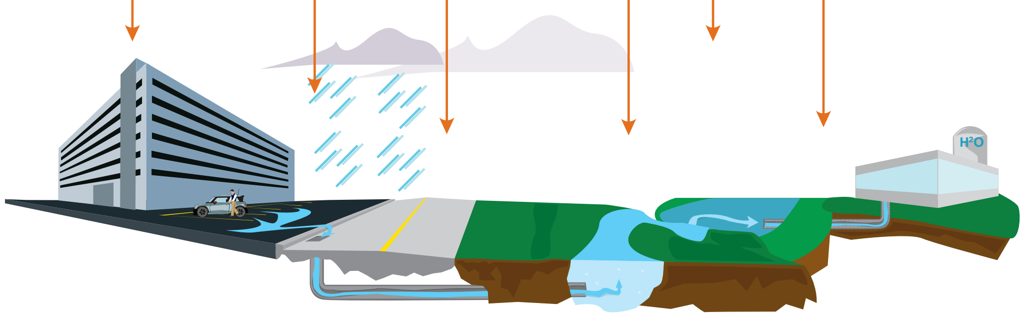


Figure 1.1.1: Conventional approach to stormwater management (Source: CVC)

Common LID practices include green roofs, permeable pavement, rain gardens, rainwater harvesting, bioswales, alternative landscaping techniques and more.

By planting a simple rain garden or by replacing you aging parking lot with permeable pavement, you can protect the environment, beautify your site, and even save money.

How can retrofitting my property help green my community?

Public lands such as parks, municipal facilities, schools and places of worship represent the majority of open spaces in our communities. They present opportunities to build resiliency, showcase new technologies, and build consensus on performance and maintenance requirements.

This chapter provides the tools you need to build a business case for LID retrofits. The following chapters will help you select, design and install the LID features that are best suited for your site.

1.2 Be a leader in sustainibility

As a municipality, religious organization, or school, it is your role to provide leadership in the community. LID practices installed on your property will emphasize your commitment to environmental stewardship and social responsibility. When you install LID on your site, you are sending a message to the public that your organization is dedicated to creating a sustainable community.

Municipalities that construct LID practices on their public lands sites are leading by example. Your willingness to implement these practices demonstrates to local businesses and residents that you are committed to walking the talk when it comes to LID.

How can you be a leader in your community?

The City of Ottawa has targeted LEED (Leadership in Energy and Environmental Design) Silver certification for all new construction and renovations over 500 square meters[1]. LID retrofits demonstrate your leadership in green infrastructure and can help you qualify for LEED credits.

Figure 1.2.1: Showcasing that you are leader in sustainability through site tours is a great way to inspire others in your community. (Source: CVC)

1.3 Minimize your risk

Your public space is a gathering place for community members. Without suitable stormwater management practices, however, your property could be susceptible to flooding. This puts people, property, and your organization at risk. Hazards include threats to safety, damage to property, financial loses and negative publicity. As mangers of public lands, you assume some level of risk every time someone enters your site, every time you host an event, and every time it rains. Those areas that pose flooding problems in the summer become ice hazards in the winter. An average WSIB claim from slips, trips and falls will cost your organization $30,000[2]. Some LID features such as permeable pavers are designed to drain quickly, helping to minimize dangers posed by winter hazards. By examining all the risks and the types of losses that can occur, you can identify how to best protect yourself, your site and your organization.

Climate change risk

Recent climate change science predicts that Canada will experience shorter, more intense storms with increased amounts of rainfall. Events now considered extreme will become more frequent[3]. Are you prepared for climate change?

Reduce Your Risk

Since 1995, extreme weather has caused a state of emergency to be declared almost every year in Ontario resulting from extreme weather events[4]. Water-related insurance claims are now the leading property claim at $1.7 billion per year, surpassing fire claims for this first time[5]. In fact, extreme weather costs Ontario tax payers approximately $6 billion per year. Retrofitting your property with LID features can help you mitigate risks to your property.

As a result of these predicted changes to rainfall patterns, water management practices and infrastructure will be more vulnerable to failure.

Do you want to bet?

A 50-year event has a 1-in-50 chance of occurring in any given year and a 100-year event has a 1-in-100 chance. If you were to wager, you might like those odds. However, you may want to consider that in the last eight years leading up to 2013, the GTHA has experienced eight extreme events, five 50-year events and three 100-year events. Are you prepared for the next perfect storm?

Flooding is not the only climate-change risk we face. A 10% decrease in fall/summer precipitation is expected in southern Ontario[6]. Combined with hotter summer conditions, this will put a strain on freshwater ecosystems and many municipal water supplies. To adapt to the new normal, we need robust stormwater management systems that can treat rainfall where it lands.

What does this mean for property managers?

Older areas often have no stormwater management systems in place. Extreme weather events are becoming more frequent and areas that do meet current stormwater standards may not provide sufficient protection. Municipalities are facing a serious infrastructure deficit and the life of infrastructure

Figure 1.3.1: Parks, municipal facilities, schools and places of worship are all vulnerable to extreme events. Could this be your property? (Source: CVC)

might need to be stretched longer than originally intended. All of these issues can lead to unanticipated flooding and increasingly expensive operational and maintenance costs borne by the municipality.

Property managers must do their part to protect their site from the risks of extreme weather. As the current infrastructure deficit highlights, there are significant repercussions of not doing enough or not recognizing the risks. Property managers must adapt if they want to minimize their risk.

By implementing LID features on its property, the Peel District School Board's Adult Education Centre South school is doing more to protect both its assets and the environment. Bioretention planters at the site capture 90% of rainfall events with only 3-6 events entering storm sewers each year. These features also helped manage the extreme rainfall on July 8 2013 – no water left the site for 40 minutes. These benefits relieve pressure on the municipal storm sewer system, reduce stream erosion, protect quality of water entering Lake Ontario and lessen risks to your property.

LID practices are easy-to-implement solutions that can help minimize risks to your property. These practices will also help relieve some of the burden being placed on aging infrastructure. Adaptation can be built into both your property and your community by using these practices.

Flood risk

In July 2013 the greater Toronto and Hamilton area (GTHA) experienced two extreme weather events in one month. On July 8, a record-breaking 125 millimeters fell in a two-hour period. The intensity of this storm rivalled records from 1954's Hurricane Hazel - one of the area's worst storms. The resulting flood stranded commuters and caused extensive infrastructure damage and business disruptions. More than 300,000 people and businesses experienced mass power outages. The storm is expected to cost insurers more than $850 million[7].

Given the changing climate, weather events that typically occur once in every 100 years may become much more frequent. Stormwater pipes have been sized for long, drawn out events however what we are seeing today are high intensity, short duration storms. Historical trends can no longer be relied on exclusively to predict future storm events. Municipalities, schools, and places of worship must take the initiative to make sure their properties are prepared for the amount and intensity of rainfall that will be landing on their properties. While flood control isn't the primary purpose of LID practices, it does provide added protection when combined with existing stormwater infrastructure. LID has the ability to reduce runoff volumes, divert or delay water from entering overstressed and aging stormwater infrastructure and better protect your site from extreme events. LID has routinely been shown to provide a 20-40% reduction in stormwater volume[8]. By retrofitting your property with LID stormwater management practices, you can take an important step in managing the risks associated with extreme weather events.

1.4 Meet municipal, provincial and federal stormwater management and sustainability objectives through LID

As a manager of a public lands site you are responsible for meeting a broad range of objectives set out by your organization. At the same time, municipal, provincial and federal governments are implementing new objectives, policies and regulations in response to modern challenges like growth and intensification, climate change and aging infrastructure. Many of these policies relate to stormwater management and sustainability.

Some examples of objectives, policies and legislation that can have a direct impact on how you manage your site include:

- Municipal strategic plans and green development policies (i.e. *Peel Climate Change Strategy)*
- Municipal stormwater utilities (i.e. *City of Kitchener Stormwater Utility*)
- Ontario Water Opportunities Act
- Canada-Ontario Agreement Respecting the Great Lakes Basin Ecosystem

Meeting all of these different objectives can be challenging. Innovative approaches like LID can offer you an effective way to help meet these objectives.

Retrofitting your public lands site with LID will not only help you to reduce risk on your own site, but will also have a positive impact on your community. Think back to the aerial photo at the beginning of this chapter; public lands have some of the largest open green spaces within a municipality. By retrofitting these areas with LID you can help your municipality meet their sustainability and stormwater management objectives.

One of the ways LID lets municipalities meet these stormwater management and sustainability objectives is that retrofits can take place within areas built before the introduction of modern stormwater controls. Retrofits at sites like yours can address stormwater needs of a specific neighbourhood, or may be part of a larger strategy to improve sustainability and stormwater management throughout the entire municipality.

The City of Mississauga is incorporating LID features into several parks and municipal facilities. These features allow the city to target stormwater needs while also helping to meet the sustainability objectives set in the City`s Green Development Standards and Strategic Pillars for Change.

Other public organizations such as schools and places of worship often have their own strategic plans in place to encourage sustainability. Implementing LID can help you meet your organization`s goals while also contributing to the broader community.

For further information on how LID can be used as a tool to meet municipal, provincial and federal objectives, policies and legislation, refer to Appendix A.

1.5 Protect your Public Lands

Ontario's population is expected to increase from 4 million people in the next 25 years[9]. Ontario municipalities must make a significant investment in older developed areas while still meeting the needs of growth areas. This work will take money and time. Like many municipalities across Ontario, City of Toronto estimates that it will take over 20 years to erase its more than $2.7-billion deficit in wastewater and stormwater infrastructure[10]. In the mean time, your public lands site remains at risk of damage caused by extreme weather events.

Managing stormwater on-site through LID will help to relieve strain on stormwater infrastructure. Managing stormwater on-site is especially important in older neighbourhoods aging stormwater management systems.

Figure 1.4.1: Even new municipal stormwater infrastructure can fail during extreme weather events.

Aging infrastructure and a backlog of maintenance issues present similar problems for school boards across the province. The Toronto District School Board has a capital deficit of approximately $50 million[11]. Like municipal stormwater infrastructure, stormwater infrastructure located on public lands is more susceptible to failure during significant rainfall events when maintenance, rehabilitation, and replacement are delayed.

Perception: 58% of Canadians feel municipalities are doing an excellent or very good job at upgrading systems to handle excess stormwater.[12]

Reality: Ontario has a substantial stormwater infrastructure deficit. For example, it is estimated that only 35% of developed urban areas in the greater Toronto area has stormwater management controls.[13]

We know from the past eight years that the current level of protection is not sufficient, so how will you protect yourself, your property, and your organization? Ask yourself:

- [ ] **Are your assets and investments protected?**

By retrofitting with LID and managing stormwater on your property, you are adding to the resiliency of the overall stormwater management system and are better protecting your assets and investments. LID practices are a resilient form of stormwater infrastructure that can better cope with changing and erratic weather patterns than conventional practices.

- [ ] **Have you diversified your level of protection?**

In combination with existing municipal stormwater infrastructure LID provides a holistic approach that better protects your property and investments from all rainfall events.

- [ ] **Are you staying ahead of regulations?**

Stormwater utilities and other related regulations could be in effect (or on the way) for your area. By retrofitting your property with LID you can stay ahead of these changes and you may even qualify for a rebate.

- [ ] **Can your operation continue to operate in extreme events?**

LID has the ability to help you stay dry during rainfall events. Combined with backup power systems and a good plan, LID gives you a better chance of operating during extreme events.

During the southern Alberta floods in 2013, churches, community centres and schools served as places of refuge and emergency relief. A dry parking lot and facility is critical to serving your community during emergencies.

1.6 Other Benefits

Create healthy communities

Now more than ever, people are making connections between their personal health and community health. Since people rely on public spaces like parks and churches for recreation and community-based activities, managers of public lands are in a unique position to promote community health. This can be accomplished through site enhancements. LID practices that include a landscaped or vegetative component enhance the aesthetics of a site and can have significant physiological and psychological benefits.

Beautiful green landscapes tend to draw people to use recreational features. In fact, some studies have demonstrated increases in outdoor physical activities, such as walking and jogging, after the implementation of LID practices[14]. Encounters with everyday nature, including a view from an office window, or a walk through a garden or well-tended landscape can restore a person's ability to concentrate, calm feelings of anxiety, and reduce aggression.

Save operations and maintenance costs

The operations and maintenance (O&M) cost savings of an LID retrofit will vary by site. Does your site currently have on-site stormwater infrastructure such as a stormwater pond? LID infrastructure is generally less expensive to maintain than traditional stormwater infrastructure.

For example, the annual maintenance cost of an appropriately designed bioswale will be less than that of a proprietary stormwater treatment device (such as an oil and grit separator, or OGS) or stormwater management pond.

In 2010, City of Waterloo and City of Kitchener established themselves as municipal leaders by implementing stormwater utility fees. Since then, four more Ontario municipalities have implemented or in the process of implementing stormwater utilities. These are fee systems where property owners pay based on the amount of stormwater generated by the site. By retrofitting your property with LID you could qualify for a credit that will reduce your fee.

Figure 1.5.1: The City of Toronto is demonstrating its commitment to being one of the greenest cities in the world through its revitalization of Nathan Philips Square. One of the ways the city is reinvigorating this space is through a green roof retrofit. (Source: Alex Mozo)

LID practices can also be designed to conserve water, which will providing operational cost savings at your site. For instance, parking lot islands can be constructed as bioretention planters that do not require irrigation. Rainwater harvesting techniques can also reduce your reliance on municipal water supplies, collecting and storing rainfall that can be used for toilets or irrigation. When LID practices are used in series with conventional practices, existing stormwater management features will require fewer sediment clean outs. Chapter 2 will review these LID practices in greater detail.

1.7 The business case for LID at schools

Schools have been one of the earliest adopters of environmentally friendly practices like LID. As a community gathering spot, schools provide a variety of valuable services, including hosting events and activities. Their ability to influence the community through education makes schools an excellent place to showcase environmental leadership.

Thinking about retrofitting your property with LID? LID can help you:

- ***Fix** property and safety issues, such as poor drainage on school grounds*
- ***Reduce** maintenance costs*
- ***Engage** students by integrating LID education into the curriculum*
- ***Meet** greening and sustainability policies*

Figure 1.6.1: There are many different options for retrofitting school grounds. Rainwater harvesting, green roofs or parking lot bioretention are just some of the ways you can better manage rainwater on your property.

"School ground stewardship brings students closer to nature and promotes taking responsibility for the environment."

- EcoSchools Portfolio Requirement Guide 2013/2014 [15]

Improving property safety and maintenance through LID

Slips, trips and falls along pedestrian walkways and parking lots are a concern at all schools. These injuries result in some of the most common and costly liability claims to property owners . You can reduce the risk of slips, trips, and falls and avoid costly claims by installing LID practices such as alternative pavement surfaces like permeable interlock pavers, pervious concrete, or porous asphalt. Due to their quick draining nature, these surfaces reduce the risk posed by puddles and ice.

LID practices can also save you save money on maintenance expenses. By introducing no-mow zones, xeriscaping or other techniques you can reduce the cost of operations and maintenance on your property.

Meeting school objectives and policies through LID

School boards across Ontario are committed to delivering effective environmental education to their students. They are also committed to maintaining environmentally responsible on-site practices. LID can help schools to achieve these goals.

Supporting environmental education through LID

In 2010, Ontario's Ministry of Education in released *Ready, Set, Green!* This document provides guidance on effective environmental education and environmentally sound practices in Ontario schools. It is intended to stimulate discussion and provide practical tools and strategies to help shape schools and communities.

The document includes many examples of student, teacher and community projects that focus on water conservation, water monitoring, health of lakes and rivers, tree planting, and biodiversity. It is easy to see how LID projects like building a rain garden or installing rain barrels can support education programs.

You don't have to do it alone

Many funding opportunities exist for programs that promote environmental education, tree plantings, energy conservation, community gardening, habitat restoration and environmental research. Some of these include community neighbourhood grants, United Way, Ontario Trillium Foundation, TD Friends of the environment, Evergreen and World Wildlife Foundation – School Grants.

Strategic partnerships between the public and private sectors can help simplify the implementation of an LID project. In many cases, schools have land that can be used for LID retrofits, but they don't have the funds or expertise required to implement them. The municipality may have implementation funds and expertise that the school does not. A partnership offers an ideal opportunity for both parties to benefit through LID retrofits. Chapter 5 will guide you through the process of implementing an LID project on school grounds.

Figure 1.6.2: Elm Drive is a project involving Peel District School Board and City of Mississauga. This project replaced aging ditches with bioretention planters and improved street parking in front of the school. (Source: CVC)

1.8 The business case for LID at parks and municipal facilities

Parks and municipal buildings provide a great opportunity for municipalities to lead by example. Across Ontario, municipalities are creating sustainability plans that will make their community a better place to live. By implementing LID practices in parks and municipal facilities, you will demonstrate commitment to these plans.

Thinking about retrofitting your property with LID? LID can help you:

- ***Provide** needed green space for stormwater management*
- ***Build** consensus for monitoring and assessment management before LID is implemented city-wide.*
- ***Demonstrate** leadership to your community*
- ***Educate** businesses and residents about environmental stewardship*

Optimizing municipal spending with LID

Many conventional stormwater practices require infrequent (but costly) maintenance, including dredging and disposal of sediment. Alternatively, most landscape-based LID features require a maintenance approach more consistent with the activities and experience provided by parks departments such as pruning, weeding, and mulching.

Figure 1.7.2: Maintenance requirements for LID features are very similar to maintenance work already carried out by parks staff. (Source CVC)

Providing community education and public action opportunities through LID

To encourage public adoption of environmentally and socially responsible land and water management practices, a municipality must lead by example. LID installations demonstrate that municipalities are dedicated to sustainable environmental solutions that benefit the community.

Additionally, the experience gained by staff during municipal implementation allows them to share lessons learned and knowledge with the community and private sector.

In 2013, the City of Mississauga identified the integration of LID in park facilities as an opportunity to demonstrate leadership among residents.

Using open green space for stomrwater management

Since the 1980s, many Ontario municipalities have used sections of parks as stormwater management facilities. In most cases these areas are low-lying grassed surfaces designed to detain stormwater during extreme rainfall events.

In some cases, recreational fields can be incorporated into dry-detention facilities. Public use of these fields is compromised only during flooding events. In general, dry-detention facilities have successfully mitigated urban flood risk without sacrificing publicly used lands or increasing municipal liability. These facilities demonstrate that stormwater management practices and parks can coexist on the same municipal properties.

Beautifying public lands through LID

Municipal facilities and parks are showcase properties that should present a positive image to the public. LID practices can greatly enhance the aesthetics of a park or municipal facility. They allow managers to incorporate plantings with a variety of textures and colours.

LID practices that use vegetation can add value and beauty to public spaces. An almost limitless selection of native and ornamental flowering perennials, grasses, shrubs and trees can be incorporated into the design to achieve the desired aesthetic. Chapters 3 and 4 will guide you through the process of implementing an LID project in parks and municipal facilities.

Figure 1.7.3: Splashes of colour draw attention from people walking nearby. (Source: Aquafor Beech)

1.9 The business case for LID at places of worship

Places of worship are pillars of the community. They act as a gathering spot, where like-minded people can meet and connect. Heads of these organizations provide guidance and inspiration to members of their congregation. This ability to influence the thoughts and actions of the community make places of worship ideal sites to demonstrate environmental leadership.

Thinking about retrofitting your property with LID? LID can help you:

- ***Solve** issues with property maintenance*
- ***Enhance** relationships with the congregation and other members of the community*
- ***Integrate** into existing environmental stewardship programs*

Figure 1.8.1: LID retrofits are ideally suited to addressing issues with drainage. Rain gardens or bioswales could be installed along this path, intercepting rainwater before it ponds at this basement entrance.

Figure 1.8.2: To help keep costs low, volunteers helped with construction of a rain garden at Portico Church in Mississauga. The project recieved funding from Walmart-Evergreen Community Grants and Sobey's Community Environment Fund. (Source: CVC)

Solving property issues through LID

Places of worship have been staples of Ontario communities for hundreds of years. In many cases, places of worship are the oldest buildings in the community. These properties are full of historical charm, but due to antiquated building practices and infrastructure that is past its expected life cycle, many sites are susceptible to significant property issues, including poor drainage and flooding.

If your site is experiencing poor drainage or urban flooding, an LID retrofit might be the answer. LID practices such as bioretention, soakaways, and infiltration chambers can store large volumes of water before gradually releasing it into the ground. These practices reduce the volume of water that collects on the property or runs into unwanted areas.

Access to funding or financing

Being sustainable prevents negative impacts to the environment, community and economy, but did you know that it also may help you access additional sources of funding?

Places of worship managing their environmental impacts are more favourably considered for credit. Financial institutions perceive them as better investments due to their integrated approach to managing financial, social, and environmental risks and performance.

Over 30 green funding and incentive programs are offered by the federal government. Those who qualify can receive funding or financing to support their imitative. This includes funding for renewable energy, building retrofits, alternative fuels and others. Chapter 6 will guide you through the process of implementing an LID project at your place of worship.

Supporting environmental stewardship though LID

Religious groups frequently run environmental stewardship programs to connect with the community and provide group activities for their congregations.

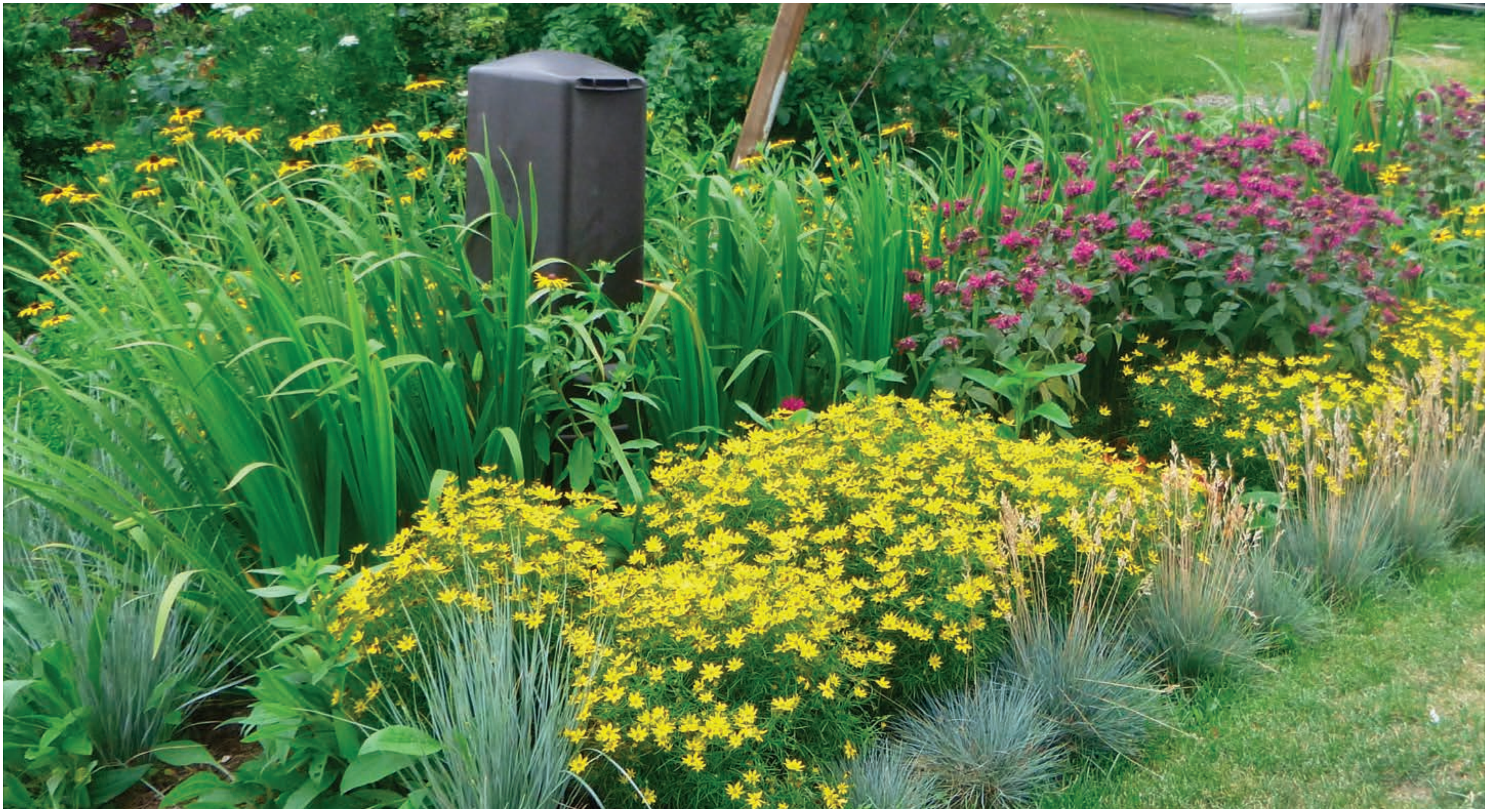
A LID retrofit can help meet these goals. The beautiful landscape that you can create with a bioswale or bioretention practice will draw community members to your site, especially if established in a highly visible area. If done right, expect inquiries from neighbouring property owners looking to beautify their own property.

When planning an LID retrofit, you can build on the existing support of your congregations, community groups, staff, and board members. You also have the opportunity to build new relationships. There are many organizations that can help you implement an LID project at your place of worship including:

- Local garden clubs or horticultural societies
- Environmental groups
- Local contractors and businesses
- Your local conservation authority

Getting your hands dirty planting flowers and shrubs in your bioswale is a perfect way to bring your religious community together to reach a common goal

2.0 LID Options for Public Lands



This chapter provides an overview of the LID options that are best suited for Public Lands. Given the wide variety of options, selecting the ones that will best meet your needs may seem daunting. To help you identify the best option(s) for your road retrofit project, the following information is provided for each LID option:

- A brief description
- Photograph(s) of the practice implemented within a public lands setting
- A Suitability & Considerations table that provides supplementary information

With this information you should have a better idea of the LID options that meet your needs. Further guidance on screening LID practices is provided in Chapters 3-6.

For further information on the LID options, see the LID Design Guide at

bealeader.ca

Bioretention

- Parking lot bioretention
- Bioretention in landscaped areas

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Swales

- Enhanced grass swales
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Permeable pavement

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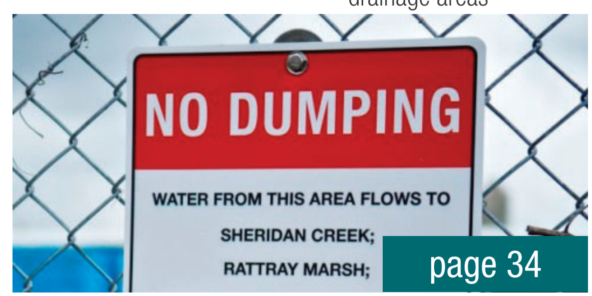

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2.1 Bioretention

Bioretention are vegetated practices that temporarily store, treat and infiltrate stormwater runoff. The most important component of these practices is the bioretention soil media. The bioretention soil media is made up of a specific ratio of sand, fine soils and organic material.

Bioretention can be integrated into a diverse range of landscapes, including existing parking lot islands, gardens, and lawn areas. They are best located within (or adjacent to) hard surfaces like roadways, parking lots, buildings and pedestrian pathways as these surfaces generate large amounts of runoff that can be treated by these features.

Bioretention maintenance requirements are similar to those of other landscaped areas and include trash removal, weeding, replacing dead vegetation, and checking for clogging of inlets and outlets. The amount of effort will vary based upon the type of vegetation – bioretention with only grass requires the least amount of effort, while formal designs need more maintenance.

Selecting either grass or plants for a particular bioretention practice depends on a variety of factors. In general, planted bioretention areas are recommended for higher profile settings where sufficient resources can be dedicated to building community buy-in and conducting regular maintenance of these practices. For more information on LID plantings refer to CVC's Landscape Guide at bealeader.ca.

Perception: *Plants are the only source of vegetation in bioretention.*

Reality: *In fact, the term bioretention refers to the bioretention soil media that forms the base for the practice. The landscaped area can include turf or plants.*

Parking lot bioretention

Parking lots produce the most significant pollutant loads and runoff volumes per unit area on public lands sites. Targeting runoff from these areas for bioretention practices produces a significant benefit to the local water balance and improves water quality.

Parking lot medians and islands represent excellent opportunities for retrofits. Bioretention practices can be integrated into parking lot median and islands of many shapes and sizes. Adding these features to a parking lot can calm traffic, direct vehicle flow, and improve pedestrian safety. It can also reduce operational costs, as they require much less irrigation than typical parking lot islands.

When planning a bioretention in a parking lot, consider pedestrian traffic, parking requirements and winter operations.

Figure 2.1.1: This bioretention facility at Kortright Center for Conservation has a beautiful aesthetic and is surrounded by curbs which provide a protective barrier from vehicles. (Source: CVC)

Bioretention in landscaped areas

Public lands often have green spaces located adjacent to hard surfaces that can be targeted for LID retrofits. Green spaces like parks, lawns, and gardens are less labour intensive to retrofit with bioretention practices than parking lots because pavement and supporting materials do not have to be removed during construction.

Figure 2.1.2: A bioretention feature was installed by CVC staff at the Terra Cotta Conservation Area to educate visitors about how they can manage stormwater on their property. The feature was placed in a prominent location near a pedestrian path and interpretive signage was installed to educate and encourage visitors to build their own bioretention gardens. (Source: CVC)

Bioretention practices add significant aesthetic value to public lands and should be considered in high-profile locations, such as walkways and building entrances. It can be combined with other site amenities to add value to parks, church properties, school grounds and municipal facilities. Benches, picnic tables, and trail systems can be planned around bioretention facilities to take advantage of the garden-like settings. Refer to CVC's Landscape Guide at bealeader.ca for more information on how to landscape a bioretention practice.

Interpretive signage is especially valuable near bioretention features in public green spaces. Signage promotes the benefits of the project, provides educational opportunities, highlights contributions by project partners and provides sources for additional information. Without signange, the public may mistake a bioretention facility for a conventional garden.

Bioretention practices on public lands can be showcased to encourage residents and business in the community to implement the same types of practices on their own lands. Events such as ribbon cutting ceremonies, barbeques, tours or workshops can help you promote your project. These types of events may also tie into your municipalities larger communications goals of encouraging green development.

Suitability	
●	Low to High demand parking areas
●	Passive use areas (lawns, gardens, trails)
○	Active use areas (sports fields)

○ Low Suitability ◎ Moderate ● High

Staff and financial considerations	
◎	Community engagement
◎	Inter-departmental co-ordination
◎	Design team
◎	Capital cost
◎	Operation & maintenance costs

○ Low Effort/Cost ◎ Moderate ● High

Design considerations	
○	Geotechnical testing complexity
◎	Infiltration testing complexity
●	Planning complexity
◎	Design complexity

○ Low Effort ◎ Moderate ● High

Benefits	
◎	Flood risk reduction (water quantity)*
●	Pollutant removal (water quality)
●	Groundwater recharge (water balance)*
◎	Stream channel erosion control
●	Amenity & aesthetic value
◎	Urban tree canopy
●	High profile with community & media

○ Low Benefits ◎ Moderate ● High

*Performance will vary based upon site characteristics and design of LID practice.

2.2 Swales

The use of simple grass swales, generally referred to as ditches, is common along the perimeter of many parking lots. Due to their low cost and simple maintenance requirements, these features are also frequently used in municipal parks and other public green spaces. While ditches do offer some form of stormwater treatment compared to a conventional pipe or concrete ditches, their primary purpose is to rapidly convey stormwater runoff from the site.

Figure 2.2.1: This enhanced grass swale uses a low maintenance fescue grass which only needs to be mowed once or twice a year. The taller grass provides added filtering and enhanced texture. (Source: CVC)

Enhanced grassed swales

Enhanced grassed swales are a preferred conveyance alternative to curb and gutter systems and storm drains. When incorporated into a site design, they can reduce impervious cover, accent the natural landscape, and provide aesthetic benefits.

Enhanced grassed swales incorporate a number of simple modifications to the traditional ditch design to improve their pollutant removal and runoff reduction capability. Design improvements can include a wider and more shallow channel and enhanced vegetation. These modifications slow the water to allow sedimentation, filtration through the root zone and soil, evapotranspiration, and infiltration into the underlying native soil.

Bioswales

Bioswales are similar to enhanced grassed swales but they also incorporate aspects of bioretention features like bioretention soil media, a gravel storage layer, and optional underdrain components.

Bioswales provide water quality treatment and water balance benefits beyond those of a enhanced grass swales. Bioswales are sloped to provide conveyance, but due to their permeable bioretention soil media and gravel, surface flows are only expected during intense rainfall events. Sites with existing swales or ditches are ideal candidates for retrofitting with bioswales.

Suitability	
●	Passive use areas (lawns, gardens, trails)
●	Active use areas (sports fields)

○ Low Suitability ◉ Moderate ● High

Staff and financial considerations	
○	Community engagement
○	Inter-departmental co-ordination
○	Design team
○	Capital cost
○	Operation & maintenance costs

○ Low Effort/Cost ◉ Moderate ● High

Design considerations	
○	Geotechnical testing complexity
○	Infiltration testing complexity
○	Planning complexity
○	Design complexity

○ Low Effort ◉ Moderate ● High

Benefits	
○	Flood risk reduction (water quantity)*
◉	Pollutant removal (water quality)
○	Groundwater recharge (water balance)*
○	Stream channel erosion control
◉	Amenity & aesthetic value
○	Urban tree canopy
○	High profile with community & media

○ Low Benefits ◉ Moderate ● High

*Performance will vary based upon site characteristics and design of LID practice.

2.3 Permeable pavement

Permeable pavement is a term used for a number of LID practices that can be used in place of conventional asphalt or concrete pavement. These alternatives contain pore spaces or joints that allow stormwater to pass through to a stone base where it is infiltrated into the underlying native soil or temporarily detained. Types of permeable pavement include:

- Pervious concrete
- Porous asphalt
- Permeable interlocking concrete pavers (PICP, or just permeable pavers)

On public lands sites permeable pavement is most commonly used in parking lots, internal roadways, and pedestrian pathways. Permeable pavement has also been used to encourage infiltration on basketball courts and other recreational hard surfaces. For parking lots and roadways, the use of permeable pavement should be limited to areas with light vehicle traffic as these materials don't always wear as well as conventional asphalt or concrete.

Permeable pavers provide both financial and safety benefits to your organization. The average life span for permeable pavers is twice that of pavement. This can save operational costs, as pavement replacements will occur less frequently. Additionally, permeable pavers are designed to drain quickly which minimizes ice forming on the surface. This will reduce slips and falls, improving safety for all users of your property.

All three types of permeable pavement share this similar base infrastructure, and provide the same level of stormwater treatment. Selecting the appropriate pavement material depends on factors like local availability and contractor experience.

Pervious concrete

Like conventional concrete, pervious concrete is primarily comprised of Portland cement, open-graded coarse aggregate and water. Pervious concrete, however, contains less sand and fines than conventional concrete. This creates void spaces that allows stormwater to filter to the underlying gravel storage layer.

The surface texture of pervious concrete is slightly rougher than conventional concrete and provides additional traction for vehicles and pedestrians. This additional traction combined with less standing water on the surface of the concrete reduces de-icing requirements.

Porous asphalt

Porous asphalt is very similar to conventional hot-mix asphalt, but it has a significantly reduced percentage of fines. This allows for the formation of stable, interconnected air pockets which lets stormwater filter through to the underlying aggregate layer and base.

On public lands sites, porous asphalt is most commonly applied in parking lots but can also be used to encourage infiltration on other large hard surfaces such as basketball courts or foot paths.

Figure 2.3.1: Pervious concrete and other permeable materials are ideal for overflow parking lots, such as this one constructed at Lakeside Park in Mississauga. (Source: Aquafor Beech)

Like pervious concrete, porous asphalt requires modified application and setting when compared to the standard asphalt. It can be a durable and cost competitive alternative to conventional asphalt. Due to the potential for clogging, use of porous asphalt for roadways where sand is used for snow or ice treatment is not recommended.

Permeable pavers

Permeable pavers have large joints that are filled with a porous aggregate material. Like porous asphalt and pervious concrete, crushed stone aggregate bedding under the permeable pavement supports the pavers and provides storage for stormwater retention, infiltration and treatment.

An advantage of this style of permeable pavement is the improved aesthetics made possible by varying the colour and pattern of the pavers. This feature lets them be used to differentiate parking lanes from the travel portion of the roadway and highlight pedestrian crossings (among other uses).

When considering retrofitting with permeable pavement it is important to examine current use of the prospective site. For instance, use of pavers in a designated or informal smoking area can result in reduced aesthetics from cigarette butts accumulating in paver joints. Regular maintenance of the paver joints is required to ensure that the aesthetic and performance of pavers are maintained.

Figure 2.3.2: Porous asphalt can be used in recreational spaces, such as this basketball court. Some applications, like skate parks, are not suited to porous asphalt as the sport requires special pavement to absorb falls and withstand wear and tear. (Source: Aquafor Beech)

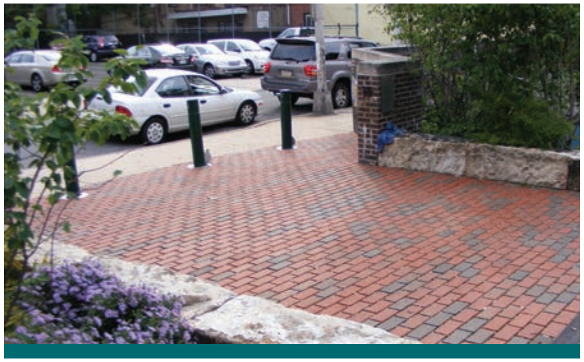


Figure 2.3.3: Coloured pavers can be arranged in patterns in public meeting spaces like this urban park. As part of a water balance based stormwater management strategy, permeable pavers can help alleviate urban flooding during intense rainfall events. (Source: Aquafor Beech)

Suitability	
●	Parking Lots
●	Roadways (Low to Medium Traffic)
●	Pedestrian Areas

○ Low Suitability ◎ Moderate ● High

Staff and financial considerations	
◎	Community engagement
○	Inter-departmental coordination
◎	Design team
●	Capital cost
◎	Operation & maintenance costs

○ Low Effort/Cost ◎ Moderate ● High

Design considerations	
●	Geotechnical testing complexity
●	Infiltration testing complexity
◎	Planning complexity
●	Design complexity

○ Low Effort ◎ Moderate ● High

Benefits	
◎	Flood risk reduction (water quantity)*
◎	Pollutant removal (water quality)
●	Groundwater recharge (water balance)*
●	Stream channel erosion control
◎	Amenity & aesthetic value
◎	Traffic calming
○	Urban tree canopy
◎	High profile with community & media

○ Low Benefits ◎ Moderate ● High

*Performance will vary based upon site characteristics and design of LID practice.

2.4 Soakaways and infiltration chambers

Soakaways and infiltration chambers are types of LID practices that focus upon infiltrating runoff (having the water be absorbed into the site's soils).

Soakaways

Soakaways, also known as infiltration galleries or dry wells, are excavations in the native soil that are filled with geotextile fabric and filled with clean granular stone. Soakaways are typically designed with a perforated pipe inlet from a relatively clean water source, such as a roof or pedestrian area. Where possible, soakaways should be installed where native soils allow for infiltration; however, like other infiltration techniques, underdrains can be installed where poorly drained soils are present.

Soakaways can be designed in a broad range of shapes and sizes. A linear variation of a soakaway is known as an infiltration trench. This technique may be appropriate for sites where space for a retrofit is limited to long strips between buildings or along property lines.

Infiltration chambers

Infiltration chambers are larger types soakaways that use prefabricated modular structures installed over a granular base to maximize the storage space and provide structural support. These systems provide more storage capacity than equivalently sized soakaways and have minimal surface footprint. Infiltration chambers are ideal for heavily urbanized sites because they can be installed below parking lots. Infiltration chambers have also been successfully installed below recreational fields and public urban courtyards. They can be designed in many configurations to suit site constraints.

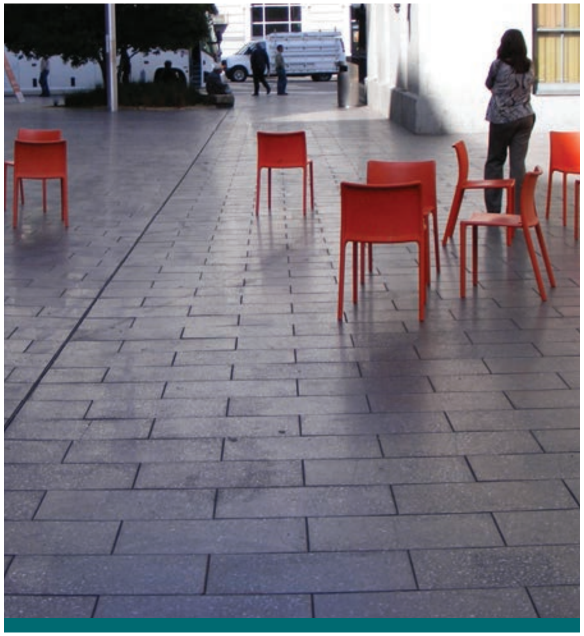


Figure 2.4.1: This urban parkette detains runoff and allows for infiltration through an underground chamber. The patio area is sloped towards the permeable joint running along the left of this photo. (Source: Aquafor Beech)

	Suitability
●	Passive use areas (lawn, gardens, etc.)
●	Active use areas (sports fields)
●	Parking Lots

○ Low Suitability ◎ Moderate ● High

	Staff and financial considerations
◎	Community engagement
●	Inter-departmental coordination
◎	Design team
●	Capital cost
◎	Operation & maintenance costs

○ Low Effort/Cost ◎ Moderate ● High

	Design considerations
○	Geotechnical testing complexity
○	Infiltration testing complexity
◎	Planning complexity
○	Design complexity

○ Low Effort ◎ Moderate ● High

	Benefits
○	Flood risk reduction (water quantity)*
◎	Pollutant removal (water quality)
○	Groundwater recharge (water balance)*
◎	Stream channel erosion control
●	Amenity & aesthetic value
◎	Traffic calming
●	Urban tree canopy
◎	High profile with community & media

○ Low Benefits ◎ Moderate ● High

*Performance will vary based upon site characteristics and design of LID practice.

2.5 Perforated pipe

Perforated pipe systems are long infiltration trenches that convey and infiltrate stormwater runoff. These underground conveyance systems are composed of perforated pipes installed in gently sloping granular stone beds allowing runoff to infiltrate into the gravel bed and underlying native soil.

Perforated pipe systems can be used in place of conventional storm sewer pipes, where topography, water table depth, and runoff quality conditions are suitable. They are capable of handling runoff from roofs, walkways, parking lots and low-to-medium traffic roads. For areas of high pollutant loading, use pre-treatment to extend life of the system.

Perforated pipe can typically be implemented with fewer dedicated resources than bioretention practices. Perforated pipe systems also require very little maintenance. For most perforated pipe systems, periodic inspections of inlet and outlet grates are typically the only requirements.

Perforated pipes have been successfully installed in several Ontario communities. In the City of Ottawa a perforated pipe system beneath a grass swale has been in operation since the early 1990's. Tests show that after 20 years of operation with very little maintenance, they still provided water treatment and runoff reduction benefits[16].

Figure 2.5.1: Perforated pipe systems use many of the same materials and construction practices as conventional storm sewer pipes while also encouraging infiltration. (Source: Aquafor Beech)

Figure 2.5.2: Perforated pipe systems are integrated into the function and aesthetics of the bioretention landscape. (Source: JF Sabourin & Associates)

	Suitability
●	Passive use areas (lawn, gardens, etc.)
●	Active use areas (sports fields)
●	Parking lot areas

○ Low Suitability ◉ Moderate ● High

	Staff and financial considerations
○	Community engagement
◉	Inter-departmental coordination
◉	Design team
●	Capital cost
○	Operation & maintenance costs

○ Low Effort/Cost ◉ Moderate ● High

	Design considerations
●	Geotechnical testing complexity
●	Infiltration testing complexity
○	Planning complexity
◉	Design complexity

○ Low Effort ◉ Moderate ● High

	Benefits
◉	Flood risk reduction (water quantity)*
◉	Pollutant removal (water quality)
●	Groundwater recharge (water balance)*
●	Stream channel erosion control
○	Amenity & aesthetic value
○	Urban tree canopy
○	High profile with community & media

○ Low Benefits ◉ Moderate ● High

*Performance will vary based upon site characteristics and design of LID practice.

2.6 Prefabricated modules

The main benefit of prefabricated modules is that product specifications are readily available from manufacturers, along with design guidance, installation considerations, and expected performance. These forms of support can help provide confidence to public lands managers not experienced with LID retrofits as well as municipalities seeking a minimal retrofit process.

Due to the rapid evolution of prefabricated modules, it is strongly recommended that you contact suppliers directly for up-to-date product information.

Many prefabricated modules are designed primarily for stormwater treatment, and as such quantity and water balance may not be addressed by these practices. Prefabricated modules are ideal as pre-treatment for other LID practices like perforated pipe. Prefabricated modules can also be used on their own if on site infiltration is not needed, or if the particular unit provides both quality and quantity treatment.

Precast tree planters

Precast tree planters are prefabricated enclosures that contain trees or shrubs, bioretention soil media and a perforated pipe underdrain outlet. These systems are specially designed to collect stormwater runoff from roads and sidewalks and treat it using the processes of bioretention. Tree planters provide the benefit of a ready-made product that can be dropped in place, but unlike bioretention planters, they may not be able to be custom-sized and designed for a particular site.

Due to the concrete bottom, these planters provide water evapotranpiration benefits on their own; however, when combined as pre-treatment for a downstream perforated pipe system, these planters can provide comprehensive watershed water balance protection.

Figure 2.6.1: Precast tree planters can be used independently or as part of a treatment train with other LIDs. (Source: CVC)

Suitability	
●	Passive use areas (lawn, gardens, etc.)
●	Active use areas (sports fields)
●	Parking lot areas

○ Low Suitability ◎ Moderate ● High

Staff and financial considerations	
◎	Community engagement
●	Inter-departmental coordination
◎	Design team
●	Capital cost
◎	Operation & maintenance costs

○ Low Effort/Cost ◎ Moderate ● High

Design considerations	
○	Geotechnical testing complexity
○	Infiltration testing complexity
◎	Planning complexity
○	Design complexity

○ Low Effort ◎ Moderate ● High

Benefits	
○	Flood risk reduction (water quantity)*
◎	Pollutant removal (water quality)
○	Groundwater recharge (water balance)*
◎	Stream channel erosion control
●	Amenity & aesthetic value
○	Traffic calming
●	Urban tree canopy
◎	High profile with community & media

○ Low Benefits ◎ Moderate ● High

*Performance will vary based upon site characteristics and design of LID practice.

Soil support systems

When soils are heavily compacted as they are in highly urbanized areas, water does not easily absorb into soils. As a result, urban tree growth can be severely stunted and the infiltration capacity of the native soil can be poor. Conversely, soil that is not sufficiently compacted can result in settling and failure of infrastructure located above it.

Soil support systems address both of these issues. They provide structural support for paved surfaces without the need for a compacted soil base within the tree root zone. These systems consist of a modular frames (or cells) that provide structural support to the pavement infrastructure.

Each cell can hold a specified volume of soil. Cells can be spread out across a wide surface area and stacked on top of each other to a specified depth. These systems create very large tree root zones and infiltration areas beneath infrastructure, particularly sidewalks. These systems are particularly beneficial for municipalities aiming to improve the health and canopy of urban trees.

Figure 2.6.2: Installation of soil support system underneath the sidewalk on part of The Queensway, in Etobicoke. (Source: Deep Root Inc.)

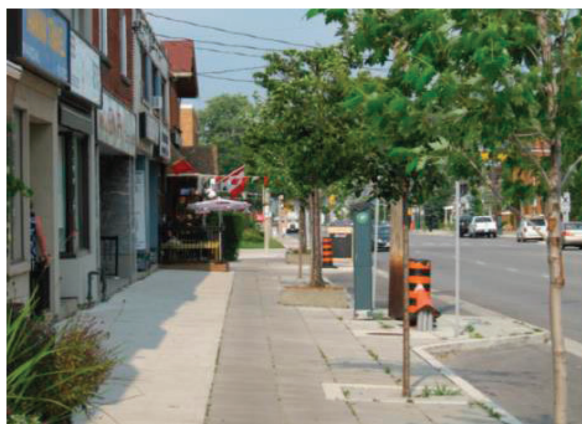


Figure 2.6.3: Sidewalk after construction with healthy trees. (Source: Deep Root Inc.)

	Suitability
●	Passive use areas (lawn, gardens, etc.)
◎	Active use areas (sports fields)
○	Parking Lot areas

○ Low Suitability ◎ Moderate ● High

	Staff and financial considerations
○	Community engagement
◎	Inter-departmental coordination
◎	Design team
●	Capital cost
◎	Operation & maintenance costs

○ Low Effort/Cost ◎ Moderate ● High

	Design considerations
●	Geotechnical testing complexity
◎	Infiltration testing complexity
◎	Planning complexity
●	Design complexity

○ Low Effort ◎ Moderate ● High

	Benefits
◎	Flood risk reduction (water quantity)*
●	Pollutant removal (water quality)
●	Groundwater recharge (water balance)*
●	Stream channel erosion control
●	Amenity & aesthetic value
○	Traffic calming
●	Urban tree canopy
◎	High profile with community & media

○ Low Benefits ◎ Moderate ● High

*Performance will vary based upon site characteristics and design of LID practice.

Phosphorus removal media

Phosphorus is a pollutant of concern in many Ontario watersheds. Excess loading of phosphorus can result in the growth of nuisance algae, loss of prey fish, degradation of drinking water and beach closures. For areas where phosphorus loading has been targeted as a concern, phosphorus removal media can help address the issue.

One type of phosphorus removal media is an oxide-coated, high surface area reactive engineered media. Another means for reducing phosphorus loading is the use of natural products or industrial byproducts. One natural product is red sand filter media. Red sand has a phosphorus retention capability, and its performance is currently being evaluated by the Lake Simcoe Region Conservation Authority (LSRCA).

Proprietary stormwater treatment devices

Proprietary stormwater treatment devices cover a range of different technologies used to treat stormwater. In general, they are comprised of an enclosure with proprietary technologies inside that are used to treat stormwater runoff flowing through the device. Some of the treatment approaches include hydrodynamic systems, commonly referred to as oil and grit separator (OGS) devices, wet vaults and media filters.

The suspended solids, metals and oils/floatables removal characteristics of proprietary stormwater treatment devices can vary widely. Like all stormwater management best management practices, their performance also depends upon regular inspection and maintenance.

Figure 2.6.4: Installation of a red sand phosphorus filter system during the retrofit of George Richardson Stormwater Management Pond in Newmarket. See the case study in Appendix B for further details. (Source: LSRCA)

Figure 2.6.5: To maximize treatment benefits, proprietary stormwater treatment devices can be installed upstream of LID practices. For instance, when retrofitting their parking lot, the IMAX Corporation had a proprietary treatment device installed to provide pre-treatment for a bioretention practice. The use of these two practices in series ensured that only the highest quality water would leave their site and be discharged to the environmentally-sensitive Rattray Marsh. (Source: CVC)

Suitability	
●	Passive use areas (lawn, gardens, etc.)
●	Active use areas (sports fields)
●	Parking lot areas

○ Low Suitability ◎ Moderate ● High

Staff and financial considerations	
○	Community engagement
○	Inter-departmental coordination
◎	Design team
●	Capital cost
●	Operation & maintenance costs

○ Low Effort/Cost ◎ Moderate ● High

Design considerations	
○	Geotechnical testing complexity
○	Infiltration testing complexity
◎	Planning complexity
◎	Design complexity

○ Low Effort ◎ Moderate ● High

Benefits	
○	Flood risk reduction (water quantity)*
●	Pollutant removal (water quality)
○	Groundwater recharge (water balance)*
○	Stream channel erosion control
○	Amenity & aesthetic value
○	Traffic calming
○	Urban tree canopy
◎	High profile with community & media

○ Low Benefits ◎ Moderate ● High

*Performance will vary based upon site characteristics and design of LID practice.

2.7 Landscape alternatives

Natural landscapes provide important functions that are lost when development occurs. The focus of landscape alternatives is to reintroduce natural features that restore these benefits. A variety of landscape alternatives can improve site aesthetics, reduce maintenance, and even save money. They include:

- Tree clusters
- No-mow zones
- Xeriscaping
- Micro-grading
- Soil amendments

Benefits of landscape alternatives include filtration of contaminants, protection from erosion, infiltration, evapotranspiration, evaporative cooling, interception of precipitation in foliage and retention and detention of stormwater.

Q ***Do you have a problem with nuisance geese on your property?***

A *Long grass is tougher, more fibrous and not the preferred dining option for these birds. Consider establishing no-mow zones around water features and other areas that geese frequent. Given the option between long grass and short grasses, these unwelcome visitors will gladly leave your property.*

Tree clusters

Tree clusters function similarly to forested areas by intercepting rainfall and allowing the processes of evapotranspiration and infiltration to reduce stormwater runoff. Tree clusters can consist of trees conserved within a pervious area during construction, or new trees planted within a pervious area.

Tree clusters improve water quality, generate organic soils, absorb greenhouse gases, create wildlife habitat, and provide shading to mitigate temperature increases at development sites.

No-mow zones

No-mow zones are areas of turf where mowing and other lawn maintenance activities do not occur on a frequent basis. These areas can include previously manicured lawns returned to their natural state or new areas planned as part of construction/reconstruction activities.

Creating no-mow zones is a great strategy for sites that have large areas of unused lawn. The cost of maintaining these lawn areas can be a significant financial burden. No-mow zones reduce the need for expensive fertilizers, irrigation and the fossil fuels required to maintain manicured turf areas.

Xeriscaping

Xeriscaping refers to landscaping, plantings and gardening practices that reduce or eliminate the need for irrigation. Synonymous with terms such as water-conservative landscapes, drought-tolerant landscaping and smart-scaping,

Figure 2.7.1: No-mow zones reduce stormwater runoff while reducing site maintenance costs. (Source: CVC)

xeriscaping was originally promoted in areas with perennial water shortages.

When xeriscaping, plants are selected based on their ability to survive with little water. The additional benefits include the elimination of the need for an automated irrigation system, lower maintenance requirements, better plant survivability and aesthetics during drought periods, and lower costs.

Figure 2.7.2: Xeriscaping can be attractive in addition to being water efficient. (Source: Athyrium Images)

Without signage the public may mistake your no-mow or xeriscape areas for unmaintained sections of your property. Interpretive signage around these areas will educate your community about these simple and effective LID practices

Micro-grading

Site grading typically refers to large scale grading of a construction site to the specified contours, elevations or slope. Grading done at this large scale usually creates a uniform ground surface on which a building may be built. As a result the uniform slope is such that water is directed quickly and efficiently.

Micro-grading is extremely detailed grading on a much smaller scale than site grading. Micro-grading focuses on individual spaces such as an individual land parcel or a sub-component such as a parking lot, walkway or landscape area. By creating subtle rolling slope changes, micro-grading acts to disperse runoff and optimize the potential for temporary runoff detention and infiltration in open spaces and landscaped areas.

Soil amendments

Although grassed areas are likely present on your site, the soils may have very little infiltration and filtration capacity due to the stripping, stockpiling, grading and compaction from construction equipment that occurs during site development. Consider soil amendments when establishing alternative landscaping. Soil amendments are generally organic materials added to the native soil to provide nutrients for plants, control soil pH, and allow for greater interaction between runoff and soils.

Sites that have undergone retrofits using soil amendments produce a smaller volume of runoff and contribute less to the

Staff and financial considerations	
◎	Design team
○	Capital cost
○	Training
○	Operation & maintenance costs

○ Low Effort/Cost ◎ Moderate ● High

Design considerations	
◎	Planning complexity
○	Design complexity

○ Low Effort ◎ Moderate ● High

Benefits	
◎	Pollutant removal (water quality)
◎	Amenity & aesthetic value
●	High profile with community & media

○ Low Benefits ◎ Moderate ● High

*Performance will vary based upon site characteristics and design of LID practice.

2.8 Rainwater harvesting

Rainwater harvesting is the process of collecting and storing rainwater for future use. Roof runoff is the ideal source for rainwater harvesting systems due to the large surface area and minimal exposure to contaminants. Rainwater harvesting not only reduces the volume of stormwater runoff leaving the site, but also reduces water bills through water conservation.

Rainwater harvesting systems convey roof runoff to a storage tank or cistern. Storage tanks can range in size from rain barrels that collect rainwater from individual downspouts to large precast concrete tanks capable of storing tens of thousands of litres. Rainwater storage tanks can be located inside a building or outside. If the water supply from an outdoor rainwater storage tank is to be used year-round, the cisterns should be buried below the frost penetration depth.

Did you know LID can save you money on your water bills? Collected rainwater can be used for outdoor irrigation and toilet flushing, lessening your reliance on municipal water supplies. This means that you will still be able to water your property, even during water bans. Many municipalities offer rebates that can cover a portion of the purchase and instillation of rainwater harvesting systems.

Rainwater that is collected in a cistern can be used for non-potable indoor or outdoor uses. For non-potable use, minimal treatment is required. The irrigation of landscaped areas and pressure washing of site features and vehicles are common uses of harvested rainwater. Indoor applications like toilet and urinal flushing also present opportunities for use.

Figure 2.8.2: To draw additional attention to its greening efforts, the Maplewood Mall in Minnesota had an external rainwater storage tank installed outside one of its entrances. A local artist was hired to create interactive art elements for the tank, making it educational and fun for visitors to the mall. (Source: CVC)

	Suitability
●	Passive use areas (lawn, gardens, etc.)
●	Active use areas (sports fields)
◉	Parking lot areas

○ Low Suitability ◉ Moderate ● High

	Staff and financial considerations
○	Community engagement
○	Inter-departmental coordination
◉	Design team
●	Capital cost
○	Operation & maintenance costs

○ Low Effort/Cost ◉ Moderate ● High

	Design considerations
○	Geotechnical testing complexity
○	Infiltration testing complexity
○	Planning complexity
◉	Design complexity

○ Low Effort ◉ Moderate ● High

	Benefits
◉	Flood risk reduction (water quantity)*
○	Pollutant removal (water quality)
○	Groundwater recharge (water balance)*
○	Stream channel erosion control
○	Amenity & aesthetic value
○	Traffic calming
○	Urban tree canopy
●	High profile with community & media

○ Low Benefits ◉ Moderate ● High

*Performance will vary based upon site characteristics and design of LID practice.

2.9 Green roofs

Flat roofs are ideal targets for green roof retrofits. Green roofs consist of a thin layer of growing media installed on top of a conventional flat roof. The vegetation planted on the growth media is selected based on climate conditions, desired aesthetics, and maintenance considerations.

Other components of green roofs include a waterproofing membrane designed to protect the roof, specially designed drainage layers that allow for storage of water for plant uptake, and a filter layer to prevent clogging of the drainage system. Green roofs are also equipped with overflows and underdrains connected to the roof drainage system to prevent excessive ponding of water during major storm events.

The City of Toronto promotes the construction of green roofs through its Green Roof Bylaw and the Eco-Roof Incentive Program. To find out more about Toronto's green roof initiatives including guidelines and construction standards, visit toronto.ca/greenroofs.

Green roofs reduce the rate and volume of runoff by providing temporary storage on the surface of the vegetation, within the growing media and drainage layers, as well as allowing water to be lost to the atmosphere via evapotranspiration. They are ideal for areas with tight soils where infiltration and volume reduction is difficult.

Green roofs can help to lower your heating and cooling costs. These systems absorb hear and act as insulators for buildings. It has been estimated that an approximately 3000m² green roof on a one story building in Toronto could save 6% of total cooling and 10% of hearing energy.

Figure 2.9.1: Green roofs must be designed and constructed around structural, drainage, ventilation and mechanical components. (Source: CVC)

Structural assessment of your roof is required before any green roof retrofit can take place. This ensures suitable load bearing capacity exists to support all media, plants, water and snow volumes and live loads associated with maintenance and operations.

Suitability	
●	Flat roofs

○ Low Suitability ◎ Moderate ● High

Staff and financial considerations	
○	Geotechnical testing complexity
○	Infiltration testing complexity
○	Planning complexity
◎	Design complexity

○ Low Effort/Cost ◎ Moderate ● High

Benefits	
◎	Flood risk reduction (water quantity)*
◎	Pollutant removal (water quality)
○	Groundwater recharge (water balance)*
◎	Stream channel erosion control
◎	Amenity & aesthetic value
○	Urban tree canopy
●	High profile with community & media

○ Low Benefits ◎ Moderate ● High

*Performance will vary based upon site characteristics and design of LID practice.

2.10 Pollution prevention (P2)

We all need to do our part to reduce pollutants entering the Great Lakes, source of drinking water for 8.5 million Canadians. There are many things you can do on your property to help ensure that only clean water enters the storm drainage system. When assessing LID options on your site, identifying pollution threats is an important part of the pre-design process. Applying the principles of pollution prevention, (the use of processes, practices, materials, products, substances or energy that avoid or minimize the creation of pollutants and waste, and reduce the overall risk to the environment and human health) can help eliminate those pollution threats, ensure that your business is in compliance with regulations and bylaws, and create a safer environment for staff and customers.

Figure 2.10.1: P2 strategies can be as simple as installing signage. On this site, illegal dumping was a serious issue. Signage indicating the waterbody to which the site flows is used to educate site users while the threat of a fine is posted as a warning. See Appendix B for Pollution Prevention Case Studies. (Source: CVC)

P2 is about anticipating and preventing pollution instead of reacting to it after a spill or release has occurred. It is part of an ongoing pollution management approach that is comprised of prevention, control and clean-up.

P2 opportunities can be found throughout any site or operation. For instance, installing different equipment or technology, or changing raw materials or staff routines can result in pollution prevention.

The ways in which P2 is achieved varies from one sector to another, but typically there are nine common opportunities:

1. **Dumpster management** - Dumpsters can be a major source of pollution that can affect water quality. When dumpster lids are left open rainwater is able to mix with the trash, resulting in a leaking fluid, or "dumpster juice" that can contain toxic organic and inorganic materials. If not treated, this dumpster juice can enter the storm drain system, contributing to poor water quality.

2. **Grease management -** Restaurants produce grease and other wastes as a by-product of normal food preparation. If grease is dumped or washed into sewers or storm drains, it can cause sanitary sewer overflows or stormwater runoff pollution. Restaurants can implement simple and low-cost P2 practices and train workers to properly dispose of used waste.

3. **Parking lot maintenance -** Maintenance operations have the potential to pollute stormwater runoff if sensible P2 practices are not employed. This is particularly true of power washing, which can deliver sediment, nutrients, hydrocarbons, and other pollutants to the storm drain system.

4. **Building maintenance -** Some building maintenance practices produce polluted wash water that can directly enter the storm drain system during dry weather, whereas others deposit fine particles or liquids that can wash away into stormsewers during wet weather.

5. **Landscaping and grounds care -** Landscaping services are generally performed by a lawn care/landscaping contractor or an in-house maintenance crew. Poor landscaping practices can create stormwater pollution, particularly in urban areas where soils are compacted.

6. **Outdoor storage -** The risk of stormwater pollution is greatest for operations that store large quantities of liquids or bulk materials at sites that are connected to the storm drain system. Protecting outdoor storage areas is a simple and effective P2 practice.

7. **Vehicle maintenance and repair -** Often, vehicles that are wrecked or awaiting repair can be a concern if leaking fluids are exposed to stormwater runoff. Vehicle

maintenance and repair can generate oil and grease, trace metals, hydrocarbons, and other toxic organic compounds. When vehicles are washed on impervious surfaces, dirty wash water can contaminate stormwater with sediments, phosphorus, metals, oil and grease, and other pollutants that can degrade water quality.

8. **Fuelling stations -** Delivery of pollutants to the storm drain can be sharply reduced by well designed fuelling areas and improved operational procedures. The risk of spills depends on whether the fuelling area is covered and has secondary containment.

9. **Snow and ice management -** Ontario experiences severe winter weather with large amounts of snowfall. Common snow removal practices include application of de-icer. De-icer is usually made from a urea compound or rock salt. Many property managers apply the products indiscriminately, assuming that more is better. However these de-icers wash into local waterways when the snow starts to melt. The key to de-icer usage is to apply it sparingly, and to remove most of the snow before application.

Here are three examples of how some P2 techniques have been applied:

Fuelling stations

If activities on your site include the loading and unloading of product or supplies such as chemicals, fuels, or oils, you should have P2 techniques in place. Spill containment

Figure 2.10.2: A fuel pump spill containment pad is recommended for all sites. In case of a spill fuel is detained within the pad until safe disposal. (Source: CVC)

measures will temporarily detain any spills allowing for the spill to be cleaned and disposed of properly This can reduce the risks of a spill draining into an LID feature, catch basin or drainage swale. Valves can be incorporated into the design of the spill containment so that it can easily be drained of rainwater or liquid.

Outdoor storage

Outdoor storage can create potential pollution threats as rainfall or runoff comes into contact with product, materials or waste being stored outdoors. Further complications are added when property facilities (i.e. waste bins, recycling bins) are susceptible to illegal dumping. To prevent and manage pollution threats from outdoor storage, there are a variety of

Figure 2.10.3: Covered spill pallets for 100 gallon drums prevent potentially harmful chemicals from leaking into watercourses. (Source: CVC)

P2 strategies that can be employed.

Simple strategies can be employed such as storing de-icing salt in a dedicated storage container to prevent continual loss of salt from precipitation. Other best practices include using large storage containers to protect chemical storage drums.

Dumpster management

Maintenance of dumpsters is often overlooked and as a result many dumpsters are in poor condition. Cracks in dumpsters will leak toxic organic and inorganic materials into catchbasins and towards waterways. Opportunities for P2 include locating dumpsters on a flat concrete surface that does not slope or drain to the storm drain system, installing a secondary

Figure 2.10.3: Garbage and recycling bins can crack resulting in leaking waste materials. Call your waste management provider to replace the cracked bins. (Source: CVC)

containment system such as a berm or curb around the dumpster, and closing and securing lids properly when the dumpster is not being loaded or unloaded.

Education is a critical component in the implementation of pollution prevention measures. Training your employees on both P2 procedures as well as the reason behind them can change attitudes towards pollution prevention. Employees may be more diligent in following P2 practices if they understand how it affects the quality of their drinking water.

For more information on P2 techniques refer to the Ontario Ministry of the Environment's Stormwater P2 Handbook

3.0 LID in Parks

Are you a parks superintendant interested in installing LID features in your park? Or a park user interested in leading a green project? This chapter will guide you through the initial planning process and provide you with resources you need to get your project off the ground.

Parks allow the public to interact with unique cultural and natural resources in a safe environment. LID practices can be implemented in parks of all shapes and sizes, from complex urban trail systems to urban parkettes. This chapter will help you identify opportunities for both large- and small-scale LID retrofits in parks. It will also discuss typical approaches to LID retrofits and provide examples of successful installations in parks.

Parks have areas of passive and active use. Passive use areas include the natural and open spaces of the park. These areas can include trails, benches and picnic areas. Typical operations and maintenance activities in passive use areas are limited to mowing and trash removal.

Active use areas include sports fields, pools, splash pads, skate parks, skating rinks, and municipal beaches. These areas attract public users and are often associated with organized recreational programs, such as sports leagues. Active use areas require a larger budget for more extensive operations and maintenance programs.

It is possible to integrate LID practices into both areas, though active use areas may require additional effort, including consultation with stakeholder groups.

Figure 3.0.1: It is essential to hold public consultations when retrofitting active areas to ensure that user needs are fully understood and met. This playground incorporates both bioretention and a permeable bonded rubber as a user-friendly alternative to permeable pavers. (Source: Aquafor Beech)

Including LID is parks shows residents of your municipality that you are working to address flooding and stormwater issues. It also demonstrates to private landowners that stormwater infrastructure can be landscaped to look attractive while still performing very important stormwater functions.

Conventional stormwater practices in parks

Due to their large surface areas, parks in many Ontario municipalities often use dry-detention facilities that are only inundated with water during significant storm events. Dry-detention facilities are large grassed areas with gradually sloped boundaries that form a bowl to temporarily store stormwater. These areas have been used successfully for decades in parks throughout the Ontario to provide flood control in urban centres. The fact that these types of systems are in use today demonstrates that stormwater management systems can be integrated within our park spaces.

One important function that can be provided by stormwater management systems is treating the stormwater (providing 'quality control') in addition to conveying it from the site. These types of systems provide significant environmental benefits, but are rare in municipal parks due to a number of challenges. LID does not face the same challenges as traditional stormwater control measures. Here's how it can help you:

Challenge 1: There are increased maintenance requirements for stormwater management practices providing quality treatment (e.g. sediment collection and disposal).

LID features require routine maintenance tasks, but they are primarily landscape based. They require no more maintenance than other landscaped areas in parks. These tasks can be integrated into existing parks programs more easily than dredging and hauling sediment from conventional water quality facilities.

Challenge 2: Stomwater infrastructure will take away park lands.

Many LID features can be implemented within an existing park. For instance, green roofs can be installed on building roofs and permeable pavement can replace old asphalt lots. Many LID practices do not require large dedicated areas. Those that do are typically located below ground, and do not impact recreation spaces in the park.

Challenge 3: There is public safety risks associated with stormwater ponds.

LID practices do not include any deep stagnant water that may pose a safety risk to park users, or provide breeding habitat for mosquitoes. In fact, LID features are designed to rapidly drain runoff into subsurface areas before significant ponding can occur on the surface.

Challenge 4: There is a negative perception associated with practices intended to clean water. The public relate wastewater treatment plants and smelly, stagnant algae filled pools with water quality treatment.

The best way to combat negative perceptions of LID practices is to show the public exactly what they look like. For instance, bioretention practices add attractive and functional features to the park. These small-scale practices are designed not to pond water for more than a day after a rain storm. This friendlier and more aesthetic approach helps to eliminate misconceptions about LID.

Parks play an important role in managing water in the community. Installing LID features and educational signage in your park gives you an opportunity to engage visitors and show them the value of green spaces.

3.1 Screening your LID options

In Chapter 2, you identified one or more LID options suitable for your park site. Here are a few more things you should consider when narrowing down your options.

What are your limitations?

Several factors can limit the type of LID you are able to construct on your site including available space, your timeframe, budget and available resources. Table 3.1.1 helps you identify the amount of resources you will need for each LID option.

As Table 3.1.1 demonstrates, many options are possible, even if you have limited resources. For example you can:

- Establish no-mow zones in passive use areas
- Plant tree clusters
- Implement xeriscaping planting strategies
- Install rain barrels
- Implement P2 practices

Table 3.1.1: Resources required for constructing LID

Project scale	LID practice
Large scale and complex LID options. Consulting support from engineers and Landscapers required	• Bioretention • Enhanced swales/ bioswales • Green Roofs
Large scale and complex LID options. Consulting support required from engineers.	• Permeable pavement • Soakaways and infiltration chambers • Prefabricated modules • Rainwater harvesting • Pollution prevention*
Small scale and easy to implement options. Can be completed with in-house resources	• Landscape alternatives • Rain barrels • Pollution prevention*

*Consultant may be required depending on complexity of project

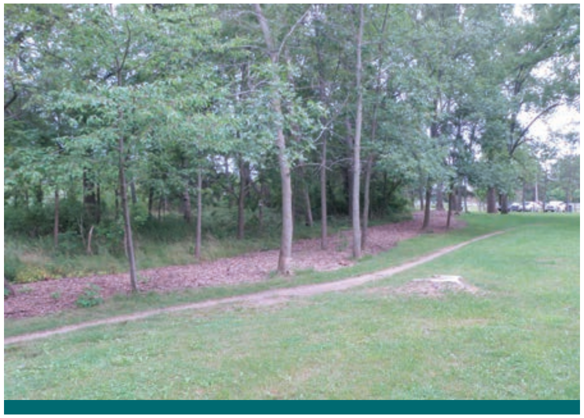


Figure 3.1.1: Tree clusters and other landscape alternatives are easy to implement and reduce maintenance costs. (Source: Aquafor Beech)

Large-scale retrofit projects require a complex approach that is best led by experienced engineering consultants. These practices include bioretention, enhanced swales, bioswales, perforated pipes, permeable pavement, soakaways, infiltration chambers, most rainwater harvesting systems, and prefabricated modules. These projects should be incorporated into planned construction associated with park redevelopment and site infrastructure rehabilitation/replacement. For more information on the consultant selection process, see Chapter 7.

Figure 3.1.2: Permeable pavement and bioswales are being constructed in this parking lot. This requires complete removal of the existing asphalt and granular bedding. Consider a parking lot retrofit when this type of area needs major rehabilitation. (Source: CVC)

Figure 3.1.3: To reduce localized flooding, consider this practice in areas that are prone to ponding water. This bioretention practice was installed in a low-lying area. (Source: LSRCA)

Q ***Ponded water in your park is attracting mosquitoes in summer and creating icy conditions in winter. Is there a retrofit option that will help address this issue?***

A *Bioretention, bioswales, perforated pipes, permeable pavement, soakaways, and infiltration chambers can all be used to infiltrate stormwater and melting snow helping to reduce surface ponding.*

Addressing site-specific issues through LID

You may be investigating LID options on your public lands site because of site-specific issues, such as localized flooding, poor water quality, or a need to reduce operations and maintenance costs. It is unlikely that all LID options will effectively address your site issues equally. Consider the options listed in Chapter 2 in relation to your site. Which ones can you eliminate immediately? Which options remain possible?

Is a highly visible integrated approach preferred?

There are generally two approaches for integrating LID practices:

Approach 1: Maintain the current look and feel of the park by integrating LID practices that blend into the existing landscape or are hidden below ground.

This approach is best suited to parks where it is difficult to establish an area dedicated solely to one or more LID features. One type of LID practice that can be implemented within existing features of the site is infiltration practices. These include soakaways and infiltration chambers as well as perforated pipe. These all occupy very little surface area. Retrofitting existing roadways, parking lots, and pathways with permeable pavement is another practice that does not require land to be set aside within parks.

Figure 3.1.4: A boardwalk gives pedestrians a complete view of this bioretention practice. The pathway also prevents damage to the facility from foot traffic. (Source: CVC)

Approach 2: Integrate highly-visible LID practices that may require some additional space, but provide greater promotional and educational opportunities for park visitors

This approach works best for demonstration projects used to promote municipal sustainability objectives. Lush, colourful perennials can be added to many LID practices. Integrate paths, benches, and public artwork with these practices to enhance visual appeal and public interaction.

LID practices in parks show the public that your municipality is serious about sustainability. If a goal of your retrofit project is

Figure 3.1.5: A combined integration strategy was used at Terraview Park in Toronto. Some stormwater features enhance the aesthetic value of the park, while an infiltration chamber was installed below a soccer field to treat water from a 40 hectare area. (Source: Aquafor Beech)

Case Study: Lakeside Park

LID Features:

- ***Pervious concrete***
- ***Green roof***
- ***Bioswale***
- ***Reclaimed water irrigation system***

Source: CVC

Lakeside Park was one of five priority parks in Mississauga chosen for redevelopment with a focus on green infrastructure. The city incorporated multiple LID features into the design while maintaining park functionality.

How it works:

The green roof, constructed over the washrooms, adds additional usable space to the park. The bioswale captures and treats runoff from the parking lot, while its lush vegetation enhances the visual appeal of the park.

Source: CVC

The pervious concrete overflow parking lot captures rainfall, filters it, and then stores it until it can infiltrate into the soils below.

Source: CVC

Stormwater collected from the park and water from a splash pad is directed into a reclaimed water irrigation system. This system helps to reduce the park's potable water consumption.

For more information, check out the Lakeside Park Case Study in Appendix B

to promote municipal sustainability initiatives, consider using highly visible practices that incorporate garden-like plantings, such as enhanced swales, bioswales and bioretention Most LID practices can be designed to attract the attention of park users. For instance, you could cover above ground rainwater harvesting tanks with promotional material, or install signage that explains permeable pavement features.

3.2 Your LID project team

Regardless of the scope of your LID project, your project team should include project champions who will promote the retrofit within your municipality and the broader community. Ideally, the project manager of a park LID retrofit is a person who is familiar with the site, its maintenance and operations. The core project team will include a range of professionals with different fields of expertise and perspectives.

The core project team develops an overall plan and provides key information to assist the project manager with decision making. The project team also helps to identify staff, external organizations, and stakeholders who can provide information, advice, or professional expertise. For projects that require external support from consultants and contractors, the core team should be able to provide support with development of the terms of reference, tender, or request for proposals (RFP). They should also review and comment on site design and assist with construction administration and oversight.

Members of the project team must possess a comprehensive understanding of goals and targets associated with stormwater management, site function, and existing operations and maintenance at the site.

The support of neighbourhood associations and community groups will help promote your project locally. Consider planning a community event to promote the project.

Partnerships

Partnerships with community groups, external organizations, and businesses can help with promotion and funding of LID retrofits in parks.

Community groups may have an interest in upgrading or beautifying facilities that they commonly use. These groups include neighbourhood associations, sports leagues that use the park and environmental groups active in your municipality. Volunteer support and even funding from these groups may be possible, especially if the project achieves common goals.

Schools, libraries, and other public sites may formally or informally share the use of municipal parks. As adjacent land owners they may have a vested interested in LID retrofits. Reach out to these groups during the planning stages to get their input, build support and address community goals.

Figure 3.2.1: Having project team members that are connected with local volunteer networks can be beneficial. Here volunteers help plant a rain garden at Terra Cotta Conservation Area. (Source: CVC).

Parks are often adjacent to school yards, making a great opportunity to form partnerships. Working together you can construct comprehensive stormwater management measures. You will also provide educational opportunities for students.

3.3 LID opportunities in parks

Parks range from simple parcels of municipal property to complex outdoor recreational facilities that include parking, sidewalks, trails, sports fields, field houses, operations facilities, and washrooms. Each distinct area of your site can be a source for runoff (referred to as a 'source area'). These areas should be targeted when introducing LID in your park.

Targeting hard surfaces

Hard surfaces like parking lots and internal driveways are the most obvious areas to target for both stormwater quality and water balance improvements. These features produce more runoff than any other area on your site. Water quality of runoff from parking lots and driveways is typically more polluted than other source areas. Common water quality concerns include sand and salt from winter de-icing operations, and hydrocarbons (gasoline) and metals from vehicle breakdowns

Runoff from vegetated areas of parks will be relatively clean and more closely match the natural water balance. On municipal park properties, hard surfaces are usually located adjacent to pervious areas such as lawns, gardens or naturalized areas. This makes an ideal location for a LID retrofit. Where grading allows, you can construct bioswales and bioretention areas in these green areas to pre-treat water prior to infiltration.

O'Connor Park in Mississauga targets hard surface areas for water quality and water balance improvements. Runoff from the parking lot drains to permeable pavers and a central bioretention unit. For more details, refer to the O'Connor Park case study in Appendix B.

Figure 3.3.1: The bioretention area installed at O'Connor Park in Mississauga is part of a stormwater management system that treats parking lot runoff prior to discharging to a local wetland. (Source: CVC)

You can also design parking surfaces and internal roadways as infiltration systems using permeable pavement. This retrofit strategy can be combined with other LID practices.

A pedestrian pathway paved with permeable pavement is another LID option for your park. They will reduce runoff volumes and encourage on-site infiltration. Pervious pipes are a viable option on many parks sites as well. They can be an alternative to conventional conveyance systems such as storm sewers. They encourage infiltration from hard surfaces and can be used to convey water to other LID features.

Case Study: City of Hamilton

LID Features:

- ***Seven soakaways***
- ***One infiltration chamber***
- ***Two permeable pavement installations***
- ***Two bioswales***

Compared to other land uses, parks have the fewest physical constraints for LID implementation. Underground utilities are rarely a problem and surface ponding in LID practices can be designed to prevent public safety concerns and work with site functions.

Several Ontario municipalities have implemented LID stormwater practices in their parks. The City of Hamilton is leading the way with 12 LID retrofits in seven wards.

How it Works:

Infiltration trenches are ideal for long strips of unused land. At the city of Hamilton's Winona Park, a perforated pipe has been installed in an infiltration trench to create a perimeter trench drain around the. When configured as long trenches, infiltration practices occupy very little space and can fit into almost any park site.

(Source: Aquafor Beech)

A soakaway provides stormwater control to a parking lot along Beach Boulevard in Hamilton. Vegetated filter strips pretreat water prior to infiltration.

(Source: Aquafor Beech)

Figure 3.3.2: Urban parkettes may look small, but they have the potential to treat a large surface area of road. Typical ratios of impervious drainage area to bioretention range from 5:1 to 15:1. (Source: CVC)

Figure 3.3.3: The road surface (left) contributes significantly more stormwater pollutants than the parkland area (right). To achieve maximum watershed benefit a designer could consider accepting runoff from this external area. (Source: CVC)

Accepting drainage from off-site areas

Does municipally owned land drain into your retrofit site? If so, this is an opportunity to provide stormwater controls for these areas.

Roads are the most common source of runoff from external properties into parks. Treating municipal road runoff in a park requires planning input from municipal roads department staff. For these projects, the team must understand how all roads activities, including winter maintenance and potential roadwork, will affect the operation of LID practices in the park.

Inter-municipal transfer of funds

Integrating LID practices into the municipal stormwater management framework may change how municipal funds are managed. Traditional stormwater management maintenance resources and funds may have to be transferred to a more landscape-based stormwater management maintenance program. Instead of infrequent but expensive stormwater management pond sediment removal operations, time and resources will be spent on more frequent but inexpensive maintenance projects including pruning and weeding bioretention practices or sweeping permeable pavement.

Municipalities generally have the required staff and infrastructure within departments (e.g. arborist and horticulturalists in parks departments) to manage the maintenance of LID measures; however, funding this maintenance may require a transfer of funding and additional training.

The federal Gas Tax Fund (GTF) is another funding option for funding LID retrofits. This is a federal transfer that provides long term funding for municipalities to build and revitalize public infrastructure. Up to 30% of municipalities yearly GTF allotment can be used towards stormwater management.

Source Areas

The LID option that best fits your site will depend what types of source areas are present. Types of source areas include:

- Active use area
- Passive use area
- Pedestrian walkway
- Internal driveway
- Parking lot

On park sites, pollution prevention is often associated with changes to operations and maintenance practices and has not been included in Table 3.3.1. An aerial photo of a park with each of these source areas accompanies Table 3.3.1. Options and implementation strategies for a few of these source areas will give you some ideas for your park site.

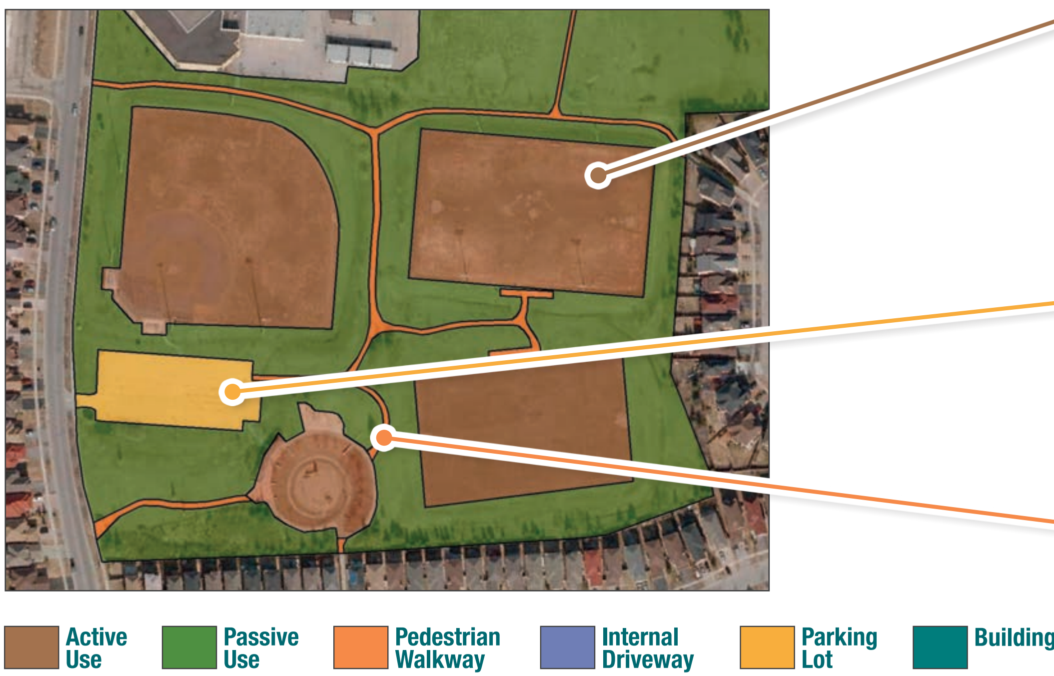
You can do this for your site too! Print off an aerial photo and highlight all the source areas. This will give you a starting place when planning your LID retrofit.

Table 3.3.1 LID options for parks

Source area	Permeable pavement	Bioretention	Enhanced grassed swales	Bioswales	Soakaways and infiltration chambers	Perforated pipe system	Landscape alternatives	Prefabricated modules
Active use area	●	○	◉	◉	●	◉	○	○
Passive use area	○	●	●	●	●	●	●	●
Pedestrian walkway	●	●	●	●	●	◉	◉	○
Internal driveway	●	●	●	●	●	●	○	◉
Parking lot	●	●	●	●	●	●	○	●

● common option ◉ possible option ○ unlikely

Figure 3.3.7: Source areas within a typical park



If this site were being retrofitted with LID practices, one option is that water from hard surfaces could be conveyed to infiltrating practices like soakaways or infiltration chambers located beneath sports fields. As these practices are located below ground, park visitors will not even know that these LID features are there. Another option is to store rainwater in buried tanks and use the rainwater to irrigate fields during the dry summer months.

Parking lots often have the largest impact on stormwater runoff from a site (in terms of quantity and quality). To minimize environmental impacts, runoff from this area should be the primary target of an LID retrofit. One option is to retrofit parking islands with bioretention. Retrofitting your parking lot also provides a good opportunity to maximize parking spaces and address traffic safety issues

Pedestrian pathways are prime areas for public interaction with LID features, such as bioswales and permeable pavement. Consider installing signage for community education, project promotion, and direction to additional project information or stewardship opportunities.

3.4 Making it happen: Approaches to getting LID into parks

The scale of your LID project will largely determine how you will proceed. This guide provides two tiers of LID park retrofit projects. You can usually complete small-scale LID projects with in-house expertise and resources. Large-scale projects will require external support from consultants and contractors.

Small-scale projects

Starting with small-scale projects is a good strategy to increase public interest in LID practices, gauge municipal support, and gain experience. Small-scale projects include retrofitting your parks site with landscape alternatives or rain barrels, or using pollution prevention strategies and practices.

Small-scale projects require fewer resources and require a smaller project budget because:

- They do not require integration into capital works projects
- Engineering consultants are not required
- Contractors may not be not required
- External approvals are not required
- Consultation with the public is limited

Due to the less significant financial commitment, it can be easier to build colleague and supervisor support for small-scale projects.

Case Study: Terra Cotta Conservation Area

LID Feature:

• Rain garden

Located in the Niagara Escarpment, Terra Cotta Conservation Area is a showcase park for Credit Valley Conservation. The newly renovated visitor centre was an ideal location for a demonstration rain garden. This rain garden was built by CVC staff and volunteers and is an example of a simple project that municipalities, schools, and other property owners can easily implement.

To build team morale and educate staff on how LID features worked, CVC staff were involved in planting the rain garden. (Source: CVC)

How it Works:

The roof downspout from the visitor center was diverted to the rain garden, located a safe distance from the building foundation.

This pipe carries runoff from the roof into the raingarden. it was burried after construction.   (Source: CVC)

Leaf compost was added to the existing fine soils, which helps to improve the ability of the soil to absorb and filter rainwater. The garden was then planted with bands of colourful flowering perennials and shrubs.

For more information, check out the Terra Cotta Case Study in Appendix B.

Figure 3.4.1: A no-mow zone is a landscape alternative that does not require construction activities. (Source: Aquafor Beech)

Small-scale projects like landscape alternatives and pollution prevention may not be easily identified as LID practices by the public. Your project team should consider establishing educational signage to inform the public.

Large-scale projects

Large-scale projects require significantly more effort, budget, and staff than small-scale projects. Large-scale LID projects include:

- Bioretention
- Enhanced grass swales
- Bioswales
- Perforated pipe systems
- Permeable pavement
- Soakaways
- Infiltration chambers
- Rainwater harvesting (excluding rain barrels)
- Prefabricated modules

Consider a large-scale project if your municipality or department would like to be a leader in sustainability. Large-scale projects are often highly visible and attract more public attention. Large-scale projects may also be the only solution to site-specific challenges. For example, if the parking lot on your site does not have existing stormwater controls, small-scale projects are not likely to fully achieve compliance with water quality and quantity objectives. Consider using an infiltration chamber or bioswale project to meet those objectives.

Before starting a large-scale retrofit project, consider the following distinctions that set these retrofits apart from small-scale projects.

Integration with capital works programs

Most large-scale LID retrofits must function with existing site infrastructure, such as storm sewers, catch basins, and pavement systems. The construction of large-scale LID practices often requires these systems to be removed, exposed, or replaced. The best time for this type of project to occur is when an infrastructure replacement or rehabilitation project is already planned.

For example, installing bioretention, infiltration chambers, or permeable pavement in a parking lot requires removal of existing pavement. Budget and resources set aside for parking lot replacement could be transferred to a retrofit project that includes replacement of this infrastructure.

Consider developing a plan that includes small-scale projects to achieve minor goals and long-term capital projects to achieve comprehensive stormwater benefits.

Involvement of consultants and contractors

Consultants are required for large-scale retrofit projects, specifically for the final screening of options, pre-design, detailed design, tender and contract documents, construction supervision and administration, and assumption and verification. The consultant selection process is described in Chapter 7.

Figure 3.4.2: When installing new parks equipment, consider whether the LID practices can be integrated into the design. Here a bioswale has been built into the landscape between a playground and sidewalk. (Source: CVC)

The contractor with the lowest bid does not necessarily deliver the best product. Request references during the bidding process to ensure selected contractors have the relevant experience.

Site contractors are also required for large-scale LID retrofits. Ideally, contractors should be pre-qualified based on previous experience with similar LID projects.

More intensive public consultation

Stakeholders must be closely involved in the retrofit process for large-scale LID projects. These projects have longer construction windows, may have significant impacts on long-term public use patterns of the park, and will cost significantly more taxpayer dollars.

Gaining public insight in advance of LID implementation can help address public concerns and information gaps, as well as identify public supporters and champions. Public consultation can help designers tailor the project to address community concerns and values.

External approvals

Large-scale park retrofits may require a variety of approvals at the municipal, watershed, provincial, and/or federal level. Since LID is still relatively new, you may encounter policies or bylaws that present barriers to LID retrofit projects. Alternatively, the municipality may have to enforce some policies and bylaws to facilitate the implementation of LID projects within parks. For a detailed discussion on approvals required for LID retrofits, refer to Chapter 7.

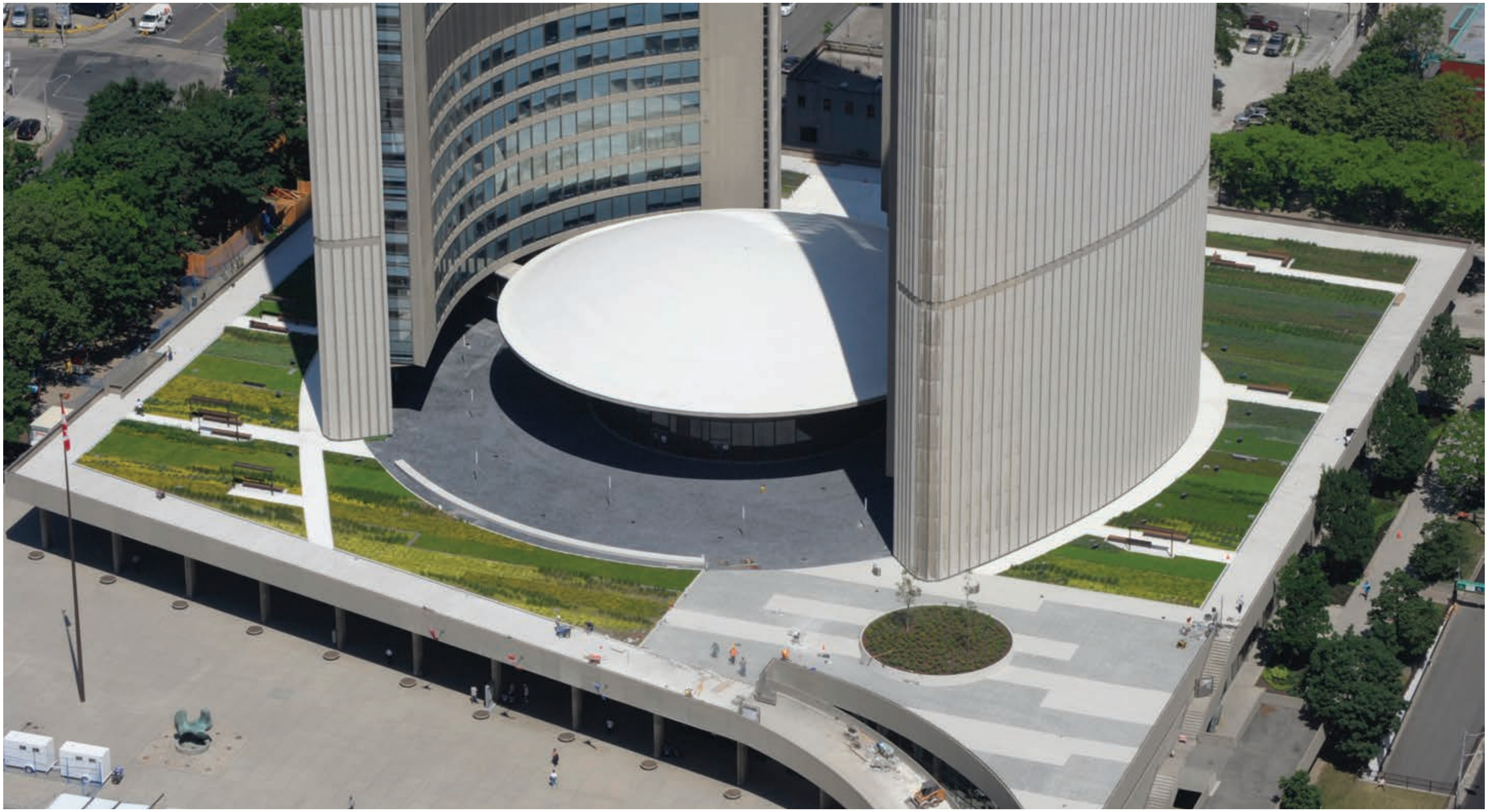
Next Steps

After reading this chapter you should know how to select the right LID practice for your site. You should also be familiar with the details you need to consider before undertaking an LID retrofit.

Chapters 4, 5 and 6 provide similar guidance aimed at municipal facilities, schools and places of worship. Reading these chapters may give you additional ideas for implementing LID on your site.

For further guidance on implementing and constructing LID practices, please refer to Chapters 7-9. These chapters provide the next steps for you to implement your LID project, including building the project team, creating a design, getting approvals, construction, certification and guidance on operations and maintenance of LID practices.

4.0 LID for Municipal Facilities



Source: Alex Mozo

Whether you are a facilities manager or a facilities user who is interested in leading an LID project, this chapter will help guide you through the initial planning process and provide you with resources you need to get your project off the ground.

Municipalities own and operate public facilities including:

- Community centres
- Libraries
- Pools
- Arenas
- Public works yards
- Municipal offices
- Recreation centres

These spaces are used for a wide range of activities throughout the year and are deeply valued community assets.

Setting a positive example for the community

Municipal facilities have a lot of public traffic and offer excellent opportunities to promote innovative approaches to managing stormwater. LID retrofits are a great opportunity to demonstrate your commitment to leading by example when it comes to environmental sustainability. By taking this approach, municipalities can demonstrate to the community that there are functional, aesthetically pleasing, cost-effective alternatives to conventional stormwater management.

Showcasing your site through site tours is a great way to introduce the private sector to LID and P2 options. When the public has been introduced to functional and aesthetically pleasing LID features like bioretention, there is a good chance that others in the private sector will take this cue and consider a similar practice when upgrading and replacing their site infrastructure.

Meeting municipal objectives

Municipalities must strive to meet a complex list of objectives specified in their official plans, green strategies, by-laws and those mandated by provincial and federal government. LID practices can help municipalities meet goals related to:

- Combined sewer overflow reduction
- Reduced urban flooding
- Carbon footprint reduction
- Climate change adaptation
- Urban forestry improvements
- Runoff objectives (quality and quantity) identified in subwatershed studies
- Provincial Water Quality Objectives
- Groundwater recharge studies
- Environmental goals in official plans
- Pollution prevention
- Public education

This chapter identifies opportunities for LID retrofits on municipal facility sites and discusses typical approaches.

Figure 4.1.1: Landscaped alternatives such as plantings that use xeriscaping strategies may not require extensive construction activities and can be completed with in-house resources. (Source: Fern Ridge Landscaping)

Figure 4.1.2: Any parking lot retrofit requires significant construction activities. These projects will require consultants and contractors for LID selection, design, and construction. (Source: Aquafor Beech)

4.1 Screening your LID options

In Chapter 2, you identified one or more LID options suitable for your municipal facility. Here are few things to consider when narrowing down your options.

What are your limitations?

Several factors can limit the type of LID practice you construct on your site including available space, time frame, budget and available resources. Table 4.1.1 will help you determine what resources are required for each LID option.

Q ***Ponded water and ice on the surface of my parking lot is causing slips, trips and falls. Is there a retrofit option that will improve parking lot conditions?***

A *Permeable pavement will address this site-specific issue. The porous surface will allow runoff to infiltrate before it freezes.*

Table 4.1.1: Resources required for constructing LID

Project scale	LID practice
Large scale and complex LID options. Consulting support from engineers and Landscapers required	• Bioretention • Enhanced swales/ bioswales • Green Roofs
Large scale and complex LID options. Consulting support required from engineers.	• Permeable pavement • Soakaways and infiltration chambers • Rainwater harvesting • Pollution Prevention (P2)* • Prefabricated modules
Small scale and easy to implement options. Can be completed with in-house resources	• Landscape alternatives • Rainwater barrels • Pollution Prevention*

*Consultant may be required depending on complexity of the project

Figure 4.1.3: Installing permeable pavement in your parking lot may reduce the quantity of de-icing salt used on your site. Permeable pavement provides good traction for pedestrians and prevents ice formation by providing quick drainage to the granular layer below the pavement surface. Reduced risk of slips, trips, and falls is a strong retrofit incentive. (Source: CVC)

Large-scale retrofit projects require a complex approach that is best guided by experienced engineering consultants. These practices include bioretention, enhanced swales, bioswales, perforated pipes, permeable pavement, soakaways, infiltration chambers, most rainwater harvesting systems and prefabricated modules. Large-scale projects should be incorporated into planned construction associated with municipal facility redevelopment and site infrastructure rehabilitation or replacement. For more information on the consultant selection process, see Chapter 7.

Addressing site-specific issues through LID

You may be investigating LID options on your municipal facility as a result of site-specific issues, such as localized flooding, poor water quality or a need to reduce operations and maintenance costs. It is unlikely that all LID options will effectively address your site issues equally. Consider the options listed in Chapter 2 in relation to your site. Which ones can you eliminate immediately? Which options remain possible?

Is a highly visible LID practice suitable for your site?

There are generally two approaches for integrating LID practices at your municipal facility:

Approach 1: Maintain the current look and feel of the municipal facility site by integrating LID practices that blend into the existing landscape or are hidden below ground

This approach is best suited for densely developed sites where it is difficult to establish an area dedicated solely to one or more LID features.

One type of LID practice that can be implemented within existing features of the site is infiltration practices. These include soakaways and infiltration chambers as well as perforated pipe. These all occupy very little surface area. Retrofitting existing roadways, parking lots, and pathways with permeable pavement is another practice that does not require land to be set aside within municipal facilities.

Figure 4.1.4: This bioretention garden is located outside of an elementary school. It includes public art and signage for public education. Consider setting up an educational display at the entrance of your municipal facility to spread the word about your retrofit project. (Source: CVC)

Approach 2: Integrate highly-visible LID practices that may require some additional space, but provide greater promotional and educational opportunities for site visitors

If a goal of your retrofit project is to promote municipal sustainability initiatives, consider using highly visible practices such as:

- Bioretention or bioswales
- Green roofs
- Rainwater harvesting

By retrofitting your site with these high-impact retrofit practices it will demonstrate your commitment to sustainability among your residents. If room allows on your site, some of these retrofits can include paths, benches, and public artwork to enhance their amenity value.

It is important that you design these LID practices to attract attention of your site users. Signage, artwork and interactive elements are all strategies you can take to engage visitors to your facilities.

4.2 Your LID project team

Whether you are planning a small-scale or large-scale LID retrofit project, your team should be comprised of project champions that promote the retrofit within your municipality and the community. The project manager should be a person who is familiar with the site and its maintenance and operations. The core project team will include a broad range of professionals with different fields of expertise and perspectives to support the project manager.

The core project team develops an overall plan and provides key information to assist the project manager with decision making. The project team also helps to identify staff, external organizations, and stakeholders who can provide information, advice, or professional expertise. For projects that require external support from consultants and contractors, the core team should be able to help with the development of the terms of reference, tender, or request for proposal (RFP). They should also review and comment on site design and assist with construction administration and oversight.

Figure 4.2.1: Community members that use your municipal facility are a great resource for identifying site needs and providing ongoing volunteer support. (Source: CVC).

Team members must possess a comprehensive understanding of goals and targets associated with stormwater management, site function, and existing operations and maintenance at the site.

Most municipalities are fortunate to have departments that can support the retrofit process. You may consider looking to the following areas for project support:

- Forestry and parks departments
- Environmental services and stewardship
- Engineering services
- Capital works
- Terrestrial and aquatic services
- Geosciences (hydrology and hydrogeology)
- Marketing and communications departments
- Community services

The size of your team, as well as the type of expertise that is available will depend on the size of your municipality. Small municipalities may not have all the departments listed above. Support from consultants and partnering organization such as conservation authorities can help to get the work done.

Operations staff are required team members since they will be most familiar with existing site maintenance practices. These members will have critical first-hand knowledge of what type(s) of LID practices are best suited given current levels of service, or what changes may be required to accommodate new LID retrofits.

Also consider what support or resources your project may receive from:

- Councilors
- Regional government
- Your local conservation authority
- Provincial staff

Forming community partnerships

Municipal facilities are hubs for community groups, interest clubs and sports teams. Partnerships with these groups can help promote and fund your LID retrofits. Community groups may have an interest in upgrading or beautifying facilities that they commonly use. Volunteer support and even funding from these groups may be possible, especially if the project achieves common goals.

Consultation with the public is probably not needed for projects that are unlikely to affect public use. Examples of LID retrofit projects that do not require public consultation include implementing pollution prevention strategies around maintenance facilities, and installing rain barrels on your roof drains. However, for small-scale practices that are to be integrated into public use areas and have the potential to change usage patterns in the municipal facility, public consultation should occur.

Figure 4.3.1: Green features in your parking lot provide shade and evaporative cooling. This plays a role in reducing air temperatures on your site and making the walk from a car to your municipal facility a better experience during hot summer days. (Source: CVC)

Figure 4.3.2: This dry hydrant is connected to a large subsurface cistern. This water supply can be used in emergency situations to fight fires on site. (Source: Aquafor Beech)

Case Study: Credit Valley Conservation Head Office

LID Features:

- ***Permeable pavers***
- ***Rainwater harvesting***
- ***Enhanced grass swale***

Credit Valley Conservation's head office incorporates a variety of LID features to better manage stormwater on its property and reduce its potable water use.

How it works:

Stormwater runoff from an asphalt roadway is directed to an enhanced grass swale. The swale helps to slow down the flow of water and improve its quality by removing larger sediment and debris.

The building uses a rainwater harvesting system to collect rainwater from the roof and re-use it for toilet flushing and outdoor irrigation. Rainwater is stored in a large tank located in the basement of the building.

Instead of a typical asphalt parking lot, staff at CVC park on permeable pavers. There are small gaps between the pavers that allow rainwater to pass through to an underground gravel storage reservoir.

Source – all photos: CVC

For more information, check out the Credit Valley Conservation Head Office Case Study in Appendix B.

4.3 LID opportunities at municipal facilities

Each distinct area of your site can be a source for runoff (referred to as a 'source area'). These areas should be targeted when introducing LID in your municipal facility.

Targeting hard surfaces

Municipal facilities have large parking lots to accommodate public demand. Parking areas represent the most significant source of pollutant loading from these sites and contribute significantly to increased runoff rates in comparison to natural conditions. Parking lots include areas for parking, areas for driving, and islands or landscape planters used for calming traffic, directing vehicles, and improving pedestrian safety.

LID practices can be incorporated into all areas of a parking lot. You can use bioretention in parking lot islands and along the lot perimeter. Standard curbs with small cut-outs (called 'curb cuts') can allow water to easily enter biorentention practices while also preventing damage from cars.

The Ontario Ministry of Transportation's Beamsville carpool parking lot installed four bioretention cells to target runoff from hard surfaces. To learn more, refer to the case study in Appendix B.

Bioswales can also be located in parking lot islands or along lot perimeters. Parking lots with existing perimeter ditching are ideal for bioswale integration due to their extended continuous flow path.

Prefabricated modular infiltration chambers are gaining acceptance for their easy integration with parking lot functions. These subsurface systems are typically installed over a coarse granular reservoir to provide storage and allow infiltration into native soils. Infiltration chambers under conventional asphalt system work well on sites where parking demand and other site uses do not allow space for a stormwater feature.

Figure 4.3.3: Bioretention planters beautify this building entrance. The entrance receives a lot of traffic during business hours, making it an ideal location for a high visibility LID practice. (Source: Aquafor Beech)

Permeable pavement can also be integrated in large municipal parking lots. Pervious concrete, permeable interlocking concrete pavers, and porous asphalt can detain stormwater and increase infiltration.

There are also excellent opportunities to integrate rainwater harvesting systems in many municipal facilities. Rainwater harvesting systems have two requirements: an area for catchment of relatively clean runoff, and a nearby demand for water usage. Municipal facilities often have large rooftop areas that produce relatively clean runoff. Installing a cistern either internal to the building or buried adjacent to the building can provide a sustainable source of water for site irrigation needs, including landscaped areas and recreational fields, as well as indoor use for flushing toilets and urinals.

Targeting highly visible areas

If your LID integration strategy involves highly visible LID practices, consider targeting areas with high-volume pedestrian traffic.

Targeting pollution prevention opportunities

On some municipal sites, pollution prevention techniques and strategies outlined in Chapter 2 are the best approaches to mitigating the environmental impact of your site.
Retrofits of municipal works yards require a different approach than other land uses discussed in this guide. Works yards do not offer substantial opportunities for public interaction. LID retrofits should focus primarily on reducing pollution generated on-site. Fuelling stations, waste storage areas, truck washing stations, sand and salt storage, staging areas, and water conveyance features should be targeted for pollution prevention.

Source Areas

The LID option that best fits your site will depend what types of source areas are present. Types of source areas include:

- Active use area
- Passive use area
- Pedestrian walkway
- Internal driveway
- Parking lot

On municipal sites, pollution prevention is often associated with changes to operations and maintenance practices and has not been included in Table 4.3.1. An aerial photo of a park with each of these source areas accompanies Table 4.3.1. Options and implementation strategies for a few of these source areas will give you some ideas for your park site.

You can do this for your site too! Print off an aerial photo and highlight all the source areas. This will give you a starting place when planning your LID retrofit.

Table 4.3.1 LID options for municipal facilities

Source area	Permeable pavement	Bioretention	Enhanced grass swales / bioswales	Green roofs	Soakaways / infiltration chambers	Perforated pipe system	Rainwater harvesting	Landscape alternatives	Prefabricated modules	Pollution prevention
Active use area	●	●	●	○	●	◉	○	◉	○	●
Passive use area	○	●	◉	○	●	●	○	●	●	●
Pedestrian walkway	●	●	●	○	●	◉	○	◉	◉	●
Internal driveway	●	●	●	○	●	●	○	○	●	●
Parking lot	●	●	●	○	●	●	○	○	●	●
Building	◉	◉	◉	●	●	◉	●	○	○	●

● common option ◉ possible option ○ unlikely

Figure 4.3.7: Landforms of a community centre

Active Use Passive Use Pedestrian Walkway Internal Driveway Parking Lot Building

Naturalizing passive use areas can save operational costs typically spent on mowing and provides privacy buffers between public spaces and external properties, such as busy roads.

On this site, landscape-based stormwater management practices like bioswales or bioretention could be established along the site's perimeter to provide water quality and volume control for the adjacent road.

Parking lots represent the most significant source of on-site stormwater pollutants. They are also highly visible areas perfect for demonstration projects.

Roof runoff is relatively clean and can be captured and stored in rainwater harvesting systems until it is needed for irrigation, gardens, or sports recreational fields.

4.4 Making it happen: Approaches to getting LID retrofits in municipal facilities

This guide provides two tiers of LID retrofit projects. The scale of your LID retrofit project will largely determine how you will proceed with the retrofit process. Small-scale LID projects can usually be completed with in-house expertise and resources. Large-scale projects will require external support from consultants and contractors.

Small-scale projects

Starting with small-scale projects is a good strategy to increase public interest in LID practices, gauge municipal support, and gain retrofit experience. Small-scale projects include retrofitting your site with landscape alternatives or rain barrels, enhancements of existing swales, or using pollution prevention strategies and practices.

Small-scale projects require fewer resources and require a smaller project budget because:

- They do not require integration into capital works projects
- Engineering consultants are not required
- Contractors may not be required
- External approvals are not required
- Consultation with the public is limited

Figure 4.4.1: A no-mow zone is a small-scale LID retrofit option. (Source: Aquafor Beech)

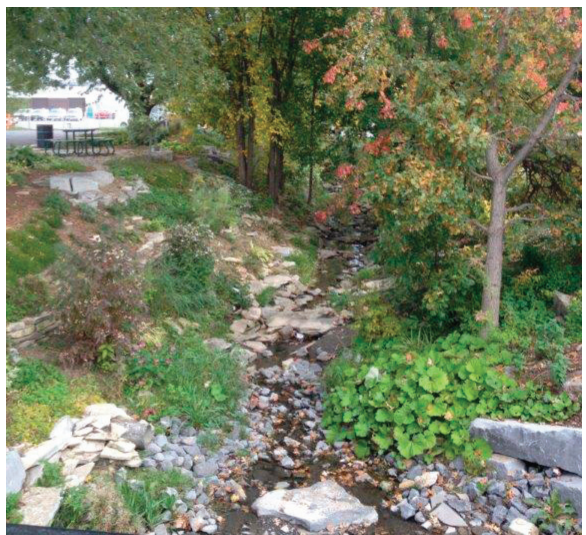


Figure 4.4.2: A buffer of natural vegetation has been established along this drainage channel. This beautifies the site and provides a stormwater filtration function. (Source: Fern Ridge Landscaping)

Figure 4.4.3: Posted in the right location, a sign reminds staff and warns illegal after-hours dumpers that a significant fine can be issued for dumping on your site. (Source: CVC)

Due to this smaller financial commitment, it can be easier to build colleague and supervisor support for small-scale projects.

Pollution prevention (P2) projects are great small-scale projects for municipal facilities like public works yards. To learn more about implementing P2 on your site, refer to the case studies on Armstrong Manufacturing Inc, Bernardi Building Supply Ltd. and Unifay-Fedar Investments in Appendix B.

Many P2 techniques and strategies do not require construction, consultants or contractors. Adding signage to a site is a simple and easy to implement pollution prevention at municipal facilities.

A successful small-scale LID retrofit project on your municipal site is a good indication that you are ready to take on a more intensive retrofit project. You now know the resources that are available and understand the internal municipal processes required to move a LID project from planning to finished product.

Large-scale projects

Large-scale projects require significantly more effort, budget, and staff than small-scale projects. Large-scale LID retrofits include:

- Bioretention
- Enhanced grass swales
- Bioswales
- Perforated pipe systems
- Permeable pavement
- Soakaways
- Infiltration chambers
- Rainwater harvesting (excluding rain barrels)
- Prefabricated modules
- Green roofs

Consider a large-scale project if your municipality or department would like to be a leader in sustainability. Large-scale projects are often highly visible and attract more public attention. Large-scale projects may also be the only solution to site-specific challenges. For example, if site infrastructure is at risk as a result of urban flooding, LID practices that detain large volumes of runoff and encourage infiltration are the most viable LID options.

Before starting a large-scale retrofit project, consider the following distinctions that set these retrofits apart from small-scale projects.

Integration with capital works programs

Most large-scale LID retrofits must function with existing site infrastructure, such as storm sewers, catch basins, and pavement systems. The construction of large-scale LID practices often requires these systems to be removed, exposed, or replaced. The best time for this type of project to occur is when an infrastructure replacement or rehabilitation project is already planned.

When LID retrofits are worked into other construction projects, such as parking lot repaving, or grading or drainage improvements, there can be substantial cost savings.

Whether big or small, every municipality spends relatively large sums of money and substantial time planning for major capital projects. This includes redevelopment of public building and spaces. Many communities who have undertaken retrofits recognize that even if a relatively small portion of the project funds goes towards LID retrofits, they can retrofit large impervious surfaces and avoid new stormwater management infrastructure projects[17].

Municipal facility rehabilitation is typically forecast well in advance of the project. Parking lot paving is typically worked into municipal budgets based on expected life cycle and observed wear. As such, funds may be set aside prior to the project planning phases. Long-term forecast budgets may also be available for site revitalizations or expansions. These budget forecasts provide opportunities to compare the capital and life-cycle costs and benefits of the conventional construction project and LID retrofit.

Involvement of consultants and contractors

Consultants are required for large-scale retrofit projects, specifically for the final screening of options, pre-design, detailed design, tender and contract documents, construction supervision and administration, and assumption and verification. The consultant selection process is described in Chapter 7.

Site contractors are also required for large-scale LID retrofits. Ideally, contractors should be pre-qualified based on previous experience with similar LID projects.

Remember, the contractor with the lowest bid does not necessarily deliver the best product. Refer to Chapter 7 for tips on how to select the right contractor for your project.

More intensive public consultation

Stakeholders must be closely involved in the retrofit process for large-scale LID projects. These projects have longer construction windows, may have significant impacts on long-term public use patterns of the site, and will cost significantly more taxpayer dollars.

Gaining public insight in advance of LID implementation can help address public concerns and information gaps, as well as identify public supporters and champions. Public consultation can help designers tailor the project to address community concerns and values. Consultation can also help the design team integrate the LID practice into the site's landscape.

External approvals

Large-scale retrofits may require a variety of approvals at the municipal, watershed, provincial, and/or federal level.

Since LID is still relatively new, you may encounter policies or bylaws that present barriers to LID retrofit projects. Alternatively, the municipality may have to amend or enforce some policies and bylaws to facilitate the implementation of LID projects on your site.

Next Steps

After reading this chapter you should know how to select the right LID practice for your site. You should also be familiar with the details you need to consider before undertaking an LID retrofit.

Chapters 3, 5 and 6 provide similar guidance aimed at parks, schools and places of worship. Reading these chapters may give you additional ideas for implementing LID on your site.

For further guidance on implementing and constructing LID practices, please refer to Chapters 7-9. These Chapters provide the next steps for you to implement your LID project, including building the project team, creating a design, getting approvals, construction, certification and guidance on operations and maintenance of LID practices.

Figure 4.4.4: At this site, a soil support retrofit is being integrated with the replacement of an adjacent parking lot. Sharing resources to complete two retrofits at the same time can save on costs (Source: Deep Root)

5.0 LID for Schools

Are you a teacher, principal, staff member, or parent interested in leading an LID project? This chapter will help guide you through the initial planning process and provide you with resources you need to get your project off the ground.

A rain garden can become a classroom's source of pride. Consider starting a garden or horticulture club to promote your LID project to the student population.

Since schools typically have an abundance of green space next to hard surfaces (such as parking lots and asphalt play areas), they represent great opportunities for LID retrofits. These retrofits can not only be used to meet broad sustainability initiatives, but also enrich the learning opportunities for students.

By retrofitting your school with LID features, you will give your students a hands-on learning opportunity that can be incorporated into a variety of lesson plans, across disciplines. For instance, LID practices can be incorporated into a discussion on how we develop our cities impacts the natural water cycle.

Other examples include having students monitor the growth of plants within rain gardens for biology or chemistry classes. Students could take advantage of inspection ports on LID practices to monitor how the level of water within the practice varies before and after it rains. They can also help to create artwork for the garden such as sculptures or signs. Students can be a part of the LID maintenance team. Classes can become bioretention "keepers" for weeks or semesters at a time.

An LID retrofit may also address safety concerns and maintenance issues at your school. For instance, areas that are prone to ponding or icing can be addressed through an LID retrofit, eliminating safety hazards on your site. This will also prevent damage to parking lots and walkways. Less frequent repair will reduce your operations and maintenance costs.

Figure 5.0.1: Consider educating the environmental stewards of the future by taking on student volunteers to help maintain and monitor your LID practice. (Source: CVC)

There are many reasons why retrofitting with LID will benefit your school and its students. This chapter is aimed at assisting you identify what type or types of LID features are best suited for your school and how to get started.

5.1 Screening your LID options

In Chapter 2, you identified one or more LID options suitable for your school. Here are a few more things you should consider when narrowing down your options.

What are your limitations?

Several factors can limit the type of LID you are able to construct on your site including available space, your time frame, budget and available resources. Table 5.1.1 helps you identify the amount of resources you will need for each LID option.

As Table 5.1.1 demonstrates, many options are possible, even if you have limited resources. For example you can:

- Establish no-mow zones
- Establish tree clusters
- Install rain barrels on outbuildings
- Define and provide buffers for drainage areas
- Pollution prevention

Large-scale retrofit projects require a complex approach that is best facilitated by experienced engineering consultants. These practices include bioretention, bioswales, enhanced grass swales, perforated pipes, infiltration chambers, most rainwater harvesting systems and prefabricated modules. Large-scale projects should be incorporated into planned construction associated with school redevelopment and site infrastructure rehabilitation/replacement. For more information on the consultant selection process, see Chapter 7.

Table 5.1.1: Resources required for constructing LID

Project scale	LID practice
Large scale and complex LID options. Consulting support from engineers and Landscapers required	• Bioretention • Enhanced swales/ bioswales • Green Roofs
Large scale and complex LID options. Consulting support required from engineers.	• Permeable pavement • Soakaways and infiltration chambers • Pollution prevention* • Rainwater harvesting • Prefabricated modules
Small scale and easy to implement options. Can be completed with in-house resources	• Landscape alternatives • Rain barrels • Pollution Prevention*

*Consultant may be required depending on complexity of project

Address specific site issues through LID

Investigating LID options on your school site may be the result of site-specific issues, such as localized flooding, poor water quality, or a need to reduce operations and maintenance

Figure 5.1.1: Rain barrels are a simple retrofit option for roofs with exterior downspouts.

Case Study: Green Glade Sr. Public School

LID Features:

- ***Bioretention (rain garden)***

Source: CVC

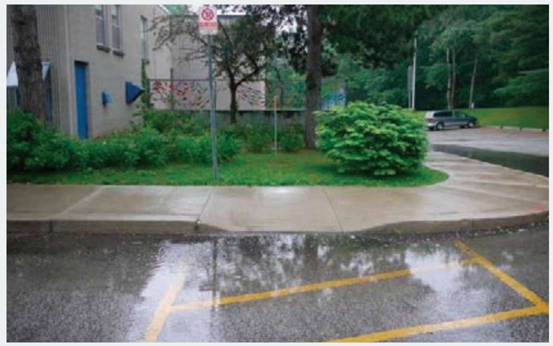
Green Glade Sr. Public School, located in Mississauga, Ontario, has installed a rain garden adjacent to their main entrance. This LID retrofit has helped to green their school grounds while also helping to address nuisance ponding on the site.

How it works:

The rain garden accepts rainfall from the roof as well as runoff from some of the parking lot.

The garden was designed to help reduce nuisance ponding that was taking place at the crossing walk in front of the school.

Before the LID retrofit:



Source: CVC

After the LID retrofit:

Source: CVC

For further information, check out the Green Glade Sr. Public School case study in Appendix B.

costs. It is unlikely that all LID options will effectively address your site issues equally. Consider the options listed in Chapter 2 in relation to your site. Which ones can you eliminate immediately? Which options remain possible?

Is a highly visible integration approach preferred?

There are generally two approaches for integrating LID practices:

Approach 1: Maintain the current look and feel of the school site by integrating LID practices that blend into the existing landscape or are hidden below ground

This approach is best suited for densely developed sites where it is difficult to establish an area dedicated solely to one or more LID features.

One type of LID practice that can be implemented within existing features of the site is infiltration practices. These include soakaways and infiltration chambers as well as perforated pipe. These all occupy very little surface area. Retrofitting existing roadways, parking lots, and pathways with permeable pavement is another practice that does not require land to be set aside within school grounds.

Approach 2: Integrate highly-visible LID practices that may require some additional space, but provide greater promotional and educational opportunities for students and visitors

This approach is preferable for most school sites. Highly visible LID practices will promote school board sustainability objectives. They will also be easier to integrate into student learning than practices that are below ground.

Create a connection with students from the beginning of the project by involving them in the design process and promotion of the LID practice. For example, have students paint rain barrels, or create ornaments for rain gardens.

If a goal of your retrofit project is to promote sustainability initiatives, consider using highly visible practices that incorporate garden-like plantings, such as:

- Enhanced swales
- Bioswales
- Bioretention

LID practices can be designed to attract attention. Examples include covering above-ground rainwater harvesting tanks with promotional material, or providing educational signage.

5.2 Your LID project team

Whether you are planning a large-scale or small-scale LID retrofit project, your team should have at least one champion who promotes the project within the school, to the school board and the community. The project champion can be the principal, teacher, custodian, or can be an individual or group of stakeholders. This project champion will help reduce the barriers and accelerate the process.

Ideally, the project manager of a school retrofit project will be a person with a thorough understanding of the property and on-site activities. Teachers can easily manage small-scale projects that require a small budget and few resources. For larger projects with complex design, approvals, and construction requirements, the project manager should be a school board employee familiar with the necessary tendering and construction procedures.

Figure 5.1.2: Interpretive signs can be a valuable tool in educating and building support among the public. This sign has an interactive cross-section that educates students about the LID practice and provides a QR code and link to a website for more information. (Source: CVC)

During summer months, it may be difficult to maintain LID practices. Considering forming partnerships with youth organizations or summer camp programs to help mobilize new volunteers during these months.

The core project team develops an overall plan and provides key information to assist the project manager with decision making. The project team also helps to identify staff, external organizations and stakeholders who can provide information, advice, or professional expertise. For projects that require external support from consultants and contractors, the core team should be able to help develop the terms of reference, tender, or request for proposal (RFP).They should also review and comment on site design and assist with construction administration and oversight.

The long-term success of your LID retrofit will be dependent on continued support from a number of groups. You project team should have representation from school administration, parent council, school board and maintenance staff. Other possible partners include:

- Local garden clubs or horticultural societies
- Environmental groups
- Local contractors and businesses
- The local conservation authority

Advocacy resources

Ontario has several resources available to schools that want to promote environmental education. Environmental advocacy groups can provide program guidance for teachers and volunteers looking to incorporate LID into the curriculum. Some organizations even offer funds for programs that promote school ground greening projects using LID practices.

Ontario EcoSchools is an education and certification program that promotes environmental literacy and provides resources for schools to reduce their environmental footprint. EcoSchools offers an annual certification process to schools educating kindergarten through grade 12. Adopted by 32 school boards[14] and some 1,200 schools[15] in Ontario since 2002, the program focuses on:

- Teamwork and leadership
- Energy conservation
- Minimization of water use
- School ground greening and curriculum
- Environmental stewardship

For more information about Ontario EcoSchools, visit ontarioecoschools.org

The David Suzuki Foundation is another organization with resources that schools can use to guide environmental learning. Their guide for grades four through six includes lessons and activity-based learning that can be integrated into the classroom.

External funding sources

Grants from private industry can help school boards operating on a tight budget to implement sustainability initiatives like LID. Successful school retrofit programs in Ontario have taken advantage of grants from many sources including local horticultural societies, RBC Blue Water Project, Shell FuellingChange™ Fund, World Wildlife Fund, and TD Friends of the Environment Foundation, among others.

5.3 LID opportunities on school properties

Each distinct area of your site can be a source for runoff (referred to as a 'source area'). These areas should be targeted when introducing LID at your school.

Targeting hard surfaces

Parking areas represent the most significant source of pollutant loading from school sites and contribute significantly to increased runoff rates in comparison to natural conditions. Parking lots of all sizes can be targeted for permeable pavement retrofits. As an added benefit, permeable pavement systems have a longer lifespan compared to conventional asphalt.

High schools often have large parking lots where the capacity outweighs the demand. These areas represent opportunities to install bioswales or bioretention areas in parking lot islands. Standard curbs with small cut-outs (called 'curb cuts') can allow water to easily enter biorentention practices while also preventing damage from cars. Often the existing drainage patterns and catch basin locations can be preserved and integrated into the design. These practices will also function to improve pedestrian safety and calm traffic.
Other types of infiltrating practices like infiltration chambers are gaining acceptance for their easy integration with parking lot functions. These subsurface systems are typically installed over a coarse granular reservoir to provide storage and allow infiltration into native soils. Infiltration chambers under conventional asphalt systems work well on sites where parking demand does not allow space for a stormwater feature.

Grassed areas adjacent the parking lots are ideal areas to implement bioswales or bioretention areas. Perforated pipe systems may also work in areas adjacent to parking lots.

Roof options

Schools typically have large flat roofs that produce a significant amount of runoff that is drained internally via rain leaders. Schools also consume large quantities of water for flushing toilets and urinals. Rainwater harvesting systems can tackle both of these issues by intercepting this rooftop runoff and re-using it for toilet flushing as well as outdoor irrigation. This option has the benefit providing an ongoing financial benefit through reduced water bills.

Figure 5.3.1: At this school property, bioretention is contained within parking lot islands. Note the sidewalks that have been included for pedestrian flow. (Source: CVC)

Figure 5.3.2: This bioretention practice accepts drainage from adjacent hard surfaces and provides stormwater controls. Posts and chains are provided to prevent damage from foot traffic. (Source: CVC)

Figure 5.3.3: Green roof retrofits can be applied to most school roofs. (CVC)

Roof runoff can also be directed to soakaways located on passive use areas around the building. As this runoff comes into contact with fewer hard surfaces, it produces better quality runoff than roads and does not require pretreatment devices.

Green roof retrofits are another retrofit option for schools. When applying for external funding from organizations, highlight the fact that green roofs reduce energy usage by providing insulation during the winter and evaporative cooling during the summer.

Pollution prevention (P2)

On school sites, P2 strategies and practices, such as modifying de-icing programs and isolating drainage from waste storage areas, can be applied to operations and maintenance activities. Discuss these changes with your school board and operations staff.

School board partnerships with municipalities

LID practices located on school grounds can also be used to treat stormwater from external properties. These partnership opportunities give schools the potential to create new revenue. Accepting and treating runoff on your existing property can make funds available through:

- Contributions to capital projects like parking lot rehabilitations which include rain gardens, permeable pavements, or subsurface infiltration facilities
- Ongoing revenues from long-term land leases to accommodate surface or subsurface LID retrofits
- Funds for maintenance of on-site LIDs

Case Study: Elm Drive & Adult Education Centre South

Regulatory Compliance

The objectives, technologies, and standard practices associated with stormwater management are constantly evolving. It is unlikely that the stormwater management practices on your site meet modern industry standards.

When you are making changes to your site, it is important to stay ahead of the regulations. Your school may not be required to improve on-site stormwater management infrastructure, but those retrofits can be beneficial and save money and time over the long term. Consider both current and future water regulations which may affect your property. Consulting with your municipality will help you determine if LID retrofits can reduce taxes or prevent costly upgrades required at a later date.

Table 5.3.1 identifies the LID practices that are common, possible and unlikely options for the source areas that you are likely to find on your retrofit site. These source areas are:

- Active use area
- Passive use area
- Pedestrian walkway
- Internal driveway
- Parking lot

An aerial photo of a school property with each of these source areas accompanies Table 5.3.1. Options and implementation strategies for a few of these source areas will give you some ideas for your site.

LID Features:

- ***Bioretention planters***
- ***Permeable pavers***

The Peel District School Board's Adult Education Centre South school partnered with the City of Mississauga to manage runoff from the adjacent street, Elm Drive, on their property. This partnership benefits the City by giving it space to provide an enhanced level of stormwater treatment, and benefitted the school through the construction of new parking lay-bys for students. The site is maintained by City of Mississauga.

How it works:

Permeable paver lay-bys not only provide spaces for parking, but also allow runoff from the street to enter an underground gravel reservoir, where it absorbs into the surrounding soils.

When the permeable paver reservoir is filled, water flows to a series of six bioretention planters. The plants and special bioretention soil in the planters helps to remove impurities from the stormwater and promote additional infiltration into the ground. Any excess stormwater not absorbed is then released to the municipal storm sewers.

For further information, check out the Elm Drive case study in Appendix B.

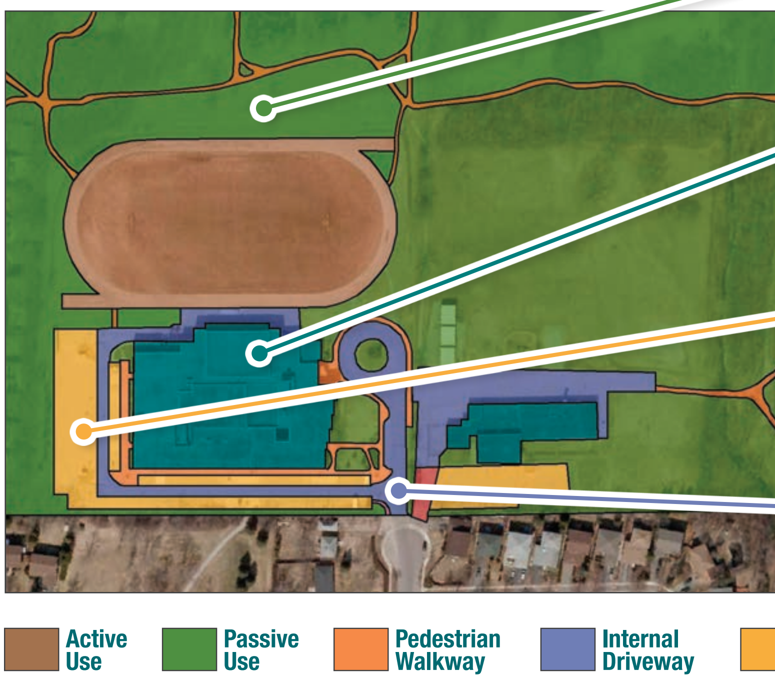
(Source: CVC)

Table 5.3.1 LID options for schools

Source area	Permeable pavement	Bioretention	Enhanced grass swales / bioswales	Green roofs	Soakaways / infiltration chambers	Perforated pipe system	Rainwater harvesting	Landscape alternatives	Prefabricated modules	Pollution prevention
Active use area	●	●	●	○	●	◉	○	◉	○	●
Passive use area	○	●	◉	○	●	●	○	●	●	●
Pedestrian walkway	●	●	●	○	●	◉	○	◉	○	●
Internal driveway	●	●	●	○	●	●	○	○	◉	●
Parking lot	●	●	●	○	●	●	○	○	●	●
Building	◉	◉	◉	●	●	◉	●	○	○	●

● common option ◉ possible option ○ unlikely

Figure 5.3.6: Landforms of a school



When considering installing an LID practice that requires more frequent maintenance routines, do not place them far from the school. Custodial staff can easily forget to perform maintenance activities for bioretention practices far from the building during the critical summer months.

Schools have large roof areas and use lots of water both indoors (for toilet flushing) and outdoors (for landscape irrigation). This makes schools ideal for rainwater harvesting systems. By harvesting rainwater, you will improve stormwater management on your property and save money on your water bill.

High schools commonly have lots reserved for students and those reserved for teachers; with driving patterns varying significantly between the two. Some school parking lots can be used as pick-up or waiting areas for school buses. Consider all uses before a parking lot LID retrofit. Landscaped practices like bioretention may be better for teacher and staff lots, whereas more rugged permeable pavers are better for student lots.

Consider how the site is currently being used by students, staff and teachers before choosing a LID practice. If students (or staff and teachers) use a particular area for an activity, such as smoking, then putting permeable pavers isn't recommended (the cigarette butts can get stuck between the pavers).

You can do this for your site too! Print off an aerial photo and highlight all the source areas. This will give you a starting place when planning your LID retrofit.

5.4 Making it happen: approaches to getting LID retrofits in schools

This guide provides two tiers of LID retrofit projects The scale of your LID retrofit project will largely determine how you will proceed with the retrofit process. You can usually complete small-scale LID projects with in-school expertise and resources. Large-scale projects will require external support from consultants and contractors.

It is often difficult to ask students or teachers to maintain LID practices during the summer break. Include summer operations staff time in your budget during the planning process.

Small-scale projects

Starting with small-scale projects is a good strategy to increase interest within your school, determine what support is available from stakeholder groups (parent council, school board, administration and operations) and gain retrofit experience. Small-scale projects include retrofitting your school property with landscape alternatives or rain barrels, or using pollution prevention strategies and practices.

Small-scale projects require fewer resources and require a smaller project budget because:

- They do not require integration into long-term infrastructure replacement and rehabilitation plans
- Engineering consultants are not required
- Contractors may not be required
- External approvals are not required
- Consultation with the public is limited

Due to the smaller financial commitment, it can be easier to build colleague and school board support for small-scale projects.

Figure 5.4.1: Native plants as an alternative to grass is a simple retrofit strategy. Another simple strategy is disconnecting downspouts and directing it into the garden. (Source: Fern Ridge Landscaping)

A successful small-scale LID retrofit project on your school property can be a good indication that you are ready to take on a more intensive retrofit project. You now know the resources that are available and understand the internal municipal processes required to move a LID project from planning to finished product.

Large-scale projects

Large-scale projects require significantly more effort, budget, and staff than small-scale projects. Large-scale LID retrofits include:

- Bioretention
- Enhanced grass swales
- Bioswales
- Perforated pipe systems
- Permeable pavement
- Soakaways
- Infiltration chambers
- Rainwater harvesting (excluding rain barrels)
- Prefabricated modules
- Green roofs

Consider a large-scale project if your school board is striving to be a leader in sustainability. Large-scale projects are often highly visible and attract more public attention. They may also be the only solution to site-specific challenges. For example, if the parking lot of your site does not have existing stormwater controls, small-scale projects are unlikely to fully achieve compliance with water quality and water quantity objectives. Instead, use a large-scale project like an infiltration chamber or bioswale.

Before starting a large-scale retrofit project, consider the following distinctions that set these retrofits apart from small-scale projects.

Integration with long-term infrastructure replacement and rehabilitation plans

Most large-scale LID retrofits must function with existing site infrastructure, such as storm sewers, catch basins, and pavement systems. The construction of large-scale LID practices often requires these systems to be removed, exposed, or replaced. The best time for this type of project to occur is when an infrastructure replacement or rehabilitation project is already planned.

Like other large public sites, schools typically have maintenance programs that take into consideration the expected life cycle of critical site components, including parking lots and roofs. To save construction costs, incorporate LID retrofits into these projects and share construction material, construction equipment, staff resources, and time.

For example, installing bioretention, infiltration chambers, or permeable pavement in a parking lot will require the existing pavement to be removed. Budget and resources that have been set aside for a parking lot replacement could be transferred to a retrofit project.

Involvement of consultants and contractors

Consultants are required for large-scale retrofit projects, specifically for the final screening of options, pre-design, detailed design, tender and contract documents, construction supervision and administration, and assumption and verification. The consultant selection process is described in Chapter 7.

Site contractors are also required for large-scale LID retrofits. Contractors should be pre-qualified based on previous experience with similar LID projects.

Remember, the contractor with the lowest bid does not necessarily deliver the best product. Refer to Chapter 7 for tips on how to select the right contractor for your project.

More intensive public consultation

Stakeholders must be closely involved in the retrofit process for large-scale LID projects. These projects have longer construction windows, larger costs, and will more significantly affect the use patterns of the property. Large-scale projects are also more complex systems that require continued inspections, operations, and maintenance to achieve continued success. All stakeholder groups must be aware of the long-term project needs before implementation.

External approvals

Large-scale retrofits may require a variety of approvals at the municipal, watershed, provincial, and/or federal level.

Since LID is still relatively new, you may encounter policies or bylaws that present barriers to LID retrofit projects. Conduct a review of relevant municipal and school board policies prior to implementing a large-scale retrofit. School board policies may require amendments to move forward.

Next Steps

After reading this chapter you should know how to select the right LID practice for your site. You should also be familiar with the details you need to consider before undertaking an LID retrofit.

Chapters 3, 4 and 6 provide similar guidance aimed at parks, municipal facilities, and places of worship. Reading these chapters may give you additional ideas for implementing LID on your site.

For further guidance on implementing and constructing LID practices, please refer to Chapters 7-9. These chapters provides the next steps for you to implement your LID project, including building the project team, creating a design, getting approvals, construction, certification and guidance on operations and maintenance of LID practices.

6.0 LID for Places of Worship

Are you a religious leader, maintenance staff, or a member of the congregation interested in leading an LID project? This chapter will help guide you through the initial planning process and provide you with resources you need to get your project off the ground.

Places of worship typically have one large building on their property, along with a large parking lot surrounded by landscaped areas. This site layout provides many opportunities for implementing LID.

Places of worship can draw upon volunteers from the congregation to help maintain LID features once they're in the ground and can even help with installation depending upon the size of the project. Environmental stewardship initiatives including LID retrofits have been extremely successful on these sites. This is largely due to a strong sense of community among members of religious institutions and the pride they have in their places of worship.

Many places of worship have youth programs that can participate in sustainability and environmental education initiatives.

Many religious organizations have programs dedicated to improving the community. LID provides you with the opportunity to not only enhance the community through beautifully landscaped features but also protect the environment at the same time. Religious leaders can use LID as part of environmental stewardship activities, using these features as a focal point for discussion.

6.1 Screening your LID options

In Chapter 2, you identified one or more LID options suitable for your place of worship. Here are a few more things you should consider when narrowing down your options.

What are your limitations?

Several factors can limit the type of LID you are able to construct on your site including available space, your time frame, budget and available resources. Table 3.1.1 helps you identify the amount of resources you will need for each LID option.

Figure 6.1.1: The Unitarian Church in Mississauga installed this bioretention feature as part of a parking lot retrofit. (Source: CVC)

Table 6.1.1: Resources needed for LID

Project scale	LID practice
Large scale and complex LID options. Consulting support from engineers and Landscapers required	• Bioretention • Enhanced swales/ bioswales • Green Roofs
Large scale and complex LID options. Consulting support required from engineers.	• Permeable pavement • Soakaways and infiltration chambers • Rainwater harvesting • Pollution prevention* • Prefabricated modules
Small scale and easy to implement options. Can be completed with in-house resources	• Landscape alternatives • Rain barrels • Pollution prevention*

*Consultant may be required depending on complexity of project

As Table 6.1.1 demonstrates, many options are possible, even if you have limited resources. For example you can:

- Establish no-mow zones
- Establish tree clusters
- Install rain barrels
- Implement P2 techniques and strategies

Large-scale retrofit projects require a complex approach that is best facilitated by experienced engineering consultants. These practices include bioretention, enhanced swales, bioswales, perforated pipes, permeable pavement, soakaways, infiltration chambers, most rainwater harvesting systems, and prefabricated modules. These projects should be incorporated into planned construction associated with site infrastructure rehabilitation/replacement. For more information on the consultant selection process, see Chapter 7.

Addressing specific site issues through LID

Investigating LID options on your property may be the result of site-specific issues, such as localized flooding, poor water quality, or a need to reduce operations and maintenance costs. It is unlikely that all LID options will address your site issues equally. Consider the options listed in Chapter 2 in relation to your site. Which ones can you eliminate immediately? Which options are possible?

For example, if there has been an increase of slips, trips, and falls in your parking lot as a result of poor drainage, ice formation, and degraded asphalt, consider permeable pavement systems. These systems prevent ice formation by ensuring water drains quickly from the parking lot. Pervious concrete and porous asphalt also provide superior traction due to their rough surface texture.

Figure 6.1.2: This photo shows the surface texture of pervious concrete. This surface is slightly rougher than conventional pavement and provides excellent traction. Most pervious concrete products are compliant with provincial accessibility standards. (Source: Aquafor Beech)

Case Study: Unitarian Church of Mississauga

LID Feature:

- ***Bioretention Cell***

The Unitarian Congregation of Mississauga has been proactively developing and implementing a sustainability plan. As part of the plan, the church has constructed a large bioretention cell which filters and absorbs all of the rainwater from the church's parking lot. The church's Greening Initiatives coordinator was able to make this project happen through donations from the congregation, grant funds, and volunteer time.

Taking advantage of the already sandy soils on the site helped to keep project costs low. Bioretention cells typically require a specially engineered soil. However since the soils on site were sandy, compost could be added to create a similar effect. This prevented a costly soil replacement.

The plantings in the bioretention cell have been designed to reflect of the church's values. The garden is an oasis of native plantings that provide food and shelter for birds and insects. The naturalistic design of the garden promotes harmony with nature and the interdependence of life.

For more information, check out the Unitarian Church of Mississauga Case Study in Appendix B.

Is a highly visible LID practice suitable for your site?

There are generally two approaches for integrating LID practices:

Approach 1: Maintain the current look and feel of your place of worship by integrating LID practices that blend into the existing landscape or are hidden below ground

This approach is best suited for densely developed sites where it is difficult to establish an area dedicated solely to one or more LID features.

One type of LID practice that can be implemented within existing features of the site is infiltration practices. These include soakaways and infiltration chambers as well as perforated pipe. These all occupy very little surface area. Retrofitting existing roadways, parking lots, and pathways with permeable pavement is another practice that does not require land to be set aside.

Be sure to consult a landscaper or horticulturalist for information on what plants will work best for your site conditions and desired long-term maintenance schedule. Or check out CVC's Landscape Guide at bealeader.ca

Figure 6.1.3: LID practices that are highly visible become demonstrations of community sustainability initiatives. Here a tour group gathers around a bioretention area at the Portico Church in Mississauga to learn about LID practices.
(Source: CVC)

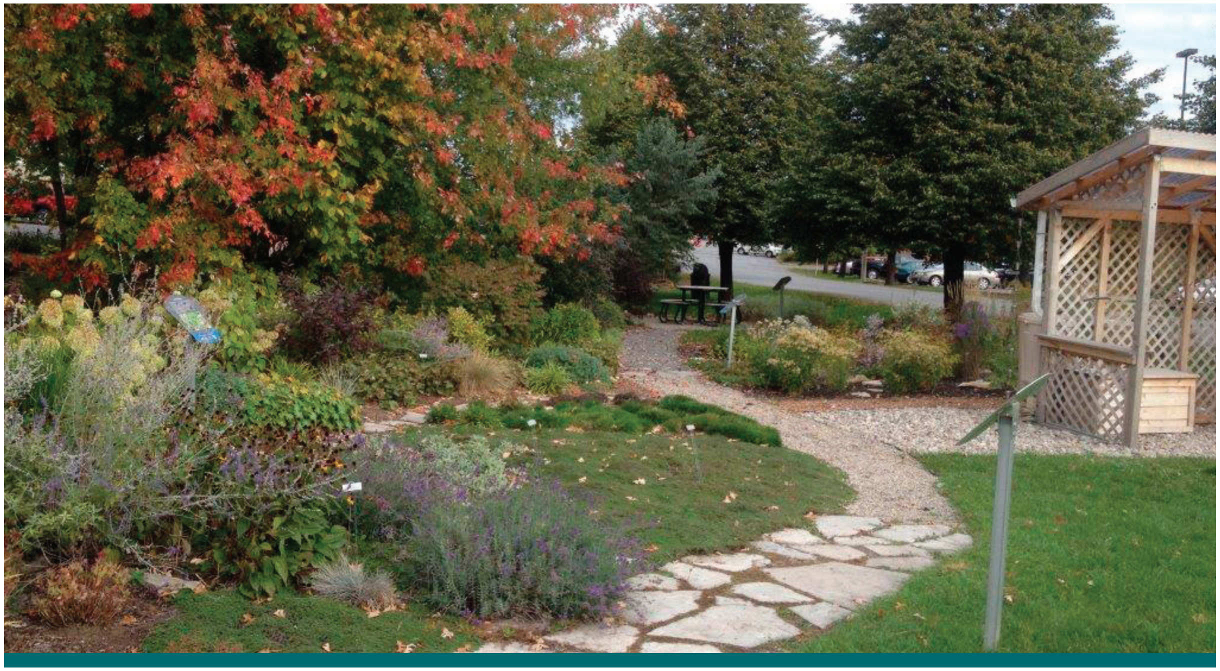


Figure 6.1.4: Consider integrating amenities into your LID practice. At this site public paths and a picnic area were incorporated into this water conservation garden. (Source: Fern Ridge Landscaping)

Approach 2: Integrate highly-visible LID practices that may require some additional space, but provide greater promotional and educational opportunities for members of your congregation and the community

Consider this approach if you will be using LID for education, promoting environmental stewardship among your congregation or beautifying the neighbourhood. If your project goals include any of these consider using highly visible practices that incorporate garden-like plantings, such as:

- Bioretention or bioswales
- Enhanced swales
- Green roofs

Highly visible LID practices, especially those located in busy areas of your site such as building entrances, quickly become points of pride for your community.

6.2 Your LID project team

Whether you are planning a large- or small-scale LID retrofit project, it is essential that your project team have at least one project champion. This person will promote the retrofit within your congregation and to the broader community. The project champion can be the project manager or another member with close ties to the community. This person will help reduce barriers and accelerate the process of LID implementation.

Ideally, the project manager for your retrofit will be someone with a thorough understanding of the property and on-site activities. Small-scale projects that require a small budget and few resources can be managed quite easily by individuals with no formal retrofit experience. Examples of rain barrel installations, landscape alternatives, and many pollution prevention techniques may be available from:

- Your municipality
- Your local conservation authority
- Environmental and/or community groups

For larger projects with complex designs, approvals, and construction requirements, the project manager should be familiar with the internal process for site infrastructure rehabilitations and replacements. This includes internal policies for hiring consultants to work on the retrofit project.

Figure 6.2.1: In this photo, a volunteer from a local conservation authority helps with planting a church's new parking lot bioretention cell. There are many organizations that can help you understand how to maintain an LID feature. (Source: CVC)

The core project team will include individuals from your community that support the project manager. Their role is to develop an overall plan and provide key information to assist the project manager with decision making, recognize knowledge gaps, and identify staff, external organizations, and stakeholders who can provide information, advice, or professional expertise.

Partnership opportunities

While places of worship can have plenty of willing volunteers, they might not have the expertise or training required to implement or conduct routine maintenance of LID features. Finding local resources to help transition from a grey site to a green one is essential to successful implementation. Consider contacting your local conservation authority for volunteer assistance as most will have strong volunteer networks already set up for work on restoration and conservation area improvement projects.

Figure 6.2.2: Faith-based youth groups may be another source of volunteers for your retrofit. (Source: CVC)

Places of worship can also tap into broader faith-based organizations that are able to provide guidance, funding, or staffing resources. Examples of these include the Toronto Faith Coalition and the Canadian Council of Churches. Promoting LID projects through such organizations can also showcase your community on a regional or national scale and potentially attract like-minded people to attend your place of worship on an ongoing basis.

Many funding opportunities exist for not-for profit organizations for programs that promote environmental education, tree plantings, energy conservation, community gardening, habitat restoration and environmental research. These include:

- Community Neighbourhood Development Grants
- United Way
- Ontario Trillium Foundation
- TD Friends of the environment
- Evergreen

Case Study: PORTICO Community Church

LID Features:
- ***Bioretention Cell***
- ***Permeable Pavers***
- ***Enhanced Grass Swale***
- ***No-Mow Zone***

PORTICO Church maximizes their positive impact on the community by minimizing their impact on the environment. The church expanded their Mississauga campus in 2009, adding more than 200 paved parking spaces to serve their growing congregation. To demonstrate their leadership in sustainability, the church added a combination of LID practices to the parking lot as well. These practices slow, filter and absorbs rainwater running off their parking lot before it flows into the adjacent Credit River.

How it works:

The parking lot is split into two drainage basins. One drainage basin directs water to a bioretention cell within a large island.

The curb around the island has openings that allow rainwater from the parking lot to flow into the bioretention cell. The diverse plantings in the bioretention cell provide interesting colours and textures year round, adding to the overall aesthetic of the church property.

The other large drainage basin directs water to a long enhanced grass swale bordered by permeable paver parking spaces. Runoff that does not drain into the permeable pavers enters the enhanced grass swale through openings in the curb. Stone check dams are located throughout the swale to help slow down and filter runoff. Landscaped areas of the campus that are not in active use and adjacent to the natural areas of the Credit River have been allowed to grow naturally in a no-mow zone.

For more information, check out the PORTICO Community Church Case Study in Appendix B.

Greening Sacred Spaces

Faith and the Common Good is an organization that fosters local inter-faith dialogue, education, organizing and action across Canada. One of their programs, Greening Sacred Spaces, assists faith communities with the educational and spiritual dimensions of greening as well as the "how-to" side of audits, retrofits and generally reducing the faith community's footprint. Trying to start a greening program for your faith community can be overwhelming. Greening Sacred Spaces provides you with a 10 step process to get members involved and take them through a site assessment and project retrofits. To support you, Greening Sacred Spaces offers guides, posters, workshops and opportunities to networking with faith community neighbors through local chapters.

For more information about Greening Sacred Spaces, visit greeningsacredspaces.net

Integration with site operations

Due to the strong, year-round volunteer opportunities at places of worship, it is possible that dedicated operations staff will not be required to conduct routine maintenance and operations. However site operations staff must still be brought into the planning process early to ensure other site operations are compatible with LID practices. This includes private contractors hired to conduct winter operations, such as snow ploughing and de-icing.

6.3 LID opportunities at places of worship

Each distinct area of your site can be a source for runoff (referred to as a 'source area'). One or more of these areas should be targeted when introducing LID at your place of worship.

Targeting hard surfaces

Hard surfaces such as parking lots are a great opportunity to implement LID. Parking lots are the main source of runoff and represent the most significant source of stormwater pollutants coming from your site.

Parking lots at places of worship are typically busy only on select days of the week when groups gather for prayer or other community activities. Due to this intermittent schedule, parking lots at these facilities are often rented for other purposes during times of low usage. On sites where peak demand does not approach the total capacity of the lot, consider reducing the parking surface.

Retrofit options for these large parking lot areas include permeable pavement, bioswales, and bioretention areas.

A benefit of permeable pavement systems is that they often have a longer lifespan than conventional infrastructure. The freeze-thaw cycle of the Ontario climate is tough on pavement. Frost heaving and slumping can cause cracks and potholes because of the expansion and contraction of water. The expected lifespan for conventional asphalt pavement in a northern climate, such as Ontario, is approximately 15 years[20]. A well-maintained porous asphalt system can last for over 30 years[21] and permeable interlocking concrete pavers can have a design life of 20 to 25 years or greater[22].

Using LID techniques to manage stormwater can also eliminate or reduce the need for an on-site storm sewer system. By eliminating piping, failure points in the pavement, such as areas around catch basins and manholes, can be eliminated. A design that does not use storm sewers also negates the need to replace on site piping, thereby saving long-term infrastructure replacement costs.

Prefabricated modular infiltration chambers are gaining acceptance because they are easy to integrate with parking lot functions. These subsurface systems are typically installed over a coarse granular reservoir to provide water storage and allow infiltration into native soils. Infiltration chambers under

Figure 6.3.1: When considering any parking lot retrofit, first determine if the parking spaces provided are consistent with the demand. In place of worship, the demand will fluctuate. (Source: CVC)

Figure 6.3.2: Infiltration chambers are often buried below parking lots. This photograph shows how they look before they are covered over during construction. (Source: Aquafor Beech)

conventional asphalt systems work well on sites where parking demand does not allow space for a stormwater feature.

Landscaped areas

Landscaped or lawn areas adjacent to the parking lot or building present opportunities for implementation of LID practices such as bioswales and bioretention areas. These areas typically accept runoff from nearby hard surfaces and provide water quality and water balance benefits.

Roof options

Rainwater harvesting systems can be simple or complex depending on the architecture and roof drainage patterns of your building. Many places of worship have peaked roofs with piping to convey water from the rooftop. If your site is set up this way, it can be easy to integrate harvesting systems into the landscape surrounding your building.

Figure 6.3.3: At PORTICO Church green areas adjacent to the parking lot were targeted for bioretention practices. (Source: CVC)

Roof runoff can also be directed to soakaways located on passive use areas around your building. Due to the relatively good quality of this runoff, pretreatment devices are not required.

Did you know that green roofs can help reduce your heating and cooling costs? *These systems absorb heat and act as insulators for buildings. It has been estimated that a 3,000 m^2 green roof on a one story building in Toronto could reduce the cost of cooling a building in the summer by 6% and the cost of heating a building by 10% in the winter[23].*

Source Areas

The LID option that best fits your site will depend what types of source areas are present. Types of source areas include:

- Active use area
- Passive use area
- Pedestrian walkway
- Internal driveway
- Parking lot

On park sites, pollution prevention is often associated with changes to operations and maintenance practices and has not been included in Table 6.3.1. An aerial photo of a park with each of these source areas accompanies Table 6.3.1. Options and implementation strategies for a few of these source areas will give you some ideas for your park site.

Places of Worship

Table 5.3.1 LID options for places of worship

Source area	Permeable pavement	Bioretention	Enhanced grass swales / bioswales	Green roofs	Soakaways / infiltration chambers	Perforated pipe system	Rainwater harvesting	Landscape alternatives	Prefabricated modules	Pollution prevention
Active use area	●	●	●	○	●	◉	○	◉	○	○
Passive use area	○	●	◉	○	●	●	○	●	●	○
Pedestrian walkway	●	●	●	○	●	◉	○	◉	○	○
Internal driveway	●	●	●	○	●	●	○	○	◉	◉
Parking lot	●	●	●	○	●	●	○	○	●	◉
Building	◉	◉	◉	●	●	◉	●	○	○	◉

● common option ◉ possible option ○ unlikely

Figure 6.3.6: Landforms of a place of worship

Places of worship often have large rooftops with either steep peaked slopes or flat roofs. Peaked sloped roofs have external downspouts, which let you more easily retrofit your place of worship with a rainwater harvesting system. With flat roofs, rainwater harvesting can be more challenging as rainwater is drained internally. An alternative for flat roofs is to consider a green roof (proving the building can support the weight).

Entrance areas are gathering spots for religious communities, especially after services and functions. Establishing LID practices like bioretention planters in these areas will help you to demonstrate your commitment to the environment while also greening your property.

Parking islands are another ideal opportunity for LID retrofits. Cuts can be made into the curbs to allow parking lot runoff to flow into them – helping to water plants, filter pollutants and reduce stormwater runoff from your property.

Church parking lots are large and often underused. Overflow parking areas are ideal for permeable pavement – you can even replace pavement with reinforced grass sod. LID features like enhanced grass swales could also be incorporated along the perimeter of your site.

You can do this for your site too! Print off an aerial photo and highlight all the source areas. This will give you a starting place when planning your LID retrofit.

6.4 Making it happen: Approaches to getting LID retrofits in places of worship

This guide provides two tiers of LID retrofit projects. The scale of your LID retrofit project will largely determine how you will proceed with the retrofit process. You can usually complete small-scale LID projects with in-house expertise and resources. Large-scale projects will require external support from consultants and contractors.

Small-scale projects

Starting with small-scale projects is a good strategy to increase interest within your community, determine if support is available from stakeholder groups and gain retrofit experience. Small-scale projects include retrofitting your property with landscape alternatives, rain barrels or using pollution prevention strategies and practices.

Small-scale projects require few resources and require a small project budget because:

- They do not require integration into capital works projects
- Engineering consultants are not required
- Contractors are not required
- External approvals are not required
- Consultation with the public is limited

Due to the less significant financial commitment, it can be easier to build the case for support for small-scale projects. A successful small-scale LID retrofit project on your property is a good indication that you are ready to take on a more intensive retrofit project. You now know the resources that

Figure 6.4.1: Landscape alternatives include landscaping with low-maintenance native plant species. (Source: CVC)

Large-scale projects

Large-scale projects require significantly more effort, budget, and staff than small-scale projects. Large-scale LID retrofits include:

- Bioretention
- Enhanced grass swales
- Bioswales
- Perforated pipe systems
- Permeable pavement
- Soakaways
- Infiltration chambers
- Rainwater harvesting (excluding rain barrels)
- Prefabricated modules
- Green roofs

Consider a large-scale project if your place of worship is striving to be a community leader in sustainability. Large-scale projects are often highly visible and attract more public attention. Large-scale projects may also be the only solution to site-specific challenges, like poor drainage. Before starting a large-scale retrofit project consider the distinctions that set these retrofits apart from small-scale projects.

Integration with long-term infrastructure replacement and rehabilitation plans

Most large-scale LID retrofits must function with existing site infrastructure, such as storm sewers, catch basins, and pavement systems. The construction of large-scale LID practices often requires these systems to be removed, exposed, or replaced. The best time for this type of project to occur is when an infrastructure replacement or rehabilitation project is already planned.

Maintenance programs and budgets that take into consideration the expected life cycle of critical site components, including parking lot and roofs, are valuable resources for large-scale projects. If the replacement of these features is forecasted in your site budget well in advance, asses if it is advantageous to incorporate LID retrofits into these projects. Remember, sharing construction materials, construction equipment, staff resources, and time will reduce the budget for your retrofit.

For example, installing bioretention, infiltration chambers, or permeable pavement in a parking lot will require the existing pavement to be removed. Budget and resources that have been set aside for a parking lot replacement could be transferred to the LID retrofit project.

Involvement of consultants and contractors

Consultants are required for large-scale retrofit projects, specifically for the final screening of options, pre-design, detailed design, tender and contract documents, construction supervision and administration, and assumption and verification. The consultant selection process is described in Chapter 7.

Site contractors are also required for large-scale LID retrofits. Contractors should be pre-qualified based on previous experience with similar LID projects.

Figure 6.4.2: Small-scale projects may still require significant labour. If planting is required, make sure you have a strong volunteer network to help. (Source: CVC)

Remember, the contractor with the lowest bid does not necessarily deliver the best product. Refer to Chapter 7 for tips on how to select the right contractor for your project.

External approvals

Large-scale retrofits may require a variety of approvals at the municipal, watershed, provincial, and/or federal level.

Since LID is still relatively new, you may encounter policies or bylaws that present barriers to LID retrofit projects. Alternatively, the municipality may have to amend or enforce some policies and bylaws to facilitate the implementation of LID projects on your site.

Next Steps

After reading this chapter you should know how to select the right LID practice for your site. You should also be familiar with the details you need to consider before undertaking an LID retrofit.

Chapters 3, 4 and 5 provide similar guidance aimed at parks, municipal facilities, and schools. Reading these chapters may give you additional ideas for implementing LID on your site.

For further guidance on implementing and constructing LID practices, please refer to Chapters 7-9. These chapters provides the next steps for you to implement your LID project, including building the project team, creating a design, getting approvals, construction, certification and guidance on operations and maintenance of LID practices.

7.0 Implementing LID Retrofits

After reading the previous chapters of this guide, you should be familiar with the LID options available as well as some strategies for narrowing down those options based upon your site characteristics and your needs. This chapter (and the following chapters) goes further by providing more detailed information and guidance on how to implement an LID retrofit on your property.

The implementation process can vary widely based upon the type and size of your LID retrofit. These retrofits can generally be broken down into the following categories:

- Small-scale projects
- Large-scale projects

Small-scale projects are typically much simpler to implement than large-scale projects. Small-scale retrofits do not require significant external resources, and they usually do not require consultants. On the other hand, large-scale projects require more effort, budget and staff resources than the small-scale projects.

Determining when a project is small- or large-scale may not be immediately obvious when considering LID retrofits. Table 7.0.1 provides assistance on identifying the type of project.

Choose your own adventure

The following chapters are intended to help guide you through the process of implementing an LID retrofit. Your organization may have its own internal procedures for things like consulting the public, issuing request for proposals and contract administration. Please feel free to choose the particular type(s) of guidance that best supports you and your organization.

Table 7.0.1: LID options and implementation steps for small- and large-scale retrofits

	Small-scale projects	Large-scale projects
LID options typically associated with scale of project	• Rain garden • Landscape alternatives • Pollution prevention • Rainwater harvesting (rain barrels)	• Bioretention • Enhanced grass swales • Bioswales • Perforated pipe systems • Permeable pavement • Soakaways • Infiltration chambers • Rainwater harvesting (excluding rain barrels) • Prefabricated modules • Green roofs
Goals being achieved through the scale of project	• Site greening • Building project team experience with LID • Address 'low hanging fruit' • Low risk project with little risk of issues/ barriers • Minimize implementation and operations & maintenance costs	• Address site-specific issues by modifying existing and/or adding new stormwater management infrastructure • Significantly improve stormwater quality, reduce site runoff and/or infiltrate water on-site

7.1 Small-scale project implementation steps

If your project fits under the category of a small-scale LID retrofit, it can be implemented using a seven-step process. The level of effort for each step will vary based upon a variety of factors like the type of LID practice being implemented, conditions at the site, volunteer contributions and other factors.

Step 1: Build your project team and establish internal support

As previously discussed in Chapters 3-6, your project team will include staff from your organization that can provide expertise and help in the decision-making process. For small-scale projects, the project team may be limited to a project manager and personnel from your organization. Staff should be familiar with the long-term plans for the site. An understanding of existing operations and maintenance practices is also important. During this step, it is critical to establish strong internal support.

Step 2: Site evaluation and reconnaissance

During the initial phases of a retrofit project, you need to perform reconnaissance on the targeted retrofit area. Site reconnaissance verifies site conditions and helps identify constraints and data gaps.

When implemented properly, LID retrofits should complement existing site function. Conduct reconnaissance during different times of the day to get a better understanding of how different areas of the property are being used.

Some small-scale retrofit projects will require more intensive site reconnaissance than others. For instance, installing a rain barrel is often a simple retrofit that does not require reconnaissance of the entire property. Other retrofits, like no-mow zones may require more extensive mapping of the property.

Figure 7.1.1: When conducting a site evaluation, bring along a map to mark up. It will be useful when you are identifying retrofit areas and screening LID options. (Source: CVC)

Step 3: Screen options and choose preferred LID practice(s)

During the screening process you should consider:

- Project budget and available resources
- Source areas within the site
- Goals and drivers for the retrofit (greening the grounds, addressing site-specific issues, meeting municipal/organizational sustainability targets or other goals/drivers)
- Integration approach (enhance site aesthetic vs. maintain existing landforms)

For further assistance on the screening process refer to Chapters 3-6.

Step 4: Determine long-term maintenance requirements

All LID practices have inspection and maintenance requirements. Before you implement any changes to your site, establish how your staff, site users and/or volunteers can meet these needs. Consult staff operation and maintenance personnel during this step. Their insight about schedules, equipment, and practices is important for smooth integration of LID practices into existing operations. Small-scale retrofit projects cannot be successful without the support of operations and maintenance personnel.

Step 5: Consult with the public/site users

Consultation with the public or site users is often optional for small scale projects. Public consultation is not necessary for projects that are unlikely to affect public use of the site. LID retrofit projects that do not require public consultation include implementing P2 strategies around maintenance facilities and installing rain barrels on buildings. Public consultation is necessary for small-scale practices that will be integrated into public use areas and could change use patterns on the site.

Site users should be included in the consultation process. If facilities are rented by community groups, contact these stakeholders for input. Mailing information to the surrounding neighbourhood can help spread the word about your retrofit project. If possible, direct the public to a website with additional information and feedback opportunities.

An interactive public consultation process will allow site users and community members to ask questions and offer suggestions to improve the retrofit project. Consider hosting a public gathering such as a BBQ, in conjunction with a public information session. This will help attract more people to the session.

Step 6: Construct / establish LID practice

Small-scale LID retrofits typically do not require extensive design activities. These projects often consist of constructing something, or establishing landscaped areas on-site.

The amount of time and effort required during the construction phase will vary based on the type(s) of LID practices, the scale of the retrofit and the number of staff, students and/or volunteers involved. Professional contractors may also be involved depending upon the type of project.

Step 7: Operations and maintenance

Review operations and maintenance requirements and establish a strategy for short and long-term operation. This strategy should include a schedule, procedures, a list of required equipment, and clearly defined responsibilities.

Be sure to involve operations, facilities and other internal staff and/or external contractors currently maintaining the property. Getting their buy-in on maintaining LID practices over the long-term is critical to the success of your retrofit. For more information on operation and maintenance of LID features refer to Chapter 8.

Figure 7.1.2: A rain barrels is a simple retrofit option that does not require extensive effort to implement.

Figure 7.1.3: Some LID retrofit options, like no mow zones will actually reduce your operations and maintenance burden on your property. (Source: CVC)

7.2 Large-scale project implementation steps

Your project team should follow a 10-step process when implementing large-scale LID retrofits. The level of effort for each step depends on the selected option(s).

Technical content ahead!

The following chapters include content that is more technical than previous chapters. If you have trouble following the guidance on these pages, ask for help from an experienced member of your project team.

Step 1: Build your project team and establish internal support

Select an appropriate team from inside your organization. Members of the project team should understand site uses and activities, as well as organizational limitations. Most importantly, they must be key decision makers within the organization (i.e. boards of directors, managers or trustees). Once the project team is assembled, stakeholder consultation can begin.

As discussed in Chapters 3-6, your project team will help in the decision-making process. For large-scale projects, the core project team will consist of the project manager and a broad range of professionals with different fields of expertise and perspectives. Members should possess a comprehensive understanding of stormwater management and site planning, and have a thorough understanding of operations and maintenance activities that occur on your site.

For large-scale projects on municipal properties (parks or municipal facilities) team members may include:

- Parks department
- Operations staff
- Capital works department

Figure 7.2.1: Your project team will help you make decisions during the screening, pre-design, and design processes. A diverse project team will bring lots of ideas and perspectives to the table.

For all public lands sites, including places of worship and schools, the project team can include:

- Facilities management/operations staff
- Engineering staff
- Environmental services and stewardship

Additional team members that you may need in a support role:

- Marketing and communications
- Terrestrial and aquatic sciences
- Fire and emergency services
- Community services
- Municipal councilors
- Regional government
- Conservation authority
- Provincial staff
- Community groups
- Site users

All project stakeholders must be included in the retrofit process. For smaller sites with specific site users, this may be a simple task, but for large sites used for a wide variety of activities, this process requires more effort.

Step 2: Site evaluation and reconnaissance

Your project team must have a comprehensive understanding of the retrofit site. Evaluate all landforms and activities that occur in and around your retrofit site. Print a map and make notes during preliminary reconnaissance. Site visits will help your project team determine the technical feasibility for LID practices as well as identify and confirm any constraints. Conduct preliminary site evaluation and reconnaissance just before your team hires a consultant. A consultant will likely conduct a more in-depth site evaluation and reconnaissance.

Step 3: Screen options and choose preferred LID practice(s)

A consultant with LID project experience will be able to provide you with valuable insight during this step. Your project team and consultant should determine preferred LID alternatives for your site based on the retrofit options presented in Chapter 2. When screening LID options consider:

- Project budget and available resources
- Source areas within the site
- Goals and drivers for the retrofit (greening the grounds, addressing site-specific issues, meeting municipal/organizational sustainability targets or other goals)
- Integration approach (enhance site aesthetic vs. maintain existing landforms)

For further assistance on the screening process refer to Chapters 3-6.

Step 4: Pre-design

The pre-design phase includes collecting field measurements to build upon information gathered during field reconnaissance and background document review. An experienced engineering consultant should conduct this step.

Step 5: Detailed design

During the detailed design phase of your retrofit, your consultant will:

- Review design guidelines and requirements
- Develop catchment areas
- Conduct hydrologic and hydraulic assessments
- Produce detailed design drawings
- Determine construction sequencing and phasing
- Produce a design brief

Step 6: Approvals

During this phase of your project, your consultant and project team will review municipal, government and agency policies and local by-laws. This review will allow the team to identify the proper application processes for obtaining approvals.

Step 7: Tender and contract documents

During this phase of your project, your consultant will review the detailed design and develop detailed cost estimates, a schedule of items, and contractual documents. By the end of this step you should have a complete tender package for submission.

Step 8: Construction supervision and administration

LID projects are relatively new to Ontario and few contractors have experience with LID projects. Inexperienced contractors can significantly impact the look and function of your LID practice. During construction of your large-scale LID practices, retain a consultant with retrofit experience to perform

Figure 7.2.2: Do not underestimate the value of conducting a proper certification process. Certification is a critical step that ensures the LID practice was constructed properly and performing as intended. (Source: CVC)

construction supervision and administration. Your consultant will supervise contractor work and provide guidance as necessary.

Step 9: Certification and commissioning

This step is a hand off moment between the contractor and the property owner. During the commissioning or assumption step, your consultant and project team are reviewing the constructed work for accuracy and consistency with the design. This ensures that any errors or issues are addressed before the contractor and consultant are released from the contract.

For practices without vegetation, the certification and commissioning would happen right after construction. For projects with vegetation, this phase may last throughout the landscape warranty period. During this step, your consultant or inspector will provide a list of deficiencies to be rectified prior to final approval of the work.

An illustrated inspection guide for bioretention and additional information on certification can be found in the Certification of Bioretention Practices Guide at bealeader.ca

Step 10: Operations and Maintenance

After reviewing operations and maintenance requirements, establish a strategy for short and long-term operation. This strategy should include a schedule, procedures, a list of required equipment, and clearly defined responsibilities.

7.3 Approvals

Before constructing your LID project, you need to acquire approvals. The necessary approvals will depend on the municipality, watershed and the land use.

Pre-consultation with municipal approvals departments and approvals agencies can help avoid redesign and keep implementation costs low.

Municipal approvals

Typically municipal approvals for LID retrofits on any land use will be limited to permits under the following generic by-laws:

Erosion and sediment control by-laws

A permit is generally required to undertake any land disturbing activities of a minimum size or greater (typically ½ to 1 hectare), or on sites of any size that are adjacent to a body of water. Retrofit activities below the minimum area requirement may not require a permit.

Plumbing, connection or water and wastewater by-laws

A permit and associated fee are typically required to establish a new connection to the municipal systems, including the storm sewer network. If the existing storm sewer connection will be maintained as the primary discharge point (i.e. no new connections are required) and the new discharge pipes do not cross property lines, a permit may not be required.

Area-specific requirements and by-laws

There are specific requirements for individual areas of a municipality relating to rooftop controls, parking lot storage, inlet controls or maximum discharge. These bylaws are generally associated with zoning requirements or previously completed studies. Such by-laws are typically enforced through the plumbing, connection or water and wastewater by-laws.

In all cases, contact your local municipality to determine the requirements. You will be asked to provide municipal staff with the site location (municipal address), area of disturbance (m^2), proposed type(s) of LID practices, and the ultimate discharge point. This information will help municipal staff determine if permits are required.

Conservation authority (CA) approvals

Conservation authorities are governmental agencies that regulate and manage lands associated with natural hazards and natural heritage features. In general, conservation authority permits will not be required for most public lands LID retrofits. The exceptions may include lands that are within the Regulated Area per the Ontario Conservation Authorities Act. Projects requiring a municipal site plan review may also need to be reviewed by the local conservation authority. Contact your local conservation authority to determine if these approvals will apply to your retrofit project.

Ontario Ministry of the Environment (MOE)

The Environmental Approvals branch of the MOE is responsible for issuing Environmental Compliance Approvals (ECAs) under the *Ontario Water Resources Act (OWRA).* The OWRA regulates sewage disposal and "sewage works" and prohibits the discharge of polluting materials that may impair water quality. The OWRA requires that all sewage discharges (including stormwater) be approved by means of an ECA, unless exempted by the OWRA or another regulation.

If your site already has an Environmental Compliance Approval (formerly known as a Certificate of Approval) an amendment is likely required for any alterations and or upgrades to the existing conditions of your approval.

Not sure whether you need an ECA or not?

Schedule a pre-consultation meeting with the Ministry of the Environment and other appropriate parties to clarify whether your site requires an ECA or is exempt under the Water Resources Act.

The Ministry of the Environment Environmental Approvals Branch provides ECA pre-consultation for all projects to clarify exemptions and or approval requirements.

Questions related to ECAs should be directed to the Environmental Approvals Branch:

2 St. Clair Avenue West, Floor 12A
Toronto ON M4V 1L5
Phone: 416-314-8001
Toll free: 1-800-461-6290
Fax: 416-314-8452
E-mail: EAASIBgen@ontario.ca

7.4 Construction phase considerations

The construction phase is critical to implementing a successful LID project. Progress is rapid and the budget is spent quickly during construction. Unforeseen circumstances can require on-the-spot decisions.

Selecting a consultant and contractor

An engineering consultant that is experienced in LID design and construction can provide great value to a project team and make all phases of the project more successful. Consultants that specialize in stormwater design can be found in all areas of the province, but experience with LID design is not as common. While there are many technical skills that are shared between conventional stormwater design and LID, the consultant should be familiar with some key components of LID designs:

Table 7.4.1: LID options and implementation steps for small- and large-scale retrofits

Discipline	Pre-qualification options
Consultants	• Minimum of two public lands LID retrofit projects successfully completed • Completion of Permeable Interlocking Concrete Pavement (PICP) training (for projects involving permeable block pavers) • Completion of Canadian Standards Association – Sustainable Stormwater Practices Training • Membership with Consulting Engineers of Ontario • Membership with Landscape Ontario (for vegetated projects) • Certification as an Inspector of Erosion and Sediment Control (CISEC) • Leadership in Engineering and Environmental Design (LEED) credentials • Completion of Credit Valley Conservation LID Construction Course
Contractors	• Minimum of one LID project successfully completed • Completion of Interlocking Concrete Pavement Institute (ICPI) training (for projects involving permeable block pavers) • Membership with Landscape Ontario (for vegetated projects) • Certification as an Inspector of Erosion and Sediment Control (CISEC) • Completion of Canadian Standards Association – Sustainable Stormwater Practices Training • Completion of Credit Valley Conservation LID Construction Course

- The methods for matching pre-development and post-development site water balances
- The dependence of many LID techniques on suitable native infiltration rates
- The importance of appropriate erosion and sediment control during construction on the long-term functionality of LID design
- The considerations for LID operations and maintenance
- The integration with existing site programs

Table 7.4.1 highlights important project team member disciplines in relation to the LID options.

When choosing a consultant, you can use a request for proposal (RFP) process. RFPs are especially important for projects that include multiple sites (i.e. multiple properties operated by the same organization) or will span more than one construction season. If using the RFP process, consider modifying the proposal scoring system to apply more weight to related project experience than cost. Remember: The most inexpensive proposal does not always reflect the best consultant choice for your LID retrofit project.

When determining which consultants and contractors are right for your project, look at what experience they have with LID implementation, especially with similar public lands sites. The project manager(s) may consider pre-qualifying consultants and contractors based on experience and training. Examples of pre-qualification requirements are in table 7.4.2.

Construction supervisor and administration

A professional with LID construction experience should lead the project team during the construction phase of an LID retrofit project. For most public lands retrofits, this person will be a consultant involved in the design process.

During the construction phase of a public lands retrofit project the construction supervisor and administrator will be responsible for:

- Scheduling and overseeing construction meetings
- Preparing progress reports
- Reporting on and providing recommendations on unforeseen project conditions
- Providing direction and answering contractor questions
- Coordinating with municipal staff and external agencies
- Enforcing erosion and sediment control plan
- Undertaking site inspections and providing feedback as necessary
- Preparing progress payment certificates
- Recording quantities as they enter and leave site
- Preparing a list of outstanding deficiencies at the end of the warranty period and ensuring these are corrected

Table 7.4.2: Suggested consultant expertise for LID practices

LID practice	Water resources engineering	Structural engineering	Geotechnical engineering	Landscape design
Permeable pavement	✓		✓	
Bioretention / bioswales	✓		✓	✓
Soakaways / infiltration chambers	✓		✓	
Perforated pipe systems	✓		✓	
Rainwater harvesting	✓	✓		
Landscape alternatives	✓		✓	✓
Prefabricated modules	✓			
Green roofs	✓	✓		

Public interaction during construction

Scheduling construction for a period when there is low public interaction with the site is ideal but not always feasible for public areas. Give advance notice so people can plan to avoid the area. Consider posting signs in the area during the weeks leading up to the planned construction. These notices should indicate off-limits areas and the length of time they will be inaccessible. It is also wise to include the project goals and contact information.

If you're responsible for construction supervision activities during LID construction projects, engage the public and approach local residents and onlookers as much as possible, especially during demonstration projects. An open approach encourages support for LID techniques, and it can make things easier if you run into a construction issue that affects stakeholders.

Rectifying contractor mistakes

Even the best contractors make mistakes. Construction projects often occur within tight timelines and have limited budgets. It is easy to miss a few details, but the success of LID practices can depend on those details. For that reason, the construction supervisor must quickly recognize and rectify mistakes. It is critical to evaluate the on-site work. Supervisors should conduct frequent walk-arounds to verify and documenting critical elements, such as grades, invert elevations, pipe slopes, and installation procedures.

Product quality assurance and control

Construction supervisors should document the delivery of materials and products to the site and, as necessary, conduct quality assurance assessments to ensure that all items meet specifications.

To ensure correct materials and products are delivered to the site, request and review product and material specifications, weight tickets, product labels, purchase orders, release forms, and material specification test results. In addition, verify with visual inspections and document with photographs. If materials do not meet specifications, it is important to flag those materials. Do not install them.

Many LID design components, especially those reliant on filtration and infiltration, are sensitive to sediment contamination. Supervisors should monitor erosion and sedimentation control measures continuously, ensure proper installations are achieved, and request dust control and general site clean-up as necessary. An erosion and sedimentation control plan must be dynamic and adapt as project progress and conditions necessitate action.

Test bioretention soil media!
Soil media analysis results must meet the desired specifications prior to installation. Media is easily contaminated by exposure to dust and sediment, so install approved media immediately after sources of sediment, such as exposed aggregate for road bases and soil stockpiles, are eliminated and erosion and sedimentation control measures are installed.

Erosion and sedimentation control

During construction:

- Cover catch basins with geotextile fabric
- Examine the drainage area for bare soil Stabilize these areas immediately. Silt fence or other measures may be needed until the area is re-seeded.
- Install internal components once the site has stabilized. Housings should be clean prior to installation of internal components to prevent premature clogging.

Figure 7.4.1: At Green Glade Sr. Public School, the bioretention soil media originally supplied did not meet the specifications. Due to an improper mixing process, the content of fines was too high. To rectify the problem, the soil was removed and replaced with the specified bioretention soil media. (Source: CVC)

7.5 Project certification

Project certification is a critical but often overlooked phase of an LID retrofit project. Project certification verifies that the LID practice has been designed per site drawings provided before the contractor is released of responsibility. It is the last opportunity to identify and resolve issues as a result of improper construction and/or unforeseen site condition before the long-term site owner takes over maintenance and operations of the practice.

For more information on certification of LID practices, refer to the Certification for Infiltration and Filtration Practices guide at

bealeader.ca

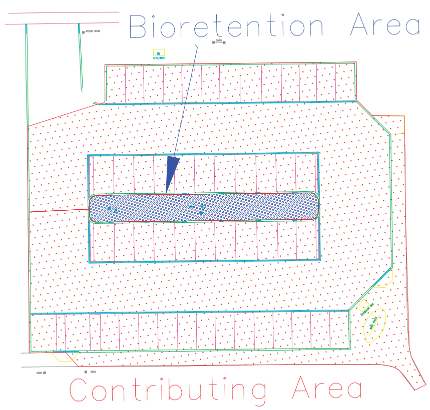


Figure 7.5.1: A post-construction survey provides an accurate measure of the drainage area and size of the practice to compare to the design plans. The survey can also show if there is any problem with stormwater flows bypassing the practice. (Source: CVC)

Levels of project certification

Depending on the complexity of the LID practice and the capabilities of the LID project team, different levels of project certification protocols can be used to verify the project. There are five levels of certification, with one being the least intensive and four being the most intensive.

Level 1: Visual inspection

Visual inspection requires minimal effort and is cost-effective, but does not provide quantitative data on performance of an LID practice. Team members walk around the facility with design plans making observations with a checklist. Complete a visual inspection after a significant rainfall event to confirm water is not ponding for more than 24 hours.

Figure 7.5.2: The water level logger has been pulled out of the bioretention cell observation well. The water level data from the logger is being downloaded directly to a laptop before being put back in the well. (source: CVC)

Level 2: Capacity testing

Capacity testing will confirm that a bioretention practice meets minimum design parameters with respect to drawdown time. In addition to the visual inspection, other checks may include a post-construction survey, soil testing and infiltration testing. These tests provide a higher level of confidence that the practice has the size and soils specified by the engineer.

Level 3: Continuous water level monitoring

Continuous water level monitoring requires loggers to measure both surface and subsurface depths over the course of a monitoring period (at least one year). Water level loggers are simple to use data collection devices that are installed in the practices observation well and can be left for months at a time. The water level data provides a picture of how long the practice takes to drain under different weather conditions and rain events. This level of project certification should accommodate hardware, staffing, and budget considerations from the onset of the project. A precipitation gauge should accompany water level loggers to establish the relationship between rainfall depths and drawdown times.

Level 4: High-intensity monitoring

This level of testing involves flow monitoring and water quality sampling at outlets. This type of monitoring is expensive and requires monitoring experts to do properly. This advanced level of monitoring may be appropriate in situations where a new technology is being tested or a technology is being used in a new climate or land use.

The level of certification you choose will depend on the type of project you have. A landscaping alternative or simple rain garden would only require a visual inspection, while a bioretention cell taking runoff from a large parking lot may call for additional data collection like a post-construction survey and water level monitoring.

To learn more about inspections, refer to the Certification of Bioretention Practices Guide at:

bealeader.ca

8.0 Lifecycle Activities

The continued success of your new LID feature(s) is dependent on conducting appropriate operation and maintenance (O&M) activities throughout their lifecycle. This chapter provides an overview of the O&M activities to consider when implementing LID practices. These O&M activities are provided for the following practices:

- Bioretention and bioswales
- Perforated pipes
- Permeable pavement
- Prefabricated modules
- Rainwater harvesting

Technical content ahead!

The following chapter includes content that is more technical than previous chapters. If you have trouble following the guidance on these pages, ask for help from an experienced member of your project team.

Designing for easy maintenance

It's easier to integrate an LID practice into an existing maintenance program if the maintenance activities and frequencies are similar to those of the existing site features. For example, installing bioretention practices on a site with existing flower beds that are already receiving weeding, pruning, and mulching will require little additional effort from operations staff. Adding the same practice to a site that is primarily lawn areas will require new tools, training, and an additional maintenance schedule.

Not all bioretention practices require the same maintenance effort. Instead of flowers, bioretention practices can be designed with either native grasses or turf. These will require less maintenance than bioretention features with plants. When you do want to have plants to add aesthetic value to your property, consider using a simple landscape and a modest number of plant varieties.

Figure 8.0.1: At this park, plant varieties were limited to Black-eyed Susan and Foxtail Grass. Maintenance activities at this facility are straightforward as a result of this simple planting plan. (Source: CVC).

When designing LID practices, consider the ease of access to areas that require frequent inspections or maintenance. Inspection ports, manholes, monitoring wells, forebay areas, and pre-treatment devices should be easily accessible to people and/or equipment during all times and site conditions. If year-round access is required, ensure winter conditions do not cause regular obstructions. During annual inspections of the LID practice, be sure to assess site access.

8.1 Bioretention and bioswales

Bioretention and bioswales share common routine maintenance requirements, including:

- Inspections
- Watering
- Removal of litter and debris
- Sediment removal
- Weeding and pruning

Bioretention and bioswales generally require maintenance of the vegetative cover. It may take two or three growing seasons for vegetation to reach the desired level. As such, contract documents often specify that the contractor is responsible for undertaking a minimum of two years of maintenance. This ensures that the contractor is responsible for the health of the plant material before, during, and after installation. As a condition of the contract documents, the contractor should replace dead vegetation on a periodic basis and not just at the end of the warranty period.

Inspections

Inspections confirm the LID practice is functioning and identify maintenance or rehabilitation issues. Conduct regular inspections to schedule routine maintenance operations, such as sediment removal, spot re-vegetation, and inlet stabilization. For the first six months following construction, inspect the site after each storm event greater than 10 mm, or a minimum of two visits. If staffing and budget allow, consider scheduling two inspections per year, one of which should occur after snow is melted and ground has thawed. At minimum, conduct annual inspections in the spring of each year. Inspections should also occur after all rainfall events in excess of 60 mm.

During inspections look for inconsistencies in vegetation density, evidence of foot or vehicular traffic through the practice, channelization, erosion, debris accumulation, sedimentation, and structural damage to concrete curbing and condition of pretreatment device.

If soil is contaminated due to a spill, soil media testing may be required. Testing will verify whether soil specifications have been compromised and to what extent the bioretention facility or bioswale will need to be rehabilitated.

Figure 8.1.1: Closely inspect any pre-treatment areas for excessive sediment accumulation from exposed soil during construction. In this photo a riprap spillway between the forebay and bioretention facility has been subject to clay deposition from upstream construction. (Source: Aquafor Beech)

Watering

Plant irrigation is necessary for the first two years or until plants are established. Watering requirements may differ with selected plants but is typically required on a weekly basis during this period. The season between May and August is a critical period for the survival of your plants. During this hot dry season, increase watering to twice a week. During overly wet periods, modify your watering schedule accordingly.

Removal of litter and debris

Trash and debris is often readily conveyed to LID practices, where it accumulates over time. Trash and large debris tends to collect around pre-treatment devices and at the inlets of LID practices. Trash may also become stuck in outlet areas affecting the function of an LID practice. Removal of trash and debris should occur at least twice a year but will depend on accumulation rates.

At high-profile demonstration sites, consider increasing the frequency of trash and debris removal to maintain the desired aesthetic value.

Sediment removal

Pre-treatment devices are designed to provide a buffer area where sedimentation occurs before it can reach the vegetated area of the bioretention or bioswale practice. These areas must be cleaned out before they lose their functionality. Sediment removal techniques will differ by pre-treatment practices but may involve hand tools, vacuum truck or combination of high-pressure washing and vacuum trucks. The frequency of sediment removal will also vary depending on pre-treatment practice and catchment conditions. Monitor sediment accumulation on an annual basis and conduct cleanouts as needed.

Weeding and pruning

To maintain compliance with municipal by-laws regarding nuisance weeds and plant growth, weeding and pruning will be required. Pruning is typically required only once per year, while weeding may be more frequent dependent on local conditions. The time and attention to pruning will depend on the design and aesthetic standard. Designs that are naturalistic or fit in a rural setting will require less frequent pruning if any.

Figure 8.1.2: This bioswale is located in a park surrounded by industrial lands where invasive plants are common. Additional effort will be required to keep the invasives in the bioswale under control. (Source: CVC)

Additional first-year maintenance

Bioretention and bioswale practices are most prone to failure during the first year. During the first year additional maintenance practices will be required, and they typically include:

- Adding reinforcement planting to maintain desired vegetation density. The construction contract should include a care and replacement warranty to ensure vegetation is properly established and survives during the first growing season following construction.
- Removing sand that may accumulate on the filter bed surface following snow melt and replacing vegetation that is impacted.
- Checking inlets, outlets and/or overflow points for clogging and remove any sediment.
- Inspecting grass filter strips for erosion or gullies and reseeding as necessary.
- Examining the drainage area for bare soil. These areas should be stabilized immediately. Silt fence or other measures may be needed until the area is reseeded.
- Identifying plant material stressed due to salt contamination following the spring melt period and replacing dead vegetation as necessary. (Note: Reduce salt loadings from de-icing practices if possible.)
- Inspecting overflows to ensure that snow blockages are prevented.

Some adjustments to your schedule may be necessary as flow patterns are established within the practice. For example, river stone might be needed to help spread flow or stabilize an area where flow concentrates.

Be sure to revisit your annual inspection and maintenance schedule every year to incorporate the experience and lessons learned gained by your O&M team.

Figure 8.1.2: At this site, coring indicates a layer of impermeable clay has clogged this bioretention unit. Major rehabilitation including replacement of the bioretention soil media will be required for proper filtration and infiltration. (Source: Aquafor Beech)

Rehabilitation

Rehabilitation and repair activities are often triggered when a practice stops draining and water is ponding for too long. This can be identified through regular inspections or it can come from public complaints. Often these drainage problems can be addressed without a full-scale replacement. Some activities to perform during rehabilitation include:

- Check underdrains and overflow structures for clogging. Cleanouts can be used to snake or flush clogs from underdrains.
- Remove accumulated leaves and add fresh mulch.
- Core aeration, deep tilling, or replacement of the top 10 cm of soil can be performed to address any surface clogging.

8.2 Perforated pipes

With appropriate pre-treatment, perforated pipe systems do not require maintenance beyond that of a conventional storm sewer. Routine maintenance activities include:

- Vacuum debris and litter from catch basins
- Replace damaged or missing grates
- Ensure drainage areas are stabilized and not generating excessive sediment

Perforated pipes have been installed to high levels of success in several Ontario communities. Conveyance systems consisting of grassed swales and underlying perforated pipes were installed in Ottawa during the 1980s and 1990s. After more than 20 years of performance, these systems continue to operate successfully and still provide their intended water quality and water balance benefits[24].

Figure 8.2.1: Video inspection (pipe scoping) is a rapid means of identifying any issues with buried pipe. Look for any indications of pipe collapse, blockages, or sediment build-up. This photograph from an Ottawa perforated pipe shows it to be in excellent condition even after more than 20 years of performance. (Source: City of Ottawa)

More extensive inspection and maintenance efforts occur following public complaints regarding drainage. Subsequent inspection efforts generally involve scoping pipes to locate obstructions and debris. Observation ports extending from the surface to perforated pipes or stone galleries should be inspected, if available.

If a problem is identified, you can remove or dislodge obstructions using vacuums or high-pressure water sprayers.

Rehabilitation

If inspections identify broken pipes, defects, or other pipe structure problems, full repairs may be necessary. Damaged perforated pipe sections should be removed and replaced with new pipe sections. Major repairs are rare and often a result of poor construction and/or inspection practices during the construction process. Thorough inspections during the construction process should prevent the need for major repairs.

8.3 Permeable pavement

All types of permeable pavement (permeable interlocking concrete pavers, pervious concrete and porous asphalt) can become clogged with sediment over time, slowing their infiltration rate and decreasing storage capacity. The primary goal of maintenance activities on permeable pavement is to prevent clogging.

Permeable pavement typically has initial infiltration rates of hundreds of millimeters per hour. Long-term infiltration capacity remains high even with clogging. When clogged, surface infiltration rates usually well exceed 25 millimeters per hour, which is sufficient in most circumstances for the surface to manage intense stormwater events. Table 8.3.1 identifies warning signs of common permeable pavement maintenance issues and actions to restore proper functions.

Table 8.3.1: Identifying permeable pavement maintenance issues

Issues	Identification and action
Ponding	• Surface should drain immediately. Verify with infiltration testing or observation after rainfall • Rule of thumb: if more than a nickel deep one minute after a rainfall event, maintenance is necessary • Remove debris and clogging from surface
Surface crusting	• Occurs when sediment accumulates • Remove debris immediately • Increase cleaning frequency of problem areas
Weeds	• Weeds will not germinate without soil and moisture • Removed weeds immediately • Clean out jointing material
Sediment covered joint material	• Identify problem and correct • Clean sediment from joint material
Chips or cracking	• Remove and replace affected paving stones • Saw cut porous asphalt or concrete and replace

Along with maintenance issues identified during inspections, the following items should be carried out for permeable interlocking concrete pavers to ensure the pavement system continues to function:

- Remove debris from pavers following landscape activities with hand blower or mechanical sweeper (as needed)
- Collect debris, dirt, topsoil or mulch which has accumulated within the paver joints and replenish joint aggregate material (as needed)
- Sweep entire paver surface with rotary brush or mechanical sweeper and replenish joint aggregate material (annually)
- Inspect for potholes, cracked or damaged pavers and remove and replace as necessary (following spring thaw)

Additional preventative activities that will ensure the longevity of all permeable pavements include:

Inlet structures: Drainage pipes and structures within or draining to the subsurface bedding beneath porous pavement should be cleaned out on regular intervals.

Heavy vehicles: Trucks and other heavy vehicles can compact dirt into the porous surface and lead to clogging. These vehicles should be prevented from tracking or spilling dirt onto the pavement. Signage and training of facilities personnel is suggested.

Drainage areas: Contributing paved areas should be swept to reduce the sediment washing onto the permeable pavement. Designs should avoid or limit the landscaped area that drains to the pavement. For landscaped areas that do, bare areas should be seeded. Mowing is recommended to keep grass from going to seed and spreading on the pavement. Grass clipping and leaves should not be piled in permeable pavement areas.

De-icers: Non-toxic organic de-icers are preferable and can be applied either as blended magnesium chloride-based liquid products, or as pre-treated salt. In any case, all de-icers should be used in moderation. Subsequent applications of de-icer are not necessary. Permeable pavements remain well draining through winter, therefore refreezing and black ice conditions do not occur.

Snow plowing: Snow plowing should be done carefully on permeable pavement surfaces by reducing plowing speeds. Operators should be aware of permeable pavement locations and adjust operations as required. Abrasive sands should not be applied on or adjacent to the pavement surfaces.

Table 8.3.2 lists some of the preventative and restorative maintenance techniques and equipment for roads and parking lots. A preventative maintenance approach removes debris before it becomes trapped within the paving surface. The restorative approach requires more extensive debris removal techniques as debris has become lodged in pores and joints of the permeable surface.

Table 8.3.2: Maintenance equipment for permeable pavers

	Technique	Effect
Preventative	Rotary brush	• Removes debris from joints of permeable concrete pavers and surface of porous asphalt and concrete. • Will require slight refilling of permeable concrete paver joint material • May force sediment into pores of porous asphalt and concrete causing clogging
	Broom sweepers	• Typical Street Sweeper Type • Do not use water to clean surface • Best for seasonal cleaning such as fall for leaf litter
	Regenerative air sweepers	• Light duty suction cleaning. • Conducive for all types of permeable pavement
Restorative	Riding litter vacuum	• Can be used as a preventative technique • Will evacuate most debris from joint except for aggregate material.
	Vacuum sweeper	• Complete evacuation of joint aggregate material • Replenish removed joint aggregate material • Conducive for all types of permeable pavement
	Pressure washer	• Complete evacuation of joint aggregate material • Replenish removed joint aggregate material • Conducive for all types of permeable pavement

Rehabilitation

Potholes in permeable pavement are unlikely, though settling might occur if a soft spot in the subgrade is not removed during construction. This section provides some general criteria for repairing potholes and broken interlocking concrete pavers.

- For damaged areas of less than 5 square metres, it can be acceptable to patch using standard pavement, as the loss of porosity in that area is insignificant. The area can also be filled with pervious pavement mix.
- If an area greater than 5 square metres must be patched, use a permeable pavement similar to the surrounding material. The paver should be approved by a qualified engineer.
- Under no circumstance should the pavement surface ever be seal coated.
- Individual interlocking concrete pavers which are broken or cracked should be removed manually by hand and replace with new pavers of identical design. Pavers are tightly packed and it may be necessary to break and replace adjacent pavers to make the repair.
- For permeable interlocking concrete pavers that no longer allow for infiltration due to significant joint clogging, remove aggregate joint material with vacuum sweeper and pressure washer, then replenish joint aggregate material as specified by paver manufacturer.

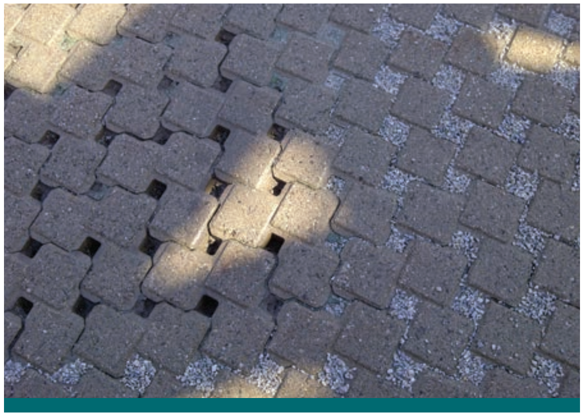


Figure 8.3.1: In this photo the aggregate has been removed from permeable interlocking concrete pavers. This will need to be replenished immediately to avoid clogging of the joints. (Source: Aquafor Beech)

8.4 Prefabricated modules

Maintenance of prefabricated modules such as soil support systems, oil and grit separators, or other standalone stormwater management practices will vary from product to product. All prefabricated products have operation and maintenance manuals from their respective manufacturers which detail specific maintenance and inspection requirements in addition to frequency and costs. In some cases, manufactures will offer to conduct annual inspection and maintenance activities for a nominal fee or offer maintenance training sessions for users. Prior to installing prefabricated modules, you should conduct research a product's maintenance requirements and offers by the manufacturer with regards to maintenance and training.

If a prefabricated module has stopped functioning before the completion of its expected life cycle despite following manufacturer-specified routine maintenance, the best course of action is to identify the failure mechanism via inspection and testing and contact the manufacturer. Common reasons for failure include:

- Improper installation practices
- Underestimating of the catchment area or expected sediment loading
- Uncertified design modifications by contractors or staff
- A change in, or unexpected, parking lot or roads operations and maintenance practices in the vicinity of the module
- Neglecting routine inspections and maintenance

In rare cases, products may be defective. If this is the case, manufacturers may provide a quick fix.

Pre-cast tree planter inspection and maintenance

Similar to bioswales and bioretention, much of the routine maintenance activities of pre-cast tree planters involves vegetation. All other maintenance issues are generally addressed through annual or seasonal inspections. See Table 8.4.1 for a list of some of the common maintenance activities associated with pre-cast tree planters.

Soil support system inspection and maintenance

Soil support system maintenance activities typically occur as part of other capital work projects in which proposed utilities and associated excavation activities damage the soil support systems. Units should be inspected and those damaged should be removed and replaced.

Table 8.4.1: Maintenance activities for pre-cast tree planters.

Regular maintenance	Annual maintenance	Long-term maintenance
• Remove debris and litter from inlets and overflows • Replace damaged or missing catch basin grates • Remove trash • Pruning and weeding • Weekly watering during first year	• Remove large sediment deposits after spring melt • Remove and replace mulch • Identify plant material stressed due to salt contamination. Replace dead vegetation as necessary • Add reinforcement planting to maintain desired vegetation density	• Ongoing maintenance and inspections are complaint driven only • Inspect underdrains for clogging and clean as required via vacuum or high-pressure water sprayers • Evaluate soil media for performance. Remove and replace soil media as required

Since products are buried below a permanent surface treatment, such as asphalt or concrete, annual and routine inspections of these products do not occur. Any possible deficiency or defects are generally noticed as a result of degradation or settling of the surface treatment. This is caused by the failing support systems. At such time, inspection of the units requires removing the surface treatment and excavating to the support system components.

Figure 8.4.1: Proper installation of soil support systems ensures settling does not occur and maintenance is not required. (Source: Deep Root)

Proprietary stormwater treatment device inspection and maintenance

Generally, these devices are inspected on two occasions during the first year following construction to determine oil and sediment accumulation rates. Subsequent inspection schedules are developed based on the accumulation rates. Table 8.4.2 provides a summary of the inspection and maintenance activities associated with these devices.

Table 8.4.2: Inspections and maintenance activities of proprietary stormwater treatment devices

Activity	Frequency
Inspect sediment accumulation depths within OSGs or sumps. If approaching capacity limits per manufacturer's specifications (generally 15%) remove via vacuum	Annually or following significant rainfall event (<25mm)
Examine the drainage area for bare soil. These areas should be stabilized immediately. Silt fence or other measures may be needed until the area is reseeded.	Spring (Onset of construction season)
Inspect units immediately after oil, fuel or chemical spill	As needed
Remove debris from inlets, pretreatments and overflows	Annually or following significant rainfall event (<25mm)

Figure 8.4.2: Along with measuring sediment depth in a proprietary stormwater treatment device, check the outlet structure (if accessible). If the device was functioning as intended this sedimentation should not be occurring, unlike in the device pictured. (Source: Aquafor Beech)

8.5 Rainwater harvesting

Maintenance activities typically associated with rainwater harvesting systems include removal of sediment from settling chambers and filters, removing debris from screens, pump maintenance and conveyance system repairs of valves and joints. The frequency of maintenance on filters and screens will depend on site-specific conditions, including the size of the roof and pollutant loading. Inspections of all components should be worked into annual inspection and maintenance schedules.

For prefabricated rainwater harvesting designs, maintenance activities will be specified by the manufacturer. Prefabricated rainwater harvesting systems are often under warranty by the manufacturer for at least the first year.

Rainwater harvesting systems have three component areas. These are:

- The catchment surface: Roof area from which runoff is collected
- The conveyance network: The pipes and occasionally gutters that convey runoff from the roof to the storage area
- Rainwater storage tank: The tank is where water is stored until the pump is initiated due to a demand

Table 8.5.1 describes maintenance actions for each of these component areas.

For further details on how to perform O&M on LID retrofits, refer to Credit Valley Conservation's Grey to Green Business & Multi-residential Retrofits guide at

bealeader.ca

Table 8.5.1: Rainwater harvesting maintenance activities

Component area	Activity
Catchment surface	• Inspect area for overhanging trees that might cause clogging and trim as necessary. • Inspect integrity of roofing material to ensure degradation is not casing contamination or clogging of inlets and filters. • Inspect and remove potential obstructions caused by animal activity such as birds' nests. • Inspect mechanical components on roof to ensure no contamination from leaks.
Conveyance network	• Inspect the pipe fittings and look for leaks along the pipe network. • Inspect and clean or replace filter as specified by filter manufacturer.
Rainwater storage tank	• Inspect tank annually for integrity, corrosion or degradation of components. • Inspect and test pump annually • If pressure tank used, check integrity and replace when necessary – approximately every 8-years • Replace pump when necessary – approximately every 10-years

9.0 Sharing your Success and Next Steps

Now that you have had a chance to read through this guide, you should have an idea of the kinds of LID projects that can be implemented on your public lands site. Whether you are a teacher interested in implementing an LID project on school grounds to educate students, or a municipal staff member looking to meet the goals of your sustainability plan, this guide has given you the resources needed to move forward with your project.

LID projects are possible on all types of public lands, even if your budget is small or internal resources are limited. Your LID project can be scaled to meet the capabilities and goals of your organization.

9.1 Tracking your success

LID projects on public lands can be led by site owners, site operators, or site users. They are often motivated by a commitment to the community they serve and a desire to be socially responsible.

LID practices provide several benefits to the community: they can reduce risk of flooding, create beautiful green spaces and provide water quality improvements. Establishing an LID practice on your site demonstrates your desire to improve your community and your local environment.

To establish your organization as a leader in sustainability, it is not enough to build an LID practice, you also need to promote it. Part of being a leader includes showcasing what you have done and encourage other organizations to do the same.

Communications Plan

To help get the word out about your project, you may want to develop a communications plan. This plan should outline what audience you want to reach, key messaging, and tactics you plan to use. A communications plan for your LID site may be implemented over several years and can include:

- Events
- Advertisements
- News releases
- Articles
- Tours
- Site signage.

A communications plan can help you create profile for your LID site. Over the last three years, CVC's LID demonstration sites have been featured in 36 magazines and newspapers articles, as well as 8 radio and television interviews.

Grand Opening Ceremony

Grand opening ceremonies are one way to showcase your successful LID project. Consider inviting the following people to your ceremony:

- Dignitaries
- Local councillors
- Media
- Project team
- Project stakeholders
- Site users
- The public

This ceremony will not only celebrate the completion of your project, but also promote it. It will help spread the word about your successful project to the broader community.

Figure 9.1.1: Mississauga's Mayor Hazel McCallion spoke at the Lakeview Park opening ceremony. (Source: CVC)

Be sure to take lots of pictures during the opening ceremony. These pictures can be included in a press release for local media. If published, a press release will further promote your project to the community.

Reporting

LID projects are often built to help organizations meet their sustainability goals. These goals are linked to broader strategic plan documents or correspond with organizational policies. Reporting back to your organization and the public on your project's success will help to fulfill the goals outlined in those documents. If your organization manages multiple facilities, your success may encourage other facilities to retrofit with LID.


The Greening Initiative at the Unitarian Congregation in Mississauga (UCM): Native plantings have created a beautiful physical barrier around the property line, replacing views of traffic and the parking areas with a colourful screen of native trees and shrubs. These provide a home for a variety of song and ground birds, which add to the beauty and tranquility of the property.

Carole Berry

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Figure 9.1.2: Greening efforts of the Unitarian Congregation of Mississauga were featured in the fall 2013 "CANU" newsletter. This national newsletter is sent to all members of the Canadian Unitarian Council member congregations. (Source: Unitarian Congregation of Mississauga)

Reporting to leadership

Leaders and champions can be the biggest advocates of your LID project. Without their buy-in, it will be difficult to maintain the practices you have built. It is also unlikely that they will push for similar practices to be constructed on other sites.

Schools, municipal facilities, parks and places of worship are typically governed by a higher authority such as a board or council. Consider making a presentation to your organization's leadership to share your success story. This may include:

- Municipal council
- School council
- Board of trustees

Annual reports, websites, and other publications

Another way to share your success within your organization and with the broader public is through publications. Does your organization produce an annual report? This might be the ideal place share how your LID retrofit project is helping your organization meet its sustainability goals.

Look at the kinds of publications your organization produces (i.e. newsletters, articles, glossy magazines/publications). Which ones would be a good place to feature your project? Including an article about your LID success will demonstrate your leadership in sustainability to a wide and varied audience.

Websites are another place you can promote your project to the public. If your webpage has a sustainability section, this is the perfect place to include your project.

Promote your LID success to a wider audience! Add your site to Credit Valley Conservation's LID Map at **bealeader.ca**

Nominate your project for awards

Winning awards can bring exposure to your project and your organization. It is also another opportunity to have your project featured in the media.

Several awards are available for green projects. Check out websites from local volunteer organizations, and environmental organizations to see what kind of awards might be available for your project. A quick web search may reveal even further options.

Figure 9.1.3: Portico Church receives an award for constructing one of the first LID parking lots in Ontario at CVC's annual Friends of the Credit Conservation Awards. (Source: CVC)

9.2 Continuing your Leadership Post-Construction

To be recognized as a leader in sustainability, it is important that you continue to maintain your project over the long term. Your site should continue to be an education tool past the construction phase of the project.

Signage

Many LID practices are difficult to identify by appearance alone. Signage explaining the practice is a simple and effective tool to inform site users about your commitment to sustainable practices on your site. It is also an easy way to provide education on stormwater management to the public. Design signage to be fun, attractive and interactive. This will help to draw people towards your sign.

Figure 9.2.1: The colourful design of this sign attracts the attention of site user. It also encourages readers to pick out LID features throughout the site. (Source: CVC)

Site tours

Site tours provide an interactive forum to showcase your LID project. Unlike publications or signage, they offer an opportunity for you to directly engage with others on your property. This is your chance to demonstrate your commitment to the environment and create positive impressions or your organization among the broader community.

Make your site available to others interested in constructing LID. You can even invite similar organizations to see your work and encourage them to build similar projects

New students? Don't forget to show off green features on site during their school tour!

Volunteer engagement

It is common for public lands sites to rely on volunteers to maintain their LID practices, particularly in organizations where resources for maintenance is limited. Volunteers offer a great opportunity to educate others on the benefits of LID practices.

However for a volunteer program to be successful, it is important to keep your volunteers engaged. Reward volunteers for their work. A happy volunteer is more likely to stay on your team longer than one who feels unappreciated. Rewards don't have to cost a lot of money. Thank you cards, certificates of merit, or a small gift will show volunteers that you are grateful for their contribution.

When relying on volunteer work to maintain your LID practice, succession planning is important. Don't leave all the work to a single volunteer. Recruit new volunteers to assist with maintenance regularly. This will ensure that you always have people trained in the maintenance practices for your site, even when there is volunteer turnover.

Maintaining your LID practice

The long-term success of your LID project will depend on its continued functionality and appearance. The key to maintaining your site is keeping up with maintenance practices.

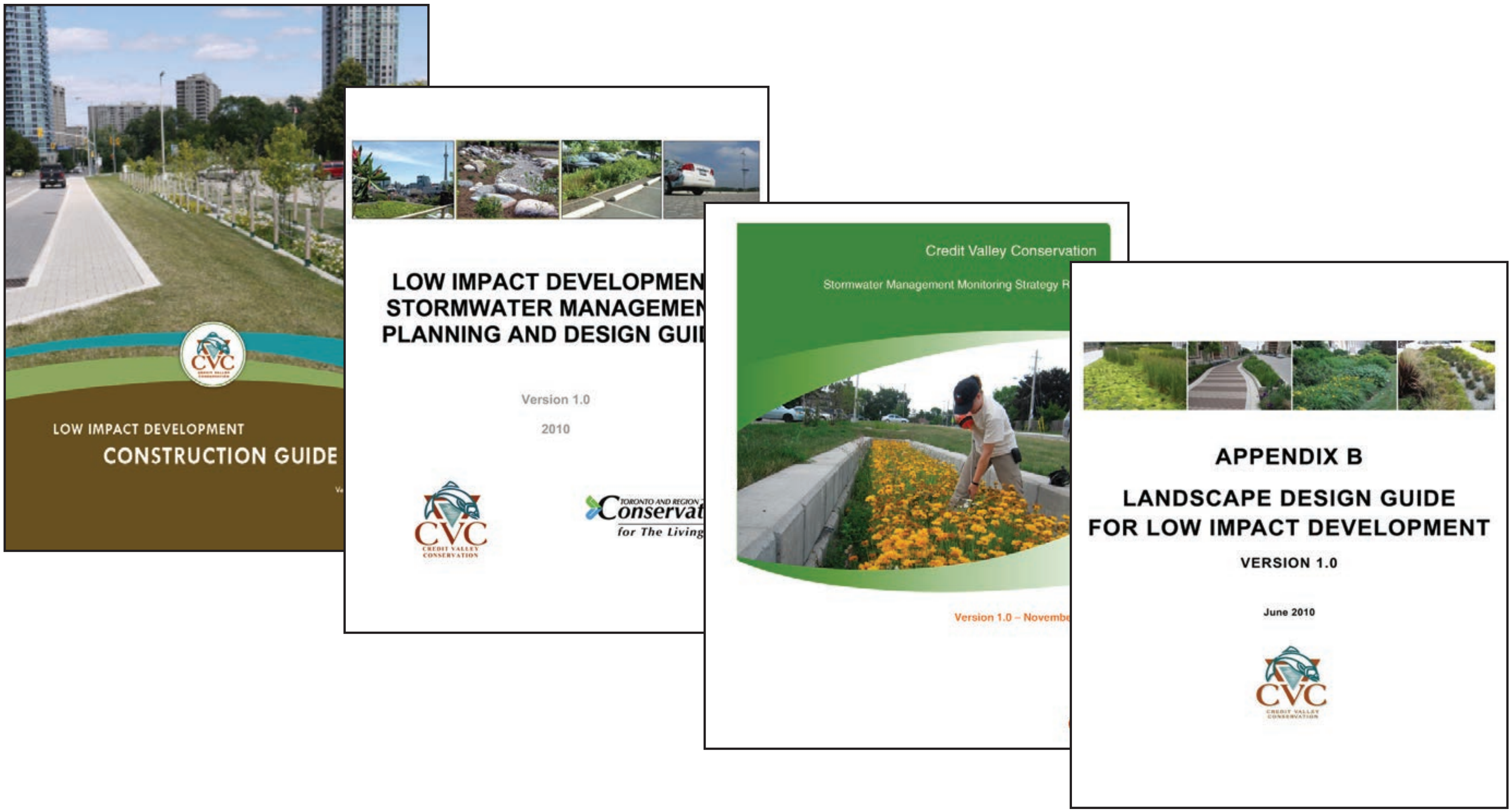
Whether your site is maintained by staff or volunteers, it is likely that it will not always be the same person. Consider documenting your maintenance procedures so they can be easily taught to the next person.

Need more help?

CVC's has a suite of guides tools, case studies and other resources to help you get LID into the ground. Visit

bealeader.ca

Refer to CVC's LID Guidance Documents for more information:



Guides can be found at **bealeader.ca**

References

[1] City of Ottawa. 2005. Green Building Policy for the Construction of Corporate Buildings - Corporate Policy. http://ottawa.ca/en/city-hall/your-city-government/policies-and-administrative-structure/green-building-policy

[2] WSIB. 2011. High-impact claims. Fact Sheet. http://www.wsib.on.ca/files/Content/FactSheetEnglishHigh-impactclaims0921A/0921A.pdf

[3] Intergovernmental Panel on Climate Change (IPCC). 2001. Climate Change 2001: The Physical Science Basis, Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Houghton, J.T., Y. Ding, D.J. Griggs, M. Noguer, P.J. van der Linden, X. Dai, K. Maskell, and C.A. Johnson (eds.). Cambridge, University Press, Cambridge, United Kingdom and New York, NY, USA,

[4] Insurance Bureau of Canada (2012), Factsheet: Water Damage is on the Rise: Are you Protected?

[5] Insurance Bureau of Canada (2012), Factsheet: Water Damage is on the Rise: Are you Protected?

[6] Guide for Assessment of Hydrologic Effects of Climate Change in Ontario (EBNFLO and AquaResource, 2010)

[7] Mills, C. 2013. Flood cost $850M in damages. Toronto Star, August 15, 2013. Pg. B1

[8] Toronto and Region Conservation Authority and Credit Valley Conservation Authority. 2011. Low impact development stormwater management planning and design guide. Version 1.0.1.

[9] Ontario Ministry of Finance. 2012. Ontario Population Projections Update. http://www.fin.gov.on.ca/en/economy/demographics/projections/

[10] Minnan-Wong, (2013) Expect the Unexpected, Water Canada, September, October 2013

[11] Toronto and District School Board. 2012. Resource Allocation Review Final Report. http://www.tdsb.on.ca/Portals/0/AboutUs/docs/TDSBResourceAllocationReviewReport-FINAL_NOV_27_2012.pdf

[12] Royal Bank of Canada. 2013. 2013 RBC Canadian Water Attitudes Study. http://www.rbc.com/community-sustainability/_assets-custom/pdf/CWAS-2013-report.pdf

[13] Toronto and Region Conservation Authority. 2013. Toronto and Region Watersheds Report Card. http://trca.on.ca/dotAsset/157180.pdf.

[14] Center for Neighborhood Technology. 2010. A Guide to Recognizing Its Economic, Environmental and Social Benefits. Final Report

[15] EcoSchools. 2013. Portfolio Requirements Guide 2013/2014.

[16] J.F. Sabourin and Associates Inc.2008. 20 Year Performance Evaluation of Grass Swales and Perforated Pipe Drainage System.

[17] Hall, G. 2009. University of New Hampshire Stormwater Center (UNHSC) design specification for porous asphalt pavement and infiltration beds. 30 p.

[18] York Region District School Board. 2011. Board Policy # 235.0 - Environmental Policy

[19] Region of Peel. 2014. Tech Green in Peel. www.peelregion.ca/conservation/teachgreen/

[20] Gunderson, J. 2008. Pervious pavements: new findings about their functionality and performance in cold climates. Stormwater [serial online], September 2008.

[21] Gunderson, J. 2008. Pervious pavements: new findings about their functionality and performance in cold climates. Stormwater [serial online], September 2008.

[22] Smith.D. 2011. Permeable Interlocking Concrete Pavements 4th Edition. Interlocking Concrete Pavement Institute. Herndon, Virginia

[23] Bass, B. and B. Baskaran. 2003. Evaluating Rooftop and Vertical Gardens as an Adaptation Strategy for Urban Areas. National Research Council Canada, Report No. NRCC-46737, Toronto, Canada

[24] J.F. Sabourin and Associates Inc.2008. 20 Year Performance Evaluation of Grass Swales and Perforated Pipe Drainage System.