APPENDIX B

LANDSCAPE DESIGN GUIDE FOR LOW IMPACT DEVELOPMENT

VERSION 1.0

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CVC
CREDIT VALLEY CONSERVATION

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1 INTRODUCTION

In recent years the development of innovative treatment and retention practices for stormwater has matured. Traditionally, stormwater management has been an end-of-pipe practice located on public property and maintained by public agencies. However, low impact development (LID) is fundamentally different because it is intended to treat stormwater runoff at the source. LID practices are predominately located on private property or within the right-of-way and will be primarily maintained by the property owner. LID is also different because many of the practices have an integral vegetated component which supports the treatment, evapotranspiration and infiltration functions. Thus, the plant selection and design are essential both for function and for the public perception and acceptance of LID practices in the landscape.

1.1 ABOUT THIS DOCUMENT

This document – the Planting Guide for Enhancing LID Measures – has been developed by Credit Valley Conservation (CVC) in consultation with the Toronto and Region Conservation Authority (TRCA) and member municipalities. It is intended to be an appendix to the *Low Impact Development Stormwater Management Planning and Design Guide (LID Guide),* providing support related to the plant selection and design of LID landscape. The *LID Landscape Design Guide* complements the *LID Guide* by providing land managers and professional practitioners with an understanding of the guiding principles of LID planting design, implementation and management. While useful for the facilities and locations described herein, these guidelines may not be suitable for natural SWM approaches (i.e. natural channel design, floodplain storage or wetland applications) or in locations outside of CVC and TRCA jurisdictions.

- The practitioner must respect local bylaws and standards, agency requirements and applicable legislation.
- Plant species recommendations are targeted for the greatest performance in the CVC and TRCA jurisdictions.

In this document you will find:

In Section 1 – The principles to guide landscaping with LID, and the value of landscape design and the role of native and introduced plants.

In Section 2 – General guidelines for the landscaping design of LID practices, including planting standards, general site conditions, fundamentals of plant selection, direction for construction and planting, and for maintenance and monitoring.

In Section 3 – Planting guidelines that are customized to each individual LID practice identified in the LID SWM Manual, including a plant species list.

In Section 4 – A master LID plant list with plant characteristics identified.

1.2 LANDSCAPING PRINCIPLES FOR SUCCESSFUL LID DESIGN

Today's urban environments require a new vision, one that is effective at improving the health of communities and watersheds through innovative landscape management and design.

Studies have found that landowners and the general public alike will respond positively to LID practices when they respond to the following principles:

Collective Vision

All residents, businesses and landowners in a city benefit from the environmental quality and aesthetics of the area in which they live and work. LID practices of a variety of scales are suited to both small residential sites as well as large private and public spaces. Each setting presents a unique opportunity to provide an environmental benefit while beautifying the space through appropriate landscaping and design. When viewed collectively at the city or watershed scale, integrated landscape projects will produce a measurable improvement to the natural and urban environments. Engaging the property owner early in the visioning process is critical to securing their support in the near and long term.

Visual Marketing

The landscape vision of the designer should acknowledge that plant material is installed for the long term yet must invoke instant appeal. Negative perceptions of sustainable or naturalized landscapes, such as being uninteresting and weedy, can be quickly overcome with attractive visual images. Instead of advocating for individual LID practices, the focus should be on a complete landscape aesthetic. When well designed, LID landscapes can be colourful, beautiful, lush, visually pleasing and functional.

Functionality

Vegetation is a vital component of the environmental and hydrologic function of LID practices. Plants are effective in slowing and soaking up runoff and treating pollution through various natural processes. Healthy vegetation is also critical to renewing the soil structure, maintaining infiltration and enhancing long term performance. Choosing the most appropriate plants for a specific site will result in the long-term success and enhanced function of any LID project and will contribute to public acceptance of what is perceived to be a new landscape and stormwater control method.

Stakeholder Involvement

Introducing LID practices in retrofit situations or redevelopment projects should be undertaken with the early involvement of the community in the design and implementation process. This is particularly important for projects in the right-of-way or roads, parks and other public properties. Early involvement of property owners in developing a shared vision for their neighbourhoods generates support of LID initiatives and allows for early identification and resolution of potential constraints. At a minimum, stakeholders and/or property owners need to be provided with information to facilitate decision-making with regards to plant selection and the functional benefits related to each plant type. Also, property owners and other stakeholders pertaining to construction, maintenance and performance need to be understood and addressed by the landscape

professional during the design process.

Outreach & Communications

Outreach and communication through visual media such as signage are useful in conveying the message that LID practices are attractive and functional amenities, are an integral part of the urban landscape and contribute a benefit to the community. It is essential to use aesthetically beautiful images of landscaped LID spaces to communicate to property owners and stakeholders the value of maintaining the vegetative component.

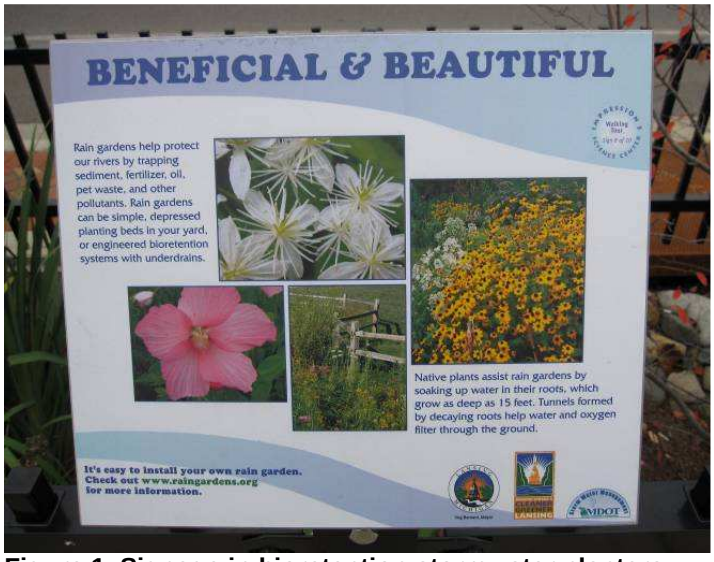


Figure 1. Signage in bioretention stormwater planters in Lansing, MI promote LID practices and educate the public. (Source: CVC)

1.3 LANDSCAPE ARCITECT'S ROLE:

The landscape architect plays a key role on the design team in creating a functional design that also has visual appeal for property owners. Rather than being the final design stage, landscape architects should be involved at the subdivision/site planning stage and throughout the design process to contribute to the LID decision process. There are no generic solutions. The landscape architect or qualified professional should:

Figure 2. Urban stormwater planters are incorporated into a constrained urban streetscape in Bridgeport, CT with ornamental grasses and trees.
(Source Talledega Design Group)

- engage property owners at the start of the design process to create a shared vision that meets the aesthetic needs and values of the property owner and community.
- draw on the property owner's personal style or corporate image in order to integrate this with the functional elements of the LID practice. Preferences can include a contemporary landscape, a natural landscape, or variations on both.
- tailor the LID practice to the conditions of the site to its context, the neighbourhood or environmental setting.

- design and select plants for the LID practice to achieve the stormwater function.,
- consider the desired level of maintenance. As a general rule, the greater the formality of a landscape, the higher the level of required maintenance effort and cost.

1.4 LANDOWNER PERCEPTIONS:

While the engineered aspects of LID practices are critical to their function, it is the aesthetic appeal of the finished landscape that the property owners care most about. Homeowners in particular have a strong emotional connection to their home's landscape, which they view seen as a reflection of who they are. When implementing LID practices, property owners need to feel that they are getting something they want and not sacrificing their landscaping goals to meet an environmental objective.

Successfully convincing property owners to implement and to maintain LID practices as part of their landscape requires capitalizing upon this emotional connection with the landscape using the tools of education and marketing, in combination with the planting design itself.

Traditional landscaping and design philosophies embrace the perception that beauty is defined by areas of manicured grass and impermeable surfaces.

Similarly, municipalities, institutions, corporations and small businesses are also very aware of how the landscaping of their properties reflects their public image and messaging. Careful LID design and landscaping will assist them in achieving the benefits of LID performance (on building maintenance and operations) while maintaining a visually pleasing landscape.

As a principle, LID landscape design should be integrated into the urban landscape. Whether large or small scale, LID practices will be part of the community for the long term. By selecting plant material appropriate to local site conditions LID practices will be attractive and functional well into the future. It is critical that the LID landscape design and plant choice be suited to the aesthetic preferences of the property owner and that they are perceived as an amenity.

Figure 3. This rain garden demonstrates aesthetic qualities consistent with market research in the Greater Toronto Area (Freeman Associates, 2008): colourful flowers, well-kept appearance, set within the backdrop of a manicured lawn. (Source: City of Maplewood, MN)

2 GENERAL GUIDANCE

2.1 LID LANDSCAPE DESIGN

The basics of planting design that are outlined below can be applied to LID practices, as they are to any other landscape design. The most successful landscapes balance aesthetic and function, combining fundamental principles of design with the appropriate use of plants for the site. LID practices can incorporate any number of design styles. A formal design style is commonly applied on corporate properties, commercial sites, and on most residential front yards. However, even a formal design can incorporate ecological elements. A naturalistic design style is also founded on basic landscape design principles to create a less formal design that may have lower maintenance requirements. This style recreates the appearance of a natural landscape by organizing plant material in groupings and asymmetry found in meadows, forests, or other natural ecosystems.

Whatever the choice of style, it is essential that the surrounding context is taken into account. While a planting design can have a natural appearance, the landscape should never appear haphazard or messy. The aesthetic goal is to achieve a visual sense of fit and scale with the site. The design should be intentional, appropriate and pleasing to the eye and consider the following:

- Maintain visual interest throughout the seasons
- Use of selective species palate
- Use of one or two species or elements to create an accent
- Consistency in plant placement and spacing; incorporating mass groupings, repeating plant groupings, materials and/or design elements.
- Avoid sparsely spaced greenery; the planting beds should be fully vegetated.
- Consider habitat attributes of plant material
- Enhanced LID function related to pollutant uptake, temperature mitigation, filtration, and evapotranspiration

The basic principles of landscape design that should be considered in the creation of any planting plan are described below. Not all need to be applied in each case, but a basic understanding provides guidance for the designer. The manner in which these principles are applied creates a particular aesthetic.

Unity/Simplicity - A degree of unity and simplicity in a planting design is essential to create an appealing aesthetic. This can be achieved through repetition and consistency. The landscape associated with an LID practice needs to convey that all parts of the planting design fit together to make a whole. The repetition of groups of plants or the character of elements (ie. height, size, texture, and colour) throughout the landscape design can assist on creating a sense of unity in the landscape.

Repetition/Rhythm - Repetition is the key element used to achieve unity. However, it is important not to overuse this technique as the result can become monotonous. A landscape design that employs a variety of species in groupings that are repeated throughout a site assists in achieving unity and interest. In contrast, a design that utilizes two or three species which are repeated throughout the entire LID practice may be monotonous.

Grouping/Massing - Planting different species as single individuals can create a disjointed and un-natural aesthetic in a landscape design. Plants should be placed into groupings of varied numbers to create a mass, which can create a much greater visual appeal. One way to create a grouping is by beginning with a larger specimen, and then adding smaller species with complementary textures, colours and shapes. To create a seasonal grouping, evergreen species, and species with dormant season distinctiveness (ie. form, height, colour) should be included.

Balance - Balance in a landscape design can be either symmetrical or asymmetrical. A symmetrical design is one that exactly duplicates itself along an axis. The informal nature of many LID practices tends to promote the application of the asymmetrical balance approach. This is achieved through the irregular placement of plant groupings along an imaginary axis so that the resulting mass is balanced.

Scale/Proportion - Scale and proportion simply refer to the size of the elements of the landscape in relation to one another and the site. While there are no rules dictating how this principle is to be achieved, it is important to consider scale and proportion when designing. For example, the placement of a large tree in a stormwater planter would be out of scale for this site condition, while the planting of an individual ornamental flower species may appear insignificant in a bioretention cell. Some plant materials may require management (thinning, pruning) in order to maintain the scale and proportion of the intended design over time.

Colour - Colour animates a landscape design. It changes throughout the seasons. Flowers, fruit, leaves or bark of vegetation contribute to colour variation, in response, the designer should understand the details of the life cycle of the plants to be utilized. Colour theory dictates that warm colours (red, orange, yellow) take prominence in the view, while cool colours (green, blue, violet) recede. Colour can be used in developing unity, repetition and balance in a landscape design, and to direct the eye to a focal point if desired.

Texture - The designer should be aware of the texture of the planting materials specified. An appealing aesthetic can be achieved by contrasting fine textured vegetation such as grasses with coarser texture species. However, in exploring design solutions it is important to understand the distance from which the LID practices will be viewed, and to mass vegetation textures accordingly when applying this element to the design.

Line - Straight lines represent more formal organizing elements in a design and imply a sense of direction and movement. Curved, organic lines promote a more 'natural' aesthetic. In either case, clean and contrived shapes have a greater visual interest than weak shapes or indistinct edges.

Form - Form describes natural shape of an individual plant. The variety of forms include weeping, globular, spreading or columnar. The form of plants should be considered both individually and as they relate in the composition of the design.

2.1.1 THE FUNCTION OF PLANTS

Consideration of the function of plants, in addition to their aesthetic characteristics is essential in determining which species should be selected. Some of the functions and

characteristics of plants that should be considered include:

- Ground cover (i.e. spreads effectively in open or shade)
- Soil stabilization
- Infiltration
- Aggressive colonization (seed, surface runners, underground rhizomes)
- Flow moderation/attenuation
- Temperature mitigation through shading
- Screening/visual buffering
- Wildlife habitat (cover, food, shelter)
- Treatment of pollutants and uptake of nutrients
- Barrier / limitation of trespass / access

Every plant species has a useful function that needs to be considered beyond the aesthetic attributes they possess.

2.2 ASSESSING SITE CONDITIONS

One of the basic principles in ecology is that organisms adapt to their environment over time through the processes of evolution and natural selection. Environments are variable; however, plant species are generally dependent upon six key environmental factors: light availability, temperature, soil type, moisture, nutrients and pollutants/disturbances. Light and temperature are typically a product of climate and vary across the CVC & TRCA jurisdictions in response to altitude, aspect (i.e. direction relative to sunlight), proximity to buildings and proximity to large bodies of water (primarily Lake Ontario). The remaining four factors - soil, moisture, nutrients and pollutants/disturbances - vary at the site level and under natural conditions, resulting in a suite of adapted plant species that together form vegetation communities.

The system for characterizing plant communities has been developed for southern Ontario by the Ministry of Natural Resources and is known as the Ecological Land Classification System (ELC). ELC can be used to guide plant selection based on associations of plants and soil conditions found in nature. Where ELC information exists for adjacent natural features it can be used to inform the selection of plants in an LID practice.

In this section the key factors, other than hardiness zone, which defines the planting environment, will be examined with a view to understanding the significance on plant selection and performance. The response of plant species to the environment will be examined in section 3 where the composition of natural vegetative communities will be revisited as the starting point for species selection in the design of landscapes for various LID practices.

2.2.1 CLIMATE

Climate is a characterization of meteorological conditions in a particular region over an extended period of time. Plants are adapted to particular geographic regions largely due to the average rainfall and temperatures that prevail in those regions. The historical minimum annual temperatures are indicative of which species can survive in a geographical area. This data has been analyzed and mapped to create plant hardiness

zones. For the CVC and TRCA jurisdictions, these zones have been assigned numbers that reflect the respective hardiness zones. These zones are identified as 5a, 5b, 6a & 6b ranging from north to south. All of the plants listed in the Master Plant List for LID Practices (see *Section 4*) are hardy within the region and are able to survive the cold winters, and the hot, humid summers typical of Southern Ontario.

2.2.2 SOILS

The important relationship between soils and plants cannot be overemphasized. It is essential to understand basic characteristics of soil in terms of particle size, structure, drainage, soil depth fertility and pH as they relate to plant species and their requirements for survival.

Soil Structure - Upper soil layers comprised of the organic (O horizon) and topsoil layer (A horizon) structure are formed by weathering and decomposition encompassing the presence of roots, earthworms, fungi, invertebrates and other organisms. The structure consists of pores that allow for infiltration, gas exchange, and contain the nutrients and water needed for plant growth. The soils that underlie topsoil are referred to as subsoil or B horizon and parent material or C horizon. The designer should verify that the site topsoil is not B or C horizon soil or blended soils which limit plant growth. Sites should be designed to take advantage of the existing topography and native soil horizons and avoid unnecessary grading and soil disturbance. Refer to Section 2.4.1 and 3 for the specific soil requirements of LID practices.

Soil Texture - The composition ratio of organic matter and relative components of mineral particles of different sizes determine the structure of soil. Sandy soils contain relatively large particles that allow for efficient drainage; as a result, sand soils are prone to periods of drought due to their inability to retain moisture. Silty soils are dominated by finer-sized particles, and clayey soils are dominated by very fine particles. Clay soil particles can hold more water, but take longer to infiltrate water, resulting in poor drainage which can deprive plant roots of essential oxygen. Soils which contain mostly organic matter will oxidize over time, and settle unless environmental conditions (such as high water tables) prevent this oxidation. Soils containing a mixture of mineral particle components (known as loams), with 3-5% (dry weight) of organic matter are the most adaptable soils for growing the broadest range of plant species.

Soil Depth - The depth of soil represents one component of the growing medium that is available to a plant, and can range from 5cm (for an extensive green roof), to 1.2 m (for some bioretention cells). Soil depth is an important variable in species selection for LID practice. Closely related to soil depth is the concept of soil *volume* which represents the three-dimensional space available for plant roots and is especially important when planting trees in order to achieve healthy trees of a mature size.

Drainage - The designer should be aware that urban site soils may contain blended soil horizons. Site soils with infiltration rates greater than 15mm/hr can be used as they exist, or existing soils may need to be amended to restore soil infiltration properties. The functional performance of some LID techniques is based on soil infiltration rates; therefore the prevention of compaction to the site is essential. The topsoil that is applied may require amendment with organic matter to achieve appropriate infiltration rates to achieve the desired infiltration function and to sustain the vegetation community.

Nutrients - The relative abundance of the major soil nutrients (nitrogen, phosphorus and potassium) determines fertility. Nitrogen aids in the development of foliage, phosphorus aids in root and flower development, and potassium aids in the development of fruits and enhances resistance to disease. It is essential that plant species be selected based on their ability to thrive in existing soil conditions, or alternatively that soils be amended to achieve necessary soil fertility. Established soils with adequate moisture, healthy plant cover and diverse soil organisms tend to maintain a nutrient balance over time. Micronutrients, such as zinc, iron, copper, manganese, nickel, boron, molybdenum and cobalt, are also important and may need to be supplemented or modified under certain growing conditions.

pH - The level of pH indicates the acidity or alkalinity of the soil. While most plants do best in neutral soils – a pH range of 6 to 7.5 - specific plants are adapted to more extreme pH levels. Amending the pH of soil is possible through the addition of organic or mineral amendments; however this amendment exercise can be problematic if large areas require treatment. The plants listed in the Master Plant List for LID Practices (see *Section 4*) are generally suited to neutral soil conditions.

Soil structure, fertility, and pH must be tested, and amended if necessary to achieve adequate growing conditions. In addition, it must be recognized that the existing soils should be amended to meet minimum requirements with respect to composition, organic content and drainage.

2.2.3 MOISTURE

Flood depth and duration significantly impact the growth of plants. For plants that are not adapted to flood conditions, seed germination and plant growth can be inhibited and vegetative reproduction reduced. In addition, root system death or decay can occur due to lack of oxygen. There are plant species that are adapted to flooding. These plants have enhanced oxygen transport systems and physiological adaptations that allow them to absorb nutrients appropriately within saturated environments. Depending on the type of LID Practice, very little water could collect, or the bottom zone could have standing water for up to 48 hours after a storm event. In addition to contending with flooding, the plants within an LID Practice must be able to survive drought conditions, unless irrigation has been installed.

In most natural ecosystems, the hydrologic cycle operates through relatively predictable seasonal cycles of precipitation, storage, runoff and evapotranspiration, with natural soils serving the primary functions of infiltration and attenuation during wet periods. These soils then provide moisture reserves throughout the drier seasons of the year with a predictable drawdown in moisture levels over the summer and early autumn. Urban ecosystems have much “flashier” characteristics due to the extent of impervious cover that generates concentrated flows. Few plant species are fully adapted to such irregularity in hydrology, and therefore this document is intended to provide guidance to address this hydrologic regime which is characteristic of southern Ontario.

Selection of plant species suited to tolerate these varied conditions is essential for the success of a planting plan. A plant’s ability to tolerate flood conditions is further correlated to its age, adaptation to the site, and condition. A well-established plant has greater reserves to withstand flood events. While it is recommended to leave the LID practice offline until plants become established (one to several years), in most instances

this may not feasible. Measures incorporated into the LID practice such as erosion and sediment controls and pre treatment cells can moderate flows enhancing survival potential. In all cases, soil surfaces must be stabilized prior to allowing flow to enter the LID facility.

It is important to distinguish between the “moisture-loving” and “moisture-tolerant” characteristics of a plant species. Relatively few plant species are truly aquatic in our region, and those that are aquatics have very specialized adaptations that allow them to withstand inundation. Many “wetland obligate” species can grow profusely in somewhat drier locations (such as in a nursery or garden), but are able to compete effectively against wet-intolerant upland species when wet soils are a factor, which leads to their being abundant where soils are seasonally wet. For the purposes of LID practices that may represent unnatural annual water cycles, using species mixtures of ”wetland obligate” and “facultative wetland” species will ensure that the diversity of species present will allow the adaptation of cover to address site specific conditions. Recent climate data indicates that both very wet summers and periods of drought have occurred in southern Ontario. This underscores the need to plant adaptive, diverse plants that can excel under the range of moisture conditions that can be expected in urban settings.

2.2.4 SALT & POLLUTANTS

The roadways within CVC and TRCA jurisdictions are regularly salted in wintertime to mitigate icing and ensure public safety. Road salt, which is sometimes mixed with sand or grit, can enter LID practices adjacent to roadways during thaws and rainfall events. CVC is currently working with municipalities and the private sectors to reduce salt use and promote alternatives.

Although vegetation varies in its reaction to salt-affected soils, salt generally reduces the ability of the roots of the plant to take up water and nutrients by impeding uptake of moisture from soil with salt-laden water. This phenomenon essentially mimics drought conditions for the plant. If salt is sprayed onto plants from automobile traffic it can reduce cold hardiness in buds and new twigs, which may then become more susceptible to freezing, mortality or deformation. Road salt can also be directly toxic to plants; the dissolved sodium and chloride ions separate and the chloride ions can reach toxic levels as they are absorbed into roots and then build up in the leaves. Vegetation most strongly influenced by salt is usually that which is growing closest to the source of the input, and is actively growing when salt levels are highest. Warm season grasses offer an advantage over cool season grasses, because they germinate later in the season when the concentrations of sodium chloride have dissipated.

Other contaminants from roadways include motor oil, grease, anti-freeze, and heavy metals. Plants vary greatly in how they can tolerate and assimilate pollutants and toxins. Individual species can be affected greatly by certain pollutants, and not at all by others. The Master Plant List for LID Practices (*see Section 4*) identifies the level of salt tolerance of individual species, as well as the tolerance of specific plants for pollutants or compaction.

2.2.5 NATURAL PROCESSES

A plant community is not a static entity; rather it is always growing and changing in

response to natural processes and disturbance events. When utilizing a plant community as an analogue for design, it is essential to understand the role of agents that affect the composition of the plant community over time. Designers and managers may need to mimic or compensate for the natural processes in a management plan. Consideration should be given for the impact of natural processes and disturbances to the long term vision of the LID landscape design. Natural ecosystems develop and are maintained through natural changes such as the onset of shading, and disturbance events such as:

- Seasonal storm events / flooding outside the design norms
- Prolonged drought
- Microclimate change and progression - sun / shade / moisture
- Plant competition, successional growth, invasive behaviour
- Weeds entering from other sources
- Herbivory
- Pests and diseases
- Changes in soil chemistry / nutrients
- Development of soil structure
- Maturation and decline of plants

2.3 SELECTION OF PLANTS

In addition to their aesthetic qualities, plants have specific functions in relation to LID practices. Some include promotion of infiltration, treatment of pollutants and stabilization of soil. The plant species that have been selected for each LID practice as described in this guide have been selected based on functionality, survivability, suitability and availability. The landscape professional should use this list as a guide, taking into consideration the appropriate planting zone, the size of the planting area versus size of the plant at maturity, tolerances to drought or periodic inundation, low maintenance requirements and adaptability. *Non-native invasive plant species are inappropriate for LID practices*. See list of plants appropriate for each LID practice in section 3.

2.3.1 CONTEXT

Selecting plant material that will be appropriate for a particular site should take into consideration the local context or setting. Some species, especially rare or potentially aggressive species, are not always conducive to the type of site or objective of the project, especially in areas near or next to natural communities. For example, a green roof that is isolated from all natural areas may be ideal for regionally rare species that are specially adapted to conditions of high exposure and shallow soils. Among the questions that should be asked are:

- Is this LID site located within, adjacent or close to a natural area? Or, is this LID site location isolated (i.e. beyond 120 m of natural feature) from the natural environment?
- What is the composition of the nearby natural area?

2.3.2 NATIVE, INTRODUCED & RARE PLANTS

The goal of planting design for LID practices is to achieve a sustainable vegetation community that is tailored to the ecological qualities of the site and the aesthetic

considerations of the landowner. Plant selection for LID practices is predicated on the principle of 'right plant for the right place'. Many LID practices are carried out within a highly urbanized context that poses unnatural stresses on plant growth and survival. This guide provides general recommendations to direct species selection. Landscape professionals should use this information to generate specific plant lists that are tailored to the conditions prevalent on site while addressing surrounding urban and natural land uses.

Plant species listed in the recommended plant list for LID practices are organized into five categories based on native origins and rarity. These two concepts are discussed below.

2.3.2.1 NATIVE AND INTRODUCED SPECIES

Native species are defined as those plants (including grasses, herbaceous species, shrubs, vines and trees) that have historically existed within a particular area. Native plants have co-evolved with the local ecosystems and natural processes. They are genetically better adapted to local climate, soils, insects and diseases of the area, and may require less maintenance to ensure health and survival. Working with native plants helps protect local native biodiversity, allows the LID feature to function ecologically while creating a more diverse, naturally-beautiful, landscape. Native plant species are denoted by a combination of diamond symbols, "♦", in the plant list.

Where conditions for growing native plants are inhospitable, diversifying the planting palate with introduced species may have a more successful result. ***Introduced species*** (or non-native species) are those that do not naturally or historically occur in a particular area. In addition to native species, many introduced plants are grown in nurseries and garden centres and are readily available to landowners. Introduced species are denoted by the symbol "**NN**" in the plant list.

Some introduced species escape from gardens and other managed landscapes and begin to reproduce in the wild. ***Invasive*** plants are typically non-native plants that out-compete native species. These species lack natural predators, grow aggressively and reproduce rapidly and can be problematic in the natural environment. Invasive species have not been included on the recommended plant list for LID practices and should not be planted in any situation.

Recommendations:

- In all applications of LID, designing with native plant species is the preferred and strongly recommended option.
- In areas containing, adjacent[1] to, or within a linkage to an existing natural heritage feature[2], native plants should be used exclusively. In areas regulated[3] by a

[1] Adjacency in this context means anything within 120m of a natural heritage feature.
[2] Natural heritage features are those areas that are naturally vegetated (e.g.: forests, wetlands, successional areas) and can occur on tablelands, lowlands, riparian areas, valleylands, *etc*.
[3] Conservation Authorities derive their authority from the *Conservation Authorities Act* and regulates development and interference with wetlands, shorelines and watercourses pursuant to Section 28 of the *Act*. Regulated area means the lands described in, and subject to, Ontario Regulation 160/06 under Section 28 of the *Act*. Conservation Authorities also provide planning and technical advice to planning authorities to assist them in fulfilling their responsibilities regarding natural hazards, natural heritage and other relevant policy areas pursuant to the *Planning Act*.

watershed authority such as the CVC or TRCA, native plants will be required for approval.

- In settings that have restricted or harsh conditions for plant growth (e.g. limited root volume, unusual patterns of drought and/or inundation, exposure to salt, sun, wind, shade and pollutants) introduced species can be used to substitute/augment native species selection. Introduced species shall be chosen to be functionally and aesthetically appropriate for the location.
- Introduced invasive species should not be planted as these can compromise the function of an LID practice, the ecology of nearby natural areas and can lead to higher maintenance costs. Non-native invasive species have *not* been included in the LID plant list.
- Except unless otherwise noted, the use of cultivars of native plants should be avoided. A ***cultivar*** is a "cultivated variety of a plant created by horticultural practice, often closed in large numbers from a similar individual[4]." Cultivar names typically appear after the scientific name of a species, e.g. *Prunus virginiana* 'Shubert'.
- When sourcing native plant material, especially from commercial nurseries and garden centres, always refer to the scientific (botanical) name for the desired plants. Confusion over cultivated varieties of plants can be avoided by asking questions of the staff to ensure that only the correct native varieties are sourced. Species that are often mislabelled and other common concerns are noted in the Master LID Practice Plant List. Several nurseries specialize in the production of native plants, many of these nurseries are listed at: http://www.creditvalleyca.ca/landscaping/downloads/CVCNativePlantNurseries.pdf

2.3.2.2 RARE SPECIES

Some of the native plants in the LID plant list are 'rare' and/or 'uncommon' within the Region of Peel / Credit River watershed, the Greater Toronto Area[5] and/or the Province of Ontario[6]. CVC and the TRCA do not support the incorporation of *rare native species* in planting plans and designs unless locally sourced material can be obtained and there is little to no threat of escape into naturally occurring populations. Genes from plants adapted to other areas can inadvertently introduce harmful traits that weaken the ability of the native population to thrive. Rare species are not always appropriate for LID practices depending on the project objectives or the characteristics of the site, especially in situations where rare species may be planted near natural communities. In these situations, the opportunity for genetic contamination of native populations is higher and the planting of rare species is unadvised.

Some native species are rare because they require specific habitat conditions in order to grow which may not exist or be able to be restored easily. The benefits to landscaping

[4] The Society for Ecological Restoration – Ontario Chapter provides more information for native plant buyers related to cultivars at: http://www.serontario.org/pdfs/SEROBuyers2010.pdf

[5] Rarity compiled from numerous sources including: Plants of the Credit River Watershed (2002) http://www.creditvalleyca.ca/programsandservices/downloads/PlantsComplete.pdf based on Kaiser, J. 2001. The Vascular Plant Flora of the Region of Peel and the Credit River Watershed and professional judgment.

[6] S1-S3 species tracked by Ontario's Natural Heritage Information System were considered 'rare' in this context.

with native, common plant material is that plantings may be better adapted to a wider range of conditions, and may tolerate more disturbance. A higher success rate and lower maintenance requirement may be achieved.

The method and collection of native plants is an important consideration when sourcing rare plant material. Ecologically responsible methods of seed collection and propagation ensure that wild populations are not overharvested and that they have the ability to keep adapting over time. Seeds should not be collected or existing plants relocated from the wild for use in LID practices. When sourcing material from growers and nurseries, the plant material origin should be confirmed as well as its method of collection and propagation.

Recommendation: In areas containing, adjacent[7] to, or within a linkage to an existing natural heritage feature, common native plants should be used exclusively. In areas regulated by a watershed authority such as the CVC or TRCA, rare species are not suitable for planting unless the local source/provenance is documented and approved. Rare species should only be used sparingly when there are no suitable common species available and reasons for selection should be provided. Where rare species are included in a design, it should be ensured that the plants are procured from locally adapted[8] seed sources. Biologists, botanists and ecologists can help guide the sourcing and selection of plant material. Nurseries that specialize in native plants should be contacted to source material.

2.3.3 PLANT CHARACTERISTICS

The Master LID Practice Plant List describes the characteristics of each plant species to assist the designers of an LID practice in the selection of appropriate vegetation. The definitions of these characteristics are listed below:

Plant Type - The list has been organized according to plant type. The basic categories are: *Graminoids* (sedges, grasses and rushes), *Broadleaved Herbaceous and Ferns*, *Shrubs*, *Trees* and *Vines*. Nurse Crops were broken out as a separate category for ease of reading, though in all cases these are *Graminoids*.

Seed - In some cases, the application of seed may be appropriate. This category states whether a species is recommended for installation through seeding.

Soil Type - Plant species are adapted to growing in specific types of soil for optimal growth. General categories of soil types include: Sand (S), Clay (C), Loam (L - mixtures of sands, silts and clays). Some plants are adaptable to and tolerant of a wide range of soil textures as well as soil chemistry (pH).

Soil Moisture - Plant species are adapted to specific levels of moisture to achieve establishment and sustained growth. Soil moisture has been characterized by three categories: Dry (D), Moist (M) and Wet (W). Some plants can tolerate a wide range of moisture regimes, whereas others perform optimally in a more narrow range of soil moisture conditions. Species soil moisture preferences denoted with a dash can tolerate a range of conditions. Species that prefer a specific level of soil moisture are described

[7] Adjacency in this context means anything within 120 m of a natural feature.

[8] Plants or seeds should be from Ontario seed sources, originate and be grown in climatic conditions similar to the site in which they will be used.

with one letter (D, M or W) or a combination of letters such as MD (mid-way between Moist and Dry) or WM (mid-way between Wet and Moist).

Coefficient of Wetness[9] - The following chart summarizes plant categories in relation to their affinity for inundation. Relatively few plant species can survive under continuous inundation; most require a drier hydroperiod that allows them to access oxygen and nutrients within the root zone. The coefficient of wetness provides a general indication of the conditions under which species of plants thrive in natural conditions. However, many plants can tolerate a range of moisture conditions in addition to those that exist in their preferred natural habitat. This criterion should be used in conjunction with the *Soil Moisture* criterion in order to provide better guidance on the placement of plants within an LID feature.

OBL	Obligate Wetland	Occurs almost always (estimated probability 99%) under natural conditions in wetlands.
FACW+		Greater estimated probability of occurring in wetlands than FACW species, but lesser than OBL species.
FACW	Facultative Wetland	Usually occurs in wetlands (estimated probability 67%-99%), but occasionally found in non-wetlands.
FACW-		Lesser estimated probability of occurring in wetlands than FACW species, but more than FAC+
FAC+		Greater estimated probability of occurring in wetlands than FAC species, but lesser than FACW-.
FAC	Facultative	Equally likely to occur in wetlands or non-wetlands (estimated probability 34%-66%).
FAC-		Lesser estimated probability of occurring in wetlands than FAC species, but more than FACU+
FACU+		Greater estimated probability of occurring in wetlands than FACU species, but lesser than FAC- species.
FACU	Facultative Upland	Occasionally occurs in wetland, but usually occurs in non-wetlands (estimated probability 1-33%)
FACU-		Lesser estimated probability of occurring in wetlands than FACU species, but more than UPL species.
UPL	Obligate Upland	Almost never (<1% estimated probability) occurs in wetlands under natural conditions.
NI	No indicator	Insufficient information was available to determine an indicator status.

Exposure - Plant species react differently to varying levels of sunlight and shade. Plant adaptations to these parameters are referred to in terms of degree of exposure. Most of the LID practices will be installed in newly developed areas, thereby providing exposure to full sun, meaning at least 6 full hours of direct sunlight for plantings. As trees develop over several years, or if an LID practice is installed in an area where there are existing trees or buildings providing partial shade, plants adapted to 3 to 6 hours of sunlight exposure should be used. Plants tolerant of full shade require less than 3 hours of direct sunlight each day. However, some shade-adapted species come into leaf early in the growing season in order to take advantage of full sunlight before tree leaves emerge and create shade.

[9] See: Oldham, J., Bakowsky, W.D., and D.A. Sutherland. 1995. Floristic Quality Assessment System for Southern Ontario. Natural Heritage Information Centre, Ontario Ministry of Natural Resources. Pp. 1-69.

Drought Tolerance - The categories of Low, Medium and High tolerance represent broad generalizations of the drought tolerance of plant species; with High representing the greatest ability for a plant to survive drought.

Salt Tolerance - The categories of Low, Medium and High are indicative of the tolerance of plant species to salt exposure and/or uptake. Plant species with Low salt tolerance should not be used in any LID practice that will be receiving stormwater that is discharged from roads or parking lots that will routinely receive high levels of road salt. Species with Medium salt tolerance can be utilized in LID practices that will be receiving road runoff, but are unlikely to be in the line of salt spray or be receiving the bulk of the runoff. Species with High salt tolerance should be planted in LID practices that are likely to receive road or parking lot runoff that routinely contains road salt. Few plants are truly "salt-loving" or halophytic; in most cases elevated salt levels are temporary and precipitation quickly dilutes and removes salt from the soil profile. The Master Plant List includes some species that are recommended for planting should be planted in LID practices that are likely to receive road or parking lot runoff.

Urban Tolerance - Based on current information, plants that tolerate either P- Pollution or C- Compaction have been included.

Growth Rate - This criterion is a somewhat subjective category, as a result parameters have been divided into slow, medium and fast. Vegetation typical of early successional landscapes tends to have a rapid growth rate, while later successional species tend to have a slower rate of growth. A variety of growth rates should be utilized to ensure both rapid cover and long term climax composition objectives.

Height/Spread at Maturity - Measurements are provided for the mature height and spread of a species. This information, along with the growth rate, assists in determining the spacing of plants within a proposed design in combination with the functional and aesthetic objectives design.

Spacing - Plant spacing is the distance at which individual plants should be planted from one another. Spacing considers the spread at maturity and growth rate of the species. Conventional spacing is denoted as 'on center' (o.c.); meaning that the distance from one plant to the next closest is measured from the center of the plant. This method of spacing creates a pattern of equidistant triangles for a mass planting of same-spaced species. Planting densities will vary somewhat according to strategies within a particular LID Practice.

Ranking - Ranking of all the plants on the Master LID Practice Plant List was based on two factors: Native origin and Rarity. Five categories were created:

		Native vs. Introduced	Rarity
♦♦♦♦	Best Choice	Native to the CVC and/or TRCA jurisdiction	Common
♦♦♦	Better Choice	Native to Ontario, but not the CVC and/or TRCA jurisdiction	Common
♦♦	Selective Choice	Native to the CVC and/or TRCA jurisdiction	Rare or Uncommon
♦	Selective Choice	Native to Ontario, but not the CVC and/or TRCA jurisdiction	Rare or Uncommon
NN	Reasonable Alternative	Introduced (Non-native) and non-invasive	n/a

Plants were assessed to determine whether they are native to Ontario and have been confirmed as present in CVC and TRCA jurisdiction. Some plants are not indigenous to these areas and have been introduced. All species were assessed for their 'rarity.' Some of the native plants in the LID plant list are 'rare' or 'uncommon' within the Region of Peel/Credit River watershed[10], the Greater Toronto Area[11] and/or the Province of Ontario[12]. In general, if a plant was designated as rare at any one of these scales, it was noted as 'rare'.

Aesthetic Attributes - Aesthetic attributes of plants include habit, flowering, autumn colour, etc. these attributes assist the landscape designer in determining whether a plant is an appropriate choice to achieve a desired aesthetic (see Section 2.1). The 'habit' of a plant species relates to the general tendency of the plant to take a certain form or growth pattern; including spreading, columnar, suckering, trailing, bushy, low-growing, etc.

Other Information - Any additional pertinent information that is useful to the professional practitioner has been added under this heading to assist in species selection.

The Master Plant List includes numerous species, many of which can be viewed at the websites listed below. These websites should be used as a tool to inform plant selection where necessary; the CVC and TRCA do not endorse any advertising or materials that may appear on the following websites.

Organization & Website	Coverage	Types of Material
Evergreen Native Plant Database http://nativeplants.evergreen.ca/	Canada / Ontario	Grasses, Ferns, Herbaceous, Shrubs, Trees, Vines
Online Plant Guide http://onlineplantguide.com/Index.aspx	USA	Grasses, Ferns, Herbaceous, Shrubs, Trees, Vines, Ornamental
North American Native Plant Society http://www.nanps.org/plant/plantlist.aspx	N. America / Ontario	Grasses, Ferns, Herbaceous, Shrubs, Trees, Vines
University of Connecticut http://www.hort.uconn.edu/plants/	USA	Shrubs, Trees, Ornamentals

2.3.4 SUPPLY ISSUES

Nomenclature of the horticultural trade tends not to keep up with the changes in scientific names which occur periodically; this can cause confusion due to multiple synonyms. For example, many aster and goldenrod species have been reclassified in the past decade and have been assigned scientific names that are still not recognized by horticulturalists. Confusion also arises when using common names, which can vary over time and across geographic regions. The involvement of a trained botanist in selecting and checking plant material identification may assist in avoiding substitution with inappropriate species. The local Conservation Authority can also be contacted for

[10] Source: Credit Valley Conservation, 2002. Plants of the Credit River Watershed. http://www.creditvalleyca.ca/programsandservices/downloads/PlantsComplete.pdf based on Varga, *et al*. 2000, and Kaiser, J. 2001. The Vascular Plant Flora of the Region of Peel and the Credit River Watershed.
[11] *Ibid*.
[12] Source: Natural Heritage Information System. S1 – S3 species.

guidance on selecting local nurseries which may provide suitable plant material (refer to CVC publication *Native Plant Nurseries and Seed Sources*).

Some of the plants listed in the Master Plant List for LID Practices (*see Section 4*) may not be readily available from local nurseries. Specialized site conditions associated with LID practices may make it worthwhile to find a unique source for a desired plant. However, as LID practices become more common in the urban landscape, nurseries will begin to supply the demand for tried and proven species.

2.4 LANDSCAPING MATERIALS

2.4.1 SOILS

Some practices like bioretention and green roofs will require soil mixes from suppliers; while others, like filter strips and grass swales, may require only native soils or compost amended native soils. The factors to consider in determining a suitable soil mix for a vegetated stormwater practice include the following:

- Ability to support and sustain selected species
- Ability to dewater within the design time
- Ability to remove the targeted pollutant load
- Life cycle and durability of the media
- Media cost and availability

Recommendations for soils used in typical LID landscapes are provided below are provided in the individual LID practice sections. In general, loamy sand and sandy loam soils are preferred.

For practices with engineered soil mixes, the mix should come from a supplier that can certify that the mix contains the proper proportions of sand, fines, and organic content. Engineered soils mixed on site have been found to be inconsistent and are often responsible for LID practice failures.

Compost Amendments - For soil amendments or enhancements, substitute organic matter from local (municipal or regional) compost sources which is more environmentally sustainable. Avoid the use of peat which is a non-renewable resource extracted from natural areas. Do not apply compost that smells of ammonia as it has not fully matured and plants will not grow in it. Mature compost will smell earthy or like a forest.

Bioretention Soil Media - Bioretention and dry swale practices can be effective at removing nutrients, nitrogen and phosphorous, however their performance is highly dependent on the characteristics of the soil media. The recommended bioretention soil media mixture is:

Component	Percent by Weight
Sand (2.0 to 0.050 mm dia.)	85 to 88 %
Fines (< 0.050 mm dia.)	8 to 12 %
Organic matter	3 to 5 %

The filter media soil mixture should have the following properties:

- The recommended Phosphorus soil test index value is between 10 to 30 ppm (Hunt and Lord, 2006). Visit the Ontario Ministry of Agriculture, Food, and Rural Affairs website (www.omafra.gov.on.ca) for information on soil testing and a list of accredited soil laboratories.
- Soils with cationic exchange capacity (CEC) exceeding 10 milliequivalents per 100 grams (meq/100 g) are preferred for pollutant removal (Hunt and Lord, 2006).
- The mixture should be free of stones, stumps, roots, or other similar objects larger than 50 mm.
- For optimal plant growth, the recommended pH is between 5.5 to 7.5. Lime can be used to raise the pH, or iron sulphate plus sulphur can be used to lower the pH. The lime and iron sulphate need to be uniformly mixed into the soil (Low Impact Development Center, 2003a).
- The media should have an infiltration rate of greater than 25 mm/hour.

Figure 4. Bioretention soil. (Source: CVC)

Topsoil - Specify that topsoil must be friable, neither heavy clay nor of a very light sandy nature. An example of sandy loam topsoil is 60 % sand, 25 % silt, 10 % clay, organic matter 5 % and pH value of 6 - 7.5. Topsoil must be capable of sustaining vigorous plant growth and to be free from subsoil, roots, vegetation, debris, toxic materials and stone over 50 mm diameter. Specify that topsoil sample must be provided to the consultant for testing and analysis including herbicide or atrazine content. All topsoil supplied must conform to a sample provided. Minimum topsoil depth is 150 mm for turf areas and ranging to 1.25 m for perennials, shrubs and trees.

Avoid creating a "bathtub" effect where isolated areas of coarser soils or loamy sands are surrounded by fine soils or clay. The design engineer and landscape architect should review both subsoil and topsoil materials for compatibility of compactness and texture in planting areas of the LID Practice. Methods, such as soil amendment and preparing a larger planting bed, may be required to prevent discontinuous soil layers. In bioretention practices with a loamy sand soil media placed in clay soil textures, an underdrain is necessary.

2.4.2 MULCH

Mulch is an essential functional component of many LID practices. Mulch assists in reducing soil erosion, retaining moisture for the plant material, moderating soil temperature, preventing surface sealing and reducing colonization by opportunistic weed species. Wood mulch allows for the cation exchange that occurs in the upper organic layer of the soil capturing heavy metals.

Avoid the use of stone as a cover for vegetated practices. While stone is a low maintenance surface treatment, it hinders the addition of plant matter and formation of topsoil in the practice and will not provide the same treatment benefits as mulch. Also, the stone can be problematic for maintenance if it migrates into the soil. See section 2.4.3 for guidance on the use of stone in vegetated LID practices.

The use of landscape fabric is a common method of reducing weed species in many landscapes. However because landscape fabric is likely to become clogged with sediment in an LID facility, it is therefore not recommended.

Shredded hardwood bark mulch should be used as it provides a good humus layer and has a lower likelihood of floating away. This type of mulch should be applied on the surface of bioretention practices at a minimum depth of 75mm, and added to cover bare areas in order to avoid erosion. Mulch should only be removed and replaced when contamination has become a concern, when clogging has occurred, or when surface storage volume has been reduced.

Figure 5. Left: River run stone used to create a dry channel effect for a residential downspout disconnection. (Source: Freeman & Associates, 2008) Right: River run stone used in a xeriscape and bioretention landscape at York University. (Source: York University, 2010)

2.4.3 STONE

Stone or gravel can serve as a low maintenance decorative feature, but it may also serve many practical functions in an LID practice. Typical stone functions in LID and direction on selection are provided in the table below:

Function	Recommended Specification
Use as a subsurface storage layer for stormwater and to surround the underdrain or subdrain	▪ 50 mm diameter clear stone should be used and should be washed and free of all fines. ▪ The depth of the gravel subsurface storage layer is a minimum of 300 mm and the underdrain is set at least 100 mm above the bottom to provide a minimum infiltration volume. ▪ A 100 mm pea gravel choking layer and optional drainage geotextile* can be used to prevent the bioretention soil from migrating into the gravel storage layer and underdrain. ▪ geotextile is not recommended around the sides and bottom of the gravel storage layer as it has been found to be unnecessary and a common cause of early clogging.
Dissipate flow and prevent erosion at inlets and outlets	▪ Angular crushed stone, which will "knit" or lock together and be less likely to shift, is recommended, however, for aesthetic purpose smooth river run stone may be desired. ▪ The stone sizing is based on flow velocities at inlets and outlets, but typically ranges between 50 mm and 250 mm. ▪ The thickness of the stone bed is twice that of the largest stone diameter. ▪ To prevent erosion of soils beneath the stone and the migration of the stone into the soil, the stone bed should be underlain by a drainage geotextile*.
Direct and spread flow throughout a large LID facility or to protect narrow channel sections where flow will concentrate	▪ While crushed stone will be less likely to shift, river run stone may be used to create a dry stream bed look. ▪ The sizing of the gravel will depend on the expected velocities

*See the LID Guide for specifications on choosing drainage geotextiles.

2.5 PLANTING PLANS & SPECIFICATIONS

For professional projects that are, beyond the scope of a simple homeowner designed and constructed rain garden, the consultant must prepare planting details and specifications that reflect the specific municipal and agency requirements. A qualified landscape architect should prepare documents in coordination with engineering design, including tender documents that encompass site development, soil preparation and earthworks. Plans are prepared on a site specific basis, incorporating planting layout, species composition and spacing. In addition, landscape plans should include construction details and pertinent notes specifying site supervision, monitoring and maintenance.

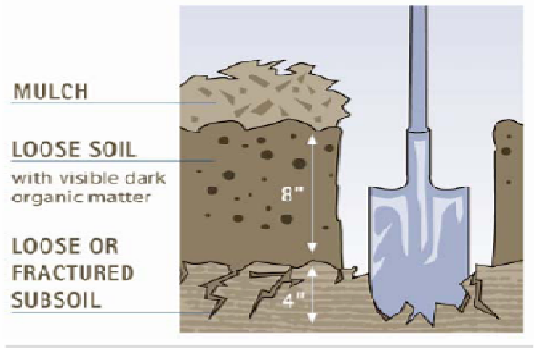
Early initiatives and successes are more likely to be public, commercial or industrial

applications as there is a higher requirement for landscape professionals to be involved and usually a greater opportunity to control and monitor initiatives. Contracts for LID practices may need to be structured slightly differently than a standard construction contract in order to address the long term function of the LID practice, including provision for securities and an extended warranty period.

2.6 CONSTRUCTION

Construction differs from one LID practice to another. However, the commonalities are:

Topsoil Preservation/Stockpiling - It is important to preserve soil structure whenever possible. Sites should be designed to take advantage of the existing topography and native soil horizons and avoid unnecessary grading and soil disturbance. Site topsoil and imported topsoil should be stored outside of LID practice areas. In addition, after periods of storage, the viability of the stockpiled soil to support plant growth should be tested prior to use and/or application.



Soil amendment sizing criteria:
impervious area / soil area = 1
– use 100 mm compost, till to 300 - 450 mm depth
impervious area / soil area = 2
– use 200 mm compost, till to 300 - 450 mm depth
impervious area / soil area = 3
– use 300 mm compost, till to 450 - 600 mm depth
Compost should consist of well-aged (at least one year) leaf compost. Amended soil should have an organic content of 8-13% by weight or 30-40% by volume.

Figure 6. Soil amendment guidelines (Source: Soils for Salmon, 2005)

Minimize Compaction and Clogging - Maintaining the qualities of soil permeability, which is integral to the function of most LID practices, is critical. Construction traffic and the storage of materials should be limited to areas that are not designated to provide infiltration capacity. Construction sediments should also be directed around and away from these areas as the fines will reduce the infiltration capacity. Construction crews need to be educated on the importance of protecting areas; hazard or protection fencing can be used as a deterrent; infiltration facilities should be installed toward the end of construction. Sometimes compaction is unavoidable and the following remedial actions can be taken:

- Removal of upper layer: If sediment has collected in an infiltration area or fines have migrated into the upper layer of the soil, then this material should be removed and moved to a location onsite where it can be stabilized.
- Deep tillage or scarification: In areas where compaction has occurred, the soils can be tilled or scarified to a depth of 150 mm to 300 mm.
- Soil Amendment: For practices not using the bioretention mix, compost soil amendments can be used to increase the infiltration and storage capacity of the soil. Local aged municipal compost is recommended

Erosion Control - Prolonged exposure of surface soils should be avoided, and the smallest practical area of land should be exposed at any one time during development.

The erosive forces of water in LID practices have the capacity to remove seeds and seedlings before they have the opportunity to become established. Several options exist for reducing erosion and the displacement of plant material depending on the individual LID practice. These options include*:

- Establishment of a nurse crop (or cover crop). Nurse crops are annual plants such as oats or ryegrass that germinate and grow quickly, thus holding the soil in place long enough for the native seeds to germinate.
- Application of Terraseeding[tm] to foster early germination. Laying out biodegradable mesh blankets or lockdown netting that is embedded with a specified seed mix and compost is an option for zones that are particularly prone to erosion.
- Installation of a mulch layer incorporated into some practices will provide surface soil stability, deter weeds and hold moisture in the soil.
- Sod can be used for stabilization. In addition to being compatible with the site soils, the sod should comply with standards and classification of Turfgrass Sod for Ontario, by Nursery Sod Growers Association of Ontario.

Plant Installation - Plantings should be installed as soon as possible upon completion of the grading and installation of drainage structures. In addition to the planting plan, plant installation details for herbaceous plants, shrubs and trees should be followed per municipal and landscape industry standards, specifications, and guidelines. Avoid staking unless necessary (ie. vandalism or high wind exposure). If staked, then the ties should be a biodegradable web or burlap and removed after the first growing season. If any plant substitutions are required, then the contractor or contract administrator should defer to the designer or municipal agency to make the substitution.

Quality Control - Supervision by a landscape architect or professional engineer during installation is recommended. They should certify that the feature has been installed in accordance with the specifications.

*Refer to the *Erosion and Sediment Control Guidelines for Urban Construction* by the Greater Golden Horseshoe Conservation Authorities for specific requirements.
(http://www.trca.on.ca/dotAsset/40035.pdf)

2.7 MAINTENANCE

Educational or guidance material should be provided to property owners that posses any LID practice. This material should outline how the LID practice functions, what indicators to monitor that will lead to a poorly functioning practice, and the appropriate maintenance activities required to ensure the functional integrity of the LID practice. As an example, a fact sheet or manual may be required to address land owner responsibilities associated with the LID practices within subdivisions or municipal easements.

The effectiveness of all LID practices is dependent on the success of the initial design, frequent monitoring and continued maintenance. Care must be taken in selecting plant species, assuming for a minimal level of maintenance as operational practice (see *Section 4: Master Plant List for LID Practices*). This minimum level still dictates that several activities must be implemented to sustant the the plantings. The following table lists items that the professional practitioner should address in the course of preparing the

design and management plan.

SITE MAINTENANCE ACTIVITIES TO BE CONSIDERED*	FREQUENCY
Watering	As required to become established; drought conditions. to ensure survival through variations in climate
Replacement of Plant Material	As required for material that is dead or in poor condition.
Removal of Unwanted Species by Hand	Twice annually (minimum) and as identified during site monitoring.
Turf maintenance	Mowing - As required to maintain appropriate height (60 mm or greater). If mowing meadow features, the timing should be after flowering, bird nesting and after migration of butterflies occurs in fall. Renovate - Bare spots can be addressed with topdressing, reseeding, overseeding or sod replacement.
Pruning and staking	Maintenance as required following arboriculture and horticulture practices appropriate for the plant species. If stakes are used, then remove after one year.
Treatment of Disease in Trees & Shrubs	As required, using integrated pest management and industry standards
Addition of Mulch / Amendments	Annually if required to cover bare soil and prevent weed growth. Soil to be tested to identify deficiencies in soil nutrients and amended. Fertilization should be avoided.
Removal of Litter	As required to maintain functions and site aesthetics.
Repairing Erosion Damage	As required. The area may need to be regraded to make the slope shallow or prevent flow from concentrating in that area. The area should be stabilized with matting, straw, and/or vegetation.
Removal of Sediment	As required. Excessive deposition may indicate upstream areas that need to be stabilized. Removed sediment should be disposed of or deposited where it will not erode and can be stabilized.

*** May not apply to all LID practices.**

It is important to remember that the property owner, property management company or government agency that maintain each LID practice need to be fully aware of the maintenance requirements associated with the practice; therefore the original design and the management plan must reflect appropriate fit to the level of tolerance for maintenance.

The following provides a description of the ways to design for minimizing landscape maintenance:

- Understand the requirements and growth habit of plants before they are included in

the design;

- Utilize plants that achieve a desired form naturally, rather than requiring pruning;
- Use mulch or groundcovers to maintain moisture levels and reduce the need for watering and mowing;
- Choose species that are drought-resistant and/or salt-tolerant;
- Perform maintenance activities regularly to address issues when they are still small;
- Examine the characteristics of plants for potential maintenance issues (ie. dropping fruits, weak branches, etc.);
- Bear in mind that trees generally require less maintenance than shrubs, while shrubs require less maintenance than perennials.

Any garden or planted landscape changes over time. What is planted at the outset grows, some plants are more successful than others, weeds enter the system, and pests and disease can damage certain species. These issues need to be monitored, and the degree to which these changes can be tolerated determines the level of maintenance.

2.7.1 PLANT SUCCESSION & WEED CONTROL

Because vegetated LID practices are living entities, goals related to aesthetics and function can be defined for the evolution of the vegetation community immediately after construction, then at the two-, five-, and ten-year marks. At the outset, plants need to become quickly established to achieve ground cover and soil stability. Over time this vegetation community will change, whether through active management or natural succession. The reasons for the change can be due to residual seed bank material left within the soil, birds bringing in seed, or the competition between the installed plants. The final suite of species within the LID practice may not be those that were originally planted. However, it is important that the plant material reflects both the functional and aesthetic intent of the design.

Competing terrestrial species will be inhibited by shallow flooding. However, flooding can create an environment that allows certain invasive species to thrive. Species such as reed canary grass (*Phalaris arundinacea*) and purple loosestrife (*Lythrum salicaria*) have been known to dominate facilities that receive stormwater. Some native plants can co-exist with these invasive species; however a regimented management plan for weeding out invasive species is necessary if the goal is to maintain the majority of planted species.

Generally, any unwanted vegetation that is established on a site is considered to be a weed. For the plantings within LID practices, weeds are plants that are invasive in nature and which do not add to the function or desired aesthetics of the planting design. Weeding is required once a year as a minimum, however higher profile sites could require greater attention. Annual mowing of grassed/meadow plantings reduces the establishment of woody material. Mowing should be done after the release of plant seeds in the fall. Mowing reduces the biomass accumulation atop the soil surface. All other weeding should be done manually in order to avoid damaging the existing vegetation.

Ontario's cosmetic pesticides ban took effect April 22, 2009 and supersedes any existing municipal by-law restricting the use of certain pesticides. The details of the ban are identified in Ontario Regulation 63/09 made under the *Pesticides Act* which has been amended by the *Cosmetic Pesticides Ban Act, 2008*.

Exemptions may be granted for: public health and safety, agriculture, forestry, natural resource management, arboriculture, the management of golf courses and specified sports fields, etc. Generally, banned pesticides would not be able to be used in areas where the public have regular access and potential exposure. Where exemptions are allowed for certain activities specific conditions must be met. More details on the ban and how it applies to particular sectors (landowners, municipalities, etc.) are available at: http://www.ene.gov.on.ca/en/land/pesticides/factsheet-pesticides.php

Natural ways of caring for natural and manicured features applicable to LID practices are available on the Ministry of the Environment's website noted above. By designing with the ecology of a site in mind, the need for pesticide and herbicide applications may be avoided while making local communities healthier places to live and work.

2.7.2 NUTRIENT MANAGMENT

Traditionally, landscaped areas have been over-fertilized, which adds harmful nutrients to stormwater runoff. Application of nutrients and minerals should not be undertaken without the results of soil testing and avoided within all LID practices. There are organic lawn care options to support healthy soils and vegetation (ie. aeration, top dressing, and overseeding) that can be used to augment soil fertility in place of synthetic fertilizers.

Nutrients can accumulate over time in an LID practice. This can result in a change in species composition. Plant species (such as reed canary grass) that thrive in nutrient-rich environments can take over if nutrients such as phosphorus accumulate in the system. Vegetation plays an important role in cleaning the water by removing nitrogen and organic carbon. Mowing and removing the debris of vegetation after seeding in the autumn is an excellent way to remove biomass, and thereby manage nutrient levels in LID Practices. This debris can be composted off-site.

2.7.3 WILDLIFE ISSUES

LID practices are not designed to function as, or replace, natural wildlife habitat. In many cases however, wildlife will be likely attracted LID practices and this can have implications on the vegetated components of the feature and their function.

Plantings of young seedlings and saplings are palatable for small mammals and deer. Effective strategies for protecting an LID feature from herbivory by larger mammals may include creating enclosures with fencing. Small mammals such as squirrels, mice or voles will not be deterred by fencing, but planted stock can be protected through the use of rodent guards. Geese are often a nuisance in urban areas and will be attracted to areas with short grass and turf. Infrequent mowing of turf and tall grasses can decrease the attractiveness of a site to geese. Landscaping with native species can have a positive effect on wildlife as well. Native plant species have co-evolved with the local insects, butterflies, birds and other wildlife and provide resources, especially in urban areas where natural habitat is scarce.

3 INDIVIDUAL LID PRACTICE PLANTING GUIDANCE

Each of the LID practices that utilize plants as an essential component of their design is described in this section. The information provided is relevant to landscape architects but also overlaps with information relevant to engineering design and provided in the LID Guide. The information for each vegetated LID practice is addressed using the following structure:

1. Practice Criteria: Site Characteristics, Plant Selection, Plant Standards
2. Construction and Planting Guidance
3. Maintenance Guidance
4. Plant List

3.1 GREEN ROOFS

There are two main types of green roofs, intensive and extensive. *Intensive* green roofs have a deep planting bed and can support deeply rooting vegetation as well as pedestrian traffic. This section will solely discuss planting considerations for extensive green roofs. *Extensive* green roofs have a porous, light-weight planting medium of shallow depth (40 mm to 200 mm) suitable for a limited number of grass and herbaceous species. Growing medium for extensive roofs varies widely and includes proprietary blends, sand, gravel, crushed brick, compost or organic matter. Extensive green roofs are intended to capture precipitation and roof runoff, require little maintenance, and are designed to succeed with minimal irrigation. It should be noted that successful green roof applications not only input from a structural engineer is required, but also from landscape architects and landscape contractors experienced with this type of project.

Figure 7 – GO Transit bus facility *extensive* green roof installation with pre-grown mats, Mississauga, ON (Source: CVC)

Figure 8 – An extensive green roof was installed on the podium level of the Toronto City Hall. Fully vegetated trays with 3" soil depths supporting low growing plants like sedums and 6" trays supporting grasses and flowering plants were used in the construction of the green roof. (Source: CVC)

Figure 9 – An extensive green roof planted with grasses on the roof a condominium building in Mississauga, ON. (Source: CVC)

GREEN ROOF CRITERIA	
SITE CHARACTERISTICS	▪ Vegetation must survive extreme microclimates, including high wind velocities, cold winter temperatures that are not moderated by the ambient heat stored in the ground, and drought. ▪ Plants must be adapted to shallow well drained soil conditions. ▪ Conditions most closely resemble the ecology of alpine/sub-alpine, shoreline, and alvar ecosystems. ▪ Aesthetics must consider that the practice may be viewed from above or incorporated into a terrace feature.
PLANT SELECTION	▪ Non-native vegetation may be considered due to harsh conditions ▪ Drought tolerant through some means other than roots as the planting medium is so shallow, such as succulent species. ▪ Plants that open their stomates at night to exchange oxygen and carbon dioxide rather than in daytime store water most effectively. ▪ Plants that are low-growing with spreading roots will be more resistant to wind. ▪ Vegetation list is comprised of drought-tolerant, perennial and low maintenance species. The list includes a variety of sedums, wildflowers and grasses.
PLANT STANDARDS	Vegetation must meet Canadian Standards for Nursery Stock, Eighth Edition and Nursery Sod Growers Association of Ontario Specifications.

GREEN ROOF CONSTRUCTION AND PLANTING GUIDANCE	
SITE PREPARATION	▪ Before construction, a structural engineer must confirm that the load bearing capacity of the building structure and roof deck are sufficient to support the weight of the soil, vegetation and accumulated water or snow, and, if applicable, pedestrians, concrete pavers, etc. ▪ The waterproof membrane must be fully tested before any other layers are applied.
GROWING MEDIUM	▪ The growing medium is usually a mixture of sand, gravel, crushed brick, compost, or organic matter combined with soil. The mix should consider the receiving water as compost and organic matter may leach nitrogen and phosphorus. ▪ Medium depth ranges from 40 to 150 mm.
PLANTING	▪ Several different types of pre-grown mats are available for green roofs which will provide instant vegetative coverage. ▪ Plant material should be free of disease, insects, defects or injuries and structurally sound with strong fibrous root systems; roots should be pruned regularly, but not later than one growing season prior to arrival on site. ▪ If seeding the feature, then seed mixes should be in accordance with Government of Canada Seeds Act and Regulation. To ensure plant coverage within the first year, the City of Toronto green roof construction standard proposes that the green roof should be planted by a seeding rate of 325 seeds/m^2, or cuttings distributed not less than 12kg/100m^2, or pre-grown plugs installed at not less

	than 11 plugs/m^2.
ESTABLISHMENT	▪ The first 2 to 3 weeks is critical to help establish plants and roots. ▪ A warranty on the vegetation should be included in the construction contract. ▪ Plants should be replaced as needed to ensure complete coverage and not just at the end of the warranty.
Note: Construction will depend on whether the green roof is constructed from a modular system or a conventional green roof assembly. A qualified green roof installer must be consulted.	

GREEN ROOF PLANT MAINTENANCE GUIDANCE	
FERTILIZER	▪ To avoid the export of nutrients the soil media should be tested before any fertilizer is applied. ▪ If fertilizer is necessary, then a coated controlled release fertilizer should be used.
PLANT HEALTH	▪ Weed biweekly to monthly for the first 2 years, pulling any species that were not planted intentionally. After two years, weeding twice annually may be sufficient. Particular attention must be paid to remove woody species seedlings to avoid damage from roots to the green roof membrane. ▪ Reseed/replant as needed, ensuring complete coverage. If the species is not surviving under the conditions, then alternative species should be considered.
WATERING/ IRRIGATION	▪ The system should be able to survive without irrigation during a typical rain year. ▪ Adequate measures are to be taken to water plantings to ensure establishment and survival through extended periods of drought.

3.1.1 GREEN ROOF PLANT LIST

Consult the Master LID Practice Plant List for a full listing of plant characteristics, tolerances and other information to inform your selection of species from the list below.

Nativeness and Rarity Ranking:	
♦♦♦♦	Best Choice
♦♦♦	Better Choice
♦♦	Selective Choice
♦	Selective Choice
NN	Reasonable Alternative (Non-Native)

Nurse Crop

NN *Lolium multiflorum*

Graminoids

♦♦♦♦	*Danthonia spicata*	♦♦	*Sorghastrum nutans*
♦♦♦♦	*Deschampsia cespitosa*	♦♦	*Sporobolus neglectus*
♦♦	*Schizachyrium scoparium (Andropogon scoparius)*		

Broadleaf Herbaceous			
♦♦♦	*Achillea millefolium ssp. Lanulosa*	♦♦	*Penstemon hirsutus*
♦♦♦	*Allium schoenoprasum* var. *sibiricum*	♦♦	*Potentilla anserina*
	Antennaria spp.	♦♦♦♦	*Rudbeckia hirta*
♦♦♦♦	*Aquilegia canadensis*	NN	*Sedum album*
NN	*Boltonia asteroides*	NN	*Sedum hybridum*
♦♦♦	*Cerastium arvense* ssp. *strictum*	NN	*Sedum reflexum*
♦♦	*Desmodium canadense*	NN	*Sedum sexangulare*
♦♦	*Erigeron pulchellus*	NN	*Sedum spurium*
♦♦♦♦	*Euthamia graminifolia*	♦♦	*Sisyrinchium montanum*
♦♦♦♦	*Fragaria virginiana* ssp. *virginiana*	♦♦♦♦	*Solidago altissima* var. *altissima*
♦	*Geum triflorum*	♦♦♦♦	*Solidago canadensis* var. *canadensis*
♦	*Heliopsis helianthoides*	♦♦♦♦	*Solidago nemoralis* ssp. *nemoralis*
♦♦♦♦	*Impatiens capensis*	NN	*Stachys byzantina*
♦	*Trichostema brachiatum (Isanthus brachiatus)*	♦♦♦♦	*Symphyotrichum ericoides* var. *ericoides*
♦♦♦♦	*Monarda fistulosa*	NN	*Thymus serpyllum*
♦	*Solidago ptarmicoides(Oligoneuron album)*	♦♦	*Verbena stricta*
♦	*Opuntia fragilis*	♦♦♦♦	*Verbena urticifolia*
♦♦♦	*Packera paupercula*		

Shrubs*			
♦	*Arctostaphylos uva-ursi*	♦♦♦	*Juniperus horizontalis*

*These shrubs are low growing and are suitable for shallow soils

Trees and vines are not recommended for extensive green roofs

3.2 BIORETENTION

Bioretention cells act as filters with plants, capturing and temporarily storing stormwater, and treating the runoff by passing it through a filter bed. The designed ponding depth is from 150-250 mm, with most of the water being stored in the voids within the soil and gravel layers. There should be no surface water ponding after 24 hours and water within the media should drain between 48 and 72 hours. Therefore there is frequent inundation (depending on the season and year), but the facility is otherwise well drained. The five types of bioretention discussed below are:

3.2.1 Bioretention Cells
3.2.2 Extended Tree Pits
3.2.3 Stormwater Planters
3.2.4 Rain Gardens
3.2.5 Curb Extensions

The site and plant characteristics for each bioretention type are provided below. The construction and maintenance guidance and plant list, which applies to all types, is provided at the end of the section.

3.2.1 BIORETENTION CELLS

A common characteristic of bioretention cells is that they have shallow earthen slopes, less than 2H:1V. The design of a bioretention cell allows for several different planting zones, see Figure 6. Bioretention cells are suited for institutional, commercial, industrial, and residential multi-unit/multi-story landuses. They are can be sited in large landscaped areas, parks, parking lot islands, or any areas where there is space for shallow earthen slopes and the multi-zone planting aesthetic is appropriate.

Figure 10 – Bioretention cell at York University, Toronto, ON (Source: TRCA)

Figure 11 – Courtyard bioretention cells (Source: City of Portland Bureau of Environmental Services)

Figure 12 – Bioretention planted with ornamental grasses, Brisbane, CA. (Source: CVC)

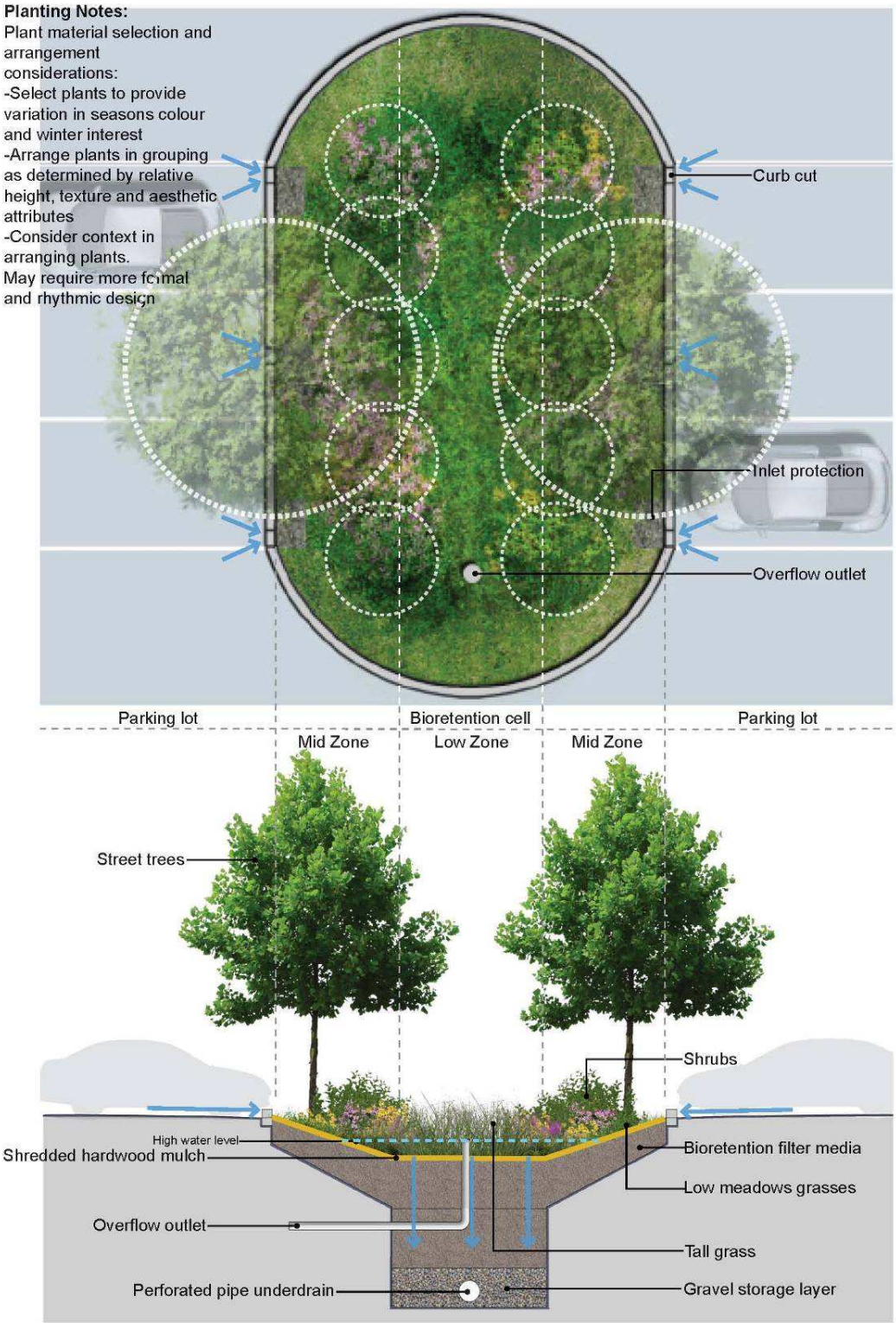


Figure 13 - Bioretention cell plan view and cross-section; sizing and layout guidance is provided in the LID Stormwater Management Planning and Design Guide.

BIORETENTION CELL CRITERIA		
	GENERAL CRITERIA	**HYDRIC ZONE CRITERIA**
SITE CHARACTERISTICS	Drainage Areas (2 basic categories): 1. Exposure to roadway or parking lot runoff ▪ Runoff is contaminated with deicers and vehicle pollutants. 2. No exposure to roadway or parking lot runoff Soil Conditions: ▪ Bioretention soil specification: 85-88% sand (2.0 to 0.05 mm), 8 to 12 % fines (<0.05 mm), and 3 to 5 % organic matter. ▪ Depth should be between 1.0 and 1.25 meters in depth. ▪ The sandy soil texture of the bioretention media influences plant species selection.	Low Zone– Often referred to as the extended detention or shoreline fringe area. This area is frequently inundated during storm events, and is well-drained between rainfall events. *Mid Zone* – Often referred to as the *floodfringe* area. This zone is inundated less frequently (2 – 100 year storm events) and has periodically high levels of moisture in the soil. The ecology of this zone is a transition from the Mineral Meadow Marsh/Beach-type community to an upland community. *High Zone* – Often referred to as *upland* area. The ecology of this zone is terrestrial due to its elevation in relation to the filter bed. The zone most closely resembles a Cultural Meadow or a Cultural Thicket community, depending on the mix of grasses, herbaceous material, shrubs and trees utilized.
PLANT SELECTION	1. Exposure to roadway or parking lot runoff ▪ Select salt tolerant grasses, other herbaceous material and shrubs. ▪ These can take on several forms, including parking lot islands, traffic islands, roundabouts, or cul-de-sacs and are often used as snow storage locations. 2. No exposure to roadway or parking lot runoff ▪ Practices allow for a greater range of species selection. ▪ These receive runoff from rooftops or areas that use no deicing salt and have low pollutant exposure, such as courtyard bioretention. Other selection factors: ▪ Most bioretention cells will be situated to receive full sun exposure. The 'Exposure' column in the master plant list identifies the sun exposure condition for each species. ▪ Facilities with a deeper media bed (greater than 1 m) provide the opportunity for a wider range of plant species (including trees). ▪ The inclusion of vegetation with a variety of moisture tolerances ensures that the bioretention cell will adapt to a variety of weather conditions. ▪ Proper spacing must be provided for aboveground and belowground utilities, and adjacent infrastructure.	

	Low Zone ▪ Mineral Meadow Marsh plant community ▪ Grasses, Sedges, rushes, wildflowers, ferns and shrubs that have an 'Obligate' to 'Facultative' designation ▪ Wetland 'Obligate' species that are flood tolerant as they will persist in average years and flourish in wetter years. ▪ Plants that are likely to occur in wetlands or adjacent to wetlands. ▪ Plants with dense root structure and /or vegetative cover are favoured for their ability to act as pollution filters and tendency to slow water velocity ▪ Be advised these practices are not constructed wetlands and are designed to fully drain within 48 hours.
	Mid Zone ▪ Plants able to survive in soils that are seasonally saturated, yet can also tolerate periodic drought. ▪ Species include grasses and groundcovers, as well as low shrub species.
	High Zone ▪ Plants should have deep roots for structure, be drought-tolerant and capable of withstanding occasional soil saturation. ▪ Trees and large shrubs planted in this zone will aid in the infiltration and absorption of stormwater. ▪ This area can be considered a transition area into other landscape or site areas. ▪ A variety (min. five) species should be used to prevent a monoculture.
PLANT STANDARDS	Vegetation must meet Canadian Standards for Nursery Stock, Eighth Edition. Seed planting is not recommended for bioretention. Plants should be container grown, balled and burlapped or wire basket. Below are recommended minimum plant sizes for planting. **Deciduous Trees -** 60 mm calliper **Coniferous Trees** - 175 cm height **Deciduous Shrubs -** 60 - 80 cm height **Coniferous Shrubs / Broadleaf Evergreens** - ▪ 40 cm height and spread for dwarf type ▪ 60 -80 cm height or spread for medium form type; ▪ 25 cm root ball for spreading form type; ▪ 80 - 100 cm height for columnar form type **Perennials/Grasses -** #1 or 1 gal. container stock **Vines -** #1 or 1 gal. container and staked

3.2.2 EXTENDED TREE PITS

Extended tree pit LID practices are ground-level contained planting beds within the hardscape of the road right-of-way. They service stormwater directly from roadways. The function of the vegetation in extended tree pits is to provide structure for the streetscape, to absorb and filter stormwater, and to discourage people from walking on/compacting the soil of the tree pits.

Figure 14 – Extended tree pit bioretention designed to capture street runoff (Source: City of Portland Bureau of Environmental Services)

Figure 15 – Extended tree pit with protective fencing in Lansing, MI (Source: CVC)

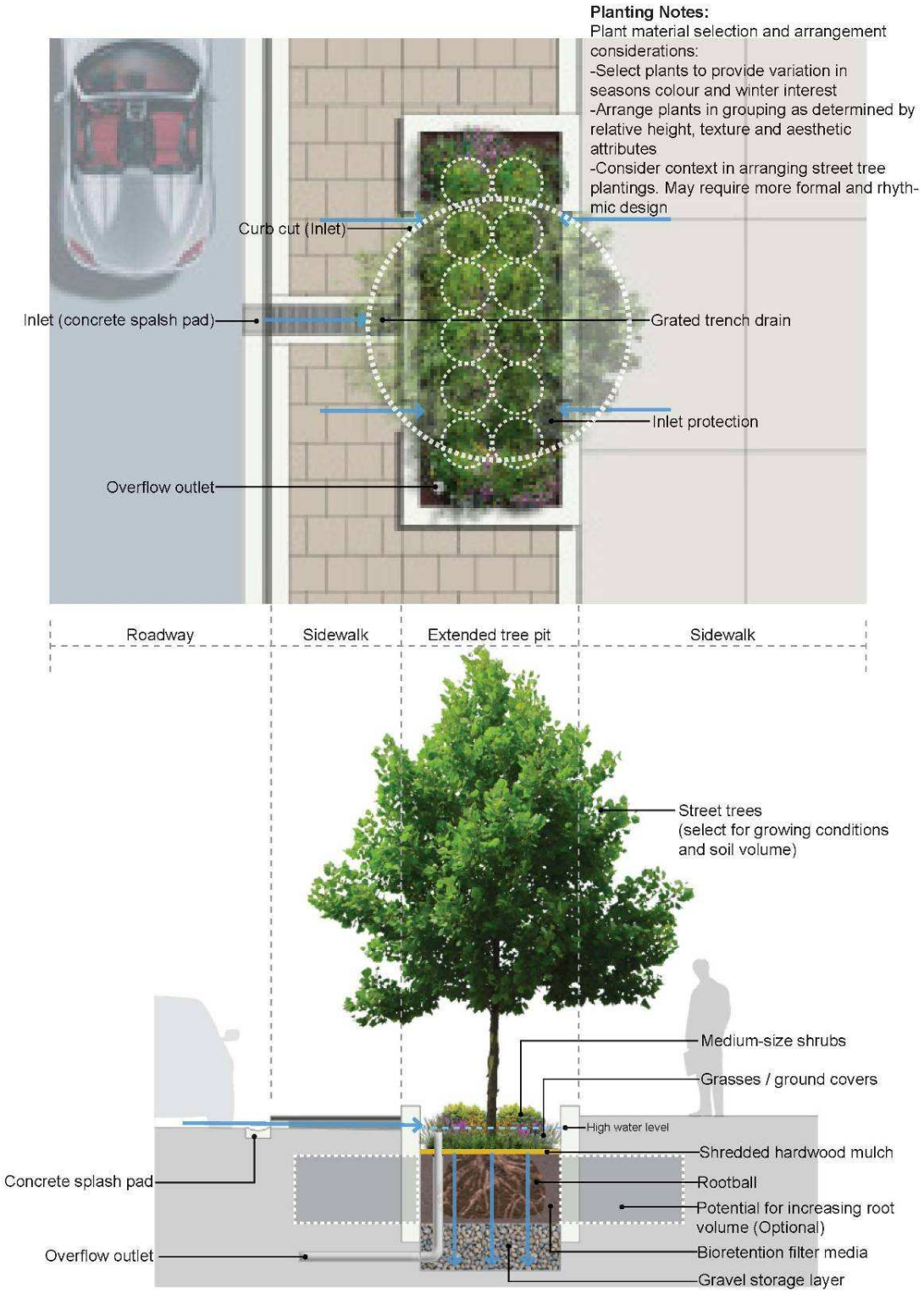


Figure 16 – Extended tree pit plan view and cross-section; sizing and layout guidance is provided in the LID Stormwater Management Planning and Design Guide.

EXTENDED TREE PIT CRITERIA	
SITE CHARACTERISTICS	▪ Due to the location within the urban landscape, the design aesthetic should be relatively formal. ▪ The visibility at pedestrian or driver eye level must not be obstructed by vegetation. ▪ The selection of tree species should additionally consider any overhead structures such as wires, lighting standards, or signage to avoid interference. ▪ The surface shape of the bioretention needs to be wide enough to allow stormwater to spread evenly over the surface. If the space is too narrow, then a mature tree with thick surface roots may hinder the flow of stormwater in the pit. Soil condition ▪ Bioretention soil specification: 85-88% sand (2.0 to 0.05 mm), 8 to 12 % fines (<0.05 mm), and 3 to 5 % organic matter. ▪ Irrigation and drainage systems are recommended for tree pits to maintain appropriate moisture levels for tree survival. The soil medium should not remain waterlogged for extended periods, as effective soil volume will be greatly reduced if anaerobic condition Tree growth and longevity is limited mostly by the availability of high quality soil. 12 cubic metres is the minimum soil volume required per tree, the soil target for larger shade trees may be greater; with some recommending minimums up to 34 cubic meters. If space for the tree pits is an issue, there are options for providing more soil volume beneath the hardscaping. Use a structural soil, a mix of open graded aggregate and planting soil, which is capable of meeting the compaction requirements for paved surfaces, allows for infiltration and growth of tree roots. Structural soils should be used to provide extra space under paved surfaces or to link up areas of natural soil that may be bisected by hardscape. Use engineered cells that hold uncompacted growing medium while providing a structural base required for hardscape. While this is a more expensive option, it shows great promise in allowing for the green infrastructure of urban areas to thrive in smaller spaces.
PLANT SELECTION	▪ An understorey can include small shrubs, adapted ornamental grasses and other herbaceous vegetation. ▪ The selected plantings must be tolerant of salt, and tolerant of other urban conditions, including polluted air & water and soil compaction. ▪ Vegetation must be able to survive prolonged dry periods unless permanent irrigation is installed.

PLANT STANDARDS	Vegetation must meet Canadian Standards for Nursery Stock, Eighth Edition. Seed planting is not recommended for bioretention. Plants should be container grown, balled and burlapped or wire basket. Below are recommended minimum plant sizes for planting. **Deciduous Trees -** 60 mm calliper **Coniferous Trees** - 175 cm height **Deciduous Shrubs -** 60 - 80 cm height **Coniferous Shrubs / Broadleaf Evergreens** - ▪ 40 cm height and spread for dwarf type ▪ 60 -80 cm height or spread for medium form type; ▪ 25 cm root ball for spreading form type; ▪ 80 - 100 cm height for columnar form type **Perennials/Grasses -** #1 or 1 gal. container stock **Vines -** #1 or 1 gal. container and staked

3.2.3 STORMWATER PLANTERS

This form of bioretention consists of raised planters that typically receive stormwater from rooftops, or hardscaped pedestrian areas. Stormwater planters have vertical sides and geometric layouts that fit in constrained ultra-urban locations.

Figure 17 –Stormwater planter accepting runoff from high density urban development, Portland, OR (Source: CVC)

Figure 18 –Lined stormwater planter accepting runoff from residential building rooftop, Portland, OR (Source: Portland Bureau of Environmental Services)

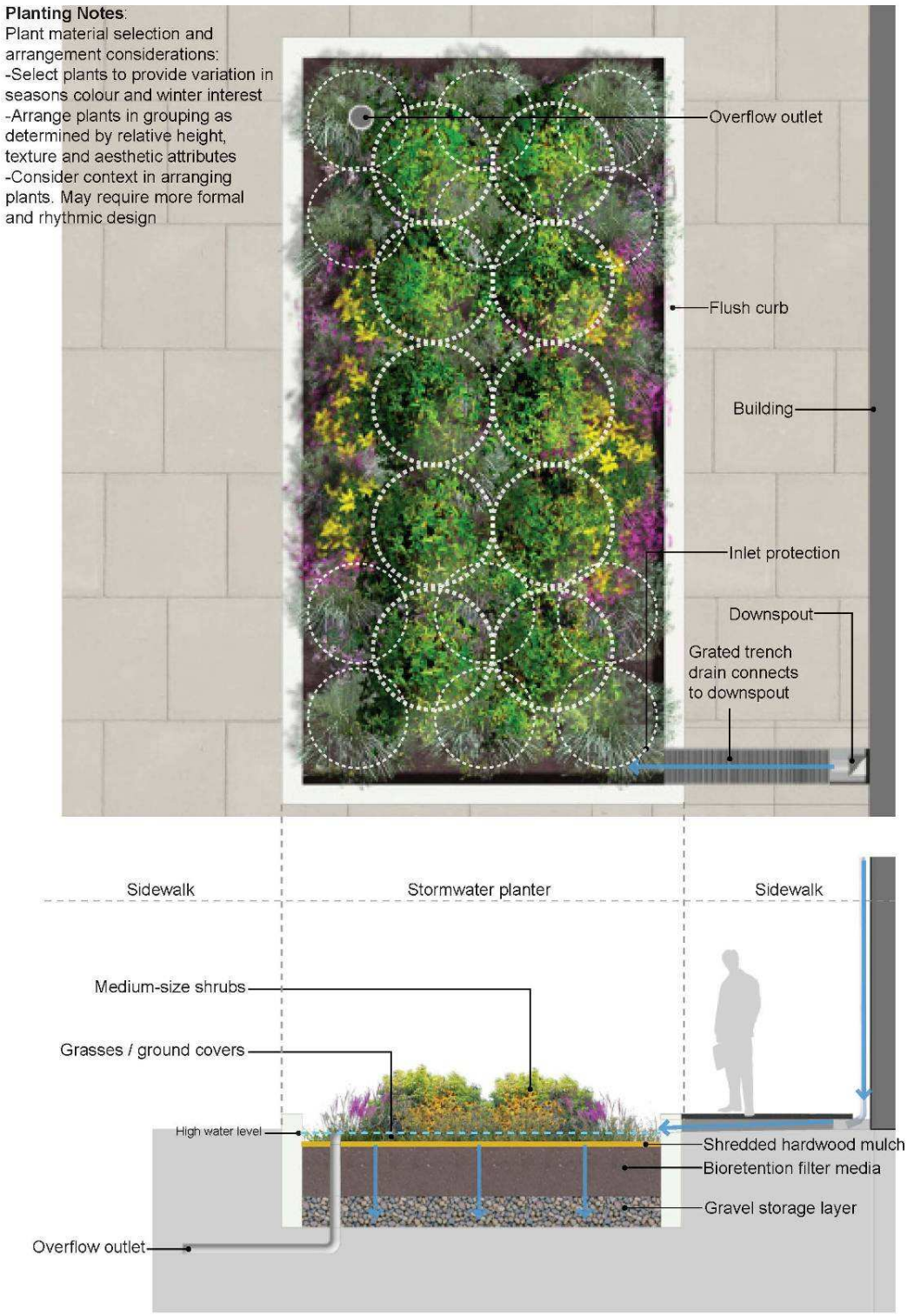


Figure 19 - Stormwater Planter plan view and cross-section; sizing and layout guidance is provided in the LID Stormwater Management Planning and Design Guide.

STORMWATER PLANTER CRITERIA	
SITE CHARACTERISTICS	▪ Planters must be designed in a way that insulates the soil through freezing temperatures, or plants species must be used that can survive the winter season in raised planters. ▪ A more formal aesthetic for the planting design is appropriate for the urban hardscape setting. ▪ If the native soils infiltrate <15 mm/hr or the practice is for filtration only, then an underdrain should be installed. Soil conditions: ▪ Bioretention soil specification: 85-88% sand (2.0 to 0.05 mm), 8 to 12 % fines (<0.05 mm), and 3 to 5 % organic matter.
PLANT SELECTION	▪ Vegetation must be tolerant of urban conditions. ▪ Vegetation must be able to sustain periodic inundation and prolonged dry periods unless irrigation and drainage are devised as part of the design ▪ Could potentially support shrubs and smaller ornamental trees.
PLANT STANDARDS	Vegetation must meet Canadian Standards for Nursery Stock, Eighth Edition. Seed planting is not recommended for bioretention. Plants should be container grown, balled and burlapped or wire basket. Below are recommended minimum plant sizes for planting. **Deciduous Trees -** 60 mm calliper **Coniferous Trees** - 175 cm height **Deciduous Shrubs -** 60 - 80 cm height **Coniferous Shrubs / Broadleaf Evergreens** - ▪ 40 cm height and spread for dwarf type ▪ 60 -80 cm height or spread for medium form type; ▪ 25 cm root ball for spreading form type; ▪ 80 - 100 cm height for columnar form type **Perennials/Grasses -** #1 or 1 gal. container stock **Vines -** #1 or 1 gal. container and staked

3.2.4 RAIN GARDENS

Rain gardens are meant to be amenities within the residential landscape. Stormwater is directed to the rain garden from the roof, the yard, and/or the driveway of a medium- or low-density residence. Rain gardens can be located in a front, rear, or side yard depending on the topography and location of the roof leaders. They are typically less engineered, with no bioretention soil media mix, although the soils may be amended to improve their storage and infiltration properties. Rain gardens can be simple retrofits undertaken by property owners or professionally designed and integrated into new developments.

Figure 20 – Residential rain garden in Maplewood, MN (Source: City of Maplewood, MN)

Figure 21 – Rain garden at US EPA building in Washington, D.C. (Source: CVC)

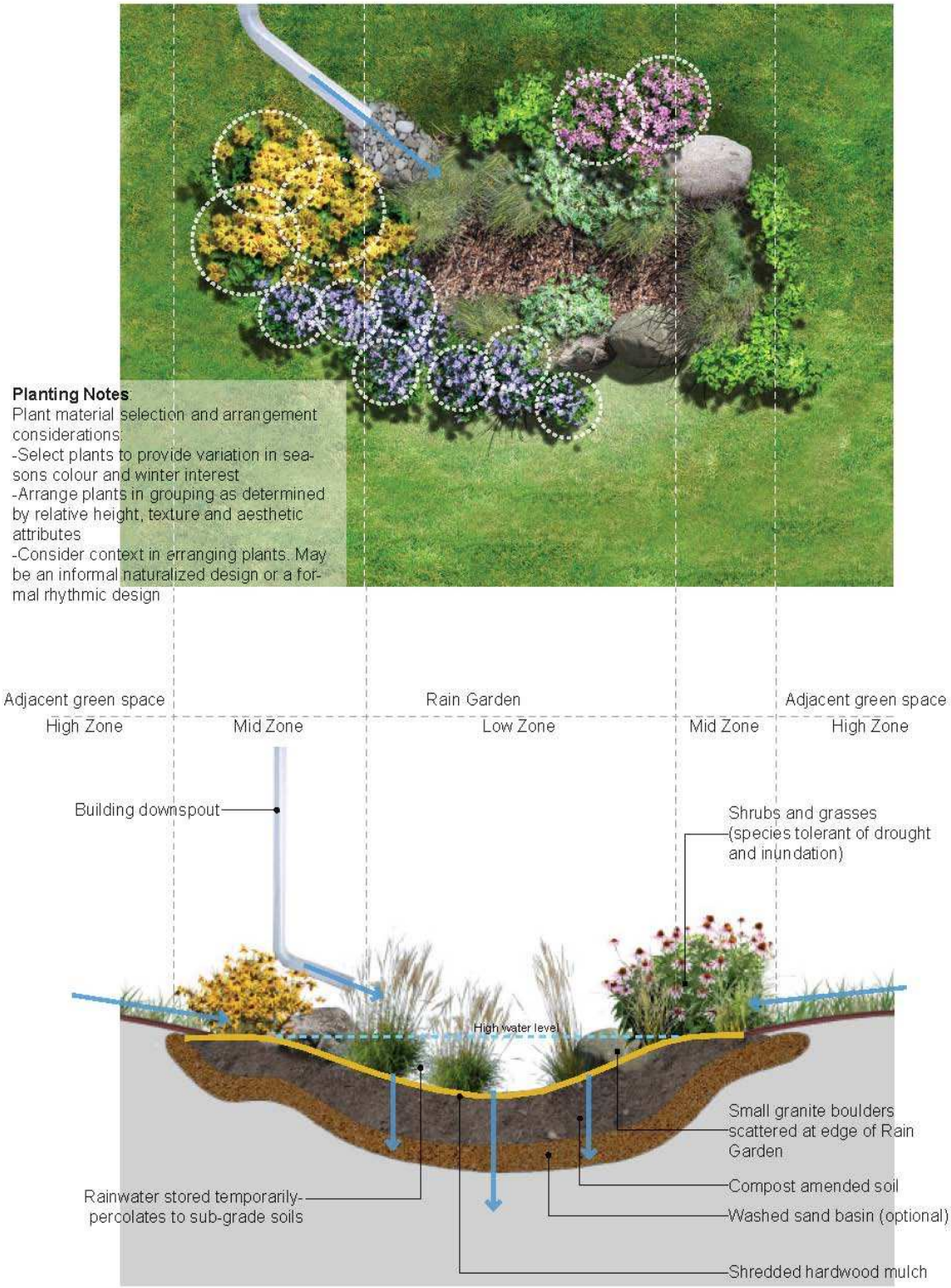


Figure 22 – Rain garden plan view and cross-section; sizing and layout guidance is provided in the LID Stormwater Management Planning and Design Guide.

RAIN GARDEN CRITERIA	
SITE CHARACTERISTICS	▪ If the bioretention soil mix is not used then the plant choice will need to take into account the existing soils which may have higher fines and organic content. ▪ The designed inundation time is 24-48 hours. If the soils are poorly drained (<15 mm/hr), then amendments of compost may increase infiltration and subsurface storage. The soil should be tilled to a depth of 300 mm and amended with compost to achieve an organic content in the range of 8-15% by weight or 30-40% by volume. ▪ If the rain garden is located within the municipal easement near the roadway, plants will need to be moderately salt tolerant. ▪ Neat edges can be established using pavers, walls or bands of turf create an attractive amenity within the residential landscape.
PLANT SELECTION	▪ A variety of plant material can be selected based on the desired aesthetic, including turf grass, ornamental grasses and perennial flowers, shrubs, and trees. ▪ The aesthetic can range from very naturalistic to quite formal, depending on the planting plan. ▪ Vegetation must also be capable of tolerating prolonged wet and dry periods unless an irrigation plan is in place ▪ If the facility is intended to be relatively inconspicuous, then the tallest plant material should be placed into the deepest part of the rain garden.
PLANT STANDARDS	Since rain gardens are typically smaller scale homeowner projects smaller stock plants may be considered. Smaller containers may be easier to purchase, transport, and plant, but it may take longer to have a fully vegetated garden. Plant material per Canadian Standards for Nursery Stock, Eighth Edition. Seed planting is not recommended for rain gardens. Plants should be container grown, balled and burlapped or wire basket. Below are recommended plant sizes for planting rain garden features. **Deciduous Shrubs -** 60 - 80 cm height **Coniferous Shrubs / Broadleaf Evergreens** - 40 cm spread (roughly #3 or 3 gal. container) **Perennials/Grasses -** 15 cm to #1 or 1 gal. container stock **Ground Cover/ Vines -** 10 cm to #1 or 1 gal. container stock

3.2.5 CURB EXTENSIONS

Curb extensions, like extended tree pits, can be installed in the road right-of-way and can also act as a traffic calming measure. Curb extensions are contained planting beds that use within the road right-of-way and that treat stormwater discharged directly from roadways.

Figure 23 – Vegetated curb extensions collecting runoff from street in downtown Indianapolis, IN (Source: CVC)

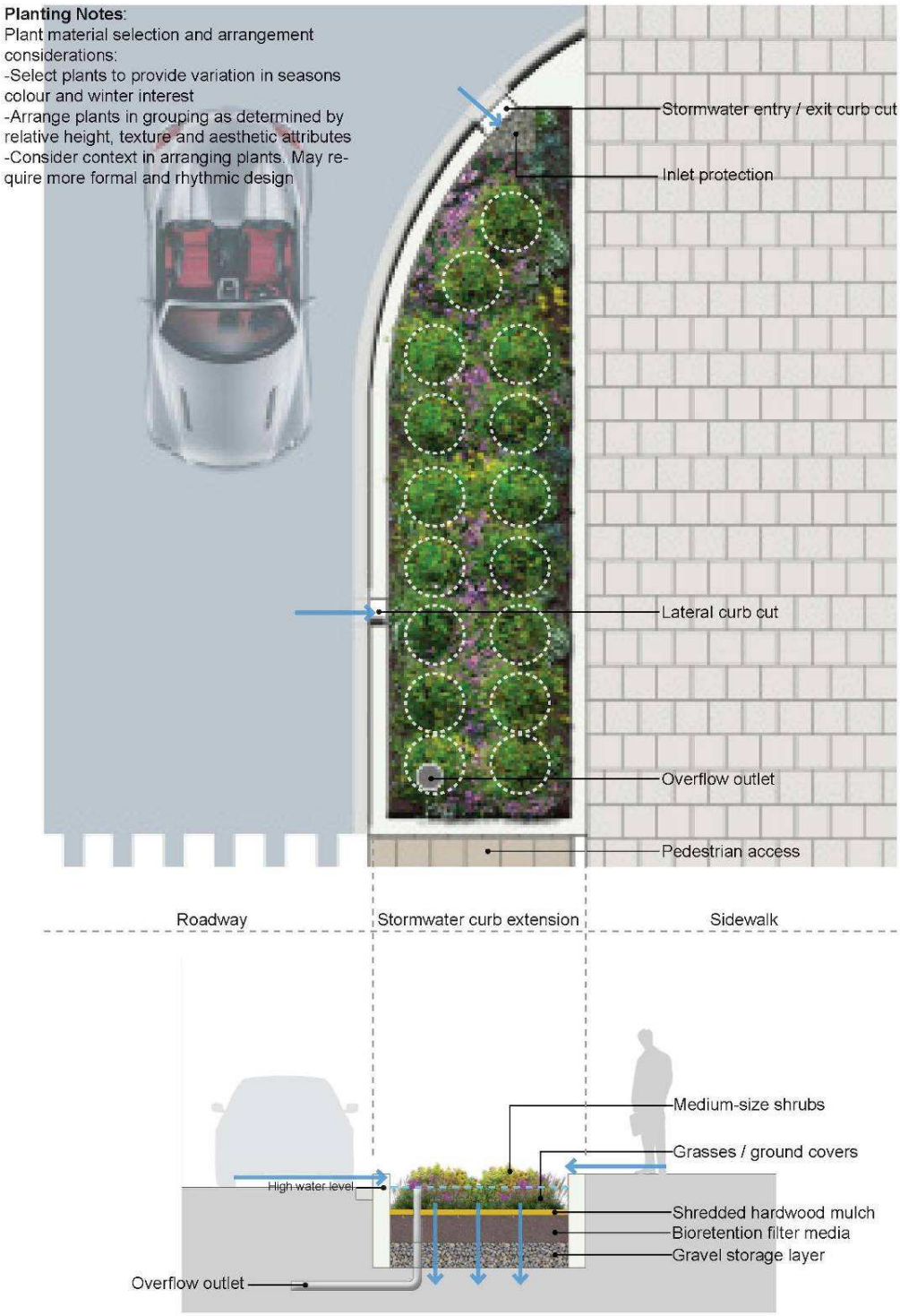


Figure 24 – Vegetated curb extensions plan view and cross-section; sizing and layout guidance is provided in the LID Stormwater Management Planning and Design Guide.

CURB EXTENTION BIORETENTION CRITERIA	
SITE CHARACTERISTICS	▪ The design and plant choices must ensure pedestrian and driver visibility. ▪ The practice is exposed to deicing chemicals and roadway pollutants. ▪ If the native soils infiltrate <15 mm/hr or the practice is for filtration only, then an underdrain should be installed. Soil Conditions ▪ Bioretention soil specification: 85-88% sand (2.0 to 0.05 mm), 8 to 12 % fines (<0.05 mm), and 3 to 5 % organic matter.
PLANT SELECTION	▪ The species palate for this LID practice is composed of grasses and herbaceous plant material that is low growing. ▪ The vegetation must be tolerant of salt, and other urban conditions (including polluted air & water and soil compaction).
PLANT STANDARDS	Vegetation must meet Canadian Standards for Nursery Stock, Eighth Edition. Seed planting is not recommended for bioretention. Plants should be container grown, balled and burlapped or wire basket. Below are recommended minimum plant sizes for planting. **Deciduous Shrubs -** 60 - 80 cm height **Coniferous Shrubs / Broadleaf Evergreens** - ▪ 40 cm height and spread for dwarf type ▪ 60 -80 cm height or spread for medium form type; ▪ 25 cm root ball for spreading form type; ▪ 80 - 100 cm height for columnar form type **Perennials/Grasses -** #1 or 1 gal. container stock **Vines -** #1 or 1 gal. container and staked

CONSTRUCTION AND PLANTING GUIDANCE APPLICABLE TO ALL BIORETENTION LID PRACTICES	
SITE PREPARATION	▪ The existing soil is replaced with an engineered bioretention soil mix. ▪ If the project is a retrofit and meant to infiltrate, then deep tilling can be used to break up compacted soils. ▪ The media bed surface needs to be level to encourage stormwater to spread over the entire surface. Ponding in one location will result in early clogging and uneven watering of the vegetation.
EROSION CONTROL	▪ Construction traffic must be limited to areas outside proposed infiltration areas. ▪ Installation of soils and vegetation should only begin after the entire contributing drainage area has been either stabilized or flows have been safely routed around the area. ▪ The facility should be kept offline during construction and ideally through the plant establishment period. If the facility will immediately begin accepting runoff, then appropriate erosion control measures include the use of a nurse crop or biodegradable matting. ▪ The application of a 75 mm shredded hardwood mulch layer will also provide some erosion control. ▪ If fine construction sediment has collected on the surface of the media bed prior to planting, then the sediment should be scraped from the surface without compacting the surface. The removed sediment should be moved to a secure location where it will not be resuspended.
PRETREATMENT	▪ Pretreatment can be used to reduce maintenance and increase practice longevity by settling suspended solids before the runoff enters the LID practice. ▪ Bioretention receiving runoff with little sediment, such as from rooftops, can function effectively with little or no pretreatment. ▪ Typical pretreatment includes forebays, vegetated filter strips, gravel diaphragms, riprap, and gutter screens, see the *CVC/TRCA LID Guide* for more detail on pretreatment design.
ESTABLISHMENT	▪ Bioretention cells can require a year of plant establishment before going on-line, in most cases this is not feasible. See erosion control for options to reduce damage during establishment. ▪ Some bioretention cells are designed to let stormwater bypass them once full. These types of practices can have their inlets blocked and be taken offline during site stabilization. ▪ The plantings in the *Low-Zone* and *Mid-Zone* will develop most successfully if the soils are regularly watered whenever the soil is dry ▪ After plantings in the *Low-Zone* and *Mid-Zone* are established, the first year should involve inundation with water depths of 1 to 2cm alternated with short dry periods (every 5 to 10 days). ▪ Under typical rainfall patterns these watering recommendations would likely occur if the practices were placed online.

MAINTENANCE GUIDANCE APPLICABLE TO ALL BIORETENTION LID PRACTICES	
ACCESSIBILITY	▪ The design should allow for easy maintenance and inspection access to the facility. Concentrating practices within the right-of-way will allow easy access to municipal staff. ▪ Underdrains should be connected to standpipes that allow observation of drawdown and access to the underdrain for cleaning out.
SOIL AMENDMENTS	▪ The recommended soil mix and contributing runoff should contain enough nutrients to sustain plant health. If plants are unhealthy, then the soil should be tested for deficiencies before amending. To avoid nutrient export, fertilizer should never be applied to bioretention. ▪ Preferably, fertilizer should not be applied to any of the drainage areas. If fertilizer is necessary, then a coated controlled release fertilizer should be used.
WATERING/ IRRIGATION	▪ Watering may be required until vegetation is established and during dry periods based on local climate. ▪ For practices within the right-of-way, municipalities will contract with water trucks or encourage neighboring property owners to water and maintain street vegetation.
ANNUAL OR AS NEEDED MAINTENANCE ACTIVITIES	▪ Remove litter, debris, and accumulated sediment from pretreatment devices, inlets and outlets. ▪ Apply mulch in bare areas. ▪ Treat trees and shrubs affected by pest and disease using Integrated Pest Management and industry standards. ▪ Vegetative maintenance as required following current aboriculture and horticulture practices. ▪ Prune and trim trees and shrubs in Spring to maintain a tidy appearance ▪ Remove and replace dead vegetation ▪ Remove weeds and invasive plants. ▪ Repair eroded areas and interplant sparsely vegetated areas.
REHABILITATION	▪ If properly designed with adequate pretreatment and protected from soil compaction, then bioretention practices will maintain their effectiveness for 20 years or more. ▪ If the facility continues to pond water after 24 hours, then several measures can be tried before the soil needs to be replaced: o Remove and replace the old mulch. o Remove the top 5-10 centimeters of silted up bioretention soil. o The underdrain can be flushed.

3.2.6 BIORETENTION PLANT LIST - NO SALT EXPOSURE

Consult the Master LID Practice Plant List for a full listing of plant characteristics, tolerances and other information to inform your selection of species from the list below.

Nativeness and Rarity:		Zone:
♦♦♦♦	Best Choice	L = Low
♦♦♦	Better Choice	M = Medium
♦♦	Selective Choice	H = High
♦	Selective Choice	
NN	Reasonable Alternative (Non-Native)	

Nurse Crop

		Zone			Zone
NN	*Avena sativa*	L	NN	*Lolium multiflorum*	L, M

Graminoids

♦♦	*Andropogon gerardii*	L M	♦♦♦♦	*Elymus virginicus* var. *virginicus*	L M
NN	*Calamagrostis acutiflora 'Karl Foerster'*	L M	NN	*Helictotrichon sempervirens*	M
♦♦♦♦	*Calamagrostis canadensis*	L	♦♦♦♦	*Juncus effusus ssp. solutus*	L
♦♦	*Carex atherodes*	M H	♦♦♦♦	*Juncus tenuis*	L M
♦♦♦♦	*Carex bebbii*	M H	♦♦♦♦	*Muhlenbergia mexicana* var. *mexicana*	M
♦♦	*Carex crinita*	L M	NN	*Pennisetum hamelin*	L M
♦♦	*Carex grayi*	M	♦♦	*Schizachyrium scoparium (Andropogon scoparius)*	L
♦♦	*Carex intumescens*	L	♦♦♦♦	*Schoenoplectus tabernaemontani (Scirpus validus)*	L
♦♦	*Carex lacustris*	L M H	♦♦♦♦	*Scirpus atrovirens*	L
♦♦	*Carex lupulina*	H	♦♦♦♦	*Scirpus cyperinus*	L
♦♦♦♦	*Carex pensylvanica*	M H	♦♦	*Sorghastrum nutans*	M H
♦♦♦♦	*Carex stipata*	L M	♦♦	*Sparganium eurycarpum*	L
♦♦♦♦	*Danthonia spicata*	H	♦♦	*Spartina pectinata*	L M
♦♦♦♦	*Deschampsia cespitosa*	L M	♦♦	*Sporobolus neglectus*	H
♦♦	*Elymus canadensis*	M H	♦♦♦♦	*Typha latifolia*	L
♦♦	*Elymus riparius*	M H			

Broadleaf Herbaceous (and Ferns)

♦♦♦	*Achillea millefolium ssp. Lanulosa*	H	♦♦♦♦	*Impatiens capensis*	L M
♦♦♦♦	*Alisma plantago-aquatica*	L	♦	*Trichostema brachiatum (Isanthus brachiatus)*	M H
♦♦♦	*Allium schoenoprasum* var. *sibiricum*	M H	♦♦	*Lespedeza capitata*	H
NN	*Amsonia hubrichtii*	H	NN	*Leucanthemum x superbum*	H
NN	*Amsonia tabernaemontana*	L M	♦♦	*Lobelia siphilitica*	L

♦♦♦♦	*Anemone canadensis*	M	♦♦♦♦	*Lysimachia ciliata*	L M
♦♦♦♦	*Aquilegia canadensis*	H	♦♦♦♦	*Matteucia struthiopteris* var. *pensylvanica*	L M
NN	*Armeria maritima 'Dusseldorf Pride'*	H	♦♦♦♦	*Monarda fistulosa*	M H
NN	*Artemisia schmidtiana 'Silver Mound'*	H	♦	*Solidago ptarmicoides(Oligoneuron album)*	M H
NN	*Aruncus dioicus*	L	♦♦♦♦	*Onoclea sensibilis*	L M
♦♦♦♦	*Asclepias incarnata ssp. incarnata*	L	♦	*Opuntia fragilis*	H
♦♦	*Asclepias tuberosa*	H	♦♦♦♦	*Osmunda cinnamomea*	L M
♦♦	*Doellingeria umbellata* var. *umbellata (Aster umbellatus)*	L	♦♦	*Penstemon digitalis*	M H
NN	*Baptisia alba*	H	♦♦	*Penstemon hirsutus*	H
NN	*Baptisia australis*	H	♦♦♦♦	*Podophyllum peltatum*	H
♦♦♦♦	*Bidens cernua*	L	♦♦	*Potentilla anserina*	M
♦♦♦♦	*Bidens frondosa*	L	NN	*Rudbeckia fulgida*	M
NN	*Boltonia asteroides*	L	♦♦♦♦	*Rudbeckia hirta*	M H
♦♦♦♦	*Caltha palustris*	L M	♦♦	*Rudbeckia laciniata*	L M
♦♦♦	*Cerastium arvense* ssp. *strictum*	H	♦♦	*Sisyrinchium montanum*	M
♦♦	*Chelone glabra*	H	♦♦♦♦	*Solidago altissima* var. *altissima*	H
NN	*Chelone lyonii*	L M	♦♦♦♦	*Solidago canadensis* var. *canadensis*	H
♦♦♦	*Coreopsis lanceolata*	M H	♦♦♦♦	*Solidago flexicaulis*	M H
NN	*Coreopsis rosea*	M	♦♦♦♦	*Solidago nemoralis* ssp. *nemoralis*	M H
♦♦	*Desmodium canadense*	M	♦♦	*Solidago rugosa* ssp. *rugosa*	M
NN	*Echinacea purpurea*	M H	♦♦♦♦	*Symphyotrichum cordifolium*	H
♦♦	*Epilobium coloratum*	L	♦♦♦♦	*Symphyotrichum ericoides* var. *ericoides*	H
♦♦	*Erigeron pulchellus*	M H	♦♦♦♦	*Symphyotrichum lanceolatum* ssp. *lanceolatum*	L M
♦♦♦♦	*Eupatorium maculatum* ssp. *maculatum*	L	♦♦♦♦	*Symphyotrichum novae-angliae*	L M
♦♦♦♦	*Eupatorium perfoliatum*	L	♦♦	*Symphyotrichum oolentangiense*	M H
♦♦♦♦	*Euthamia graminifolia*	L M	♦♦♦♦	*Symphyotrichum puniceum*	M
♦♦♦♦	*Fragaria virginiana* ssp. *virginiana*	H	♦♦♦♦	*Thalictrum pubescens*	M H
NN	*Gaillardia aristata*	M H	♦♦♦♦	*Thelypteris palustris* var. *pubescens*	L M
♦♦	*Geranium maculatum*	M H	NN	*Tradescantia virginiana*	H
♦	*Geum triflorum*	M H	♦♦♦♦	*Verbena hastata*	L M
♦♦	*Helianthus divaricatus*	H	♦♦	*Verbena stricta*	M H
♦♦	*Helianthus strumosus*	M H	♦♦♦♦	*Verbena urticifolia*	M H
♦♦♦♦	*Helianthus tuberosus*	M	♦	*Veronicastrum virginicum*	H
♦	*Heliopsis helianthoides*	M H	♦♦♦♦	*Waldsteinia fragarioides*	H
NN	*Hosta spp.*	H	NN	*Yucca filamentosa*	M H

♦♦♦♦	*Hydrophyllum virginianum*	M H	♦♦	*Zizia aurea*	M H
Shrubs					
♦♦♦♦	*Amelanchier arborea*	M H	♦	*Prunus pumila* var. *pumila*	H
♦♦	*Amelanchier laevis*	M H	♦♦♦♦	*Prunus virginiana* ssp. *virginiana*	M H
♦♦	*Amelanchier sanguinea*	M H	♦	*Rhus aromatica*	M H
♦	*Amelanchier spicata*	M H	♦♦	*Rhus glabra*	H
♦	*Arctostaphylos uva-ursi*	M	♦♦♦♦	*Rhus typhina (Rhus hirta)*	M H
♦♦	*Aronia melanocarpa (Photinia melanocarpa)*	M	♦♦♦♦	*Ribes americanum*	M
♦♦♦♦	*Cornus alternifolia*	M H	♦♦♦♦	*Ribes cynosbati*	H
♦♦	*Cornus amomum* ssp. *obliqua*	M H	♦♦	*Ribes triste*	H
♦♦	*Cornus foemina spp. racemosa*	M H	♦♦♦♦	*Rosa blanda*	H
♦♦♦♦	*Cornus sericea* ssp. *sericea (Cornus stolonifera)*	M H	♦♦♦♦	*Rubus allegheniensis*	M
♦	*Corylus americana*	M H	♦♦♦♦	*Rubus idaeus* ssp. *strigosus*	M
♦♦♦♦	*Corylus cornuta*	M	♦♦♦♦	*Rubus odoratus*	M H
NN	*Cotoneaster apiculatus, C. divaricata, C. horizontalis, C. microphylla*	M H	♦♦♦♦	*Rubus pubescens*	M
♦♦♦♦	*Diervilla lonicera*	H	♦♦♦♦	*Salix bebbiana*	M
♦♦	*Hamamelis virginiana*	M H	♦♦♦♦	*Salix discolor*	M
NN	*Hydrangea arborescens 'Annabelle'*	M	♦♦♦♦	*Salix eriocephala*	M
♦♦♦	*Hypericum kalmianum*	M	♦♦	*Salix exigua*	M
♦♦♦	*Juniperus communus*	M H	♦♦	*Salix petiolaris*	M
♦♦♦	*Juniperus horizontalis*	H	♦♦♦♦	*Sambucus canadensis*	M
NN	*Kerria japonica*	M H	♦♦♦♦	*Sambucus racemosa* ssp. *pubens*	M H
♦♦	*Lindera benzoin*	M	♦♦	*Shepherdia canadensis*	M H
♦♦♦♦	*Lonicera dioca*	H	♦♦	*Spiraea alba*	M
♦	*Myrica pensylvanica*	M H	♦♦♦♦	*Viburnum acerifolium*	H
♦♦	*Physocarpus opulifolius*	M H	♦♦♦	*Viburnum dentatum*	M
♦♦	*Potentilla fruticosa (Dasifora floribunda)*	M	♦♦♦♦	*Viburnum lentago*	M H
♦♦♦♦	*Prunus pensylvanica*	M H	♦♦	*Viburnum rafinesquianum*	H
Trees					
♦♦♦♦	*Acer rubrum*	M H	♦♦	*Platanus occidentalis*	M H
♦♦♦♦	*Acer saccharum* ssp. *saccharum*	M	♦♦♦♦	*Populus balsamifera* ssp. *balsamifera*	M H
♦♦	*Acer x freemanii*	M H	♦♦♦♦	*Populus deltoides*	M H
♦♦♦♦	*Betula papyrifera*	M H	♦♦♦♦	*Populus grandidentata*	H
♦♦♦♦	*Carpinus caroliniana*	H	♦♦♦♦	*Populus tremuloides*	M H
♦♦♦♦	*Carya ovata*	H	♦♦♦♦	*Prunus serotina*	H
♦♦♦	*Celtis occidentalis*	H	♦♦	*Quercus alba*	H
♦♦♦♦	*Fraxinus americana*	M H	♦♦	*Quercus bicolor*	M
♦♦	*Fraxinus nigra*	M	♦♦♦♦	*Quercus macrocarpa*	M H
NN	*Ginkgo biloba*	H	♦♦♦	*Quercus muehlenbergii*	H

♦♦♦	*Gleditsia tricanthos* var. *inermis*	H	♦♦♦	*Quercus palustris*	M H
♦♦♦♦	*Juglans nigra*	H	NN	*Quercus robur* var. *fatigiata*	H
♦♦	*Larix laricina*	M	♦♦♦♦	*Quercus rubra*	H
♦♦♦♦	*Liriodendron tulipifera*	M	♦♦	*Salix amygdaloides*	M
♦♦	*Picea glauca*	M	♦♦	*Salix nigra*	M
NN	*Picea pungens*	H	♦♦♦♦	*Thuja occidentalis*	M H
NN	*Pinus mugho*	M H	♦♦♦♦	*Tilia americana*	M H

Vines

♦♦	*Parthenocissus quinquefolia*	M H	♦♦	*Euonymus obovata*	M H
♦♦♦♦	*Clematis virginiana*	M	♦♦	*Lonicera hirsuta*	H

3.2.7 BIORETENTION PLANT LIST - SALT EXPOSURE

Consult the Master LID Practice Plant List for a full listing of plant characteristics, tolerances and other information to inform your selection of species from the list below.

Nativeness and Rarity:	♦♦♦♦	Best Choice	Zone:	L = Low
	♦♦♦	Better Choice		M = Medium
	♦♦	Selective Choice		H = High
	♦	Selective Choice		
	NN	Reasonable Alternative (Non-Native)		

Nurse Crop

		Zone			Zone
NN	*Avena sativa*	L	NN	*Lolium multiflorum*	M H

Graminoids

♦♦	*Andropogon gerardii*	L M H	♦♦♦♦	*Elymus virginicus* var. *virginicus*	L M
♦♦	*Bromus latiglumis*	M	NN	*Helictotrichon sempervirens*	M
NN	*Calamagrostis acutiflora 'Karl Foerster'*	L M	♦♦♦♦	*Juncus effusus ssp. solutus*	L
♦♦♦♦	*Calamagrostis canadensis*	L	♦♦♦♦	*Juncus tenuis*	L M
♦♦	*Carex atherodes*	L	♦♦♦♦	*Muhlenbergia mexicana* var. *mexicana*	M
♦♦♦♦	*Carex bebbii*	L M	NN	*Pennisetum hamelin*	L M
♦♦	*Carex brevior*	M H	♦♦	*Schizachyrium scoparium (Andropogon scoparius)*	M H
♦♦	*Carex grayii*	M	♦♦♦♦	*Schoenoplectus tabernaemontani (Scirpus validus)*	L
♦♦♦♦	*Carex hystericina*	L M	♦♦♦♦	*Scirpus atrovirens*	L
♦♦	*Carex lacustris*	L M	♦♦♦♦	*Scirpus cyperinus*	L
♦♦♦♦	*Carex pensylvanica*	L M H	♦♦	*Sorghastrum nutans*	M H
♦♦♦♦	*Carex stipata*	L M	♦♦	*Sparganium eurycarpum*	L
♦♦♦♦	*Danthonia spicata*	H	♦♦	*Spartina pectinata*	L M
♦♦♦♦	*Deschampsia cespitosa*	L M	♦♦	*Sporobolus neglectus*	H

♦♦	*Elymus canadensis*	M H	♦♦♦♦	*Typha latifolia*	L
♦♦	*Elymus riparius*	M H			

Broadleaf Herbaceous (and Ferns)

♦♦♦	*Achillea millefolium ssp. Lanulosa*	H	NN	*Leucanthemum x superbum*	H
♦♦♦♦	*Alisma plantago-aquatica*	L	♦♦♦♦	*Monarda fistulosa*	M H
♦♦♦♦	*Anemone canadensis*	M	♦	*Solidago ptarmicoides(Oligoneuron album)*	M H
♦♦♦♦	*Aquilegia canadensis*	H	♦	*Opuntia fragilis*	H
NN	*Armeria maritima 'Dusseldorf Pride'*	H	♦♦	*Potentilla anserina*	M
NN	*Artemisia schmidtiana 'Silver Mound'*	H	NN	*Rudbeckia fulgida*	H
♦♦♦♦	*Asclepias incarnata ssp. incarnata*	L	♦♦♦♦	*Rudbeckia hirta*	M H
♦♦	*Asclepias tuberosa*	H	♦♦	*Rudbeckia laciniata*	L M
♦♦	*Doellingeria umbellata* var. *umbellata (Aster umbellatus)*	L	♦♦	*Sisyrinchium montanum*	M
NN	*Baptisia alba*	H	♦♦♦♦	*Solidago altissima* var. *altissima*	H
NN	*Baptisia australis*	H	♦♦♦♦	*Solidago canadensis* var. *canadensis*	H
♦♦♦♦	*Bidens cernua*	L	♦♦♦♦	*Solidago flexicaulis*	M H
♦♦♦♦	*Bidens frondosa*	L	♦♦♦♦	*Solidago nemoralis* ssp. *nemoralis*	M H
♦♦♦	*Cerastium arvense* ssp. *strictum*	H	♦♦	*Solidago rugosa* ssp. *rugosa*	M
♦♦♦	*Coreopsis lanceolata*	M H	♦♦♦♦	*Symphyotrichum cordifolium*	H
NN	*Coreopsis rosea*	M	♦♦♦♦	*Symphyotrichum ericoides* var. *ericoides*	H
♦♦	*Desmodium canadense*	M	♦♦♦♦	*Symphyotrichum lanceolatum* ssp. *lanceolatum*	L M
NN	*Echinacea purpurea*	M H	♦♦♦♦	*Symphyotrichum novae-angliae*	L M
♦♦	*Epilobium coloratum*	L M	♦♦	*Symphyotrichum oolentangiense*	M H
♦♦♦♦	*Eupatorium maculatum* ssp. *maculatum*	L	♦♦♦♦	*Symphyotrichum puniceum*	M
♦♦♦♦	*Euthamia graminifolia*	L M	♦♦♦♦	*Thalictrum pubescens*	M H
♦♦♦♦	*Fragaria virginiana* ssp. *virginiana*	H	♦♦♦♦	*Verbena hastata*	L M
♦♦	*Helianthus divaricatus*	H	♦♦	*Verbena stricta*	M H
♦♦	*Helianthus strumosus*	M H	♦♦♦♦	*Verbena urticifolia*	M H
♦♦♦♦	*Helianthus tuberosus*	M	♦	*Veronicastrum virginicum*	H
♦	*Heliopsis helianthoides*	M H	♦♦♦♦	*Waldsteinia fragarioides*	H
NN	*Hosta spp.*	M H	NN	*Yucca filamentosa*	M H
♦♦	*Iris versicolor*	L	♦♦	*Zizia aurea*	M H
♦♦	*Lespedeza capitata*	H			

Shrubs					
♦♦♦♦	*Amelanchier arborea*	M H	♦	*Prunus pumila* var. *pumila*	H
♦♦	*Amelanchier laevis*	M H	♦♦♦♦	*Prunus virginiana* ssp. *virginiana*	M H
♦♦	*Amelanchier sanguinea*	M H	♦	*Rhus aromatica*	M H
♦	*Amelanchier spicata*	M H	♦♦	*Rhus glabra*	H
♦	*Arctostaphylos uva-ursi*	M	♦♦♦♦	*Rhus typhina (Rhus hirta)*	M H
♦♦	*Aronia melanocarpa (Photinia melanocarpa)*	M	♦♦♦♦	*Rubus idaeus* ssp. *strigosus*	M
♦♦	*Cornus foemina spp. racemosa*	M H	♦♦♦♦	*Rubus odoratus*	M H
NN	*Cotoneaster apiculatus, C. divaricata, C. horizontalis, C. microphylla*	M H	♦♦♦♦	*Salix discolor*	M
♦♦♦	*Hypericum kalmianum*	M	♦♦♦♦	*Salix eriocephala*	M
♦♦♦	*Juniperus communus*	M H	♦♦	*Salix exigua*	M
♦♦♦	*Juniperus horizontalis*	H	♦♦	*Salix petiolaris*	M
NN	*Kerria japonica*	M H	♦♦♦♦	*Sambucus racemosa* ssp. *pubens*	M H
♦♦	*Lindera benzoin*	M	♦♦	*Shepherdia canadensis*	M H
♦	*Myrica pensylvanica*	M H	♦♦♦	*Viburnum dentatum*	M
♦♦	*Physocarpus opulifolius*	M H	♦♦♦♦	*Viburnum lentago*	M H
♦♦	*Potentilla fruticosa (Dasifora floribunda)*	M	♦♦	*Viburnum rafinesquianum*	H
♦♦♦♦	*Prunus pensylvanica*	M H			

Trees					
♦♦♦♦	*Betula papyrifera*	M H	♦♦♦♦	*Populus balsamifera* ssp. *balsamifera*	M H
♦♦♦	*Celtis occidentalis*	M	♦♦♦♦	*Populus deltoides*	M H
♦♦♦♦	*Fraxinus americana*	M H	♦♦♦♦	*Populus grandidentata*	H
♦♦	*Fraxinus nigra*	M	♦♦♦♦	*Populus tremuloides*	M H
NN	*Ginkgo biloba*	H	♦♦♦♦	*Prunus serotina*	H
♦♦♦	*Gleditsia tricanthos* var. *inermis*	H	♦♦	*Quercus alba*	H
♦♦	*Juniperus virginiana*	H	♦♦	*Quercus bicolor*	M
♦♦	*Larix laricina*	M	♦♦♦♦	*Quercus macrocarpa*	MH
NN	*Picea pungens*	H	♦♦♦	*Quercus muehlenbergii*	H
NN	*Pinus mugho*	M H	♦♦♦♦	*Quercus rubra*	H

Vines					
♦♦	*Parthenocissus quinquefolia*	M H	♦♦♦♦	*Clematis virginiana*	M

3.3 FILTER STRIPS

Vegetated filter strips are designed to appear as natural vegetation communities and are typically located adjacent to roadways or parking lots. They are generally comprised of a level spreader to convey stormwater down a gentle slope in order to promote uniform sheetflow into a strip of vegetation. The vegetation filters out pollutants and promotes infiltration.

Figure 25 – Filter strip planted with shrubs and herbaceous plants treating a parking lot with no curbs in the Hill Center project in Green Hills, TN (Source: Hawkins Partners, Inc)

Figure 26 - Grass filter strip with gravel diaphragm (Source: Aquafor Beech)

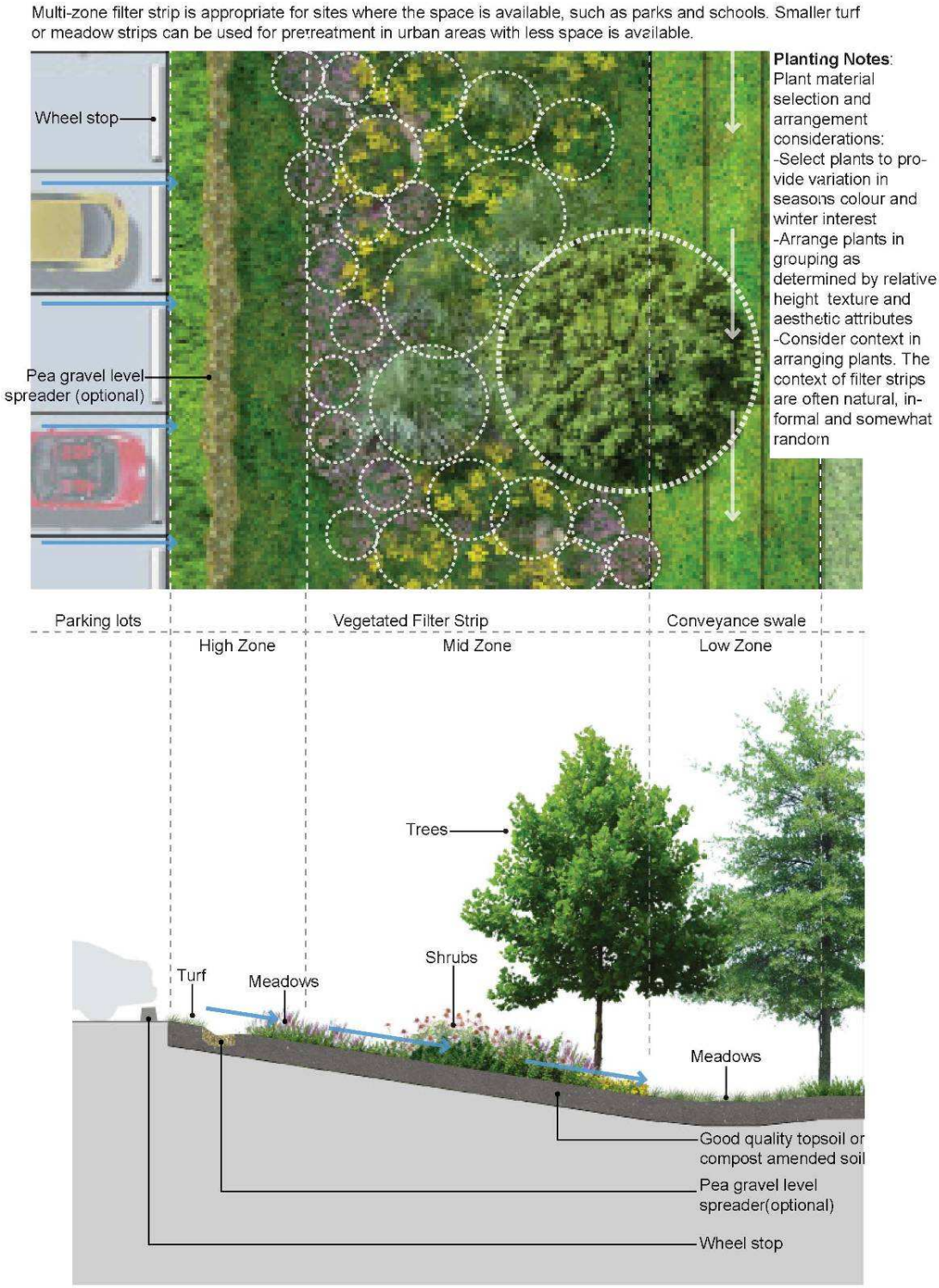


Figure 27 - Grass filter strip plan view and cross-section; sizing and layout guidance is provided in the LID Stormwater Management Planning and Design Guide.

FILTER STRIP CRITERIA	
SITE CHARACTERISTICS	▪ The vegetation strip is typically 5 to 20 metres wide; strips used as pretreatment for other practices may have shorter flow paths. ▪ Recommended slope for vegetated strips is between 2 to 5%. ▪ The stormwater flow through the filter strip should be sheet flow. The practice may be subject to a flow depth ranging from 50 to 100 millimetres. ▪ Vegetated strips are suitable for all soil types; compacted soils or soils of low fertility can be tilled to a depth of 300 mm and amended with compost to achieve an organic content of 8 to 15% by weight or 30 to 40% by volume.
PLANT SELECTION	▪ Vegetation should be tolerant of salt and other stormwater pollutants when used for strips treating road runoff or used for snow storage. ▪ Strips used for snow storage should not contain any woody vegetation ▪ Vegetation at the toe of the slope, where ponding will occur, should be able to withstand both wet and dry soil conditions. There are three vegetation variations of a filter strip LID Practice: **1. Grassed filter strip** Comprised of turf that is salt tolerant. **2. Herbaceous filter strip** Comprised of grasses and/or other herbaceous vegetation. This plant material must be salt-tolerant, as well as tolerant of prolonged dry periods. The most analogous natural ecosystem is the dry-prairie or mesic-prairie, comprised of deep-rooted grasses. **3. Multi-Zone filter strip.** Transition area from turf to meadow vegetation incorporating shrubs and trees. This type of filter strip is typically used when abutting tree areas. This vegetation should be salt-tolerant and able to survive prolonged dry periods.
PLANT STANDARDS	Vegetation must meet Canadian Standards for Nursery Stock, Eighth Edition and Nursery Sod Growers Association of Ontario Specifications. **Native Seed -** Typical sowing rates for native seed mixes are 22-45 kg/hectare (21-23 lbs/acre) or 250g/ 90m^2 (1/2 lb/1000 ft^2). The application rate will vary based on the seed mix. When using native seed, an annual nurse crop applied at a rate of 22 kg/hectare (21 lbs/acre) should be used. For best germination of native seed, sowing should take place in the fall. Stock plants should be container grown, balled and burlapped or wire basket. Below are recommended minimum plant sizes for planting. **Deciduous Trees -** 60 mm calliper **Coniferous Trees** - 175 cm height **Deciduous Shrubs -** 60 - 80 cm height **Coniferous Shrubs / Broadleaf Evergreens** -

	▪ 40 cm height and spread for dwarf type ▪ 60 -80 cm height or spread for medium form type; ▪ 25 cm root ball for spreading form type; ▪ 80 - 100 cm height for columnar form type **Perennials/Grasses -** #1 or 1 gal. container stock

FILTER STRIP CONSTRUCTION AND PLANTING GUIDANCE	
SITE PREPARATION	▪ If the strip must be graded, then the topsoil should be removed from the area to be re-spread after grading. Tilling to break up compaction may be required. ▪ The topsoil needs to be tested to determine what types of vegetation can be sustained, and amended if desired. ▪ Topsoil with low infiltration or poor fertility can be tilled to a depth of 300 mm and amended with compost to achieve an organic content of 8 to 15% by weight or 30 to 40% by volume. ▪ Unless used for construction of the filter strip, all vehicular traffic should not be allowed within 3 metres of the strip. ▪ Micro-grading is critical to ensure sheet flow.
PLANTING	▪ Whatever the type of vegetation used, it must be densely planted to slow runoff, collect sediment, and allow for infiltration.
ESTABLISHMENT	▪ Runoff should be diverted from the filter strip until the vegetation has become established to avoid rills and plant die-off.

FILTER STRIP MAINTENANCE GUIDANCE	
MAINTAINING PERFORMANCE	▪ Vegetated filter strips are most effective when upstream areas are stabilized and not producing sediment. ▪ Maintaining sheet flow along the level spreader ensures that treatment is maximized, and erosive forces are minimized. ▪ Low levels of sediment will be incorporated into the soil structure. Sediment deposits that hinder the function of the practice must be removed from the vegetated filter strips using a vacuum truck or small grading equipment.
PLANT	▪ Monitoring is required to ensure that the establishment and persistence of plantings is adequate to maintain the high vegetation density for proper function. ▪ Mowing as appropriate to the vegetation community should take place after flowering and butterfly migration in the fall.
WATERING/ IRRIGATION	▪ Regular watering may be required while vegetation is becoming established and during dry periods.
OTHER MAINTENANCE ACTIVITIES	▪ Remove trash and debris annually or as needed ▪ Inspect strip for erosion and rills quarterly for first 2 years and twice annually thereafter; regrade and replant if necessary.

3.3.1 FILTER STRIP PLANT LIST

Consult the Master LID Practice Plant List for a full listing of plant characteristics, tolerances and other information to inform your selection of species from the list below.

Nativeness and Rarity:
- ♦♦♦♦ Best Choice
- ♦♦♦ Better Choice
- ♦♦ Selective Choice
- ♦ Selective Choice
- NN Reasonable Alternative (Non-Native)

Strip Type:
- F = Forested
- M = Multi-Zone
- H = Herbaceous/Grassed

Nurse Crop

		Practice			Practice
NN	*Avena sativa*	M H	NN	*Lolium multiflorum*	M H

Graminoids

♦♦	*Andropogon gerardii*	H	♦♦	*Elymus riparius*	M H
♦♦	*Bromus latiglumis*	H	NN	*Festuca spp. (see: other information)*	H
♦♦♦♦	*Calamagrostis canadensis*	M H	NN	*Helictotrichon sempervirens*	M H
♦♦♦♦	*Carex bebbii*	M H	♦♦♦♦	*Juncus effusus ssp. solutus*	M H
♦♦	*Carex brevior*	M H	♦♦♦♦	*Juncus tenuis*	M
♦♦	*Carex grayii*	M H	♦♦	*Schizachyrium scoparium (Andropogon scoparius)*	H
♦♦	*Carex intumescens*	M H	♦♦♦♦	*Schoenoplectus tabernaemontani (Scirpus validus)*	M H
♦♦	*Carex lacustris*	M	♦♦♦♦	*Scirpus cyperinus*	M
♦♦	*Carex lupulina*	M H	♦♦	*Sorghastrum nutans*	M H
NN	*Chasmanthium latifolium*	F M	♦♦	*Spartina pectinata*	M
♦♦♦♦	*Deschampsia cespitosa*	F M H	♦♦	*Sporobolus neglectus*	M H
♦♦	*Elymus canadensis*	M H			

Broadleaf Herbaceous (and Ferns)

♦♦♦♦	*Alisma plantago-aquatica*	M H	♦♦♦♦	*Matteucia struthiopteris* var. *pensylvanica*	M H
♦♦♦	*Allium schoenoprasum* var. *sibiricum*	H	♦♦♦♦	*Monarda fistulosa*	M H
♦♦♦♦	*Anemone canadensis*	M H	♦	*Solidago ptarmicoides(Oligoneuron album)*	M
♦♦♦♦	*Aquilegia canadensis*	M H	♦♦♦♦	*Onoclea sensibilis*	M H
NN	*Armeria maritima 'Dusseldorf Pride'*	H	♦	*Opuntia fragilis*	M
NN	*Artemisia schmidtiana 'Silver Mound'*	H	♦♦	*Penstemon digitalis*	M
♦♦	*Asclepias tuberosa*	M	♦♦♦♦	*Podophyllum peltatum*	F M

NN	*Boltonia asteroides*	F M H	NN	*Rudbeckia fulgida*	M H
♦♦♦♦	*Caltha palustris*	M H	♦♦	*Rudbeckia laciniata*	M H
♦♦♦	*Cerastium arvense* ssp. *strictum*	F M	♦♦	*Sisyrinchium montanum*	M
NN	*Chelone lyonii*	M	♦♦♦♦	*Solidago altissima* var. *altissima*	M
♦♦♦	*Coreopsis lanceolata*	M H	♦♦♦♦	*Solidago canadensis* var. *canadensis*	M
NN	*Echinacea purpurea*	M H	♦♦♦♦	*Solidago nemoralis* ssp. *nemoralis*	F M
♦♦	*Epilobium coloratum*	M	♦♦	*Solidago patula*	M H
♦♦♦♦	*Eupatorium perfoliatum*	F M H	♦♦	*Solidago rugosa* ssp. *rugosa*	M H
♦♦♦♦	*Euthamia graminifolia*	M	♦♦♦♦	*Symphyotrichum novae-angliae*	H
♦♦	*Helianthus strumosus*	F M	♦♦	*Symphyotrichum oolentangiense*	M
♦♦♦♦	*Helianthus tuberosus*	H	♦♦♦♦	*Symphyotrichum puniceum*	M H
NN	*Hosta spp.*	M H	♦♦♦♦	*Thalictrum pubescens*	M
♦♦♦♦	*Hydrophyllum virginianum*	M	♦♦♦♦	*Thelypteris palustris* var. *pubescens*	F M
♦♦	*Iris versicolor*	M	♦♦	*Verbena stricta*	M H
NN	*Leucanthemum x superbum*	M H	♦♦♦♦	*Verbena urticifolia*	F M H
♦♦	*Lobelia siphilitica*	M H	♦	*Veronicastrum virginicum*	M
♦♦♦♦	*Lysimachia ciliata*	M			

Shrubs					
♦♦	*Amelanchier sanguinea*	F	♦	*Rhus aromatica*	F M
♦	*Arctostaphylos uva-ursi*	M	♦♦	*Rhus glabra*	F M
♦♦	*Aronia melanocarpa (Photinia melanocarpa)*	F M	♦♦♦♦	*Rhus typhina (Rhus hirta)*	F M
♦♦	*Cephalanthus occidentalis*	M	♦♦♦♦	*Ribes cynosbati*	F M
♦♦	*Cornus amomum* ssp. *obliqua*	M	♦♦	*Ribes triste*	M
♦♦	*Cornus foemina spp. racemosa*	M	♦♦♦♦	*Rosa blanda*	F M
♦♦♦♦	*Corylus cornuta*	M	♦♦♦♦	*Rubus allegheniensis*	F M
NN	*Cotoneaster apiculatus, C. divaricata, C. horizontalis, C. microphylla*	M	♦♦♦♦	*Rubus idaeus* ssp. *strigosus*	F M
♦♦♦♦	*Diervilla lonicera*	M	♦♦♦♦	*Rubus pubescens*	M
♦♦	*Hamamelis virginiana*	F M	♦♦♦♦	*Salix discolor*	M
♦♦♦	*Hypericum kalmianum*	F M	♦♦	*Salix exigua*	F M
♦♦♦	*Juniperus communus*	F M	♦♦	*Salix petiolaris*	M
♦♦♦	*Juniperus horizontalis*	F	♦♦♦♦	*Sambucus canadensis*	F M
♦♦	*Lindera benzoin*	F M	♦♦♦♦	*Sambucus racemosa* ssp. *pubens*	F M
♦	*Myrica pensylvanica*	F M	♦♦	*Shepherdia canadensis*	F M
♦♦	*Physocarpus opulifolius*	F M	♦♦♦	*Viburnum dentatum*	F M
♦	*Prunus pumila* var. *pumila*	F	♦♦♦♦	*Viburnum lentago*	F M
♦♦♦♦	*Prunus virginiana* ssp. *virginiana*	F M	♦♦	*Viburnum rafinesquianum*	F M

Trees

♦♦♦♦	*Acer rubrum*	F M	♦♦	*Larix laricina*	F M
♦♦♦♦	*Acer saccharinum*	F	♦♦	*Picea glauca*	F M
♦♦♦♦	*Acer saccharum* ssp. *saccharum*	F M	♦♦♦♦	*Pinus strobus*	F M
♦♦	*Acer x freemanii*	F M	♦♦	*Platanus occidentalis*	F M
♦♦♦♦	*Carpinus caroliniana*	F M	♦♦♦♦	*Populus deltoides*	F M
♦♦♦♦	*Carya cordiformis*	F M	♦♦♦♦	*Populus grandidentata*	F M
♦♦♦♦	*Carya ovata*	F M	♦♦♦♦	*Prunus serotina*	F M
♦♦♦	*Celtis occidentalis*	F M	♦♦	*Quercus alba*	F M
♦♦	*Fraxinus nigra*	F M	♦♦♦	*Quercus muehlenbergii*	F M
♦♦♦♦	*Fraxinus pennsylvanica*	F M	♦♦♦	*Quercus palustris*	F M
NN	*Ginkgo biloba*	F	♦♦♦♦	*Quercus rubra*	F M
♦♦♦	*Gleditsia tricanthos* var. *inermis*	M	♦♦	*Salix lucida*	F M
♦♦♦♦	*Juglans nigra*	F M	♦♦♦♦	*Thuja occidentalis*	F M
♦♦	*Juniperus virginiana*	F M	♦♦♦♦	*Tilia americana*	F M

3.4 ENHANCED GRASS SWALES

Enhanced grass swales are effective for pollutant removal, particularly when designed with a shallow and wide configuration. Enhanced grass swales also incorporate design features such as modified bottom and side geometry and check dams that improve the contaminant removal and runoff reduction. The function of this practice is to slow the water to allow sedimentation, filtration through the root zone and soil matrix, evapotranspiration, and infiltration into the underlying native soil.

Figure 28 – Manicured shallow grass swale combined with areas of herbaceous plantings and trees between the curb and sidewalk in Seattle, WA (Source: SVR Design Company)

Figure 29 – A no mow grass swale in Brisbane, CA (Source: CVC)

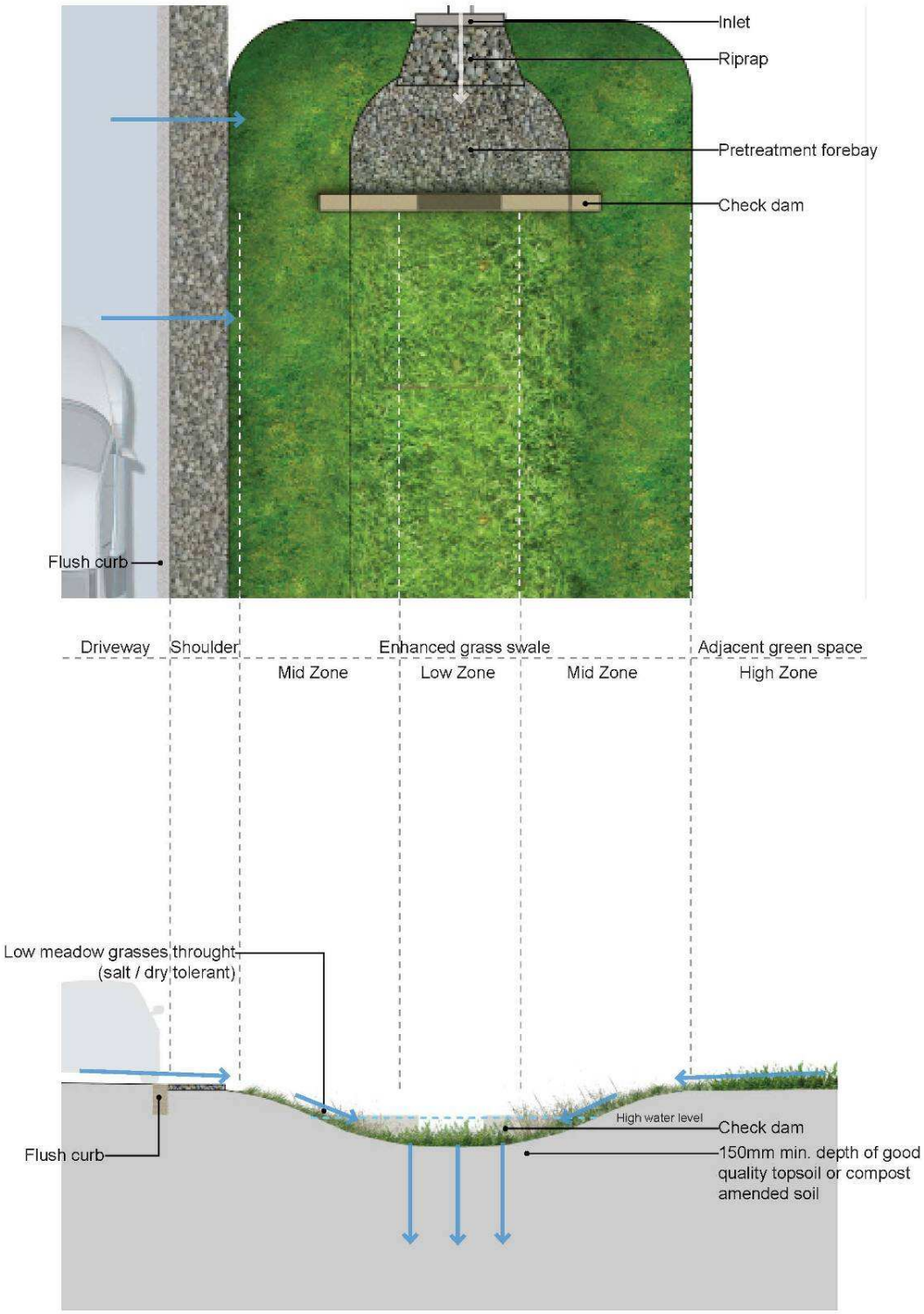


Figure 30 – An enhanced grass swale plan view and cross-section; sizing and layout guidance is provided in the LID Stormwater Management Planning and Design Guide.

ENHANCED GRASS SWALE CRITERIA	
SITE CHARACTERISTICS	▪ Typically grass swales are used to treat and convey road and parking lot runoff and will therefore accept runoff with deicers and vehicle pollutants. They are often used for snow storage as well. ▪ Grass swales can be applied on sites with any type of soil; fertility and infiltration can be improved on poor soils with compost amendments. ▪ For most storm events, a properly designed grass swale will have a flow depth of no more than 100 mm and a flow velocity of no more than 0.5 m/s. ▪ In natural systems, grasses tend to occur in areas with shallow or seasonal flooding. Vegetation in systems with relatively shallow water levels and frequent flooding tend to be comprised of sedges, rushes and spikerushes.
PLANT SELECTION	▪ Grasses and herbaceous species with dense root structure cover should be favoured along the bottom of the swale for their ability to increase infiltration, stabilize soils, retain pollutants and assist with suspended solids. ▪ The plant material on the slopes of grass channels must be capable of withstanding periodic inundation in addition to extended periods of drought. Species include grasses and groundcovers, as well as low shrub species. ▪ Plants along the exterior of this zone act to slow the flow during stormwater events, reducing sedimentation and increasing infiltration. The root structure of this plant material also acts to reduce erosion. ▪ Selected grasses or groundcovers for grassed swales should be allowed to grow between 75 to 150 mm to assist in filtering suspended solids from stormwater. Therefore these species are either shorter naturally, or tolerate periodic mowing. ▪ When grasses grow taller they have a tendency to flatten down from the water flow. ▪ Fine, close-growing species provide for good soil stabilization. ▪ Species are salt-tolerant due to the typical location of grass channels along roadways and parking lots. ▪ They can tolerate prolonged dry periods in addition to periodic flooding and water velocity of less than 0.5m/s.
PLANTING STANDARDS	Vegetation must meet Canadian Standards for Nursery Stock, Eighth Edition and Nursery Sod Growers Association of Ontario Specifications. **Native Seed -** Typical sowing rates for native seed mixes are 22-45 kg/hectare (21-23 lbs/acre) or 250g/ 90m^2 (1/2 lb/1000 ft^2). The application rate will vary based on the seed mix. When using native seed, an annual nurse crop applied at a rate of 22 kg/hectare (21 lbs/acre) should be used. For best germination of native seed, sowing should take place in the fall. **Perennials/Grasses -** If stock perennials/grasses are planted, then #1 or 1 gal. container size should be used.

ENHANCED GRASS SWALE CONSTRUCTION AND PLANTING GUIDANCE	
SITE PREPARATION	▪ Prior to construction, the topsoil should be removed from the practice area to be re-spread to a minimum depth of 150 mm after grading. ▪ Add compost amendments if necessary; compost is tilled to a depth of 300mm to achieve an organic content of between 8 to 15 % by weight or 30 to 40 % by volume. ▪ To protect infiltration capacity, construction traffic and storage of materials must not occur in the swale area; the area should be clearly marked before site work begins; if compaction of some areas from construction is unavoidable, then the compacted area should be tilled to a depth or 300 mm to break up any hard soil pan. ▪ Final grading and planting should not occur until the adjoining areas draining into the swale are stabilized. ▪ Erosion protection such as river stone or riprap will be required to dissipate the energy from incoming concentrated flow.

EROSION CONTROL	▪ If possible, flow should not be diverted into the swale until the banks are stabilized. To reduce the erosive force of stormwater flow and avoid erosion and damage to planting, the following options can be applied:
	  ▪ A cover crop or nurse crop of annual grasses
	  ▪ erosion control blankets, such as coconut fiber mats; do not use geotextile
	  ▪ a turf reinforcement mat placed beneath turf and topsoil at a depth of 300mm
	▪ The use of straw bale or silt fence check dams are not recommended. Sediment logs and temporary rock flow checks have proven to be more effective.

PLANTING	Two approaches are possible for the construction of an Enhanced Grass Swale: 1. Sodded: An alternative for rapid stabilization, and is used instead of seeding in critical areas or areas that near a 5% slope. The channel must be overcut to the depth of the sod prior to its placement. 2. Seeded: A nurse crop of annual grasses should be included in the seed mix in order to obtain a quick vegetative cover. In either situation the channel must be vegetated immediately after grading. Preferably, the swale should be planted in the spring so that the vegetation can become established with minimal irrigation.

ENHANCED GRASS SWALE MAINTENANCE GUIDANCE	
MAINTAINING PERFORMANCE	▪ Grass swales are most effective when upstream areas are stable and maintained. ▪ For runoff entering the swale, maintaining sheet flow will minimize erosive forces.
PLANT	▪ Inspect for vegetation density (at least 80%), quarterly for the first two years and twice annually thereafter. ▪ Any damage due to sediment removal or erosion must be repaired and requires immediate re-seeding or planting. ▪ Mowing should be done frequently enough to maintain grasses at an appropriate height (75 to 150 mm), and to promote vigorous growth and pollutant uptake. ▪ Mowing will reduce invasion by weeds and woody vegetation. ▪ Mowing should take place after flowering and butterfly migration in the fall, allowing vegetation to reach upwards of 150 mm. ▪ Grass clipping should be disposed of off-site to remove nutrients and pollutants.
WATERING/ IRRIGATION	▪ Watering may be required while vegetation is becoming established and during dry periods.
OTHER MAINTENANCE ACTIVITIES	▪ Remove trash and debris annually or as needed ▪ Regularly inspect swale for erosion and rills; regrade and replant if necessary. ▪ Scrape out and remove sediment when deposits exceed 25 mm in depth; revegetation may be required.

3.4.1 ENHANCED GRASS SWALES PLANT LIST

Consult the Master LID Practice Plant List for a full listing of plant characteristics, tolerances and other information to inform your selection of species from the list below.

Nativeness and Rarity:

♦♦♦♦	Best Choice
♦♦♦	Better Choice
♦♦	Selective Choice
♦	Selective Choice
NN	Reasonable Alternative (Non-Native)

Nurse Crop

NN	*Avena sativa*

Graminoids

♦♦	*Andropogon gerardii*	♦♦♦♦	*Carex vulpinoidea*
♦♦	*Bromus latiglumis*	♦♦♦♦	*Danthonia spicata*
♦♦♦♦	*Calamagrostis canadensis*	♦♦	*Elymus canadensis*
♦♦	*Carex crinita*	♦♦	*Elymus riparius*
♦♦	*Carex grayii*	NN	*Festuca spp. (see: other information)*
♦♦♦♦	*Carex hystericina*	NN	*Pennisetum hamelin*
♦♦♦♦	*Carex pensylvanica*	♦♦	*Sorghastrum nutans*

Broadleaf Herbaceous			
NN	*Amsonia hubrichtii*	♦♦	*Geranium maculatum*
NN	*Amsonia tabernaemontana*	♦	*Solidago ptarmicoides(Oligoneuron album)*
NN	*Baptisia australis*		

Shrubs, trees and vines are not recommended for enhanced grass swales.

3.5 DRY SWALES

Dry swales have the same characteristics and functions as bioretention facilities, but their form is linear. Dry swales are also referred to as infiltration swales or bio-swales. Dry swales are similar to enhanced grass swales in terms of the design of their surface geometry, slope, check dams and pretreatment components. They are also similar to bioretention cells in terms of the design of the filter media bed and optional underdrain components. In general, they are open channels designed to convey, treat, attenuate and infiltrate stormwater runoff.

Figure 31 – Dry swale constructed as part of the Seattle Public Utilities Street Edge Alternative program. (Source: Center for Watershed Protection)

Figure 32 – Dry swale planted with a mix of herbaceous, shrub, and small trees in Seattle, WA (Source: CVC)

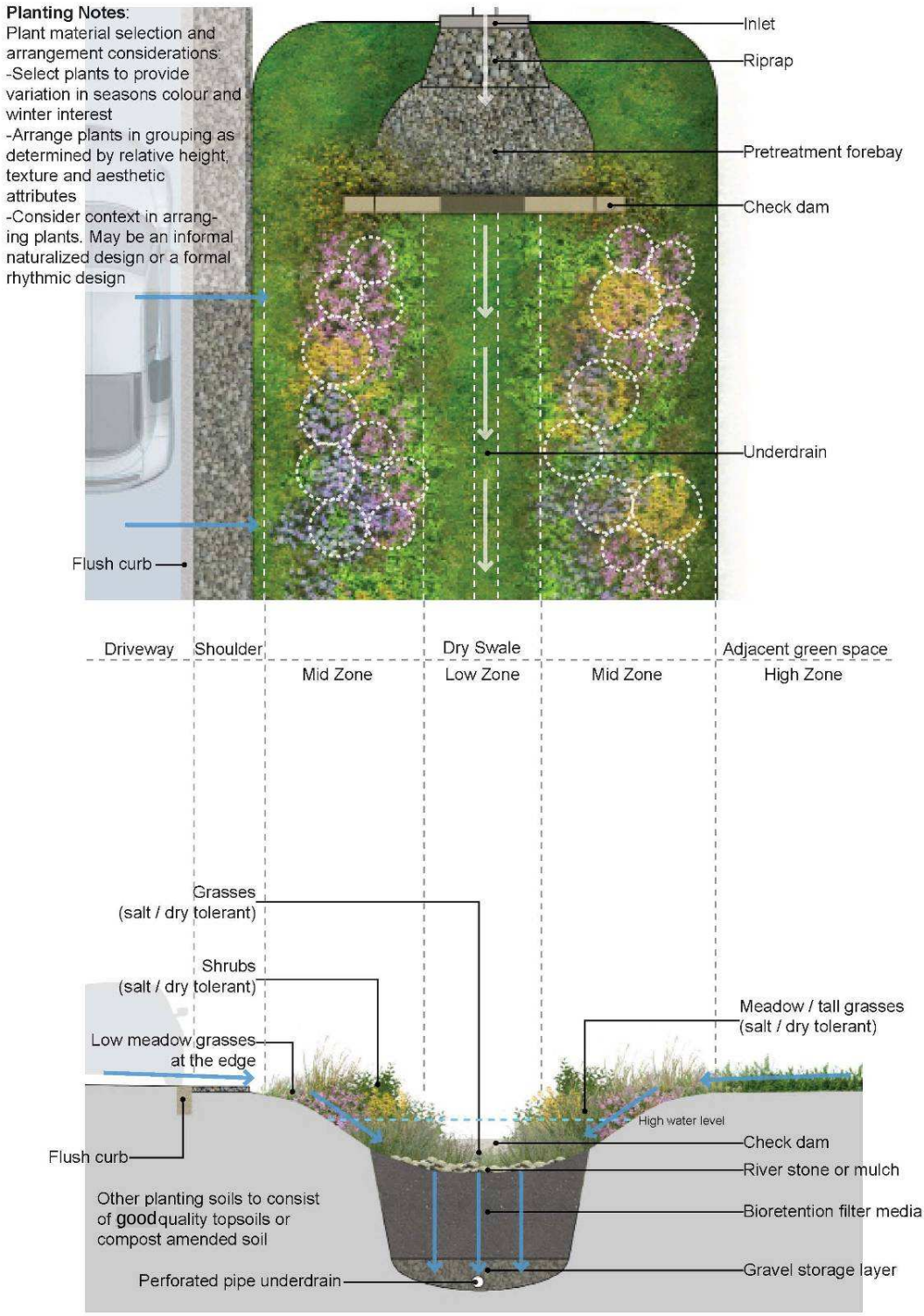


Figure 33 – Dry swale plan view and cross-section; sizing and layout guidance is provided in the LID Stormwater Management Planning and Design Guide.

DRY SWALE CRITERIA		
	GENERAL CRITERIA	**HYDRIC ZONE CRITERIA**
SITE CHARACTERISTICS	Drainage Areas (2 basic categories): 1. Exposure to roadway or parking lot runoff ▪ Runoff is contaminated with de-icers and vehicle pollutants. 2. No exposure to roadway or parking lot runoff Dry swale width will vary from narrow to wide depending on the available space and storage requirements. Wider versions allow for application of defined Low, Mid, and High Zones. Soil Conditions: ▪ Bioretention soil specification: 85-88% sand (2.0 to 0.05 mm), 8 to 12 % fines (<0.05 mm), and 3 to 5 % organic matter. ▪ Depth should be between 1.0 and 1.25 meters in depth. ▪ The sandy soil texture of the bioretention media influences plant species selection. ▪ Added topsoil may be needed in the extended high zone area supporting trees. ▪ May incorporate river run stone	Low Zone– Often referred to as the extended detention or shoreline fringe area. This area is frequently inundated during storm events, and is well-drained between rainfall events. *Mid Zone* – Often referred to as the *floodfringe* area. This zone is inundated less frequently (2 – 100 year storm events) and has periodically high levels of moisture in the soil. The ecology of this zone is a transition from the Mineral Meadow Marsh/Beach-type community to an upland community. *High Zone* – Often referred to as *upland* area. The ecology of this zone is terrestrial due to its elevation in relation to the filter bed. The zone most closely resembles a Cultural Meadow or a Cultural Thicket community, depending on the mix of grasses, herbaceous material, shrubs and trees utilized.

PLANT SELECTION	1. Exposure to roadway or parking lot runoff: Select salt tolerant grasses, other herbaceous material and shrubs. These can take on several forms, including parking lot islands, traffic islands, roundabouts, or cul-de-sacs and are often used as snow storage locations. 2. No exposure to roadway or parking lot runoff: Practices allow for a greater range of species selection. These receive runoff from rooftops or areas that use no deicing salt and have low pollutant exposure, such as courtyard bioretention. Other selection factors: ▪ Most dry swales will be situated to receive full sun exposure. The 'Exposure' column in the master plant list identifies the sun exposure condition for each species. ▪ Facilities with a deeper media bed (greater than 1 m) provide the opportunity for a wider range of plant species (including trees). ▪ The inclusion of vegetation with a variety of moisture tolerances ensures that the dry swale will adapt to a variety of weather conditions. ▪ Proper spacing must be provided for aboveground and belowground utilities, and adjacent infrastructure.
	Low Zone ▪ Grasses, Sedges, rushes, wildflowers, ferns and shrubs that have an 'Obligate' to 'Facultative' designation ▪ Species that are flood tolerant and will persist in average years and flourish in wetter years. Be advised these practices are not constructed wetlands and are designed to fully drain within 48 hours.
	Mid Zone ▪ Plants able to survive in soils that are seasonally saturated, yet can also tolerate periodic drought. ▪ Species include grasses and groundcovers, as well as low shrub species.
	High Zone ▪ Plants should have deep roots for structure, be drought-tolerant and capable of withstanding occasional soil saturation. ▪ This area can be considered a transition area into other landscape or site areas. ▪ A variety (min. five) species should be used to prevent a monoculture.

PLANT STANDARDS	Vegetation must meet Canadian Standards for Nursery Stock, Eighth Edition. Seed planting is not recommended for dry swales. Plants should be container grown, balled and burlapped or wire basket. Below are recommended minimum plant sizes for planting. **Deciduous Shrubs -** 60 - 80 cm height **Coniferous Shrubs / Broadleaf Evergreens** - ▪ 40 cm height and spread for dwarf type ▪ 60 -80 cm height or spread for medium form type; ▪ 25 cm root ball for spreading form type; ▪ 80 - 100 cm height for columnar form type **Perennials/Grasses -** #1 or 1 gal. container stock **Vines -** #1 or 1 gal. container and staked

DRY SWALE CONSTRUCTION AND PLANTING GUIDANCE	
SITE PREPARATION	▪ Topsoil is removed from the dry swale are prior to construction and applied to the mid to high zone areas. ▪ The existing soil in the dry swale bed or low zone is replaced with an engineered bioretention soil mix. ▪ If the project is a retrofit or redevelopment and meant to infiltrate, then deep tilling can be used to break up compacted soils.
EROSION CONTROL	▪ Construction traffic must be limited to areas that will not be expected to provide infiltration capacity. ▪ Installation of soils and vegetation should only begin after the entire contributing drainage area has been either stabilized or flows have been safely routed around the area. ▪ The facility should be kept offline during construction and ideally through the plant establishment period. If the facility will immediately begin accepting runoff, then appropriate erosion control measures include the use of a nurse crop or biodegradable matting. ▪ A 75 mm depth shredded hardwood mulch layer is appropriate for dry swales with shallow slopes (<2%) and low surface flow velocities. ▪ If fine construction sediment has collected on the surface of the filter bed prior to planting, then the sediment should be scraped from the surface without causing compaction. Removed sediment should be moved to a secure location where it will not be resuspended. ▪ The use of straw bale or silt fence check dams are not recommended. Sediment logs and temporary rock flow checks have proven to be more effective.
PRETREATMENT	▪ Pretreatment can reduce maintenance and increase practice longevity by settling suspended solids before the runoff enters the LID practice. ▪ Dry swales receiving runoff with little sediment, such as from rooftops, can function effectively with little or no pretreatment. ▪ Typical pretreatment includes forebays, vegetated filter strips, gravel diaphragms, riprap, and gutter screens, see the *CVC/TRCA*

	LID Guide for more detail on pretreatment design.
ESTABLISHMENT	▪ Dry swales can require a year of plant establishment before going on-line depending on the vegetation selected. In many cases this may not be feasible, see erosion control for options to reduce damage during establishment. ▪ The plantings in the *Low-Zone* and *Mid-Zone* will develop most successfully if the soils are regularly watered whenever the soil is dry.

DRY SWALE MAINTENANCE GUIDANCE	
ACCESSIBILITY	▪ The design should allow for easy maintenance and inspection access to the facility. ▪ Underdrains should be connected to standpipes that allow observation of drawdown and access to the underdrain for cleaning out. The standpipes should be capped, and the cap should be lockable if vandalism is a concern.
SOIL AMENDMENTS	▪ The recommended soil mix and contributing runoff should contain enough nutrients to sustain plant health. If plants are unhealthy, then the soil should be tested for deficiencies before amending. To avoid nutrient export fertilizer should never be applied to bioretention. ▪ Preferably, fertilizer should not be applied to any of the drainage areas. If fertilizer is necessary, then a coated controlled release fertilizer should be used.
WATERING/ IRRIGATION	▪ Watering may be required until vegetation is established and during dry periods. ▪ For practices within the right-of-way, municipalities should contract with water truck operators or encourage neighboring property owners to water and maintain street vegetation.
ANNUAL OR AS NEEDED MAINTENANCE ACTIVITIES	▪ Remove litter, debris, and accumulated sediment from pretreatment devices, inlets and outlets. ▪ Apply mulch in bare areas. ▪ Treat trees and shrubs affected by pest and disease using Integrated Pest Management and industry standards. ▪ Vegetative maintenance as required following current arboriculture and horticulture practices. ▪ Prune and trim trees and shrubs in Spring to maintain a tidy appearance ▪ Remove and replace dead vegetation ▪ Remove weeds and invasive plants. ▪ Repair eroded areas and interplant sparsely vegetated areas.

3.5.1 DRY SWALE PLANT LIST

Dry Swale

Summary of Recommended Plants

Consult the Master LID Practice Plant List for a full listing of plant characteristics, tolerances and other information to inform your selection of species from the list below.

Nativeness and Rarity:		
	♦♦♦♦	Best Choice
	♦♦♦	Better Choice
	♦♦	Selective Choice
	♦	Selective Choice
	NN	Reasonable Alternative (Non-Native)

Nurse Crop

		Zone			Zone
NN	*Avena sativa*	L M	NN	*Lolium multiflorum*	L, M

Graminoids

♦♦	*Andropogon gerardii*	M H	♦♦	*Elymus riparius*	M H
♦♦	*Bromus latiglumis*	L M H	♦♦♦♦	*Elymus virginicus* var. *virginicus*	L M
NN	*Calamagrostis acutiflora 'Karl Foerster'*	L M	NN	*Helictotrichon sempervirens*	L M
♦♦♦♦	*Calamagrostis canadensis*	L M	♦♦♦♦	*Juncus tenuis*	L M
♦♦♦♦	*Carex bebbii*	M H	♦♦♦♦	*Muhlenbergia mexicana* var. *mexicana*	L
♦♦	*Carex brevior*	H	NN	*Pennisetum hamelin*	L M
♦♦	*Carex grayii*	L M	♦♦	*Schizachyrium scoparium (Andropogon scoparius)*	M H
♦♦♦♦	*Carex hystericina*	L M H	♦♦♦♦	*Schoenoplectus tabernaemontani (Scirpus validus)*	L M
♦♦	*Carex lacustris*	M	♦♦♦♦	*Scirpus atrovirens*	L M
♦♦♦♦	*Carex pensylvanica*	M H	♦♦♦♦	*Scirpus cyperinus*	M
♦♦♦♦	*Carex vulpinoidea*	M	♦♦	*Sorghastrum nutans*	M H
♦♦♦♦	*Danthonia spicata*	H	♦♦	*Sparganium eurycarpum*	L M
♦♦♦♦	*Deschampsia cespitosa*	L M	♦♦	*Sporobolus neglectus*	M H
♦♦	*Elymus canadensis*	L M H			

Broadleaf Herbaceous (and Ferns)

♦♦♦	*Achillea millefolium ssp. Lanulosa*	H	♦♦♦♦	*Lysimachia ciliata*	L M
♦♦♦	*Allium schoenoprasum* var. *sibiricum*	H	♦♦♦♦	*Monarda fistulosa*	M H
♦♦♦♦	*Anemone canadensis*	M	♦	*Opuntia fragilis*	H
♦♦♦♦	*Aquilegia canadensis*	H	♦♦♦♦	*Podophyllum peltatum*	M H
NN	*Armeria maritima 'Dusseldorf Pride'*	H	♦♦	*Potentilla anserina*	L M

NN	*Artemisia schmidtiana 'Silver Mound'*	H	NN	*Rudbeckia fulgida*	M H
♦♦♦♦	*Asclepias incarnata ssp. incarnata*	L	♦♦♦♦	*Rudbeckia hirta*	H
♦♦	*Asclepias tuberosa*	M H	♦♦	*Rudbeckia laciniata*	L M
♦♦	*Doellingeria umbellata* var. *umbellata (Aster umbellatus)*	L M	♦♦	*Sisyrinchium montanum*	M
NN	*Baptisia alba*	H	♦♦♦♦	*Solidago altissima* var. *altissima*	H
NN	*Baptisia australis*	H	♦♦♦♦	*Solidago canadensis* var. *canadensis*	H
♦♦♦	*Cerastium arvense* ssp. *strictum*	H	♦♦♦♦	*Solidago flexicaulis*	M H
♦♦♦	*Coreopsis lanceolata*	M H	♦♦♦♦	*Solidago nemoralis* ssp. *nemoralis*	M H
NN	*Coreopsis rosea*	M	♦♦	*Solidago rugosa* ssp. *rugosa*	L M
♦♦	*Desmodium canadense*	M	♦♦♦♦	*Symphyotrichum cordifolium*	M
NN	*Echinacea purpurea*	M H	♦♦♦♦	*Symphyotrichum lanceolatum* ssp. *lanceolatum*	L M
♦♦	*Erigeron pulchellus*	M H	♦♦♦♦	*Symphyotrichum novae-angliae*	L M
♦♦♦♦	*Euthamia graminifolia*	L M	♦♦	*Symphyotrichum oolentangiense*	M H
♦♦♦♦	*Fragaria virginiana* ssp. *virginiana*	M	♦♦♦♦	*Symphyotrichum puniceum*	L
NN	*Gaillardia aristata*	M H	♦♦♦♦	*Thalictrum pubescens*	M H
♦	*Geum triflorum*	M H	♦♦♦♦	*Thelypteris palustris* var. *pubescens*	L M
♦♦	*Helianthus divaricatus*	H	♦♦♦♦	*Verbena hastata*	L M
♦♦	*Helianthus strumosus*	M H	♦♦	*Verbena stricta*	M H
♦♦♦♦	*Helianthus tuberosus*	L M	♦♦♦♦	*Verbena urticifolia*	M H
♦	*Heliopsis helianthoides*	M	♦	*Veronicastrum virginicum*	H
NN	*Hosta spp.*	M H	♦♦♦♦	*Waldsteinia fragarioides*	H
♦	*Trichostema brachiatum (Isanthus brachiatus)*	H	NN	*Yucca filamentosa*	M H
♦♦	*Lespedeza capitata*	H	♦♦	*Zizia aurea*	M H
NN	*Leucanthemum x superbum*	H			

Shrubs					
♦♦	*Amelanchier laevis*	M H	♦	*Prunus pumila* var. *pumila*	H
♦♦	*Amelanchier sanguinea*	M H	♦♦♦♦	*Prunus virginiana* ssp. *virginiana*	M H
♦	*Amelanchier spicata*	M H	♦	*Rhus aromatica*	M H
♦	*Arctostaphylos uva-ursi*	M	♦♦	*Rhus glabra*	M H
♦♦	*Aronia melanocarpa (Photinia melanocarpa)*	M	♦♦♦♦	*Rhus typhina (Rhus hirta)*	M H
♦♦♦♦	*Cornus alternifolia*	M H	♦♦♦♦	*Ribes cynosbati*	H
♦♦	*Cornus foemina spp. racemosa*	M	♦♦♦♦	*Rubus allegheniensis*	H
NN	*Cotoneaster apiculatus, C. divaricata, C. horizontalis, C. microphylla*	M H	♦♦♦♦	*Rubus idaeus* ssp. *strigosus*	M
♦♦♦♦	*Diervilla lonicera*	M H	♦♦♦♦	*Rubus odoratus*	M H
♦♦	*Hamamelis virginiana*	M H	♦♦♦♦	*Salix bebbiana*	M
♦♦♦	*Juniperus communus*	M H	♦♦♦♦	*Salix discolor*	M
♦♦♦	*Juniperus horizontalis*	M	♦♦♦♦	*Salix eriocephala*	M
NN	*Kerria japonica*	M H	♦♦	*Salix petiolaris*	M
♦♦	*Lindera benzoin*	M	♦♦♦♦	*Sambucus canadensis*	M
♦♦♦♦	*Lonicera dioca*	H	♦♦♦♦	*Sambucus racemosa* ssp. *pubens*	H
♦	*Myrica pensylvanica*	M H	♦♦	*Shepherdia canadensis*	M H
♦♦	*Physocarpus opulifolius*	M H	♦♦♦	*Viburnum dentatum*	M
♦♦	*Potentilla fruticosa (Dasifora floribunda)*		♦♦♦♦	*Viburnum lentago*	M H
♦♦♦♦	*Prunus pensylvanica*	M H	♦♦	*Viburnum rafinesquianum*	M H

Trees					
♦♦♦♦	*Acer rubrum*	M H	♦♦♦♦	*Populus balsamifera* ssp. *balsamifera*	H
♦♦	*Acer x freemanii*	M	♦♦♦♦	*Populus deltoides*	M
♦♦♦♦	*Betula papyrifera*	M H	♦♦♦♦	*Populus grandidentata*	H
♦♦♦	*Celtis occidentalis*	M	♦♦♦♦	*Populus tremuloides*	M H
♦♦♦♦	*Fraxinus americana*	H	♦♦♦♦	*Prunus serotina*	H
♦♦	*Fraxinus nigra*	M	♦♦	*Quercus alba*	H
NN	*Ginkgo biloba*	H	♦♦	*Quercus bicolor*	M
♦♦♦	*Gleditsia tricanthos* var. *inermis*	H	♦♦♦♦	*Quercus macrocarpa*	M H
♦♦♦♦	*Juglans nigra*	M	♦♦♦	*Quercus muehlenbergii*	H
♦♦	*Juniperus virginiana*	H	♦♦♦♦	*Quercus rubra*	H
♦♦	*Larix laricina*	M	♦♦	*Salix amygdaloides*	M
NN	*Picea pungens*	H	♦♦	*Salix lucida*	M
NN	*Pinus mugho*	H			

4 MASTER LID PRACTICE PLANT LIST

MASTER LID PRACTICE PLANT LIST

Refer to Section 2.3.3 for desciptions of "Plant Characteristics" and how to interpret the Master LIS Practice Plant List.

SPECIES		PLANT CHARACTERISTICS													
Scientific Name	Common Name	Recomm-ended as Seed Yes/ No	Soil Type Preference S=Sand L=Loam C=Clay	Soil Moisture M=Moist W=Wet D=Dry	Coefficient of Wetness UPL = Upland OBL = Wetland FAC= Facultative (wetland or upland) NI = No Indicator	Exposure Sun / Part Shade / Shade	Drought Tolerance High / Med / Low	Salt Tolerance High / Med / Low	Urban Tolerances P = Pollution C=Compaction	Growth Rate Fast / Med / Slow	Height / Spread at Maturity	Spacing (cm)	Ranking ♦=Selective ♦♦=Selective ♦♦♦=Better ♦♦♦♦=Best NN = Non-native	Aesthetic Attributes	Other Information
NURSE CROPS															
Avena sativa	Cultivated Oat	Y	SLC	M	UPL	Sun	H	H	C	F	40-60 cm x 10-15 cm	seeded	NN		Nurse crop for soil stabilization.
Lolium multiflorum	Annual Ryegrass	Y	Variable	Variable	FACW	Sun / Part Shade	H	H	P,C	F	40-50 cm x 30-50 cm	seeded	NN	Low-growing cool season meadow grass	Nurse Crop for soil stabilization; considered minimally invasive - to be controlled if necessary and limit spread to other areas.
GRAMINOIDS															
Andropogon gerardii	Big Bluestem	N	SLC	WM-MD	FACW	Sun	H	M	C	M	45-70 X 28-45 cm	50-100	♦♦	Turkey-foot shaped head, very tall.	Grows in clumps, sod-forming. Suitable for planters.
Bromus latiglumis	Broad-glumed Brome	N	SLC	W-M	FACW-	Part shade	M	M		M	75-125 cm H		♦♦		
Calamagrostis acutiflora 'Karl Foerster'	Karl Foerster Feather Reed Grass	N	SLC	M-D	NI	Sun	M	M	P,C	M	100-150 cm H	50-100	NN	Maintains structure throughout winter.	Cool season; clump forming; cut down in early spring prior to new growth.
Calamagrostis canadensis	Canada Blue-joint	N	SLC	W-M	OBL	Sun	L-M	M		M	1-1.5 m spread	30	♦♦♦♦	Vertical fluffy seed heads, arching foliage.	Grows in clumps or small patches.
Carex atherodes	Awned Sedge	N	LC	W	OBL	Sun	M	M		F	0.5-0.6 X 1-2 m	30-50	♦♦	Dark green, robust forming solid stands.	Grows in wet areas and along base of slopes.
Carex bebbii	Bebb's Sedge	Y	SLC	W-M	OBL	Sun	L-M	M	C	F	30 cm x 30 cm	30-50	♦♦♦♦	Small spiky plant with small but attractive seed heads.	
Carex brevior	Brevior Sedge	Y	SL	M-D	FACW+	Sun	M-H	M	C	F	30-90 cm H	30-50	♦♦	Golden foliage as it matures.	
Carex crinita	Fringed Sedge	N	SLC	WM	FACW+	Part shade	L	L		M	1-1.5 m spread	40-50	♦♦	Small plant with drooping seed heads.	Grows in clumps.
Carex grayii	Asa Gray Sedge	N	LC	WM	FACW+	Sun / Part Shade	L	M		M	60-90 X 45-60 cm	30-50	♦♦	Showy spiked seed heads in May, wide arching foliage.	Tolerates temporary flooding.
Carex hystericina	Porcupine Sedge	N	SLC	W	OBL	Sun	L	M		M	45 cm x 30-40 cm	30-40	♦♦♦♦	Bottlebrush-shaped seed heads.	Tolerates temporary flooding; spreading; useful for erosion control.
Carex intumescens	Bladder Sedge	Y	LC	W	FACW+	Sun / Part Shade	L	L		M	60 cm H	30-50	♦♦		
Carex lacustris	Lake-bank Sedge	Y	LC	W-M	OBL	Sun / Part Shade	L	M		M	75 x 50 cm	30	♦♦	Upright seed heads.	
Carex lupulina	Hop Sedge	Y	LC	M	OBL	Sun / Part Shade	L	L		M	0.5 X 0.5 m	30-50	♦♦	Large seed heads, lush green leaves	Found in wetlands.
Carex pensylvanica	Pennsylvania Sedge	N	SL	D	UPL	Part shade	M-H	M		M	30-45 cm spread	30-60	♦♦♦♦	Delicate foliage, forms low mound.	Spreads rapidly; sod-forming in full sun.
Carex stipata	Stalk-grain Sedge	Y	SLC	W-M	OBL	Sun	L	M	C	F	40-50 cm x 50-60 cm	30-50	♦♦♦♦	Sprays of golden yellow seed heads in summer.	Highly suitable.
Carex vulpinoidea	Fox Sedge	Y	SLC	W-M	OBL	Sun	L-M	M	P,C	F	40-50 cm x 50-60 cm	30-50	♦♦♦♦	Brown-yellow upright seed heads in mid-summer.	Grows in clumps; highly suitable.
Chasmanthium latifolium	Upland Sea Oats	N	SLC	M	NI	Sun / Part Shade	M	H		F	80-100 X 45-60 cm	30-50	NN	Green with pendulous seed heads.	Ornamental; suitable for formal plantings.
Danthonia spicata	Poverty Oatgrass	N	SL	M-D	UPL	Sun	H/M	H	C	F	15-30 cm X 30 cm	30	♦♦♦♦	Small plant, thin curly leaves.	Highly suitable.
Deschampsia cespitosa	Tufted Hairgrass	N	SLC	D	FACW+	Part shade	M	M-H		F	20-30 X 30-60 cm	30-50	♦♦♦♦	Very fine texture, evergreen.	Grows in clumps.
Elymus canadensis	Canada Wild-rye	Y	SLC	M-MD	FAC-	Sun	M-H	H	C	F	60-90 X 60-90 cm	30-50	♦♦	Attractive drooping seed heads.	Individual plants do not persist, but does self-seed.
Elymus riparius	River Wild-rye	Y	SL	M	FACW	Sun / Part Shade	M	M	C	F	60-75 cm x 60-90 cm	50-75	♦♦	Attractive drooping seed heads.	Highly suitable; individual plants do not persist, but does self-seed.
Elymus virginicus var. *virginicus*	Virginia Wild-rye	N	SLC	W-M	FACW-	Sun / Part Shade	M	M	C	F	60-75 cm x 60-90 cm	50-75	♦♦♦♦	Attractive upright seed heads.	Highly suitable; will grow more robust in full sun; clumping.

SPECIES		PLANT CHARACTERISTICS													
Scientific Name	**Common Name**	**Recomm-ended as Seed** Yes/ No	**Soil Type Preference** S=Sand L=Loam C=Clay	**Soil Moisture** M=Moist W=Wet D=Dry	**Coefficient of Wetness** UPL = Upland OBL = Wetland FAC= Facultative (wetland or upland) NI = No Indicator	**Exposure** Sun / Part Shade / Shade	**Drought Tolerance** High / Med / Low	**Salt Tolerance** High / Med / Low	**Urban Tolerances** P = Pollution C=Compaction	**Growth Rate** Fast / Med / Slow	**Height / Spread at Maturity**	**Spacing** (cm)	**Ranking** ♦=Selective ♦♦=Selective ♦♦♦=Better ♦♦♦♦=Best NN = Non-native	**Aesthetic Attributes**	**Other Information**
Festuca spp. (see: other information)	Fescue species.	Y	SL	M-D	n/a	Sun / Part Shade	H	M-H	P, C	S	20-25 cm		NN	Low-growing, fine-textured, dense mix that does not need to be mowed as a replacement to traditional turf grass.	Proprietary fescue mixes are created for seeding, with very few inputs required; commercially available blends for the region include 'Eco-Lawn' by Wildflower Farm. Not to be mowed more than once a month. Some fescues can be mildly invasive. Seek more information prior to use.
Helictotrichon sempervirens	Blue Oat Grass	N	SLC	M-D	NI	Sun	M	M		M	60-90 X 60-75 cm	60	NN	Mounding blue-grey grass, larger than *Festuca glauca* .	Ornamental; suitable for formal plantings.
Juncus effusus ssp. solutus	Lamp Rush	N	SLC	W-M	OBL	Sun	L	H	P,C	F	28-35 X 28-35 cm	30-90	♦♦♦♦	Evergreen rush. Seeds in fall.	Highly suitable.
Juncus tenuis	Path Rush	N	SLC	M	FAC	Sun / Part Shade	M	H	C	F	15-60 X 15-60 cm	30	♦♦♦♦	Somewhat small and inconspicuous.	Highly suitable; more drought tolerant than other rushes.
Muhlenbergia mexicana var. *mexicana*	Mexican Muhly	Y	L	M	FACW	Sun / Part Shade	M	M		F	50-75 X 30 cm	30	♦♦♦♦	Sleek, multi-headed grass, silvery-green.	Highly suitable; widely adapted on moist meadow soils.
Pennisetum hamelin	Fountain Grass	N	SLC	M-D	NI	Sun	H	H		M	60-90 X 60 cm	60	NN	Elegant ornamental grass with plumes resembling bottle brushes appear that in summer.	
Schizachyrium scoparium (Andropogon scoparius)	Little Bluestem	N	S	D	FACU	Sun	H	M-H	P,C	F	60-90 X 45-60 cm	60	♦♦	Blue summer colour, reddish fall colour stems remain upright during winter.	Clump forming; best on poor, dry soil to avoid being outcompeted. Sometimes difficult to establish.
Schoenoplectus tabernaemontani (Scirpus validus)	Soft-stem Bulrush	Y	SLC	W	OBL	Sun	L	M-H	P	F	50-75 X 20-60 cm	30	♦♦♦♦	Delicate foliage.	Highly suitable; tolerates brackish water.
Scirpus atrovirens	Dark-green Bulrush	Y	LC	W	OBL	Sun	L	M	P	F	30 -200 cm H	30	♦♦♦♦	Rush with clustered reddish seed heads.	Highly suitable.
Scirpus cyperinus	Cottongrass Bulrush	Y	SLC	W	OBL	Sun	M	M		M	75-100 X 50-60 cm	30-90	♦♦♦♦	Rush with attractive woolly seed heads.	
Sorghastrum nutans	Yellow Indian-grass	N	SLC	M-D	FACU+	Sun / Part Shade	H	M-H	C	F	90-150 X 60-90 cm	30 - 100	♦♦	Tall grass with attractive reddish seed head.	Spreading, can be aggressive. Very drought-tolerant.
Sparganium eurycarpum	Large Bur-reed	Y	SLC	W	OBL	Sun / Part Shade	L	M		F	40-60 X 50-75cm	30-50	♦♦	Large spiked seed pod.	Highly suitable.
Spartina pectinata	Prairie Cordgrass	N	SL	W-M	FACW+	Sun / Part Shade	M	M	P	M	1-1.5 X 1 m	30-50	♦♦	Thin arching foliage, reddish fall colour.	Spreading, can be aggressive on moist sites.
Sporobolus neglectus	Small Dropseed	Y	SL	MD-D	UPL	Sun	H	H	C	M	15-25 X 10-20 cm	20	♦♦	Distinctive when mass-planted on dry soils.	Develops late in growing season; self-seeds.
Typha latifolia	Broad-leaf Cattail	N	SLC	W	OBL	Sun	L	M-H	P	F	80-120x 50-75	30-50	♦♦♦♦	Provides texture and screening especially in larger stands.	Highly suitable; efficient at pollution uptake. CAUTION: Ensure it is not contaminated with Typha x glauca or Typha angustifolia.
BROADLEAF HERBACEOUS and FERNS															
Achillea millefolium ssp. Lanulosa	Common Yarrow	N	SL	M	FACU	Sun	M-H	M	P,C	F	60 X 60 cm	30	♦♦♦	Flat-topped white flowers, feathery foliage.	Highly suitable; naturalizes readily in disturbed areas.
Alisma plantago-aquatica	American Water-plantain	Y	LC	W	OBL	Sun	L	M		F		30	♦♦♦♦		Highly suitable.
Allium schoenoprasum var. *sibiricum*	Wild Chives	Y	SLC	M	FACU	Sun	M	L			30-45	15-30	♦♦♦	Pale green stems, globose pink flowers in June	
Amsonia hubrichtii	Arkansas Blustar flower	N	SLC	M-D	FACU	Sun / Part Shade	M	L		S	60-90 X 75-90 cm	75	NN	Very fine leaf texture, blue flowers, blooms in late spring, yellow fall foliage.	Useful on edges.
Amsonia tabernaemontana	Eastern Bluestar	N	SLC	M	FACW	Sun / Part Shade	M	L		S	25-30 X 30-35 cm	30	NN	Blue star-shaped flowers, dwarf cultivar 'Short Stack' available.	
Anemone canadensis	Canada Anemone	N	SLC	WM-M	FACW	Sun / Part Shade	L-M	M		M	30-60 X 60-75 cm	30-50	♦♦♦♦	White flowers in spring. Spreading groundcover, foliage declines in late summer.	Highly suitable.

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Antennaria spp.	Pussytoes	N	SLC	M-D	UPL	Sun	H	M		S	10-15 cm X 30-50 cm	30-50	Multiple		
Aquilegia canadensis	Wild Columbine	Y	SLC	M	FAC	Sun / Part Shade	M	M	C	F	60-90 X 30-60 cm	30	♦♦♦♦	Red pendulous flowers.	Suitable for nutrient-poor, low competition situations; habitat value for butterflies & hummingbirds; self sows; easy to maintain once established.
Armeria maritima 'Dusseldorf Pride'	Dusseldorf Pride Sea Thrift	N	SLC	M-D	NI	Sun	H	H		M	10-15 X 15-30 cm	30	NN	Blooms mid-Spring to early-Summer; deep pink.	Ornamental plantings only.
Artemisia schmidtiana 'Silver Mound'	Silver Mound Artemesia		SLC	M-D	NI	Sun / Part Shade	M-H	H		M	25-30 X 30-60 cm	30-45	NN	Silver-green mound, blooms small white flowers mid-summer.	Ornamental plantings only.
Aruncus dioicus	Bride's Feathers	Y	SLC	W-M	FACW	Part shade / Shade	L-M	M		F	45-70 X 35-60 cm	150-180	NN	White flowers in summer.	Suitable for large-scale plantings.
Asclepias incarnata ssp. incarnata	Swamp milkweed	Y	SLC	W	FACW+, OBL	Sun	M	M		F	90-120 X 60-75 cm	30-50	♦♦♦♦	Deep pink flower in summer.	Highly suitable; spreads rapidly.
Asclepias tuberosa	Butterfly Milkweed	N	SLC	M-D	FACU	Sun	M-H	M-H		S	60-90 X 45 - 60 cm	50-100	♦♦	Orange summer flower.	Young plants transplant easily, mature plants difficult to move; does not tolerate wet soil.
Baptisia alba	Rattlebox, White Wild Indigo	N	SLC	D	FACU, FAC	Sun / Part Shade	H	H		M	75-90 X 75-90 cm	50-100	NN	White flowers in late spring.	Deep tap-root. Attracts butterflies.
Baptisia australis	Blue Wild Indigo	N	S	D	FACU	Sun	H	H		M	75-90 X 75-90 cm	50-100	NN	Blue flowers in early summer.	Deep rooted.
Bidens cernua	Nodding Beggar-ticks	Y	SLC	W	OBL	Sun / Part Shade	L	M	P	F	15-90 X 50 cm	30	♦♦♦♦	Small yellow flowers.	Highly suitable; less drought tolerant than other *Bidens* species; easy to grow; self-sows.
Bidens frondosa	Devil's Beggar-ticks	N	SLC	WM-M	FACW	Sun / Part Shade	L-M	M	P	F	30-90 x 50 cm	30	♦♦♦♦	Small greenish-yellow flowers.	Easy to grow; self-sows; can be aggressive.
Boltonia asteroides	Boltonia, False Aster	N	SL	M	FACW	Sun	M	M		F	90-120 X 75-90 cm	60-90	NN	White flowers in summer.	Easy to grow
Caltha palustris	Marsh Marigold	N	LC	W-M	OBL	Sun / Part Shade	L	L		M	30-45 X 30-45 cm	30	♦♦♦♦	Showy yellow flower in spring.	
Cerastium arvense ssp. *strictum*	Field Chickweed	Y	S	D	FACU-	Sun / Part Shade	M	M		F	10-25 X 30-45 cm	30-50	♦♦♦	Spreading, delicate white flowers	
Chelone glabra	White Turtlehead	N	SLC	W-M	OBL	Sun	L	L		M	60-90 X 45-60 cm	30-50	♦♦	White flowers.	Cannot tolerate drought; attracts butterflies.
Chelone lyonii	Pink Turtlehead e.g. cultivar 'Hot Lips'	N	SLC	M	FACW+	Sun / Part Shade	L	L		M	60-90 X 30-45 cm	30-50	NN	Pink flowers in mid-late summer.	Attracts butterflies and birds.
Coreopsis lanceolata	Lance-leaved Coreopsis	Y	SLC	M-D	FACU	Sun / Part Shade	H	H		F	30-90 cm H	30-50	♦♦♦	Abundant yellow flowers.	Intolerant of compaction, easily grown from seed.
Coreopsis rosea	Pink-flowered Tickseed	Y	SLC	M	FAC	Sun	M	M		M	30-55 X 45-60 cm	30-50	NN	Blooms early-summer to early-autumn; pink/white flowers.	
Desmodium canadense	Showy Tick-trefoil	N	SLC	M-D	FAC-	Sun	L-M	H	C	F	60-125 cm	30-50	♦♦	Pink-purple flowers in large open panicles.	Increases nitrogen content of soils.
Doellingeria umbellata var. *umbellata (Aster umbellatus)*	Flat-top White Aster	N	SLC	W-M	FACW	Sun	L	M-H		M	100x 50 cm	30-50	♦♦	White flowers in broad flat-topped cluster.	Somewhat rare - there are some genetic swamping issues for existing populations.
Echinacea purpurea	Eastern Purple Coneflower	N	SL	M-MD	UPL	Sun	M	M		M	75-120 X 45-60 cm	30-50	NN	Large pink/purple flowers on stiff stalks in mid-late summer. White cultivar available, dwarf cultivars are about 40% smaller.	Attracts butterflies and birds.
Epilobium coloratum	Purple-leaf Willow-herb	Y	LC	W	OBL	Sun	M	M	P,C	F	60-70 cm x 40-60 cm	30	♦♦	Small white-pink flowers, leaves tinged with purple.	
Erigeron pulchellus	Robin's Plantain Fleabane	Y	SL	M-D	FACU	Sun	H	M		F	10-15 cm X 1-2 m	30	♦♦	Pale pink composite flowers from basal rosettes	Forms colonies.
Eupatorium maculatum ssp. *maculatum*	Spotted Joe-pye Weed	Y	SLC	W	OBL	Sun	M	M	C	F	150-160 X 45-60 cm	30	♦♦♦♦	Mauve flower in late summer.	Highly suitable; nectar source for bees & butterflies; establishes best with organic matter.

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Eupatorium perfoliatum	Common Boneset	Y	SLC	W-M	FACW+	Sun / Part Shade	M	L	C	F	150-200 X 90-120 cm	30	♦♦♦♦	White flower clusters, distinctive "piercing" leaves.	Highly suitable; tolerates drier soils than *Eupatorium maculatum* ; grows easily from seed.
Euthamia graminifolia	Flat-top Goldentop	Y	SLC	WM-M	FACW-	Sun / Part Shade	M-H	M	P,C	F	70-80 x 40-60 cm	30	♦♦♦♦	Clusters of showy yellow flowers in fall.	Highly suitable; spreading by root system, can be aggressive in moist sunny locations.
Fragaria virginiana ssp. *virginiana*	Common Strawberry	N	SLC	M-D	FAC-	Sun / Part Shade	M	M	P,C	M	15 X 60 cm	30-50	♦♦♦♦	Small white flowers, small red strawberries in summer.	Highly suitable; spreads rapidly in spring and fall by runners; important food source for insects, birds, & animals.
Gaillardia aristata	Great Blanket-flower	N	SL	M	UPL	Sun	M-H	L-M	C	F	30 X 30 cm	30	NN	Plentiful orange/red flowers.	May be suitable in formal areas; may flower in first year from seed.
Geranium maculatum	Wild Crane's-bill / Wild Geranium	N	SL	M-DM	FACU	Sun / Part Shade	M	L		S	30-60 X 70-90 cm	30-50	♦♦	Purple flowers in summer.	Best if planted in fall; spreads slowly. Best suited to part shade.
Geum triflorum	Prairie Smoke	N	SL	M-MD	FACU-	Sun	H	M		M	25-30 X 15-25 cm	30	♦	Pink flowers in spring, followed by development of hairy 'tails' giving smoky appearance	Poor soils and gravels; seasonally moist; dislikes strong competition
Helianthus divaricatus	Woodland Sunflower	N	SLC	M-D	UPL	Sun / Part Shade	M	H	C	M	0.5-2 m H	60	♦♦	Yellow flowers, very tall.	Forms colonies.
Helianthus strumosus	Pale-leaf Sunflower	N	SLC	M-DM	UPL	Part shade	M-H	M-H	?	F	0.5-2 m H	60	♦♦	Yellow flowers, very tall.	Fast growing; can be aggressive; more upland.
Helianthus tuberosus	Jerusalem Artichoke	N	SL	D	FAC	Sun / Part Shade	M	H	P,C?	F	1-3 m H	90	♦♦♦♦	Yellow flowers, very tall.	Extremely fast growing; can be aggressive; native to floodplains.
Heliopsis helianthoides	Oxeye Sunflower	Y	SLC	M	UPL	Sun	M-H			M	1-2 X 1 m	50	♦	Double yellow flowers, many cultivars available.	Quick to establish; may not be long-lived; self seeds; tolerates a wide range of conditions.
Hosta spp.	Hosta (many varieties)	N	Variable	Variable	NI	Dependent on variety.	L-M	M		F	Dependent on variety.	60	NN	One of the most distinctive perennials due to form and leaf size.	Many varieties are available; ranging in size, colour, and preferences for soil and moisture.
Hydrophyllum virginianum	John's Cabbage / Virginia Waterleaf	N	L	M	FACW-	Sun / Part Shade	M	M		F	25-40 X 100	30-50	♦♦♦♦	Cut-leaved, densely-growing with white flowers.	Highly suitable; outcompetes invasives such as Garlic Mustard.
Impatiens capensis	Spotted Touch-me-not	Y	SLC	M	FACW	Sun / Part Shade	L-M	L		F	60-150 X 45-75 cm	seed / 50	♦♦♦♦	Interesting orange flowers.	Highly suitable; very easy to grow from seed; does not transplant well; forms colonies; annual.
Iris versicolor	Blue Flag	N	SLC	W	OBL	Sun	L	M		S	90-120 X 60-75 cm	30	♦♦	Blue flower in late spring, interesting seed heads.	Requires full sun to bloom; spreads slowly. CAUTION: often mislabelled as *Iris virginicus, Iris sibiricus* , or *Iris pseudacorus* . Ensure correct identification.
Lespedeza capitata	Round-head Bush-clover	Y	SL	M-D	FACU	Sun / Part Shade	H/M	H	C	M	60 X 60 cm	60-100	♦♦	Tall spike of yellowish flowers.	Grows easily from seed; adds nitrogen to soil.
Leucanthemum x superbum	Shasta Daisy	N	SLC	M-D	UPL	Sun	H	M		M	75- 90 X 30-45 cm	30-60	NN	White double daisy-like flowers.	
Lobelia siphilitica	Great Blue Lobelia	Y	SLC	W-M	FACW+	Sun / Part Shade	L	L		F	40-60 cm x 50-60 cm	30-50	♦♦	Blue orchid-like flower.	Easy to grow; self-sows.
Lysimachia ciliata	Fringed Loosestrife	N	SL	WM-M	FACW	Sun / Part Shade	M	L-M		F	100-125 X 150 cm	50-100	♦♦♦♦	Yellow, nodding, star-shaped flowers.	Can be aggressive.
Matteucia struthiopteris var. *pensylvanica*	Ostrich Fern	N	LC	W-M	FACW	Sun / Part Shade	M	L-M		F	100-125 X 150 cm	50-100	♦♦♦♦	Lush fern growth, fruiting on separate fronds.	Highly suitable; colonial, can cover extensive areas.
Monarda fistulosa	Wild Bergamot Bee-balm	Y	SLC	WM-D	FACU	Sun	M-H	M-H	P,C	F	60-120 X 60-90 cm	30	♦♦♦♦	Lavender flowers, many cultivars available.	Easy to grow from seed; spreading. Soil depth should be >15cm.
Onoclea sensibilis	Sensitive Fern	N	LC	W-M	FACW	Part shade / Shade	L-M	L-M		M	30-90 X 90-120 cm	30-50	♦♦♦♦	Light green fronds, brown spiked seed cluster in fall.	Highly suitable; spreads rapidly; tolerates full sun if soil is consistently wet.
Opuntia fragilis	Spreading Prickly-Pear	N	SL	D	UPL	Sun / Part Shade	H	H		S	2-10 X 20-30 cm	30	♦	Cactus; forms low-growing mats; yellow flowers in summer.	

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Osmunda cinnamomea	Cinnamon Fern	N	LC	W-M	FACW	Shade	L-M	L		S	70-150 X 60-90 cm	50	♦♦♦♦	Upright deciduous green fern.	Colonial in seasonally inundated areas; organic or mineral soil.
Packera paupercula	Balsam Ragweed	N	SLC	M-D	FAC+	Sun	H	M		M	10-60 X 15-25	30	♦♦♦	Bright yellow aster like flowers, dark green leaves.	Rocky and alvar habitats.
Penstemon digitalis	Foxglove Beardtongue	Y	SLC	M-D	FAC-	Sun	M-H	M-H	P	F	75-90 X 30-35 cm	30	♦♦	White flowers May-June.	Easily grown from seed; readily self-sows.
Penstemon hirsutus	Hairy beardtongue		SLC	M-MD	UPL	Sun / Part Shade	H			S-M	50 X 20 cm	30	♦♦	Pink flowers May.	Easily grown from seed; readily self-sows.
Podophyllum peltatum	May Apple	N	LC	M	FACU	Part shade / Shade	L			M	30-40 X 25 cm	30	♦♦♦♦	Large umbrella-like leaves; white flower in spring; apple-like fruit.	
Potentilla anserina	Silverweed	N	SLC	W	FACW+	Sun	H	M	P, C	F	5-15 X 100+	30	♦♦	Yellow flowers, silvery leaves, creeping.	Shoreline species; spreads by runners; tolerates foot traffic.
Rudbeckia fulgida	Orange Coneflower	Y	SLC	M-MD	FAC, OBL	Sun	H			M	60-75 X 45-60 cm	50	NN	Golden daisy flower June-October, typical cultivar: 'Goldstrum'.	Very drought-tolerant; attractive to bees, butterflies and/or birds; self-sows freely; deadhead if you do not want volunteer seedlings.
Rudbeckia hirta	Black-Eyed Susan	Y	SLC	WM-DM	FACU	Sun	M-H	H		F	60-75 X 45-60 cm	30-60	♦♦♦♦	Yellow daisy flower June-October.	Self sows easily, dry-mesic meadow habitat.
Rudbeckia laciniata	Green-Headed Coneflower, Cut-leaf Coneflower	Y	SLC	W-M	FACW+	Sun / Part Shade	M	M	P,C	F	150- 210 X 90-120 cm	50	♦♦	Yellow flower in summer, can look lanky.	Easy plant to cultivate, can form colonies.
Sedum album	White Stonecrop	N	SLC	MD-D	UPL	Sun	H	M	P	S	10 X 30 cm	30	NN	White flowers.	Spreading; **only for use on green roofs** due to potential to become invasive elsewhere.
Sedum hybridum	Hybrid Stonecrop	N	SLC	MD-D	NI	Sun	H	M	P	S	15 X 20 cm	30	NN		Spreading; **only for use on green roofs** due to potential to become invasive elsewhere.
Sedum reflexum	Jenny's Stonecrop	N	SLC	MD-D	NI	Sun	H	M	P	S	10 X 20 cm	30	NN	Bluish foliage, yellow flowers.	Spreading; **only for use on green roofs** due to potential to become invasive elsewhere.
Sedum sexangulare	Tasteless Stonecrop	N	SLC	MD-D	UPL	Sun / Part Shade / Shade	H	M	P	S	10 X 20 cm	30	NN		Spreading; **only for use on green roofs** due to potential to become invasive elsewhere.
Sedum spurium	Dragon's Blood Sedum	N	SLC	MD-D	UPL	Sun	H	M	P	S	10-15 X 20 cm	30	NN	Yellow flowers, many cultivars available.	Spreading; **only for use on green roofs** due to potential to become invasive elsewhere.
Sisyrinchium montanum	Strict Blue-eyed-grass	Y	SLC	W-M	FAC+	Sun	M	M		M	10-15 X 10-15 cm	30	♦♦	Bright blue flowers in spring.	Self-seeds once established; tolerates inundation
Solidago altissima var. *altissima*	Tall Goldenrod	Y	SLC	W-M	FACU	Sun / Part Shade	M	M	P,C	F	100-150 X 100 cm	30-50	♦♦♦♦	Large, loose, upright yellow flower cluster in fall.	Spreads rapidly, self-seeds; very aggressive - plant only with the most aggressive species. Attracts birds and butterflies.
Solidago canadensis var. *canadensis*	Canada Goldenrod		SLC	W-M	-	Sun / Part Shade	M	M	P,C	F	90-180cm	30-50	♦♦♦♦	Large, loose, upright yellow flower cluster in fall.	Spreads rapidly, self-seeds; very aggressive - plant only with the most aggressive species. Attracts birds and butterflies.
Solidago flexicaulis	Zig-zag Goldenrod	N	L	M	FACU	Sun / Part Shade	M	M-H	P	F	30-50 X 50+ cm	30-50	♦♦♦♦	Showy golden flowers, finely fringed dark green leaves.	Highly suitable; endures conditions of difficult urban sites.
Solidago nemoralis ssp. *nemoralis*	Grey Goldenrod	Y	S	D	FACW-	Sun / Part Shade	M	H	P,C	M	30-40 X 20-30 cm	30	♦♦♦♦	Large upright yellow flower cluster in late summer/fall.	Highly suitable on less fertile soils; forms colonies.
Solidago patula	Roundleaf Goldenrod	N	SLC	WM-M	OBL	Sun	L	L		M	60-150 X 75-90 cm	30	♦♦	Large upright yellow flower cluster in late summer/fall.	Forms colonies.
Solidago ptarmicoides(Oligoneuron album)	Prairie Goldenrod	Y	S	MD-D	UPL	Sun	H	M	P	M	15-30 X 15 cm	30	♦	white flowers in late summer, compact rosettes.	Grow from seed or install as plugs; tolerates short term inundation if drainage is good.

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Solidago rugosa ssp. *rugosa*	Wrinkleleaf Goldenrod	Y	SLC	WM-M	FAC+	Sun	L-M	M	C	F	90-120 X 60-75 cm	90	♦♦	Large upright yellow flower cluster in late summer/fall.	Highly suitable; clumps spread readily; transplants best with added leaf mold & manure.
Stachys byzantina	Lambs' Ears	N	SLC	MD-D	NI	Sun	M-H	M		M-F	30-45 X 30-45 cm	30-50	NN	White-green fuzzy leaves, purple flowers.	Spreads well, very hardy; **only for use on green roofs** due to potential to become invasive elsewhere.
Symphyotrichum cordifolium	Heart-leaved Aster	Y	SLC	D	UPL	Part shade	M-H	M-H	P	F	25-45 X 75-90 cm	30-50	♦♦♦♦	White flowers in August, large heart-shaped leaves	Highly suitable; forms colonies; excellent groundcover in partial shade.
Symphyotrichum ericoides var. *ericoides*	White Heath Aster	Y	SLC	M-D	FACU-	Sun	M	M-H	P,C	M	60 cm H	30	♦♦♦♦	Blooms in August; profuse tiny white flowers.	Highly suitable.
Symphyotrichum lanceolatum ssp. *lanceolatum*	Panicled Aster	Y	SLC	M	FACW	Sun / Part Shade	M	M-H	P,C	M	75x45-60 cm	30-50	♦♦♦♦	Profuse small white flowers, narrow leaves.	Highly suitable; prefers soil which pools water then later dries out.
Symphyotrichum novae-angliae	New England Aster	Y	SLC	M	FACW	Sun / Part Shade	M	M-H	P,C	F	120-150 X 45-60 cm	30-60	♦♦♦♦	Blue/light purple flowers in fall.	Highly suitable; grows easily from seed, spreads quickly; dry-mesic meadow habitat.
Symphyotrichum oolentangiense	Sky-blue Aster	Y	SL	D	UPL	Sun / Part Shade	M-H	M	C	M	0.5 X 0.3	30	♦♦	Arrow-shaped leaves, deep blue flowers in late summer.	Self-seeds; diversifies on poor soils; attracts butterflies.
Symphyotrichum puniceum	Swamp Aster	Y	SLC	W-M	FAC	Sun	L-M	M-H		M	120-240 X 60-90 cm	30-50	♦♦♦♦	Light purple flowers in fall.	Highly suitable.
Thalictrum pubescens	Tall Meadow-Rue	N	SLC	W-M	FACW-	Part Shade	M	M		F	60-70 x 50-75 cm	30-50	♦♦♦♦	Delicate rounded white flower clusters, very tall.	Highly suitable.
Thelypteris palustris var. *pubescens*	Marsh Fern	N	SLC	W-M	FACW+	Shade	L	L-M		M	75-90 X 75-90 cm	30	♦♦♦♦	Upright deciduous fern.	Highly suitable; intolerant of long-lasting standing water or dense shade.
Thymus serpyllum	Mother-of-Thyme	N	SLC	MD-D	NI	Sun	H	M-H	P	M-F	7 X 7-30 cm	30	NN	Soft fragrant foliage, purple flowers.	Mat-forming; **only for use on green roofs** due to potential to become invasive elsewhere.
Tradescantia virginiana	Virginia Spiderwort		LC	M	UPL	Sun / Part Shade	L	L		M	45-60 X 45-60 cm	50	NN	Many cultivars with colours in purple, magenta, white; cut back after flowering.	
Trichostema brachiatum (Isanthus brachiatus)	False Pennyroyal	Y	S, Gravel	D	UPL	Sun	H	M		M	10-50 X 15-45	30	♦	Carpet-growing with blue flowers.	Grows naturally in rocky or gravelly landscapes
Verbena hastata	Blue Vervain	Y	SLC	W-M	FACW+	Sun	L-M	M-H	P,C	F	0.5 - 1.5 X 0.5 m	50	♦♦♦♦	Spikes of blue flowers.	Highly suitable, spreading, self-sows; easy to grow from seed.
Verbena stricta	Hoary Vervain	N	SL	M-D	UPL	Sun	M-H	M	C	M-F	60-120 X 45-60 cm	30-50	♦♦	Spikes of purple flowers, hairy leaves, can be weedy-looking.	Highly suitable, spreading.
Verbena urticifolia	White Vervain	Y	SLC	M	FAC+	Part shade	H	M	C	F	50-75 x 40-60 cm	30-50	♦♦♦♦	Spikes of very small white or lavender flowers.	Highly suitable, spreading, can be weedy, self-seeds.
Veronicastrum virginicum	Culver's-root		SLC	WM-MD	FACU, FAC	Sun	H	M		M	120-180 X 75-90 cm	75	♦	Upright with white flowers in summer.	
Waldsteinia fragarioides	Barren Strawberry	N	SLC	M-MD	UPL	Part shade	M	M-H		M	10-15 X 110 cm	30-50	♦♦♦♦	Profuse yellow flowers on low, spreading strawberry-like plants.	Tolerates drought once established
Yucca filamentosa	Narrow-Leaved Yucca	N	SL	MD-D	NI	Sun	M-H	M		S	60-90 X 60-90 cm	100	NN	Spiky greyish green leaves, fragrant white flower spikes, very tropical looking.	Dry, sunny areas.
Zizia aurea	Common Alexanders	N	SLC	WM-MD	FAC+	Sun / Part Shade	M	M	C	F	45-90 X 45-60 cm	30	♦♦	Yellow flowers.	Easy to grow & maintain.
SHRUBS															
Amelanchier arborea	Downy Serviceberry	N	SL	M-D	FACU	Sun / Part Shade	M	L		M	5 X 3 m	200	♦♦♦♦	White flowers- spring, red fall colour.	Sensitive to salt & compaction.
Amelanchier laevis	Allegheny Servicebery / Smooth Serviceberry	N	SL	M-D	UPL	Part Shade	M	M		M	5-8 X 4-6 m	250	♦♦	Showy.	
Amelanchier sanguinea	Roundleaf Serviceberry / Dwarf Juneberry	N	SL	M-MD	UPL	Sun / Part Shade	M-H	M	C	M	1-2 X 1-1.5 m	100-150	♦♦	White flowers in spring.	
Amelanchier spicata	Low Serviceberry / Shadbush serviceberry	N	SLC	M-MD	FACU	Sun / Part Shade	M	M	C	M	1-2 x 1.5 m	100-150	♦	White flowers- spring, red fall color.	

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Arctostaphylos uva-ursi	Bearberry	N	SL	M-D	UPL	Sun / Part Shade	M-H	M-H		M	15-30 cm X 1-2 m	30	♦	Evergreen small, dark-green, shiny leaves; small, white to pink flowers in spring, followed by red berries in late summer; red fall color.	Highly suitable on green roofs; spreads slowly. Does well on gravelly substrates.
Aronia melanocarpa (Photinia melanocarpa)	Black Chokeberry	N	SL	W-D	FACW	Sun / Part Shade	L-M	M-H		M	1-2 X 1-2 m	100	♦♦	White flowers May-June, black berries in fall.	Forms colonies.
Cephalanthus occidentalis	Common Buttonbush	N	SLC	W-M	OBL	Sun / Part Shade	M	M	C	S	3 X 2 m	100	♦♦	White orb-like flowers in summer.	Can form colonies.
Cornus alternifolia	Alternate-leaf Dogwood	N	L	M	UPL	Sun / Part Shade	M	L-M	C	M	2-3 X 3-4 m	100-150	♦♦♦♦	Very attractive tiered growth pattern, white flowers in spring.	Highly suitable; sensitive to pollution; recovers slowly from transplanting; avoid planting in fall; tolerant of periodic short-term inundation.
Cornus amomum ssp. *obliqua*	Silky Dogwood	N	SLC	W-M	FACW+	Part shade	M	L	C	M	2-3 X 2-3 m	100-150	♦♦	Blue fruit in fall.	Highly suitable, sensitive to salt.
Cornus foemina spp. racemosa	Stiff Dogwood / Gray Dogwood	N	SLC	M-D	FACW-	Sun / Part Shade	M	M-H	C	M	2-3 X 2-3 m	100	♦♦	White fruit, red fall colour.	Highly suitable; tolerant of periodic short-term inundation; colony forming.
Cornus sericea ssp. *sericea (Cornus stolonifera)*	Red-Osier Dogwood	Y	SLC	W-M	FACW	Sun / Part Shade	M	L	C	F	1.8-2.8 X 2.4-3.6 m	100	♦♦♦♦	White flowers in late spring, showy red twigs in winter.	Highly suitable; sensitive to salt, tolerant of periodic short-term inundation. CAUTION: *Cornus alba* often mistakenly used instead.
Corylus americana	American Hazelnut	N	LC	M-D	FACU-	Sun / Part Shade	M	L	C	M	3-4.8 X 4.8-5.1 m	100	♦	Coppery-red fall color, nuts in fall.	Generally multi-stemmed.
Corylus cornuta	Beaked Hazelnut	N	SL	M-D	UPL	Sun / Part Shade	M	L	C	M	1-2 X 1-2 m	100	♦♦♦♦	Rough-looking leaves, nuts in fall.	
Cotoneaster apiculatus, C. divaricata, C. horizontalis, C. microphylla	Cotoneaster	N	L	M	NI	Sun / Part Shade	H	M-H	P	M	30-60 X 60-150 cm	species dependent	NN	Small, often shiny, green leaves and small, pink flowers in spring followed by red fruits; red fall color.	Used as ground or bank covers; may require extra attention the first year but do well once established.
Diervilla lonicera	Northern Bush-honeysuckle	N	SLC	M-D	UPL	Sun / Part Shade	M	L-M	C	F	1 X 1 m	50	♦♦♦♦	"Scraggly" looking.	Colony forming - needs large area.
Hamamelis virginiana	American Witch-hazel	N	SL	M-D	FACU	Sun / Part Shade / Shade	M	L		M	4.5-6 X 4.5-6 m	200	♦♦	Yellow flowers in early spring, orange fall colour, irregular habit.	Not affected by many pests.
Hydrangea arborescens 'Annabelle'	Annabelle Hydrangea	N	Variable	M	NI	Sun / Part Shade	L	H		F	1.2 X 1.2 m	100	NN	Large, solid globular flower heads from mid-summer to late autumn.	Heavy flower heads need to be supported; pruned each spring to produce flowers on new growth.
Hypericum kalmianum	Shrubby/Kalm St. Johns-wort	N	S	W-M	FACW	Sun / Part Shade	M-H	H	H	M	50-90 X 50 cm	30-50	♦♦♦	Compact bush, yellow flowers in June-July.	A shoreline species, good in gravel with periodic inundation. Ensure local seed sourcing.
Juniperus communus	Common Juniper	N	S	D	FACU	Sun	H	H	P	M	80-120 X 150-200 cm	100	♦♦♦	Blue-green foliage, blue berry-like fruits, aromatic in warm weather.	Shoreline and rocky site species; fine pointed leaves discourage pedestrians
Juniperus horizontalis	Creeping Juniper	N	S	D	FACU	Sun	H	H	P	M	15-10 X 100-150 cm	50-100	♦♦♦	Blue-green foliage, blue berry-like fruits, aromatic in warm weather	Shoreline and rocky site species
Kerria japonica	Japanese Rose	N	L	M-MD	NI	Sun / Part Shade	H	H		M	1.2 X 2 m	150	NN	Yellow flowers late-spring to late-summer.	Suitable for mass plantings and borders in areas not adjacent to natural features. Plant only in root-restricted sites since it can spread through root suckers.
Lindera benzoin	Spicebush	N	SLC	W-M	FACW-	Sun / Part Shade	M	M		S	2-3 x 2-3 m	100	♦♦	Showy yellow flowers & fruit, fragrant leaves.	Difficult to transplant.
Lonicera dioca	Mountain Honeysuckle	N	SL	M-D	FACU	Sun / Part Shade	M	L-M	C	F	0.75-3 X 0.5 m	50	♦♦♦♦	Graceful vining, red flowers and unusual leaves.	Climbing shrub, flowers are attractive to insects and hummingbirds.
Myrica pensylvanica	Bayberry	N	S	M-D	FAC	Sun / Part Shade	H	H		M	1.5-3 X 1.5-3 m	150	♦	Evergreen; attracts birds; fragrant and showy foliage; showy fruit.	
Physocarpus opulifolius	Eastern Ninebark	N	SLC	W-D	FACW-	Sun / Part Shade	M-H	H		F	1.5-2.4 X 1.2-1.8 m	100-150	♦♦	Lobed leaves, peculiar shredded bark, whitish flowers, drooping clusters of inflated fruits, arching habit.	Easy to cultivate; very adaptable; use local genotypes as cultivars are commonly grown.

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Potentilla fruticosa (Dasifora floribunda)	Shrubby Cinquefoil	N	SLC	W-D	FACW	Sun / Part Shade	M-H	M	C	F	0.5-1 X 1-1.5 m	50-75	♦♦	Abundant yellow flowers.	Attracts pollinators. CAUTION: only use the native species for natural areas (there are a few nurseries that supply it); European varieties appropriate for ornamental settings.
Prunus pensylvanica	Pin Cherry	N	SLC	M-D	FACU-	Sun	M-H	M	C	F	2-5 x 2-3	150	♦♦♦♦	White flowers, red berries, reddish bark.	
Prunus pumila var. *pumila*	Sand Cherry	N	S	W-D	UPL	Sun	H	M		M	30-50 X 75-100 cm	100	♦	Creeping shrub, white flowers, relatively large cherry fruit	Forms colonies on suitable barren soils/rocky sites; low-growing may be suitable for green roofs.
Prunus virginiana ssp. *virginiana*	Chokecherry	N	SL	M-D	FAC-	Sun / Part Shade / Shade	M	H	C	F	5-8 X 6-10 m	100	♦♦♦♦	White flowers in a spike, reddish-black berries, cultivars available.	Highly suitable; aggressive; tolerant of periodic short-term inundation; colony forming.
Rhus aromatica	Fragrant Sumac	N	SL	M-D	UPL	Sun / Part Shade	M-H	M	C	F	1-2 X 2-3 m	150	♦	Red fruit, aromatic leaves.	Colony forming; smaller and less aggressive than *Rhus typhina* ; may be suitable on some green roofs (semi-intensive); will not persist on richer sites due to competition.
Rhus glabra	Smooth Sumac	N	S	D	UPL	Sun	H	H		M	3-4.5 X 3-4.5 m	200	♦♦	Red fruit, flaming red fall colour.	Can be highly aggressive.
Rhus hirta (Rhus typhina)	Staghorn Sumac	N	SLC	M-D	FAC	Sun	H	H	P, C	F	2.7-4.5 X 2.7-4.5 m	100-150	♦♦♦♦	Red fruit, red fall color, fuzzy new growth.	Highly suitable; transplants easily; colony forming; needs lots of space.
Ribes americanum	Wild Black Currant	N	LC	W-M	FACW	Sun / Part Shade	L	L	C	F	0.5-0.75 x 0.5m	50	♦♦♦♦	Peeling brown bark, black fall fruit.	Highly suitable; colony forming.
Ribes cynosbati	Prickly Gooseberry	N	SLC	M-D	UPL	Part shade	M	L		M	60-120 X 100 cm	50	♦♦♦♦	Peeling brown bark, prickly berries.	Highly suitable.
Ribes triste	Swamp Red Currant	N	SLC	W-M	OBL	Part shade	L	L-M		M	50-75 X 30-50 cm	30-50	♦♦	Soft leaves, red berries.	Colony forming
Rosa blanda	Smooth Rose	N	SLC	M-D	FACU	Sun	M	L-M	C	M-F	75-150 X 100 cm	75	♦♦♦♦	Single pink/purple flower.	Highly suitable; colony forming.
Rubus allegheniensis	Allegheny Blackberry	N	SLC	M	FACU+	Sun / Part Shade	M	L	P	F	1-2 X 2-3 m	75	♦♦♦♦	Prickly stems and leaves, black berries.	Highly suitable; transplants easily; colony forming; can be aggressive; high wildlife value; thorny.
Rubus idaeus ssp. *strigosus*	Common Red Raspberry	N	SLC	W-MD	FACW-	Sun / Part Shade	M	M	C	F	0.5-1 X 0.5-2 m	75	♦♦♦♦	Prickly stems, red berries.	Highly suitable; colony forming.
Rubus odoratus	Purple Flowering Raspberry	N	SLC	M-D	UPL	Sun / Part Shade	M	M	C	F	0.75-1.25 X 1-1.5 m	75	♦♦♦♦	Large pink/purple flowers, large leaves.	Highly suitable; colony forming.
Rubus pubescens	Dwarf Red Raspberry	N	SLC	M	FACW+	Shade	L	L		M	15-20 X 75-150 cm	30-50	♦♦♦♦	White flowers, low trailing form, pale leaves.	Colony forming.
Salix bebbiana	Bebb's Willow	N	SLC	W	FACW+	Sun / Part Shade	L-M	unknown	C	F	2-10 X 2-4 m	150	♦♦♦♦	Leaf margins mostly without teeth, shiny grey-green bark with reddish marks.	Highly suitable; usually multi-stemmed; does not form colonies; tolerates inundation. Caution: some *Salix* species have extensive root systems. Avoid planting if there is an underdrain.
Salix discolor	Pussy Willow	N	SLC	W	FACW	Sun / Part Shade	L-M	M	C	F	2-3 X 1-3 m	100	♦♦♦♦	Attractive fuzzy flower heads in early spring.	Highly suitable; sensitive to pollution; sometimes forms colonies; tolerates inundation. CAUTION: beware of misidentification; usually *S. caprea* , sometimes even *S. cinerea* or *S. aurita* labelled as *S. discolor* . Avoid if you can't control the source. Some *Salix* species have extensive root systems. Avoid planting if there is an underdrain.
Salix eriocephala	Woolly Headed Willow	N	LC	W	FACW	Sun / Part Shade	L-M	unknown		F	2-6 X 1-3 m	75-100	♦♦♦♦		Highly suitable, particularly for intense storm water inputs; shrub willow; tolerates inundation. Caution: some *Salix* species have extensive root systems. Avoid planting if there is an underdrain.

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Salix exigua	Sandbar Willow	N	S	W-M	OBL	Sun	M-H	M	P	F	1.5-2 X 3-5 m	100-150	♦♦	Slender leaves, high screening.	Highly suitable, particularly for intense storm water inputs; tolerates short-term inundation; colony forming. Caution: some *Salix* species have extensive root systems. Avoid planting if there is an underdrain.
Salix petiolaris	Meadow Willow	N	C, Variable	W-M	FACW+	Sun	L-M	unknown	P	F	1-6 X 1-3 m	75-100	♦♦		Highly suitable; tolerates inundation; colony forming.
Sambucus canadensis	Common Elderberry	N	SLC	W-M	FACW-	Sun / Part Shade	L-M	L-M	C	F	2-3 X 2-3 m	100-150	♦♦♦♦	White flower clusters June-July, purple fruits Aug-Sept.	Highly suitable; suckers to form large thickets; tolerant of periodic short-term inundation; sensitive to salt and pollution.
Sambucus racemosa ssp. *pubens*	Red Elderberry	N	SL	M	FACU+	Sun / Part Shade	M-H	M	C	F	1.5-2 X 1.5-2 m	100-150	♦♦♦♦	White flower clusters June-July, red fruits Aug-Sept.	Highly suitable; fruit very attractive to birds; prefers drier soils than Sambucus canadensis.
Shepherdia canadensis	Canada Buffalo-berry, Soapberry	N	S	D	UPL	Sun / Part Shade	H	H	P	M	2 X 2 m	100	♦♦	Abundant small red berries.	Restrict to less fertile soils; intolerant of competition. Difficult to transplant.
Spiraea alba	Narrow-leaved Meadow-sweet	N	SLC	W	FACW+	Sun / Part Shade	M	L	C	M	0.75-0.9 X 0.5-1 m	50-100	♦♦	White flowers in spike.	Highly suitable; sensitive to salt.
Viburnum acerifolium	Maple-leaf Viburnum	N	SL	M	UPL	Part shade	M	L		S-M	100-200 X 100 cm	50	♦♦♦♦	White flowers in June, fruits persist into fall.	Sensitive to pollution and salt, transplants well.
Viburnum dentatum	Arrowwood	N	SLC	M-D	FACW-	Sun / Part Shade	M	M		M	2-3 X 2-3 m	100	♦♦♦	White flowers in summer, blue fruits in fall.	Transplants well; not native to Toronto area, suitable for Hamilton south.
Viburnum lentago	Nannyberry	N	SLC	W-M	FAC+	Sun	M	L-M	P	F	4-5 X 2-4 m	100	♦♦♦♦	White flowers, brilliant red fall color.	Highly suitable; tolerant of periodic short-term inundation.
Viburnum rafinesquianum	Downy Arrowwood	N	SL	D	UPL	Sun / Part Shade	H	M	P	M	1-2 X 1-2 m	100	♦♦	White flowers in summer, blue fruits in fall.	Colony-forming, excellent screening and wildlife cover
TREES															
Acer rubrum	Red Maple	N	SLC	W-M	FAC	Sun / Part Shade	M	L	P, C	F	10-20 X 10-20m	500-800	♦♦♦♦	Medium-sized shade tree, orange to bright red fall color.	Common on poorly aerated soils, tolerant of periodic short-term inundation, best planted in early spring, sensitive to salt; requires acidic soils and will go chlorotic on alkaline.
Acer saccharinum	Silver Maple	N	SLC	W-M	FACW	Sun	M	L-M	C	F	20-35 X 10-20 m	500-800	♦♦♦♦	Large shade tree, known to drop branches when mature.	Very tolerant & easy to transplant, aggressive roots, tolerant of periodic short-term inundation. Do not use in underdrained situations.
Acer saccharum ssp. *saccharum*	Sugar Maple	N	SLC	M	FACU	Part shade / Shade	M	L		M	12 X 8-12	500-800	♦♦♦♦	Large shade tree.	
Acer x freemanii	Hybrid Maple / Freeman Maple	N	SLC	W-M	FAC	Sun / Part Shade	M	L-M	C	F	15-20 X 3-5 m	200-500	♦♦	Medium-large shade tree.	Naturally-occurring hybrid between *A. rubrum* & *A.saccharinum* .
Betula papyrifera	Paper Birch	N	SL	M-D	FACU+	Sun	M-H	M-H		M	15-20 X 5-15 m	300-500	♦♦♦♦	Medium shade tree, attractive peeling white bark.	Difficult to transplant - use small size container stock.
Carpinus caroliniana	American hornbeam / Blue Beech	N	LC	W-M	FAC	Sun / Part Shade	M	L		S	8-10 X 8-10 m	400-800	♦♦♦♦	Interesting, thin, smooth "muscular" slate gray bark	Sensitive to compaction, difficult to transplant - plant BB in early spring.
Carya cordiformis	Bitter-nut Hickory	N	SLC	W-D	FAC	Sun / Part Shade	M	L		M	18-25 X 8-12 m	500-800	♦♦♦♦	Medium-large shade tree, yellow fall color, nuts in fall.	Highly suitable. Grows fast.
Carya ovata	Shag-bark Hickory	N	LC	M-D	FACU	Sun / Part Shade	H	L		S	20-25 X 10-12 m	500-800	♦♦♦♦	Medium-large shade tree, attractive peeling bark, nuts in fall.	Sensitive to salt, difficult to transplant - plant BB in early spring.
Celtis occidentalis	Common Hackberry	N	L	M	FAC-	Sun	M	M	C	F/M	12-18 X 18X20 m	500-800	♦♦♦	Large shade tree, smooth gray bark with "warts".	Easily transplanted in spring, plant with care in fall, generally tolerant.
Fraxinus americana	White Ash	N	LC	M-MD	FACU	Sun / Part Shade	M-L	M-H		M	15-20 X 10-20 m	500-800	♦♦♦♦	Yellow-orange fall colour.	Highly suitable; susceptible to Emerald Ash Borer; sensitive to pollution.
Fraxinus nigra	Black Ash	N	SLC	W-M	FACW+	Sun / Part Shade	M-L	M-H	C	M	15-20 X 10-15 m	500-800	♦♦	Corky bark.	Highly suitable; susceptible to Emerald Ash Borer.

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Fraxinus pennsylvanica	Green Ash	N	SL	W-M	FACW	Sun	M	L-M	C	F	12-20 X 10-15 m	500-800	♦♦♦♦	Purple fall colour.	Highly suitable; susceptible to Emerald Ash Borer; sensitive to pollution, tolerant of periodic short-term inundation, transplants easily in spring or in autumn with care.
Ginkgo biloba	Ginkgo	N	SL	M	NI	Sun / Part Shade	M	M-H	C,P	S	15 X 10 m	400-800	NN	Yellow fall color, unique leaves.	Specify male trees to avoid fruit litter and fruit foul smell. Easy fall clean up if necessary since all leaves drop within days of each other.
Gleditsia tricanthos var. *inermis*	Thornless Honey Locust	N	SLC	M-D	FAC	Sun / Part Shade	H	H	C,P	F	12-25 X 10-20	400-800	♦♦♦	Yellow fall colour, delicate texture.	Intolerant of inundation or standing water.
Juglans nigra	Black Walnut	N	SL	M-D	FACU	Sun / Part Shade	H	L-M		M	20-25 X 18-30 m	400-800	♦♦♦♦	Large spreading tree, often forms stands, nuts in fall.	Highly suitable; roots produce juglone in soil which inhibits growth of some plants.
Juniperus virginiana	Eastern Red Cedar	N	SLC	M-D	FACU	Sun / Part Shade	M-H	M	P	S	15 X 3-7 m	100-500	♦♦	Fine textured evergreen shrub or small tree.	Highly suitable; sensitive to compaction; will not tolerate standing water over 48 hours; plant BB in early spring or late fall.
Larix laricina	Tamarack / American Larch	N	SLC	W-D	FACW	Sun / Part Shade	H	H		M	12-25 X 5-10 m	200-500	♦♦	Medium-large coniferous tree which drops needles in winter, yellow fall colour.	Tolerant of periodic short-term inundation.
Liriodendron tulipifera	Tulip Tree	N	SL	M	FACU+	Sun / Part Shade	L	L		F	20-30 X 10-20m	500-800	♦♦♦♦	Distinct yellow spring flowers.	Sensitive to compaction, transplant BB in early spring and avoid fall planting; Carolinian zone species, try to locate Ontario seed sources for hardiness in our winters.
Picea glauca	White Spruce	N	LC	M	FACU	Sun	M	L	P	F	10-20 X 3-6 m	500	♦♦	Medium-large cone-shaped conifer.	
Picea pungens	Colorado Spruce	N	SL	M	NI	Sun	M	H		M	10-20 X 3-6 m	500	NN	Medium-large cone-shaped conifer, blue cultivar commonly available.	
Pinus mugho	Mugo Pine	N	SLC	M-D	NI	Sun / Part Shade	M	H		S	3 X 4 m	200	NN	Mounding/spreading conifer, dwarf cultivar available.	Dwarf or semi-dwarf ornamental of high-altitude European environments; will not persist long-term in competition.
Pinus strobus	Eastern White Pine	N	SL	M-MD	FACU	Sun	M	L		S-M	15-25 X 6-12 m	500-600	♦♦♦♦	Large conifer, mature form varies greatly from immature form.	Sensitive to pollution, salt, & compaction, transplant BB in early spring.
Platanus occidentalis	Sycamore	N	SL	W-M	FACW	Sun	M	L	C	F	20-30 X 20-30 m	500-1000	♦♦	Large shade tree, distinctive white/green spotted/peeling bark and seed balls.	Easily transplanted. CAUTION: often gets mixed up with hybrid non-native *Platanus x acerifolia* .
Populus balsamifera ssp. *balsamifera*	Balsam Poplar	N	SLC	M	FACW	Sun	M	H		F	10-15 X 5-10	500	♦♦♦♦		Highly suitable; very aggressive roots; tolerant of periodic short-term inundation; fast maturing; colony forming; short-lived trees that are appropriate for sites away from utilities, homes roadways and infrastructure.
Populus deltoides	Eastern Cottonwood	N	SLC	M	FAC+	Sun	H	M-H	P, C	F	20-30 X 10-15 m	500	♦♦♦♦	Fluffy seeds in spring.	Highly suitable; very aggressive roots; easily transplanted in spring or fall, fast maturing; short-lived trees that are appropriate for sites away from utilities, homes roadways and infrastructure.
Populus grandidentata	Large-tooth Aspen	N	SL	M	FACU	Sun	H	M-H		F	15-25 X 5-8	500	♦♦♦♦	Fluffy seeds in spring. Orange-tinted bark.	Highly suitable; fast maturing; colony forming.
Populus tremuloides	Trembling Aspen	N	SLC	M	FAC	Sun	M	M-H		M	10-15 X 3-6 m	150-500	♦♦♦♦	Smallest leaf of the *Populus* species, leaf rattles in wind.	Highly suitable; very aggressive roots; sensitive to pollution & compaction; tolerant of periodic short-term inundation; transplant in early spring or fall, fast maturing; colony forming.

SPECIES		PLANT CHARACTERISTICS													
Scientific Name	**Common Name**	**Recomm-ended as Seed** Yes/ No	**Soil Type Preference** S=Sand L=Loam C=Clay	**Soil Moisture** M=Moist W=Wet D=Dry	**Coefficient of Wetness** UPL = Upland OBL = Wetland FAC= Facultative (wetland or upland) NI = No Indicator	**Exposure** Sun / Part Shade / Shade	**Drought Tolerance** High / Med / Low	**Salt Tolerance** High / Med / Low	**Urban Tolerances** P = Pollution C=Compaction	**Growth Rate** Fast / Med / Slow	**Height / Spread at Maturity**	**Spacing** (cm)	**Ranking** ♦=Selective ♦♦= Selective ♦♦♦=Better ♦♦♦♦=Best NN = Non-native	**Aesthetic Attributes**	**Other Information**
Prunus serotina	Wild Black Cherry	N	SL	M	FACU	Sun	M	M-H		F	18-25 X 10-15 m	200-500	♦♦♦♦	Med-large tree when mature, white flowers in a spike, reddish-black berries, mature trees have distinctive black flaky bark.	Highly suitable; sensitive to compaction; somewhat difficult to transplant.
Quercus alba	White Oak	N	SL	M-D	FACU	Sun / Part Shade	H	H		S	20-30 X 15-25	500-1000	♦♦	Large canopy tree.	Extremely sensitive to compaction; difficult to transplant but very much worth the effort to do so; suitable in non-compacted soil where there is room; use plugs/small containers or seed; maintain carefully for 1-2 yrs after planting.
Quercus bicolor	Swamp White Oak	N	LC	W-M	FACW+	Sun	H	M-H	C	S	18-25 X 10-15 m	600-800	♦♦	Large canopy tree, coarse branching, bark peeling when young.	Withstands spring season inundation; wildlife food/shelter; Planted with increasing frequency outside its natural habitat and range.
Quercus macrocarpa	Bur Oak	N	SLC	W-D	FAC-	Sun	H	M-H	C	S	18-25 X 18-25 m	600-800	♦♦♦♦	Large canopy tree. coarse branching structure, corky bark, unique acorn.	Highly suitable; wildlife food/shelter.
Quercus muehlenbergii	Chinquapin oak / Yellow oak	N	SL	D	UPL	Sun	M-H	M		S	10-15 X 15-20 m	600-800	♦♦♦	Large canopy tree	Carolinian zone plant. Ensure appropriate seed sourcing.
Quercus palustris	Pin Oak	N	LC	W-M	FACW	Sun	M-H	L		S	10-15 X 15-20 m	600-800	♦♦♦	Formal pyramidal growth habit.	Use as ornamental. Requires acidic soils and will go chlorotic on alkaline.
Quercus rubra	Red Oak	N	SLC	M-D	FACU	Sun	M	H	P	M	25 X 25 m	600-800	♦♦♦♦	Large canopy tree, red fall color.	Sensitive to compaction, provides wildlife food/shelter, transplants easily in early spring. Ensure plant material suitable to local growing conditions, often sources for *Q. rubra* are from populations outside of Ontario.
Salix amygdaloides	Peach-Leaved Willow	N	SL	W	FACW	Sun	L-M	H	C	F	6-20 X 1-10 m	200-500	♦♦	Underside of leaves white, twigs often drooping.	Highly suitable; can be multi-stemmed; does not form colonies; tolerates inundation. Caution: some Salix species have extensive root systems. Avoid planting if there is an underdrain.
Salix lucida	Shining Willow	N	LC	W	FACW+	Sun	L-M	H	C	F	4-7.5 X 3-4 m	75-150	♦♦		Highly suitable; colony forming; tolerates inundation. Caution: some *Salix* species have extensive root systems. Avoid planting if there is an underdrain.
Salix nigra	Black Willow	N	SLC	W	OBL	Sun	L	M-H	C	F	18-30 X 6-10 m	400-600	♦♦	Large native willow.	Sensitive to pollution, grows well on poorly drained soils, transplants easily in any season, sometimes forms colonies, tolerates inundation. CAUTION: Common misidentification; usually *S. x rubens* , sometimes even *S. alba* or *S. pentandra* labelled as *S. nigra* . Avoid if you can't control the source. Some *Salix* species have extensive root systems. Avoid planting if there is an underdrain.
Thuja occidentalis	Eastern White Cedar	N	SLC	W-M	FACW	Sun	M-H	L-M		F	15 X 10 m	100-200	♦♦♦♦	Evergreen; several dwarf varieties available.	Highly suitable; tolerant of periodic short-term inundation; provides wildlife habitat; sensitive to salt-spray.
Tilia americana	American Basswood	N	SL	M	FACU	Sun / Part Shade	M	L-M	M	M	12-20 X 10-15 m	400-600	♦♦♦♦	Dense, wide crown with large leaves, nut-like fruit; single or multi-stem form.	Highly suitable; tolerates relatively high moisture conditions; attracts pollinators. CAUTION: there are some issues about identification confusion with various Eurasian lindens. Verify the source.

SPECIES		PLANT CHARACTERISTICS													
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VINES															
Clematis virginiana	Virginia Virgin-bower	N	SLC	W-D	FAC	Sun / Part Shade	M			F	1 X 6 m	75	♦♦♦♦	Profuse small white flowers.	Highly suitable; can be an aggressive vine.
Euonymus obovata	Running Strawberry-bush	N	L	M-D	UPL	Part shade / Shade	L-M	L		M	0.20 x 1.5 m	50	♦♦	Greenish flowers, orange to red fruits.	Suitable for shade; Creeping vine, non-aggressive.
Lonicera hirsuta	Hairy Honeysuckle	N	L	W-M	FAC	Sun	M	M		F	60-75 cm x 50 cm	75-100	♦♦	Small yellow flowers, red berries.	Forms thickets, flowers are attractive to insects and hummingbirds.
Parthenocissus quinquefolia	Virginia Creeper	N	SLC	M	FAC-	Sun / Part Shade	M	H	P,C	F	10-15 X 1-2 m	50-100	♦♦	Red fall color, blue berries in fall.	Climbing vine, good for fences or trellises. Spreading, competitive; use away from existing natural areas and trees. Attractive to songbirds.
Smilax hispida (Smilax tamnoides)	Hispid Greenbrier	N	SLC	M	FAC	Part shade	L-M	L		S	1-2 X 6-12 m	75	♦♦	Vine with bristles and spines.	Highly suitable.
Vitis riparia	Riverbank Grape	N	SLC	M	FACW-	Sun / Part Shade	M	H	P, C	F	0.5 X 15 m	50-100	♦♦♦♦	Large leaves, grapes in fall.	Extremely aggressive and competitive; use mostly in situations where invasive exotics are a major threat, can smother small trees and shrubs, wildlife food & habitat.

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