city of hamilton

landscape design guidelines for stormwater facilities

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in association with:

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Hamilton

Hamilton

Landscape Design Guidelines for Stormwater Management Facilities

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This document was developed by the Capital Planning and Implementation Division of the Public Works Department of the City of Hamilton to guide the siting and design of stormwater management facilities and the landscapes associated with them. This document is generated with the goal of integrating stormwater management facilities as aesthetic and environmental amenities within the City and its open space system.

This report sets out the principles that are to be considered in the selection, siting and design of stormwater management systems, giving primacy to the recognition that stormwater is a resource. The report emphasizes the position that stormwater management initiatives should be integrated with, and complementary to, the character and function of the community and the environment of which they are a part. The document also emphasizes the importance of considering the planning and design of the stormwater management system early in the overall development planning process to ensure that opportunities to realize environmental, social and practical objectives are maximized.

The Public Works Department within the City of Hamilton has developed a set of standards for the design of stormwater quantity and quality control facilities. It is intended that the landscape guidelines be implemented together with other Public Works Department standards to address all aspects of the design of stormwater management facilities in the City of Hamilton. The use of the standards and guidelines ensures that a comprehensive design approach is applied to address all issues and aspects related to the design of stormwater management facilities in accordance with City requirements.

The Stormwater Management Planning and Design Manual prepared by the Ontario Ministry of the Environment (MOE) were developed to provide "technical and procedural guidance for the planning and design and review of stormwater management practices" in the Province of Ontario. The City of Hamilton's landscape guidelines are intended to supplement the MOE manual with a focus on inspiring the generation of innovative solutions that address the unique biophysical, social and planning perspectives and policies of the City of Hamilton.

The landscape design guidelines have been developed to assist in the achievement of the following objectives:

- stormwater management facilities should be fully integrated within their physical, social and ecological contexts;
- landscape design objectives should be addressed as an integral component of the planning process, beginning at the watershed scale, to ensure that opportunities to achieve a range of community and environmental objectives are achieved in addition to primary stormwater management targets;
- the design process should be dedicated to maximizing the benefits that can be achieved as a product of the implementation of stormwater management facilities, including the protection and enhancement of existing natural heritage resources, enhancement of terrestrial and aquatic habitats and the provision of recreational and interpretive opportunities and aesthetic benefits;
- the process of locating, siting and configuring stormwater management facilities should be focused on ensuring that they are integral components of the bioregional open space system;
- the application of innovative techniques should be promoted to enhance facility performance, minimize maintenance requirements, enhance stability and longevity, and address public safety concerns, in addition to other practical issues;
- the implementation of stormwater management facilities, including specific construction techniques and strategies, should be developed with an emphasis on minimizing the potential impacts on the ecosystem arising from construction and initial operation;

- stormwater management facilities should be designed to minimize the frequency and complexity of maintenance. Maintenance considerations should be addressed as an integral component of the design process.

Consistent with the submission requirements for the approval of proposed developments within the City of Hamilton, opportunities to explore landscape-based stormwater management solutions should be addressed at various stages in the development approvals process including:

- Official Plan Amendment, Secondary Plan and Large Infill Development Applications
- Master Environmental Servicing Plans
- Subdivision Applications
- Site Plan Applications

Outside of the development approvals process, opportunities may arise through other initiatives to apply landscape-based stormwater management solutions as recommended in this document, for example, in the retrofitting of existing stormwater management facilities or the renewal of existing transportation or servicing infrastructure.

Responsible broad-scale planning that recognizes the need for stormwater management at the outset – combined with an understanding of the ecological and functional attributes of the landscape – provides the fundamental basis for achieving integrated, efficient, practical and cost-effective stormwater management solutions. At this broad scale, stormwater management opportunities afforded by the physiographic, biophysical and ecological characteristics of the landscape can be identified and capitalized upon. Landscape-based solutions identified at the broad-scale are rooted in a recognition of the potential presented by the existing physical and ecological characteristics of the landscape.

Within the context of this document, the term “community” is used to describe a level of planning at which the design for a “community” is being resolved and may include the preparation of a Secondary Plan, master plan for a community, a design plan for a development, or a Plan of Subdivision. At this scale, where land use patterns, road networks and open space systems are being defined, a range of opportunities to implement landscape-based solutions is afforded. Open space systems should be considered with the vision of establishing a network of natural features and complementary and compatible land uses, including SWMF’s (Stormwater Management Facility) that will be the spine or centerpiece of the new community.

Proposals to implement new SWMFs need to be regarded in consideration of their context not only with respect to the physical landscape, but also related to the function of the subwatershed ecosystem. The various types of SWMFs have the potential to modify the ecological function of the landscape in a number of ways. The degree to which positive influences can be realized is determined by factors relating to the siting and design of a particular stormwater management facility.

The City of Hamilton is located within the jurisdiction of four Conservation Authorities including the following:

- Grand River Conservation Authority
- Niagara Peninsula Conservation Authority
- Hamilton Conservation Authority
- Conservation Halton

Each of these Conservation Authorities regulate the management of their water resources within the City of Hamilton and administer the approval of works proposed within and adjacent to wetlands, water bodies, valley and stream corridors and floodplains under the Conservation Authorities Act.

In addition, a portion of the City of Hamilton is located within the jurisdiction of the Niagara Escarpment Plan (NEP). The Niagara Escarpment Plan includes land use policies that regulate the location of stormwater management facilities in relation to hydrologically sensitive features and significant natural features. The document provides direction related to the integration of Conservation Authority approvals, processes, and conformity with the Niagara Escarpment Plan.

The Landscape Design Guidelines document is also focused on demonstrating possibilities and exploring opportunities through a brief review of stormwater management alternatives. These alternatives are presented to demonstrate the range of opportunities afforded at both community-wide and site-specific scales to achieve stormwater management objectives.

To expedite the submission, review and approval processes, this document provides direction regarding the process for submitting drawings and supporting documentation to facilitate the submission, review and approval of the landscape design for stormwater management facilities. The document also sets out procedures for certification and City assumption of completed landscape works.

The process for the review and approval of design drawings and landscape plans for stormwater management facilities is consistent with the submission, review and approvals process for development applications within the City of Hamilton. The City regards stormwater management facilities as integral components of the open space network and as such, their location, layout and design should be addressed in conjunction with the development of the parks and open space master plan for a proposed community.

Consequently, it is important that City staff review and approve the location, configuration and design of stormwater management facilities at key stages in the development planning and design processes in order to expedite the approval process and ensure consistency with the principles and objectives set out in this document.

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Landscape Design Guidelines for Stormwater Management Facilities

1.0 INTRODUCTION

This report was developed by the Capital Planning and Implementation Division of the City of Hamilton's Public Works Department with the goal of directing the integration of stormwater management facilities as aesthetic and environmental amenities within the community and the City's open space and natural heritage systems while at the same time enhancing their functional performance.

This report serves as a reference that outlines important considerations that should be taken into account when siting and designing stormwater management facilities within the City of Hamilton.

The Stormwater Master Plan created for the City of Hamilton Public Works Department (Aquafor Beech: 2007) sets out a number of policies and guidelines to direct the design of stormwater management systems within the City. In addition, the document entitled "Criteria and Guidelines for Stormwater Management Infrastructure Design" (2007) also provides direction to guide the siting and design of stormwater management facilities within the City.

The landscape guideline document was developed by the City of Hamilton to guide the planning and design of stormwater management facilities and their related landscape components with the goal of optimizing their benefits to the community in terms of environmental sustainability, aesthetic quality, and integration with community design, public safety and functional performance. The landscape guideline document is intended to complement the "Stormwater Master Plan" and the "Criteria and Guidelines for Stormwater Management Infrastructure Design".

The guidelines are founded on the principle that stormwater is a resource and that stormwater management initiatives should be integrated with, and complementary to, the character and function of the community and the environment of which they are a part. The document emphasizes the importance of considering the planning and design of stormwater management systems early in the overall planning process to ensure that opportunities to realize environmental, social and practical objectives are maximized.

This report provides guidance related to the location and siting of various types of stormwater management facilities in consideration of the unique ecological and hydrological context of the City of Hamilton. The report also provides an overview of the recommended approach to planning for stormwater management and sets out the principles, objectives and rationale as the basis designing the landscapes associated with stormwater management facilities. The document also provides detailed guidelines to direct the landscape design process as well as comprehensive lists of plant species that are appropriate for use in the landscaping of various types of stormwater management facilities.

2.0 PURPOSE OF THE DOCUMENT

Wet Pond Facility, Mountview – Hamilton

This document was developed to guide the planning of stormwater management initiatives in consideration of their context within the landscape. The document addresses broader landscape-scale planning issues, as well as requirements to be addressed at the site-specific scale related to the landscaping of facilities.

Although the document is focused on addressing contextual and site-specific landscape issues, it is not intended to direct the practical engineering design of stormwater management facilities. The Stormwater Master Plan prepared by Aquafor Beech Ltd. as well as "Criteria and Guidelines for Stormwater Management Infrastructure Design" (2007) should be referenced for guidance related to engineering and functional design.

The document is intended to be used by planners, landscape architects and engineers to guide the development of stormwater management strategies and to direct the siting and design of stormwater management facilities. Guidelines and recommendations are provided to address the broad spectrum of planning scales from the watershed-wide to the site-specific.

The following provides a synopsis of the general objectives and composition of the document. The document is intended to:

- Address the planning and design of stormwater management facilities in the context of the larger landscape;
- Set out the general principles and approach to planning for stormwater management;
- Identify a spectrum of stormwater management planning opportunities;
- Define the approach to siting and design of facilities in the context of the ecosystem;
- Identify a range of community-scale and site-specific stormwater management opportunities for consideration in the planning process;
- Set out the process for developing stormwater management strategies and site-specific designs;
- Address site-specific landscape design issues;
- Set out specific guidelines for grading, planting and other elements that comprise the landscape of a specific stormwater management facility;
- Provide details for key landscape elements;
- Set out maintenance recommendations;
- Define monitoring protocols;
- Provide implementation guidelines for stormwater management facilities.

Although the guidelines are focused on the implementation of the landscape components of the facility, general directions are provided related to the staging of facility construction as a whole since the sequence and timing of construction have a bearing on the establishment of the vegetation community, slope stability and other considerations.

Overall the document sets out recommendations that address all of the various stages of the planning and design process with a consistent focus on ensuring that stormwater management facilities are fully integrated within the landscape.

Figure 1.0 below provides a graphic illustration of the sequence of stages in the planning, design and approval of stormwater management facilities within the City of Hamilton.

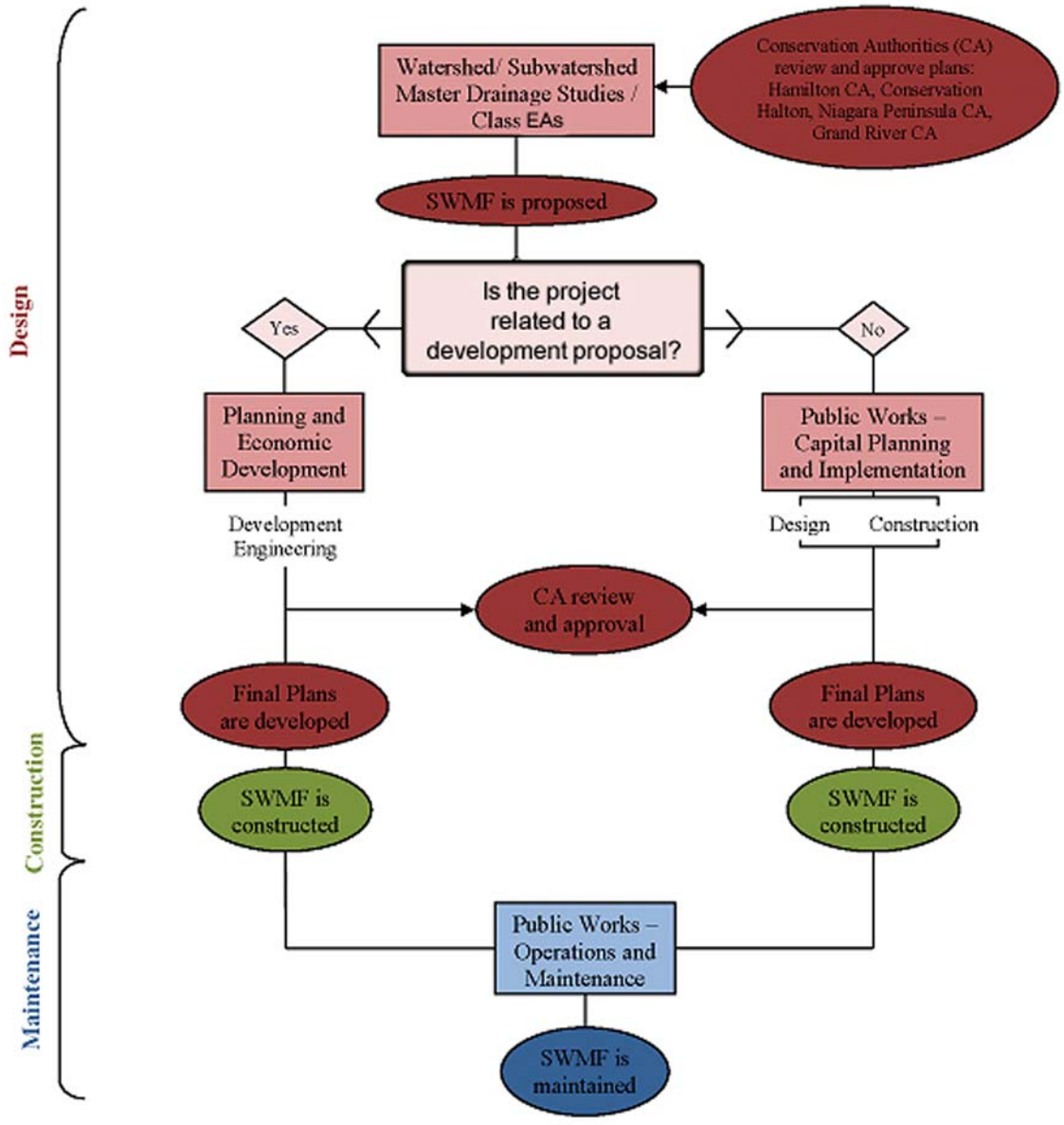


Figure 1 : Stages in Planning and Design of Stormwater Management Facilities (SWMF)

3.0 BACKGROUND

3.1 DESIGN OBJECTIVES

The implementation of facilities to mitigate the impacts of stormwater runoff on the health and stability of watersheds is a relatively recent development. The initial steps to implement stormwater quality improvement facilities were undertaken by the Ontario Ministry of the Environment in the 1980's. Since that time, designs have evolved to enhance facility performance in response to the increased availability of monitoring data and the expanding body of knowledge derived from experience with the design, implementation, operation, maintenance and monitoring of stormwater management facilities.

However, throughout this same period, little change has occurred in the approach to determining the location and configuration of stormwater management facilities to ensure that they are fully integrated components of the community open space system and the larger landscape. This document has been developed to promote an integrated approach to the planning and design of stormwater management facilities with the objective of ensuring that these facilities provide optimal performance while existing as valued community assets.

These guidelines have been developed to assist in the achievement of the following objectives:

- stormwater management facilities should be fully integrated within their physical, social and ecological contexts;
- landscape design objectives should be addressed as an integral component of the planning process, beginning at the watershed scale, to ensure that opportunities to achieve a range of community and environmental objectives are achieved in addition to primary stormwater management targets;
- the design process should be dedicated to maximizing the benefits that can be achieved as a product of the implementation of stormwater management facilities including the protection and enhancement of existing natural heritage resources, enhancement of terrestrial and aquatic habitats and the provision of recreational and interpretive opportunities and aesthetic benefits;
- the process of locating, siting and configuring stormwater management facilities must include consideration for practical catchment area and drainage parameters, in addition to being founded on consideration of the potential of stormwater management facilities to be integral components of the bioregional open space system;
- the application of innovative techniques should be promoted to enhance facility performance, minimize maintenance requirements, enhance stability and longevity, and address public safety issues, in addition to other practical issues;
- stormwater management facilities should be designed with a focus on maintaining a natural water balance, enhancing water quality and mitigating potential thermal impacts on downstream water resources;
- the implementation of stormwater management facilities, including specific construction techniques and strategies, should be developed with an emphasis on minimizing the potential impacts on the ecosystem arising from construction and early operation;
- monitoring programs and protocols should be realistic and effective with the objective of ensuring that functional targets are achieved; and

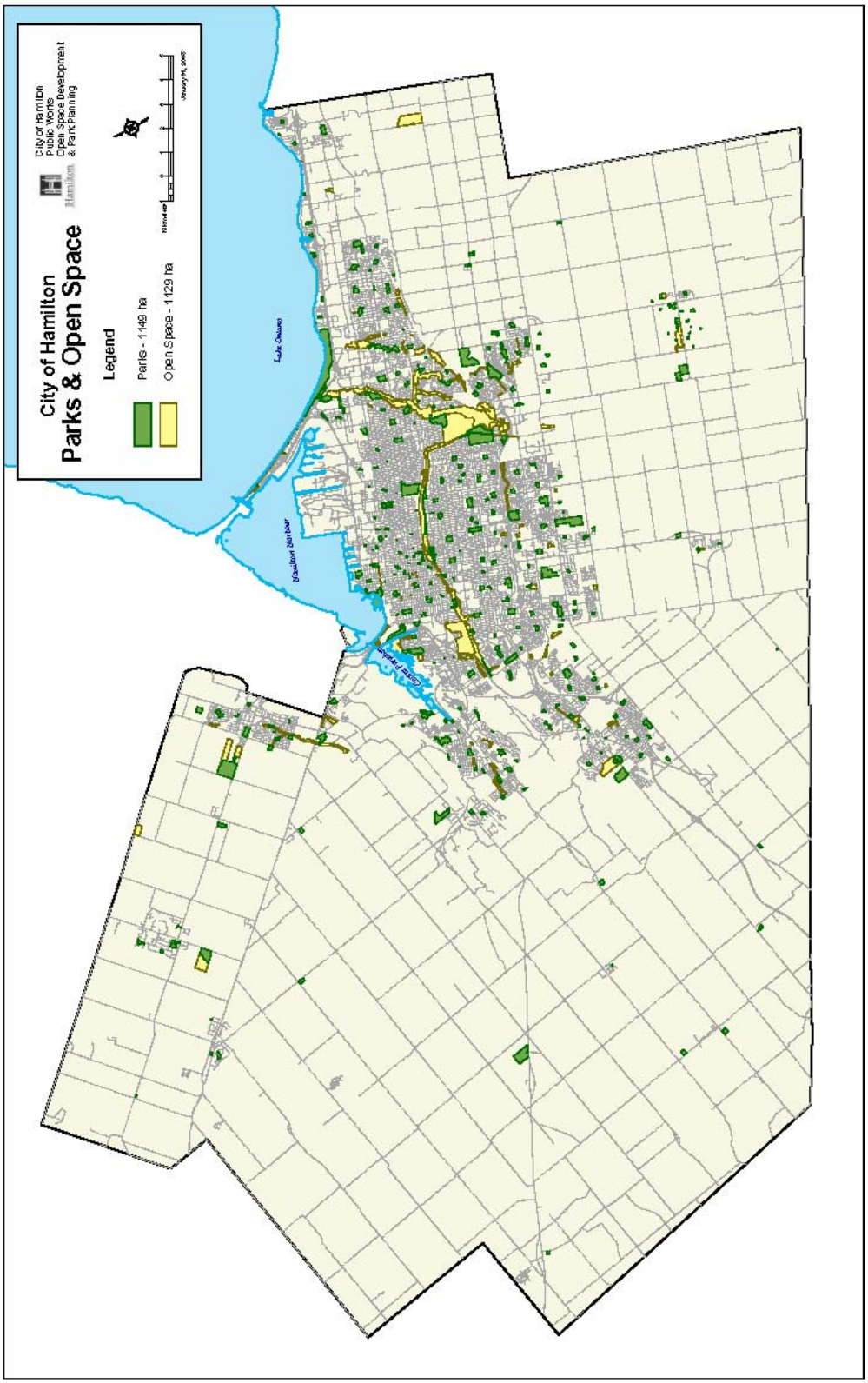


Figure 2: City of Hamilton Parks and Open Space System

- stormwater management facilities should be designed to minimize the frequency and complexity of maintenance. Maintenance considerations should be addressed as an integral component of the design process.

At the present time, there are currently approximately 130 (Aquafor Beech Limited 2007) constructed stormwater management facilities in the City of Hamilton. There are approximately an additional 50 facilities planned to be implemented within the municipality. These facilities, both existing and proposed, encompass a significant land area and consequently are key components of the visual landscape and natural heritage and open space systems within the City of Hamilton (Figure 2.0). Through the application of the guidelines and criteria set out in this document, the benefits of the implementation of stormwater management facilities to the health of the watershed ecosystem and well being of residents of the City of Hamilton will be maximized.

3.2 THE HOLISTIC LANDSCAPE

Wet Pond Facility, Mountview – Hamilton.

In the context of stormwater management, 'landscape' is typically considered to pertain to the grading, planting and implementation of other landscaping initiatives within the confines of a specific site. This perspective may be appropriate at the detailed design level; however, to achieve the vision, principles and objectives defined in the guideline document, it is essential that "landscape" be considered in a more holistic context. In this larger context, "landscape" is defined as encompassing all of the physical, ecological and temporal elements and their systemic interrelationships associated with a site, subwatershed or bioregion.

The perception of the larger landscape should not be confined to natural elements and systems, but should also recognize the presence and influences of human kind. When regarded in this context, it is important that innovative landscape design techniques be explored at scales ranging from watershed-wide to site-specific in order to maximize opportunities to achieve the primary goal of protection and enhancement of water resources, as well as numerous other social, ecological and functional objectives. Accordingly, opportunities to employ landscape-based solutions should be explored initially at the broad, watershed scale and subsequently at scales decreasing in size and increasing in level of detail in order to achieve the most effective overall stormwater management strategy.

Stormwater management facilities have the potential to be integral and complementary components of a community. Planning approaches that do not address stormwater management facilities as potentially valuable components of the community open space system are inconsistent with the vision and principles of the City of Hamilton. A well executed open space network that includes stormwater management facilities has been proven to enhance the marketability of a development by establishing a character for the community and increasing the range of available amenities. In considering the design and landscaping of the open space network, emphasis should be placed on establishing a seamless system of spaces with complementary uses built upon the existing natural features of the site.

Consistent with the submission requirements for the approval of parks and the open space components of a development, opportunities to explore landscape-based stormwater management solutions should be addressed at various stages in the development approvals process including:

- Official Plan Amendment, Secondary Plan and Large Infill Development Applications;
- Master Environmental Servicing Plans;
- Plans of Subdivision; and
- Site Plan Applications.

Outside of the development approvals process, opportunities may arise through other initiatives to apply landscape-based stormwater management solutions as recommended in this document. Examples of specific initiatives include:

- bioregional studies, including natural heritage system and corridor studies, as well as other planning initiatives that present the opportunity to consider stormwater management initiatives as an integral component of the larger landscape;

- watershed and subwatershed studies, that afford the opportunity to explore alternatives to integrate stormwater management facilities into the watershed ecosystem; and

- retrofit initiatives that provide the opportunity to explore integrated stormwater management solutions at the community and site-specific scales with the objective of addressing historic stormwater management concerns.

Although these opportunities may arise through initiatives outside of the development approvals process, the guidelines, criteria and recommendations set out in this document should be considered in the planning process for each. This will ensure that the consistent vision and objectives related to the planning and design of stormwater management facilities will be achieved.

4.0 THE DESIGN PROCESS

Figure 3: Integrated Design Solution

To achieve the objectives set out in Section 3.0, the process of generating stormwater management plans and detailed designs for stormwater management facilities must consider a range of functional, environmental and social factors in unison (Figure 3.0). The process must be founded on an understanding of existing site features and functions, as well as the implications of the proposed development. The City of Hamilton recognizes that an integrated approach to design, involving the efforts of a multi-disciplinary team, is fundamental to ensure that complementary stormwater management, environmental and community objectives are achieved. In response, the City promotes the application of the integrated design process described in the following sections and encourages practitioners to explore innovative solutions within a multi-

4.1 THE INTEGRATED DESIGN PROCESS

The application of a process that is focused on identifying the widest range of opportunities is the basis for the generation of innovative stormwater management planning and design solutions that will achieve the maximum benefit to the community and environment. The landscape is multi-dimensional and comprised of a diverse assemblage of natural and cultural heritage elements integrated within a complex and dynamic system. The process aim is to achieve the successful creation of a new landscape in the form of a community, development or site specific initiative, and the stormwater management system integral to it, as well as addressing the integration of elements within a system that functions efficiently and effectively. The integrated design process is an effective means to ensure that complementary environmental, social and practical objectives are achieved in the process of developing stormwater management strategies.

To be fully effective, the integrated design process requires the involvement of a planning and design team that encompasses a range of disciplines, including professionals from the fields of landscape architecture, engineering, planning and ecology. Additional expertise may be required contingent upon the specific characteristics of the study area to ensure that planning and design decisions are made on the basis of a comprehensive understanding of the features, functions and regional influences of the landscape and the implications of the proposed development.

Mountain Brow Road – Hamilton.

Stormwater management pond, Christopher Drive – Hamilton.

It is also important that the integrated design process be executed with an understanding of the long-term implications, as well as recognition of the historic origins and interim anthropogenic influences that have evolved the environment to its present state. A design process focused on achieving objectives based on recognition of the present or short term, without an understanding of the past or consideration for the future will yield solutions that do not achieve the optimal benefit to the environment or the community over the long term. It is important that innovative stormwater management solutions be generated on the basis of a comprehensive understanding of the nuances of the study area combined with recognition of temporal factors.

The integrated design process is comprised of a number of key progressive steps. The initial steps in the process are focused on identifying and confirming a suite of primary objectives, in addition to those that are set out in this document, to ensure that recommended stormwater management strategies are custom-tailored to address the specific characteristics of a specific study area. The following sub-sections describe the key steps in the integrated design process.

4.1.1 Establishing Objectives

Core objectives to be achieved in the siting and design of stormwater management facilities are set out in Section 3.0 of this document. These objectives were generated in consideration of a number of factors and are based on an understanding of the general physical, environmental and social characteristics of the City of Hamilton. These objectives are intended to provide a foundation for the development of stormwater management plans and designs that are consistent with the vision of the City of Hamilton. Each specific study area or site will possess unique environmental and social characteristics and attributes while presenting a range of unique opportunities. Therefore, it is important that additional objectives specific to the study area and site be generated to address both interim and long term stormwater management initiatives as well as construction impact mitigation procedures. A suite of site-specific objectives should be developed as an overlay to the core objectives set out in this document. Specific design objectives should be described in supporting documentation included with submissions for approval by the City of Hamilton.

4.1.2 Identifying Targets

This document, as well as the Ministry of the Environmental Stormwater Management Facility Planning and Design Guidelines and the City's Stormwater Management Guidelines document, set out a number of targets to be achieved in the design and implementation of stormwater management facilities. Consistent with the process described in the previous section, more specific targets and criteria should be generated based upon the additional objectives defined through an understanding of site-specific conditions. Specific targets will provide the basis for the development of design solutions to address unique site characteristics, conditions and issues of concern. Targets should be generated with the objective of addressing ecological, social,

functional and practical considerations. Targets generated as a product of this process should be described in supporting documentation accompanying submissions for approval by the City of Hamilton.

Carlisle Road – Hamilton. Natural inlet and outlet configurations address site-specific conditions and objectives.

4.1.3 Defining Techniques

Once additional site-specific objectives and targets are established as a product of the integrated design process, techniques to achieve these targets should be generated and evaluated. Although there are a number of techniques illustrated in this document, modifications to each technique will be required to address site-specific targets related to a range of objectives. For example, outlet configuration will need to be designed to address specific water quality targets, temperature targets related to downstream fish communities, groundwater recharge targets, etc. All landscaping of stormwater management facilities should be designed to integrate with and complement the surrounding landscape. Even within a pond block, a range of landscape types could be required for example, areas of facilities that abut natural landscapes should be designed to complement the natural aesthetic while areas fronting on streets should be more formal and complement the urban design aesthetics of the streetscape. Although specific landscaping techniques will be illustrated on the design drawings to be provided as part of the submission package, the rationale supporting the design of specific techniques is required to support submissions for approval.

Dry Detention Facility, Mountview – Hamilton

4.1.4 Design Evolution

To ensure that stormwater management facilities are fully integrated within the context of ecology, environment and community, it is important that the integrated design process and multi-disciplinary team approach be applied at all stages and levels of detail throughout the planning and design process. Objectives, targets and techniques should be generated through collaboration, or at a minimum, reviewed by all relevant members of the design team in the process of evolving the final design. The goal of this process is to ensure that designs are resolved to achieve maximum benefits in consideration of all factors, even at the finest level of detail. Staff at the City of Hamilton as well as the Conservation Authority having jurisdiction should be consulted at key stages throughout the design process to ensure that designs generated reflect the City's vision and the policies and regulations of the Conservation Authority. This consultation will also ensure coordination between ongoing stormwater management initiatives and other environmental projects being undertaken by the City of Hamilton and the relevant Conservation Authorities.

5.0 STORMWATER MANAGEMENT FACILITIES – ECOLOGICAL IMPLICATIONS

There has been much discussion and debate regarding the potential ecological benefits and liabilities of stormwater management facilities (SWMFs), related in particular to constructed ponds and wetlands. The implementation of these types of facilities typically requires significant alteration of the landscape, not only in terms of physical change, but also related to the function of the subwatershed ecosystem. Ponds and wetlands have influences beyond simply managing the quality and controlling the rate of discharge of runoff, affecting the function of the landscape of which they are a part. Consequently, proposals to implement new SWMFs need to be regarded in consideration of their context not only with respect to the physical landscape, but also related to the function of the subwatershed ecosystem. The various types of SWMFs have the potential to modify the ecological function of the landscape in a number of ways. The degree to which positive influences can be realized is determined by factors relating to the siting and design of the facility. The following figure (Figure 4.0) provides a summary of the potential positive influences of various types of SWMFs.

Stormwater management facilities offer opportunities in the urban environment to buffer or enhance a range of wildlife habitat features and functions. These opportunities are typically, though not always, associated with linear corridors that ultimately connect with the natural drainage systems of the local landscape unit. Stormwater management facilities may also provide complementary or buffer functions for existing, enhanced or created wildlife habitat features on adjacent land. These approaches to wildlife habitat considerations may provide the opportunity to address upper tier municipal planning requirements as well as the relevant portions of Section 2.3 of the Provincial Policy Statement (2005) with respect to wildlife habitat. However, their very nature and function may compromise the wildlife habitat utility of a stormwater management facility (MOE 1994). ***It is important to recognize that stormwater management facilities are functional and necessary urban infrastructure and in and of themselves should not be considered to be viable wildlife habitat.*** In addition, in order to maintain functional efficiency over the long term, periodic maintenance of stormwater management facilities required.

Depending on the type and size of a facility, important life cycle functions can be satisfied on a local scale for terrestrial vertebrates and invertebrates (for example, amphibians, birds, a wide range of insects, mammals and reptiles) on lands around the perimeter of pond or wetland facilities. These functions include foraging, breeding, loafing, roosting and shelter. A broad range of urban and near urban fauna may benefit from such habitat opportunities including summer residents, seasonal visitants and migrants. These include wetland songbirds, rails, herons, waterfowl and shorebirds; mammals may include bats, muskrats, raccoons, long-tailed weasels, mink and deer among others; and, reptiles such as turtles and selected snakes will be attracted to these facilities and their adjacent lands Adams et al. (1986). Where wildlife habitat use of lands associated with stormwater management facilities has been successful, potential detrimental impacts of human interference may arise where the facility is associated with public open space or parkland. The severity of this potential interaction is dependent upon the species complex using that habitat, the rarity of the fauna and their sensitivity to the presence of humans and/or feral pets.

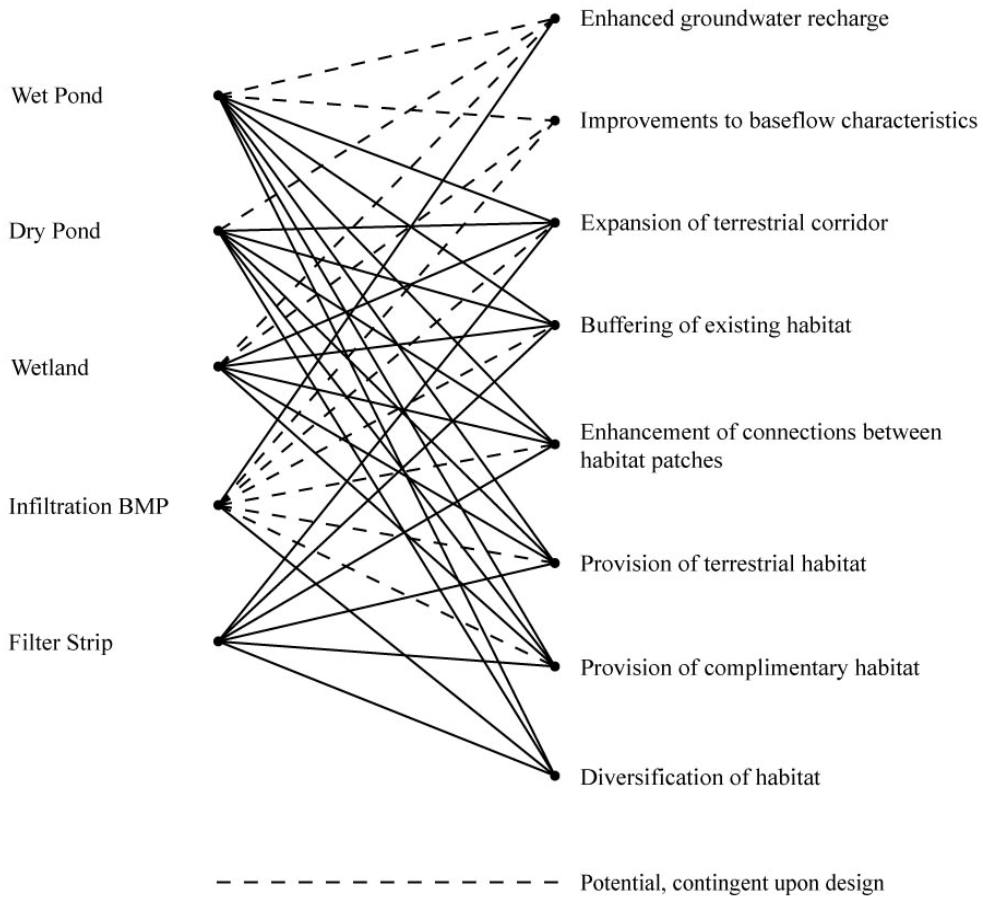


Figure 4 : Potential Stormwater Management Facility Positive Effects

Habitat enhancement and connection of facilities to neighboring natural areas can result in an enrichment of wildlife at and around those facilities. This can yield a positive public attitude toward stormwater management facilities, particularly for permanent wet pond systems and associated fauna.

While wildlife habitat functions within lands associated with stormwater management facilities may be desirable, there are also situations in which wildlife use of these areas should be deterred. Examples include, among others, attraction of excessive numbers of animals approaching nuisance levels, control of flocking birds in the vicinity of airport flight paths. In addition, creating new habitat in association with stormwater management facilities may deplete the local fauna from existing habitat within the vicinity as a result of disturbance or predation. Contamination of sediments and macrophytes in certain facilities may also be harmful to fauna. Bishop et al. (1999) documented the uptake of contaminants and persistent pollutants by fauna feeding at stormwater management facilities in both short and long-term periods.

The design of a stormwater management facility should be consistent with potential habitat function. Effective planting and grading design can assist in promoting habitat in areas beyond the wetted perimeter of the pond or water. Control of wildlife use of these facilities may be desirable either to reduce nuisance species interactions with humans or to prevent harmful effects on wildlife from contaminants in the facility.

5.1 HABITAT ENHANCEMENT OPPORTUNITIES AND CONSTRAINTS

In most cases, stormwater management facilities are designed to provide both quality and quantity control functions typically to protect aquatic habitat features and functions within of the receiving systems. The quality of surface drainage from the urban environment is often contaminated with a variety of materials common to that urban community: sediments, fertilizers, pesticides and herbicides, metals, petroleum products and byproducts, industrial materials and/or various sewage and septic wastes (Wren et al. 1997). The character and land use patterns of the catchment area of the facility appear to affect the general nature of the contaminant types (Olding 2000). Accumulation of these materials in the sediments and macrophytes of water quality treatment facilities has been suggested or documented to cause detrimental or potentially detrimental effects on a range of wildlife species that inhabit these facilities for some significant period of their life cycle (Wren et al. 1997; Bishop et al. 2000).

Natural Mosquito Control through Predation

However, for any given site, exposure risk for various taxa should normally be viewed as related to duration of exposure, relative timing of exposure within a life cycle and the avenues of contaminant absorption/ingestion. Consequently, resident aquatic species may be considered most at risk, be they fish or invertebrate species resident in the facility. Amphibious species with significant terrestrial portions of life cycle, either seasonal or life stage, should be considered at a lower level of risk. However, it should be noted that some persistent contaminants can bioaccumulate as they move up the food chain posing risks to higher carnivores (both terrestrial and aquatic). Certain contaminants may pose a greater risk from certain chemicals that aquatic species may be subject to. However, it should be noted that the over-wintering habitat preferences of various herpetiles may raise their overall risk level, particularly those species that burrow into substrates for several months. Although metabolic rates are significantly diminished during these periods, contaminant exposure may be notably more severe. Migratory or transitory users of SWM facilities, including bird and mammal species, may be at lower risk in measure with the duration of exposure to facility contaminants. Again, however, should the young of these species be fed or exposed to contaminants during critical development periods, the long-term health and/or productivity of that species can be significantly diminished.

Of particular concern is the need to deter colonization of stormwater management ponds by Canada Geese. In southern Ontario, populations of Giant Canada Geese (*Branta canadensis maxima*) have grown dramatically. This subspecies of Canada Geese has become well adapted to urban landscapes. Stormwater management ponds are attractive nesting sites for Canada Geese, which typically nest within 50m of a body of water. Although most subspecies of Canada Geese will not nest in close proximity to another nesting pair, urban adapted Canada Geese may nest within 2.0m to 3.0m of one another, creating the potential for high concentrations of Canada Geese within an individual stormwater management pond site. Impacts on ponds from colonization by Canada Geese are well documented and include the following:

- degradation of water quality due to nitrogen loading from goose droppings;
- eutrophication and/or acute algae growth resulting from increased nutrient inputs;
- loss of vegetation around the perimeter of the pond as a result of grazing;
- trampling of grass and soil compaction in clay based soils;
- potential for transmission of several diseases, including salmonella;
- limitations on public enjoyment and use resulting from aggressive behaviour and fouling of walkways and adjacent park areas; and
- nuisance impacts related to noise, as well as feather and down litter during molting periods.

As Canada Geese populations continue to grow, problems associated with colonization of stormwater management ponds will increase, requiring that additional management initiatives be implemented as part of a comprehensive integrated management strategy. A variety of techniques have been explored to deter Canada Geese from colonizing pond sites including habitat modification, hazing, control of reproduction, removal, and the application of chemical repellants. Each of these techniques has specific advantages and disadvantages with varying degrees of effectiveness.

The biotic and abiotic variables associated with wildlife habitat implications of SWMF contamination preclude a definitive statement. However, as long as research demonstrates that wildlife can be placed at risk by virtue of their use of SWMFs, it is not recommended that these facilities be specifically designed to attract wildlife. Simply put, since SWMFs are intended to intercept, filter and retain potentially toxic materials that are undesirable in the receiving aquatic environment due in part to their adverse or potentially adverse effects on wildlife, it is reasonable to recommend that SWMFs should not be designed to actively attract or support wildlife, but should, as noted previously, be designed to support existing adjacent or downstream habitat by enhancing its diversity and function.

In consideration of the potential wildlife habitat opportunities associated with SWMFs, it is important to note that these facilities are designed to arrest and contain contaminants and that over time they possess the potential to become a containment sink which will require period maintenance / management to ensure efficiency of function over the long term.

Deer Print, Mountain Brow Road stormwater facility – Hamilton.

Opportunities to enhance wildlife habitat capabilities should be determined based on an assessment of the characteristics of the area that contributes runoff to the pond, anticipated degree of contamination of runoff and required frequency of maintenance. Facilities that are anticipated to require frequent maintenance hold less potential to enhance wildlife habitat since removal of contaminated sediments will result in the disturbance of the vegetation community.

Stormwater management facilities that are proposed to treat runoff from catchment areas that include a high proportion of industrial land uses or the potential for elevated levels of contaminants should be designed with a focus on deterring wildlife habitation and use. The following guidelines are to be applied in the process of designing stormwater management ponds that are determined through an assessment of the catchment area to present a high risk to wildlife.

1. Artificial appearance of facilities will deter wildlife use. An absence of trees, shrubs and lush herbaceous vegetation will generally deter use of the site. Homogenous features surrounding the facility and within the pond component also diminishes the attractiveness of the site to wildlife. However, this approach should only be utilized in extreme cases in ponds that are proposed to be located within catchment areas where containment levels in runoff may pose a serious risk to wildlife as vegetation is an important functional component of stormwater management facilities.

2. Steep slopes (3:1 or steeper) within and adjacent to facilities minimizes the shallow water habitat that provides the dominant feeding area for gulls and waterfowl. Steep submerged banks tend to reduce the growth of emergent and submergent macrophytes and the associated invertebrate community upon which many wildlife species feed. Uniformly deep water in the wet pond component of a facility provides reduced feeding opportunities. Available nesting and feeding area for waterfowl and shorebirds is comparatively diminished in steep bank facilities. However, steep slopes may pose a risk to the public and should only be utilized in exceptional cases and in

conjunction with barriers, signage, guards or barrier plantings to ensure that ponds are designed with full regard for public safety.

3. Dense plantings of trees and/or shrubs, i.e.: at least 3.0m wide and plants 50-80cm tall, or a dense mix of woody and herbaceous species, 6-10m wide, on the perimeter of the facility or placement of large diameter river run stone to create a near vertical bank can impede waterfowl access to and from the water. A continuous dense band of robust emergent macrophytes will also deter Canada Goose use of the facility. These shoreline treatments, therefore, render the facility unattractive as nesting and rearing habitat for many waterfowl species. Overhead wire grids, while aesthetically intrusive, can be successful at substantially reducing the number of Canada Geese grazing, loafing and nesting next to ponds.

4. Large terrestrial species can be effectively excluded from facilities with fencing. However, fencing height and density must be species specific. Drift fencing, if installed prior to completion of construction of a facility may be effective in deterring smaller amphibians and reptiles from colonizing a site.

5. Elongated ponds with comparatively narrow open water components are less attractive as breeding and rearing habitat for waterfowl because paths for escape from terrestrial predators are minimized.

6. Mowing of herbaceous vegetation adjacent to a pond facility should be avoided to deter Canada Goose use of the habitat. Waterfowl tend to feed on new growth shoots with their elevated protein levels. Taller herbaceous growth also interferes with sight lines and facilitates approach by predators.

These guidelines should only be applied to ponds that are determined to pose a high level of risk to wildlife due to their catchment area characteristics. Generally, ponds within residential subwatersheds should be sited and designed to complement and support the regional natural heritage system.

Mallard Duck, Mountain Brow Road stormwater facility – Hamilton.

Stormwater Management Facilities should not be designed to actively attract or support wildlife, but should be designed to support existing adjacent or downstream habitat by enhancing its diversity and function.

While stormwater management facilities may offer opportunities to enhance or create wildlife habitat in the urban environment, water quality, processes and maintenance requirements associated with the facilities must be considered. Stormwater management facilities must be recognized first and foremost as treatment facilities and not a replacement for natural wetlands, Ontario Ministry of Environment (MOE 2004). In addition, under no circumstances should existing natural wetlands be converted to function as stormwater management facilities.

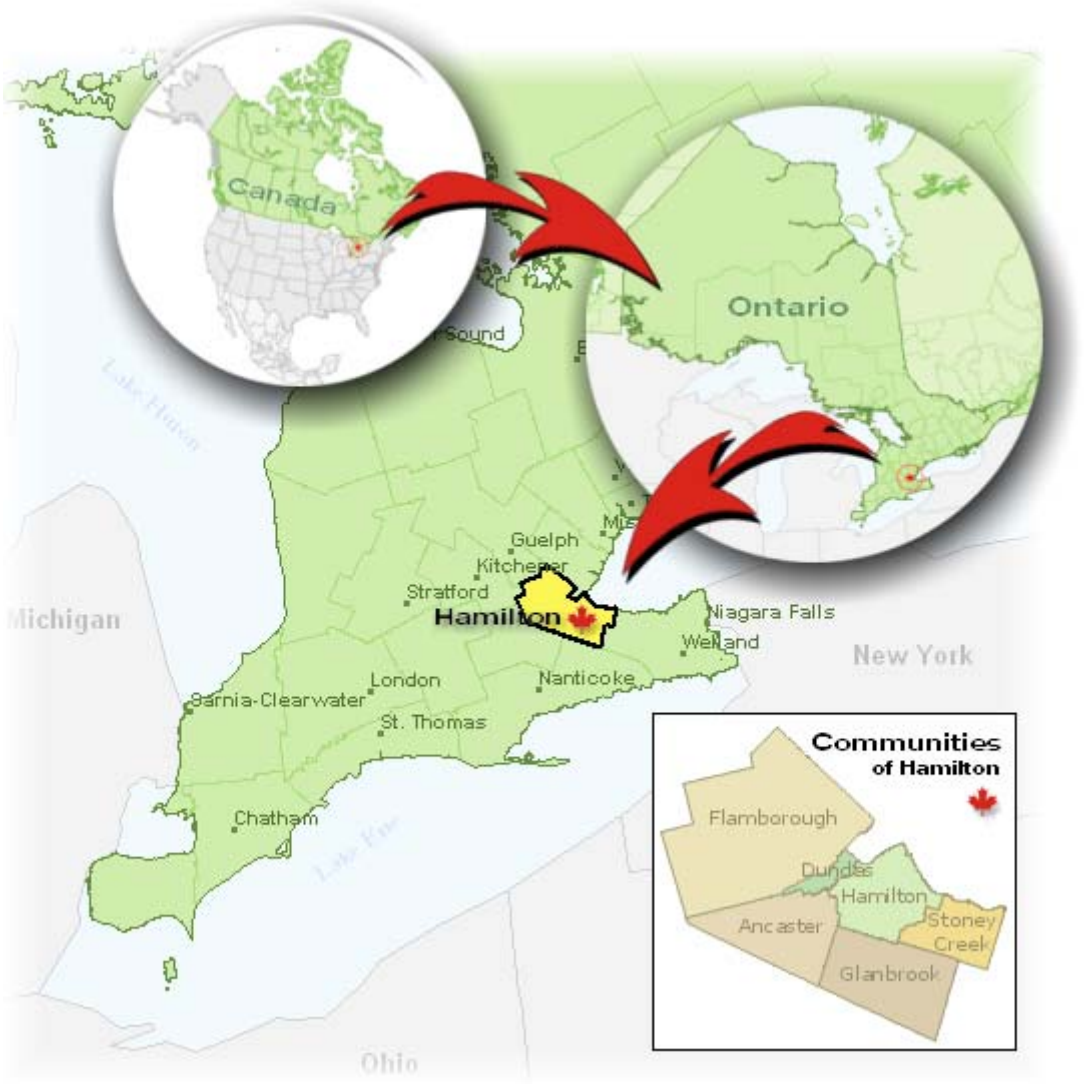


Figure 5 : City of Hamilton, Context and composition

Source: City of Hamilton, Ontario Geographic Information System

6.0 CITY OF HAMILTON – CONTEXT, CHARACTERISTICS, AND OPPORTUNITIES

The City of Hamilton is comprised of a mosaic of landscapes and land uses including residential communities, agricultural areas, commercial developments and natural landscapes. It is important that the determination of the appropriate type of stormwater management facility proposed to be implemented is appropriate and complementary to the unique characteristics, functions and sensitivities of each specific landscape type. In response, the following summary of the characteristics and context of the City of Hamilton is provided along with a discussion of the stormwater management opportunities associated with each.

6.1 GEOGRAPHY, LOCATION AND REGIONAL CONTEXT

The City of Hamilton is located about 100km from Toronto on the shores of Hamilton Harbour and Lake Ontario (Fig 5.0). The City is located at the west end of Lake Ontario with the industrialized area known as the "Golden Horseshoe". The Niagara Escarpment runs east to west through the middle of Hamilton, dividing ''Mountain'' residents from the rest of the region by a drop of approximately 50 m. This unique natural feature influences local air patterns (Clougherty, 1999), and affects regional transportation and development (see Dear et al., 1987). It also forms a natural corridor that runs through the City. Development within the escarpment area is regulated by the local Conservation Authorities and the Niagara Escarpment Commission. (S. Wakefield, C. McMullan 2005).

Within the City there are 15 watersheds, and associated tributaries and creeks, as well as several receiving bodies of water including Cootes Paradise, Hamilton Harbour and the Welland River. The diversity of the City's landscape and environmental context was considered in the process of developing these guidelines. It should be noted that for the purposes of this report, existing environmental conditions were characterized based on the background information compiled and summarized by Aquafor Beech Limited.

The presence of natural features and corridors associated with the Niagara Escarpment and the many tributaries and watercourses that traverse the City presents the opportunity to situate and design stormwater management to be integral and complementary components of the natural heritage and open space system, contingent on fundamental practical and functional drainage considerations.

Notwithstanding the fact that SWMFs must be situated on the basis of topography and practical drainage parameters, they should be located and designed to become integral components of the community open space system, enhancing recreational opportunities, providing interpretive benefits and contributing to the visual character of the landscape. Stormwater management ponds in particular possess significant potential to become prominent visual features and valued community assets. As a component of the broad-scale stormwater management planning process, the context of a proposed facility as it relates to the existing community and the proposed development is an important consideration. Trail connections, linkages to surrounding open spaces, parks, natural areas, schools and the road network, as well as relationships to the visual character of the community should be analyzed and understood.

Planning executed at the broad scale is the most effective means to identify the potential to implement landscape-based solutions that are fully integrated into the regional open space system. However, it is important that regard for context not be limited to the broad-scale planning stage. The approach should be applied consistently at the community and site-specific levels of detail to ensure that stormwater management opportunities afforded by site and context are identified and achieved

6.2 NATURAL HERITAGE AND OPEN SPACE SYSTEMS

The following information was sourced primarily from the report "Hamilton Natural Areas Inventory 2003". The City of Hamilton is located in the transition zone between two major forest regions: the Eastern Deciduous Forest (Carolinian Zone) and the Great Lakes – St. Lawrence Forest. In addition, the area boasts an exceptionally diverse physical landscape dominated by three features: the western Lake Ontario Shoreline and Hamilton Harbour Embayment; the Niagara Escarpment cuesta, which runs parallel to the shoreline, but some 2 km inland; and, the Dundas Valley, a major partially buried bedrock gorge in the shoreline and Escarpment. The physical landscape also creates some diverse microclimate conditions, particularly between the Escarpment and the Lake shoreline. Consequently, the floral and faunal assemblage is diverse and includes many species that are near the northern or southern limits of their geographic range (Hamilton NAI, Dwyer, 2003). Aquatic, wetland and terrestrial ecological systems are represented within the City of Hamilton as follows:

- Aquatic environments, including the Lake Ontario shoreline zone, the Hamilton Harbour – Cootes Paradise embayment, numerous small watercourses draining into the Harbour, Lake Ontario, the Grand River and the Niagara River, four inland reservoirs, and some natural and artificial ponds.

- Significant coldwater streams including Bronte Creek and Grindstone Creek.

Table 1: Summary of Natural Areas by Special Status Designation

Area type	Number of Areas	Total Area (ha)
Earth Science ANSI's	9	705
Life Science ANSI's	13	5,438
Candidate Earth Science ANSI's	17	not known
International Biological Program Areas	5	1,191
ESA's (including candidate ESA's)	103	20,924
Provincially Significant Wetlands	25	7,546

- Wetland environments are generally much more prevalent here than in other parts of Southwestern Ontario, particularly in Flamborough, where extensive areas of relatively undisturbed lowland forest are present on poorly drained, shallow, rocky soils. These forests include broadleaf swamps, mixed swamps, and cedar swamps. Other wetland environments include riparian marshes and swamps, small slough forest remnants, shoreline marshes and a few kettle bogs.

Throughout most of Hamilton, the terrestrial environment is dominated by agricultural and urban land use. The Dundas Valley and Niagara Escarpment corridors represent the largest remaining natural terrestrial habitats in the Hamilton area. Smaller, more disturbed upland areas with woodlots, plantations and old field habitats are widespread.

The natural areas of Hamilton encompass diverse natural features and serve important ecological and hydrological functions. Natural areas include both undeveloped lands (woodlots, wetlands, wildlife reserves, Escarpment lands and ravines) and previously disturbed lands that are reverting to a more natural state either spontaneously or deliberately. The present distribution of natural areas has been determined largely by geographic factors. Although no part of the area can be considered pristine, several relatively undisturbed greenspace areas remain. The largest natural areas are associated with either the Niagara Escarpment or the extensive bedrock plain found above the Escarpment in Flamborough. Based on the Natural Areas Inventory (Dwyer, 2003) study, a total of 107 sites were assessed, leading to the identification of 103 Environmentally Significant Areas (ESA's). Table 1.0 provides a summary of natural heritage features within the City.

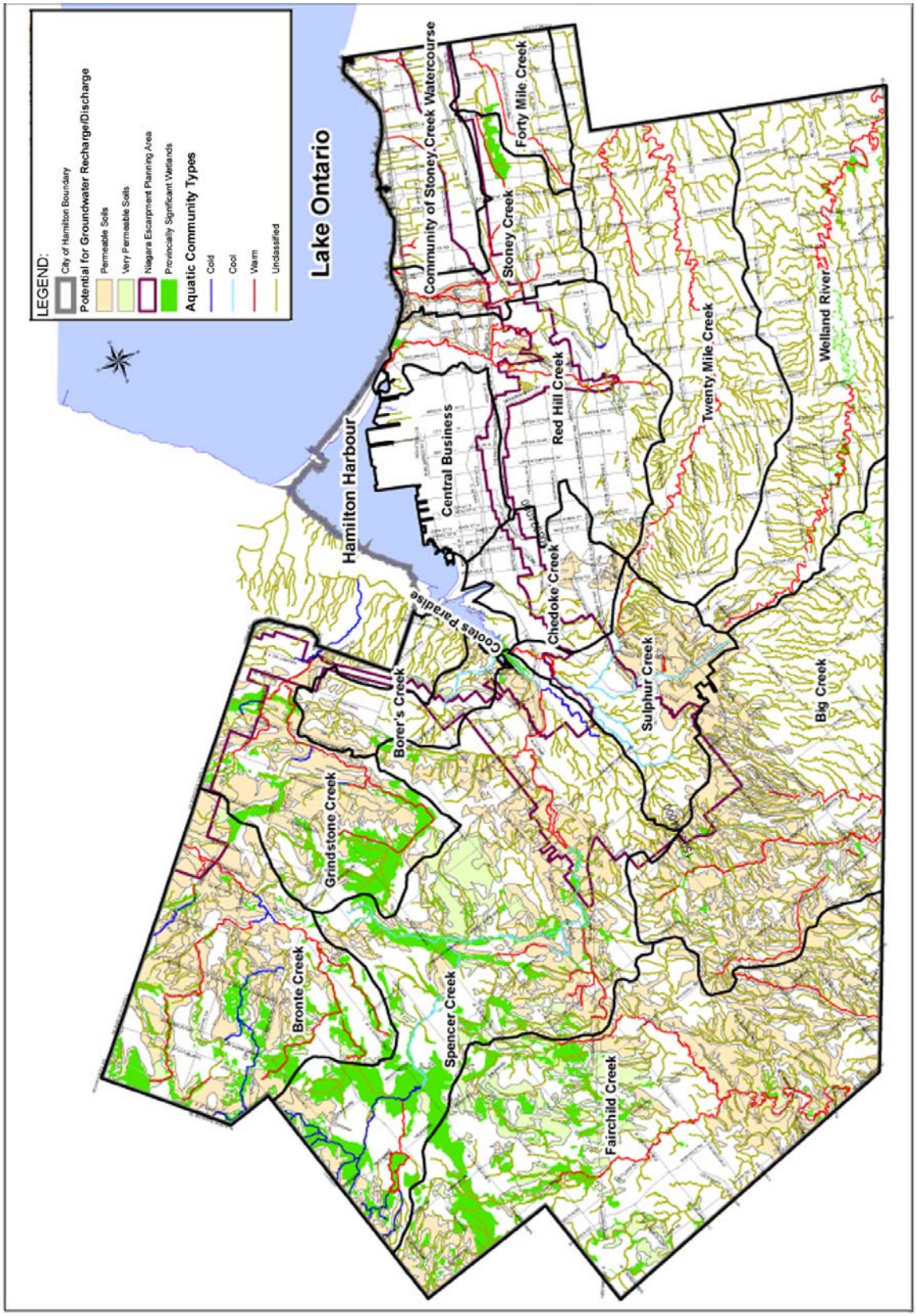


Figure 6 : The City of Hamilton Thermal Regimes (Chapter 2 Aquafor Beech)

The distribution of these features is shown in Figure 7.0. There is considerable overlap among the 3 key special status areas of wetlands, forests and stream corridors, and as a result, the total natural area within the City with protection status is less than the sum of the individual categories. Table 2.0 provides a summary by watershed, of the area covered by designated natural features within the City. . (Aquafor Beech, 2007:9-10).

Table 2: Distribution of Natural Areas by Watershed

Watershed	Receiving Waterbody	Natural Areas (ha)	Watershed Area (ha)	Percent Natural Area (%)
Big Creek	Grand River	1165	12473	9.3
Borer's Creek	Hamilton Harbour	350	2092	16.7
Bronte Creek	Lake Ontario	3247	8901	36.5
Central Business	Hamilton Harbour	110	3132	3.5
Chedoke Creek	Hamilton Harbour	224	2658	8.4
Community of Stoney Creek Watercourses	Lake Ontario	442	3491	12.7
Fairchild Creek	Grand River	4172	17421	23.9
Forty Mile Creek	Lake Ontario	140	1986	7.0
Grindstone Creek	Hamilton Harbour	2274	7088	32.1
Red Hill Creek	Hamilton Harbour	905	6912	13.1
Spencer Creek	Hamilton Harbour	5868	36249	16.2
Stoney Creek	Lake Ontario	510	3079	16.6
Sulphur Creek	Hamilton Harbour	1796	4128	43.5
Twenty Mile Creek	Lake Ontario	362	10985	3.3
Welland River	Niagara River	743	10534	7.1
Total		**22308***	**131131**	**17.0***

* Numbers rounded

The location and configuration of valley and stream corridors, vegetation communities, aquatic and terrestrial habitats and other natural heritage features present opportunities to integrate stormwater management facilities into the landscape with the objective of improving linkages, enhancing habitat connectivity and affording a range of benefits that extend beyond the limits of the stormwater management facility. An understanding of the attributes and deficiencies of the regional natural heritage system should be considered a priority in the process of developing stormwater management strategies. This will ensure that important features and functions are maintained while identifying opportunities to mitigate deficiencies enhance integrity and diversity and achieve watershed-wide benefits.

However, in the process of siting SWMFs, consideration should be given to the fact that SWMFs are not "natural" systems. Their primary function is to treat stormwater runoff and moderate storm flows. SWMFs require long term maintenance to ensure that tier functional efficiency is maintained. In response, SWMFs should not be constructed as a part of the natural heritage system but rather as a component of the open space system that may complement the natural heritage system by enhancing water quality, extending the breadth of corridor and providing buffering effects.

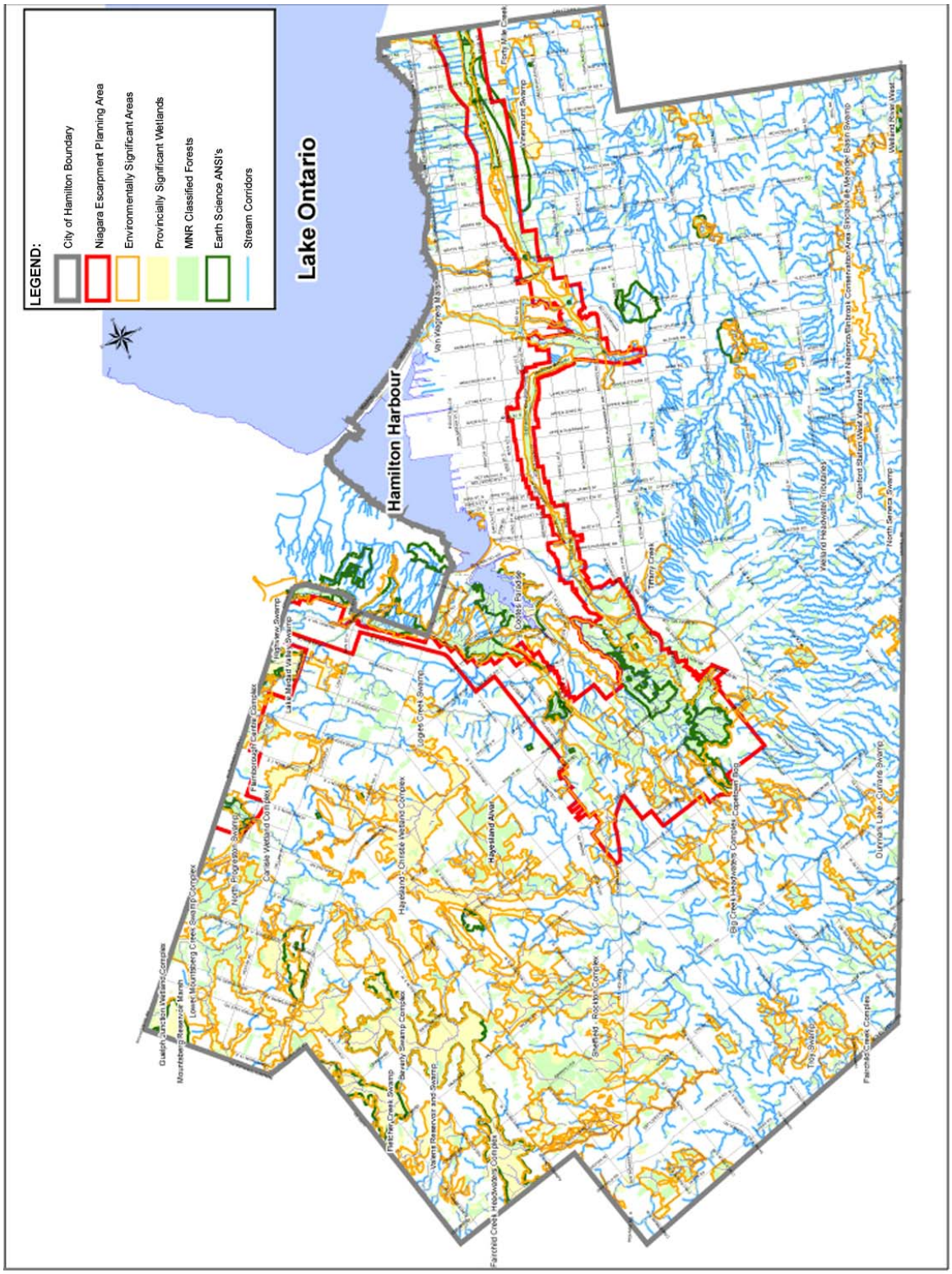


Figure 7: **City of Hamilton Natural Areas Inventory (Chapter 2 Aquafor Beech**

6.3 PHYSIOGRAPHY AND SOILS

Portions of the following physiographic regions, as described by Chapman and Putnam (1984), occur within the study area:

- Niagara Escarpment,
- Iroquois Plain,
- Flamborough Plain,
- Horseshoe Moraines, and
- Norfolk Sand Plain.

Together with their proximity to Lake Ontario, Hamilton Harbour and Cootes Paradise, these features create a complex mosaic of geology and topography, unique in southern Ontario. Overburden is thin to non-existent in the northern part of the City; however richer loamy and silty clay soils persist to south and east. Below the Escarpment, which is mostly urban, are the glacial lake deposits and prehistoric shore features of Lake Iroquois. The Niagara Escarpment, which runs through the centre of the City's jurisdiction around the harbour, is the most prominent topographic feature and creates radically different environmental conditions between the landscapes at its base versus those above it. There are also numerous karst features scattered along the Escarpment, most notably in Twenty Mile and Spencer Creeks. Significant recharge areas exist in the northern part of the City above the Escarpment and also in scattered areas along the landward side of the Escarpment to the south and east. The headwaters of Big and Fairchild Creeks also have some extensive recharge areas. The Bedrock aquifers are found primarily in the dolostones of the Guelph and Amabel/Lockport Formations, occurring above the Niagara Escarpment and supply municipal wells at Freelton, Carlisle and Greensville. This aquifer, referred to as the Guelph-Lockport Aquifer or in the area north of Hamilton, as the Guelph-Amabel Aquifer, is considered to be one of the major aquifers in Ontario. Shallow groundwater supplies are generally poor, and the majority of the watercourses above the Escarpment are intermittent in nature, except where wetlands provide a source of stream flow by storing surface runoff. This is the case with Fairchild, Grindstone, Spencer and Bronte Creeks. As the creeks fall over the Escarpment there is significant groundwater discharge, to the extent that some streams that are warmwater streams above the Escarpment become coldwater streams below it, for example, Ancaster, Sulphur, Borer's and Grindstone Creeks (Aquafor Beech, 2007:30-31).

Mountain Brow Road – Hamilton. Stormwater management facilities should be designed to respond to their physical, social and ecological surroundings

Generally, the location of stormwater management facilities will be dictated by the drainage characteristics of the watershed, subwatershed or catchment area. Natural depressions in landform afford the opportunity to implement detention type stormwater management facilities. The use of these depressions minimizes the requirement to execute extensive earthworks, thereby achieving cost savings while preserving landscape character.

Grading is a key element that influences both the performance and appearance of stormwater management facilities. Length of flow path, pool depth, length-to-width ratio and size are fundamental in determining the functional efficiency of stormwater management facilities within the context of the watershed. The topography and bathymetry of a pond defines in large part the composition of the plant community that will evolve and thrive within the stormwater management facility over the long term. This in-turn affects factors such as the degree of shading for the mitigation of increases in water temperature, the ability to establish a thicket around the perimeter of the pond to deter colonization by nuisance waterfowl and vegetation density in wetlands and filter strips. Consequently, it is important for the implications of physiography, soils and topography on the living landscape to be recognized early in the design process.

In Hamilton, depth to bedrock and other physiographic characteristics will influence the feasibility and design characteristics of specific types of SWMFs. In response, an understanding of local physiography is necessary to guide the selection and design of various stormwater management alternatives.

Soil permeability is a key consideration in the process of defining an overall stormwater management strategy. The presence of highly permeable soils affords opportunities to apply a stormwater management approach that is focused on maximizing infiltration and/or filtration type stormwater management initiatives. In areas of low soil permeability, opportunities to implement infiltration-based stormwater management facilities will be limited in favour of detention-based facilities. Additional detailed information regarding the hydrogeological context of the City of Hamilton is provided in Section 6.4.

6.4 HYDROGEOLOGY

The aquifers in the study area consist of granular deposits within the shallow overburden and thicker deposits found within or on the flanks of bedrock valleys, such as the Dundas Valley.

The Bedrock aquifers are found primarily in the dolostones of the Guelph and Amabel/Lockport Formations, occurring above the Niagara Escarpment and supply municipal wells at Freelton, Carlisle and Greensville. This aquifer, referred to as the Guelph-Lockport Aquifer or in the area north of Hamilton, as the Guelph-Amabel Aquifer, is considered to be one of the major aquifers in Ontario. In the Niagara Peninsula, this aquifer has a maximum thickness of over 60 m, but in the vicinity of Carlisle and Freelton municipal wellfields, where the Guelph formation is absent, the aquifer thickness is significantly less, about 13 – 27 m. The Salina formation, which overlies the Guelph Formation in western parts of the study area, is not exploited as a source of municipal water supply within the City of Hamilton, however it does serve as the source of water for many private wells and can be considered as a regional aquifer, however water quality problems occasionally arise.

The shales of the Cataract Group that underlie the Dolostones form a regional aquitard beneath the area, as is apparent from the springs which occur along the face of the Niagara Escarpment at the contact beween the water-bearing dolostones and the underlying shales. While the Guelph-Amabel/Guelph- Lockport Aquifer extends beneath much of the City and is used as a source of water throughout the area, it is only in the Dundas Valley, where it has been developed as a source of municipal water supply. Limestones and dolostones, while typically having low permeability, frequently have a high secondary permeability due to the presence of solution channels that develop along faults, fractures and bedding planes. The aquifers in Freelton, Carlisle and Greensville are developed on these characteristics.

The complex nature of the surficial and bedrock geology as well as the complexity of the aquifer systems results in some variable effects on groundwater discharge streams. In areas where there is Karst topography, there are “losing” streams, streams that recharge the groundwater through the stream bed. Such areas occur in the middle and upper reaches of Spencer Creek, in Twenty Mile Creek and possibly in parts of Bronte Creek. In many areas above (upstream) of the Escarpment, it appears that there is limited local groundwater supplies to support stream base flows and as a result, many headwater drainage features in all of the watersheds are intermittent. Instead, recharge occurring on and above the Escarpment tends to supply deeper aquifer systems and often discharges to watercourses as they descend over the Escarpment.

This phenomenon is sufficiently pronounced, that in the case of some streams, such as Grindstone, Borer's, Ancaster and Sulphur Creeks, there is a marked reduction in stream temperature, in some cases sufficient to result in cool/cold water stream status.
While there are numerous wetlands, particularly in the northern part of the City, the function of these wetlands in recharging groundwater supplies appears limited to recharging the deep aquifer system. These wetlands do also serve a significant water storage function and as such contribute to stream base flow in Spencer, Bronte and Fairchild Creeks.

The groundwater system behaves similarly within the headwaters of Big Creek, Welland River, Twenty and Forty Mile Creeks, in that the majority of headwater streams are intermittent and bedrock outcrops in these systems occur much further downstream outside of the City limits (Aquafor Beech, 2007:28-29).

The proximity of the water table, location of groundwater discharge and recharge areas, groundwater interflow patterns and characteristics of the underlying aquifers are all factors that need to be considered in defining stormwater management strategies at a broad scale. A comprehensive understanding of hydrogeological conditions is particularly important in areas that are located in the vicinity of the Niagara Escarpment and where groundwater interflow patterns are complex. Regional hydrogeological characteristics should be considered in the planning process, not only from the perspective of identifying opportunities to implement infiltration-based stormwater management facilities, but also with the objective of mitigating the potential contamination of groundwater reserves through the introduction of pollutants from stormwater into the groundwater system. In recognition of the fact that many residents of the City of Hamilton derive their drinking water from groundwater sources, the potential for contamination is a consideration of key importance in the process of designing stormwater management systems.

6.5 HYDROLOGY

The selection and design of stormwater management facilities should be founded on a careful consideration of the hydrological characteristics of the watershed or catchment area within which the facility is proposed to be implemented. Hydrology has a bearing not only on the selection of the optimal location and type of proposed stormwater management facilities but also on the ability to maintain the functional integrity of other hydrologic features within the watershed or catchment area. For example, stormwater management facilities that are proposed to be implemented upstream of a natural wetland must be designed with an understanding of the specific attributes and sensitivities of the wetland related to biological functions. Similarly, stormwater management facilities that are proposed to discharge into an existing watercourse should be designed based on a knowledge of the characteristics of the watercourse related to such factors as stream stability, composition of the fish community, etc., so that specific elements of the stormwater management facility, such as the outlet structure can be designed to ensure that any potential impacts are adequately mitigated. With respect to natural wetlands, which are particularly sensitive to changes in watershed hydrology, the implementation of stormwater management facilities upstream of these features can have both positive and negative effects on the function and long term sustainability of these features. Natural wetlands provide a continuous of habitat and water quality benefits. Wetlands play an important storage and baseflow and groundwater recharge role within a watershed. They provide flow attenuation and flood control benefits and provide cover, spawning and nursery habitat for a range of fish species and support the life cycle requirements of herptiles and waterfowl (Mitsch and Gosslink, 1993). Through carefully considered siting and appropriate design, SWMFs can assist in ensuring that these important functions are maintained by enhancing water quality and mitigating discharge rates in watershed that is undergoing land use change from predominantly natural or rural to urban. Conversely, if not designed appropriately, SWMFs can impact downstream natural wetlands by modifying the hydrology of the watershed in such a way that alterations to flow rates exceed the threshold of tolerance within the wetland, leading to the decline of species and changes to the composition of the wetland vegetation community. Although wet ponds and constructed wetlands are generally effective tools to enhance water quality and addressing quantity control objectives, they are less effective in replicating the ecological function of natural wetlands. Furthermore, the requirement for repeated and on-going maintenance activities to be implemented to ensure the long-term functional performance of SWMFs and the potential impacts of these

necessary operations in downstream wetlands and waterways needs to be considered in the process of site selection and design. In addition to specific design initiatives to enhance the performance of a SWMF to address the maintenance and enhancement of the function of existing downstream wetlands and water bodies, the siting and design process should also include the determination of minimum setbacks from and buffers between SWMFs and adjacent wetlands, watercourses and other hydrologically sensitive features. An understanding of the hydrological dependences of wetlands and watercourses will need to be demonstrated in the process of developing stormwater management strategies and designing specific structure management facilities to facilitate approval by the City of Hamilton and achieve the permitting requirements of the Conservation Authority having jurisdiction.

6.6 MICROCLIMATE

The City of Hamilton's climate is classified as "humid continental", Dfa type in accordance with the Köppen climate classification system and is relatively mild in comparison to most Canadian cities. The average annual temperature ranges from a high of 13°C to a low of 2°C with July and August being the hottest months of the year and January and February registering the lowest temperatures. The City receives on average 910mm of precipitation annually with higher levels of precipitation occurring during the summer months. Table 3.0 provides a breakdown of the distribution of precipitation on monthly basis.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum Temperature ˚C	-2	-1	4	11	19	24	26	25	21	14	7	1
Minimum Temperature ˚C	-9	-9	-4	1	7	12	15	14	11	5	0	-6
Precipitation mm	61	54	74	74	71	78	81	85	82.1	84	66	80

Table 3: Weather Averages for Hamilton, Ontario
Source: weather network- data covers 30 years from 1961 to 1990

The City of Hamilton is located within the transition between plant hardiness zones 6a and 5b (Natural Resources Canada) and as such can support Carolinian species. The growing season is approximately 3 weeks longer than that of the Toronto area. Consequently, a broader range of species can inhabit the Hamilton area, presenting the potential for increased biodiversity.

The extent and composition of existing vegetation cover affords opportunities to moderate the rate of runoff through the interception of rainfall and the filtration of runoff. The contribution of vegetation, including the urban forest, in moderating flow rates through interception is difficult to quantify and factor into the stormwater management equations. However, studies have demonstrated that in a drainage shed with 22% urban forest cover, for the one year storm event (6hr duration / 46mm of rainfall (Dafter, Ohio)) forest cover can reduce runoff rates by 7%. Studies have also shown that interception rates averaged approximately 15% for 5mm/24hr storm and 7.1% for 25mm/24hr storm in Sacramento, California (Technical Bullentin N.O.G., University of British Columbia, James Taylor Chair in Landscape and Liveable Environments, October 2000). Consequently, the maintenance of existing forest cover, combined with restoration initiatives to enhance the extent of natural forest cover and the urban forest will have a positive effect on the overall function and effectiveness of the stormwater management system. These benefits will increase over time in tandem with the growth and maturation of the vegetation community.

6.7 REGULATORY CONTEXT

The City of Hamilton is located within the jurisdiction of 4 conservation authorities, these include:

- Grand River Conservation Authority
- Hamilton Conservation Authority
- Conservation Halton
- Niagara Peninsula Conservation Authority

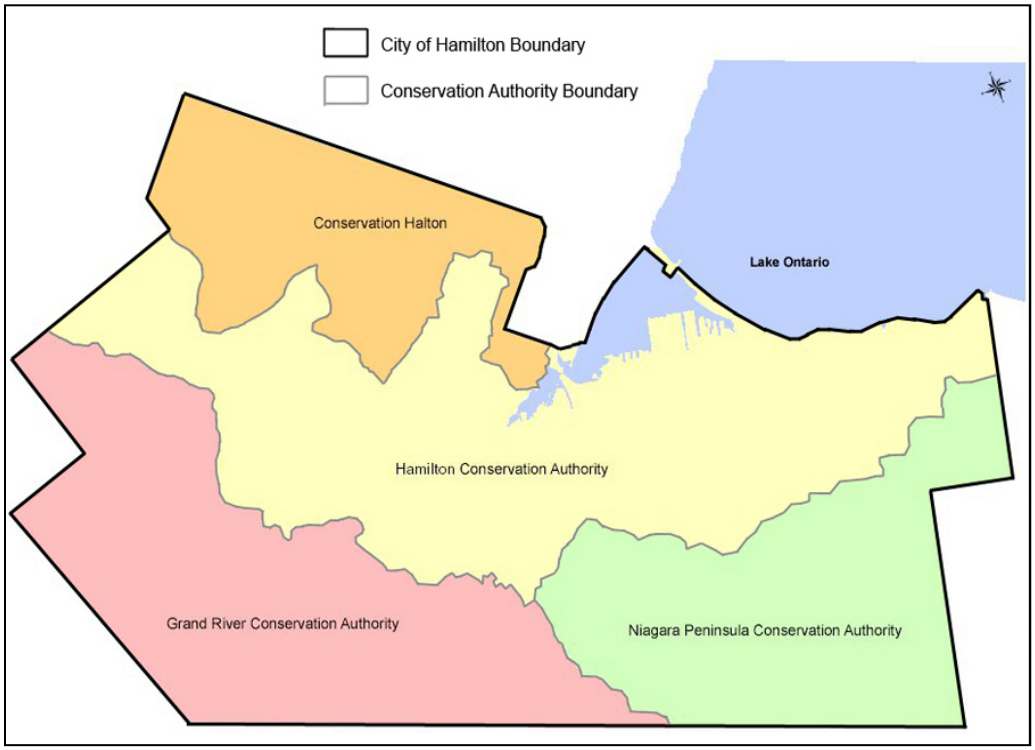


Figure 8: Conservation Authority Boundary Jurisdictions – Hamilton Area

Each of these Conservation Authorities are responsible for the regulation of development within or in the vicinity of wetlands, shorelines, and watercourses within their respective jurisdictions. Provincial regulations enacted through the Conservation Authorities Act restrict the location of stormwater management facilities within watercourses, wetlands or floodplains. The implementation of stormwater management facilities may also be restricted on lands adjacent to these features subject to Conservation Authority approval. Figure8.0 illustrates the limits of the areas of jurisdiction for each Conservation Authority within the area encompassed by the City of Hamilton.

Each of these Conservation Authorities are charged with enacting legislation that regulates development within each of their respective jurisdictions. These regulations prohibit development in or on the following area:

a) adjacent or close to the shoreline of the Great Lakes-St. Lawrence River System or to inland lakes that may be affected by flooding, erosion or dynamic beaches, and within the 15 meters allowance;

b) within 15 meters of a river or stream valleys that have depressional features associated with a river or stream, whether or not they contain a watercourse;

c) hazardous lands;

d) wetlands; or

e) other areas where development could interfere with the hydrologic function of a wetland, including areas within 120 meters of all provincially significant wetlands and wetlands greater than or equal to 2.0 hectares in size, and areas within 30 meters of wetlands less than 2.0 hectares in size, but not including those where development has been approved pursuant to an application made under the Planning Act or other public planning or regulatory process.

Provincial legislation also prohibits alteration to straighten, change, divert or interfere in any way within the existing channel of a river, creek, stream or watercourse or change or interfere in any way with a wetland prior to receiving written consent of the Conservation Authority. Any new development, including the creation of new structures, grading activities, alterations to waterways (both watercourse and the Lake Ontario Shoreline) and alterations to wetlands with the areas of jurisdiction of the various Conservation Authorities will require a permit pursuant to Ontario Regulations 162/06, 155/08, 150/06 or 161/06 under Ontario Regulation 97/04 contingent on the Conservation Authority having jurisdiction.

With respect to the process of review and approval of stormwater management facilities designs, the various Conservation Authorities will provide comments related to SWM facility proposals within the regulated areas within their respective jurisdictions. In addition, Conservation Authorities will provide peer review advice on stormwater management proposals to the City of Hamilton. Conservation Authority staff will also provide comments in conjunction with Fisheries and Oceans Canada (DFO) with regards to Section 35 of the Federal Fisheries Act and the potential Harmful Alteration, Disruption or Destruction (HADD) of Fish Habitat associated with the construction of SWM facilities and outlet structures.

Therefore, consultation with and permission from the Conservation Authority having jurisdiction is required when a stormwater facility and/or associated works (including grading) are proposed within the regulation limit.

In addition to the Conservation Authorities, portions of the City of Hamilton fall within the jurisdiction of the Niagara Escarpment Plan (NEP) 2002. The NEP includes specific policies that regulate the location of stormwater management facilities. The NEP stipulates that:

> "Stormwater management facilities are not permitted in the following hydrologically sensitive features or significant natural features:
> - Permanent or intermittent streams
> - Wetlands
> - Kettle lakes
> - Seepage areas and springs."

In addition, under the Federal Fisheries Act, Fisheries and Oceans Canada regulates direct and indirect fish habitat resources including permanent and intermittent streams, wetlands and water bodies. Authorization from Fisheries and Oceans Canada is required to permit the harmful alteration, disruption or destruction (HADD) of fish habitat may be anticipated as a result of the implementation of a stormwater management facility, including outfall structures. Ontario's Ministry of the Environment (MOE) regulates the implementation of stormwater management infrastructure in Ontario. Typically a Certificate of Approval (C of A) is required to be acquired from the MOE to facilitate the implementation of storm sewers and stormwater management facilities.

The Landscape Design Guidelines have been generated with the objective of harmonizing the requirements, criteria and regulatory agencies having jurisdiction with the objective of streamlining the review. Approval processes, notwithstanding, formal approvals and permits from various regulatory agencies will be required in addition to approvals granted by the various departments within the City of Hamilton.

7.0 EXPLORING INNOVATIVE SOLUTIONS: OPPORTUNITIES TO APPLY LANDSCAPE-BASED SOLUTIONS TO ACHIEVE STORMWATER MANAGEMENT OBJECTIVES

Although this report has been developed to set out guidelines to direct the design of stormwater management facilities in the City of Hamilton, the primary purpose of the document is not to set out a "cookbook" of techniques to be applied universally. Rather, the underlying goal of the document is to inspire the exploration of innovative solutions that are appropriate within the context of ecosystem and community. To this end, this section of the report illustrates and describes a suite of potential techniques that could be applied at a range of scales to address stormwater management objectives. For guidance in the selection of the appropriate SWMF to address site specific parameters, the Ontario Ministry of the Environment Stormwater Management BMP Planning and Design Manual (MOE, 2003), Tables 1.3 and 4.1 should be referred to.

Responsible broad-scale planning that recognizes the need for stormwater management at the outset – combined with an understanding of the ecological and functional attributes of the landscape – provides the fundamental basis for achieving integrated, efficient, practical and cost-effective stormwater management solutions. At this scale, stormwater management opportunities afforded by the physiographical, biophysical and ecological characteristics of the landscape can be identified and capitalized upon. The policies of the City of Hamilton stress environmental responsibility as a key principle in the planning process. This reinforces the importance of applying a watershed planning approach to ensure that important natural features and other interrelated factors that contribute to the sustainability of the regional ecosystem are identified and understood at the outset of the planning process. Through the application of this approach, the framework is established for the generation of a stormwater management system that is fully integrated with the environment. Landscape-based solutions afforded at the broad-scale are rooted in recognition of the value and potential benefits presented by the existing physical and ecological characteristics of the landscape. The following are examples of opportunities to achieve stormwater management objectives afforded by the characteristics of the regional landscape.

Stormwater management facility, Rymal Road - Hamilton

7.1 LANDSCAPE-BASED STORMWATER MANAGEMENT OPPORTUNITIES

One of the objectives of this document is to inspire the exploration of creative and innovative stormwater management strategies that are a complementary component of the urban fabric. To achieve this objective, a full spectrum of landscape-based stormwater management options is presented in this section. The options presented are applicable at a variety of scales ranging from lot level to end of pipe. Potential solutions that can be integrated with built form are also presented.

7.1.1 Centralized Solutions

Garth Street, Hamilton

Centralized solutions are defined as larger stormwater management facilities that are designed to treat a large development area and that are located on lands that will be conveyed into public ownership as part of the community open space system.

Centralized solutions are typically employed at a number of locations throughout a community to function as a comprehensive system. If considered at the watershed-wide and community scales, the framework for an effective, efficient system of centralized facilities will already have been established, making available for consideration a wide range of possibilities to integrate facilities into the open space network. If this process has not been employed, options to implement centralized controls may be much more limited. Centralized facilities can be designed to utilize detention, infiltration, exfiltration or filtration, or a combination of one or more of these processes to achieve stormwater management targets.

To integrate stormwater management facilities in existing developed areas of the City, the option exists to retrofit centralized facilities in existing parks. For example, infiltration systems can be constructed beneath soccer fields or baseball diamonds with little or no impact on the functionality of the recreational facility while providing stormwater management benefits. Centralized infiltration systems can be implemented beneath the boulevards or medians within the road network. However, in the process of exploring opportunities to mitigate facilities within the public realm, facilities should be designed to ensure that human contact with stormwater is not permitted. These options should be considered in retrofit situations in the existing urban area where no stormwater control exists.

Facilities that utilize detention to remove pollutants can be integrated creatively into many types of landscapes. Ponds, water features and fountains are an aesthetic asset to any development and can be designed to achieve stormwater quantity improvement or quality control objectives. A linked series of centralized facilities can be designed as a contrived, yet viable open space system where the configuration of existing natural features presents no such opportunity. Creatively designed

centralized facilities afford the advantages of optimizing performance while minimizing land area requirements, with the added benefit of providing additional recreational and aesthetic value.

7.1.2 End-of-pipe Solutions

Currently, the dominant approach to stormwater management is focused on using one or more end-of-pipe facilities to manage stormwater discharged from larger development areas. End-of-pipe facilities are typically much larger than centralized facilities and therefore possess a greater potential to affect the visual character of the community. End-of-pipe solutions may include wet ponds, wetlands, dry ponds, hybrid systems and infiltration systems. End-of-pipe facilities, if designed with care, can become established as the central visual and recreational amenity within the community, affording opportunities for nature appreciation, interpretation and passive recreation. The guidelines contained within the subsequent sections of this document primarily address the planning and design of centralized and end-of-pipe stormwater management facilities.

7.2 COMMUNITY-SCALE OPPORTUNITIES

Landscape design solutions can be applied to a range of components of a proposed community beyond the limits of the areas specifically dedicated to stormwater management. The road network, individual lots and other components can be designed to achieve stormwater management objectives through the application of the integrated design process.

7.2.1 The Urban Forest

Enhancing the extent of tree cover throughout the community contributes to the moderation of runoff discharge rates through interception and the mitigation of temperature increases through increased shading. In addition, through transpiration the urban forest cycles rainfall absorbed into the soil back to the atmosphere.

Specific guidelines are provided to direct the density and species composition of planting within areas designated for stormwater management. However, increasing the extent of urban forest in streetscapes, in parks, on public lands, and on private property should be a priority in new developments, as well as throughout the existing developed areas within the City of Hamilton.

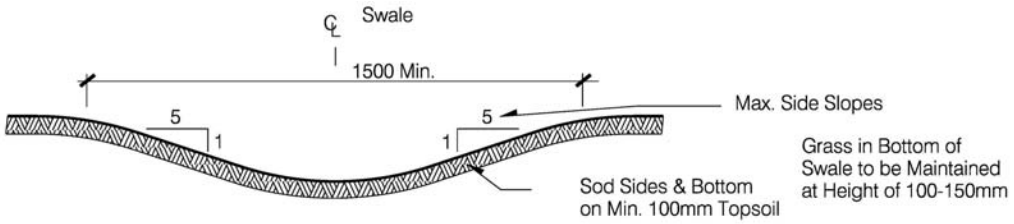
In new developments, narrow lot frontages and the network of underground utilities may limit the ability to increase the density of street tree plantings. However, the implementation of policies and initiatives to encourage the planting of trees in rear and side yard areas of private residential lots is recommended. Similar policies have proven to be successful in the City of Waterloo and other municipalities in Southwestern Ontario.

7.2.2 Road Network

A number of stormwater landscape design solutions can be applied to the network of roads within a community. Although more constrained by requirements related to servicing, alignment and gradient than the open space system, road rights-of-way present the opportunity to implement simple, cost-effective and beneficial landscape-based stormwater management solutions. The following techniques should be considered in the course of refining the stormwater management strategy for a proposed development.

7.2.2.1 Grassed Swales

Grassed swales have been proven to be effective in filtering pollutants from stormwater runoff. In addition, grassed swales provide benefits related to snow storage as well as groundwater recharge where appropriate soil conditions exist. Grassed swales are a cost-effective alternative to conventional storm sewers and require minimal maintenance to remain functional and effective. Narrow lot frontages and the close proximity of driveways to one another limit opportunities to use grassed swales in most new residential developments. However, in specific situations, including large lot residential communities, institutions and industrial developments, grassed swales may be a practical alternative. Although there is a perception that grassed swales convey an unkempt visual image, many of the more desirable neighborhoods in Toronto and York Region including the Bridal Path and Cachet Estates, are serviced using grassed swales. Implications on public safety should be considered in determining the size of, conveyance volume and flow velocity of water within proposed grassed swales. An example of grassed swale is provided in Figure 9.0.



TYPICAL SWALE CROSS SECTION

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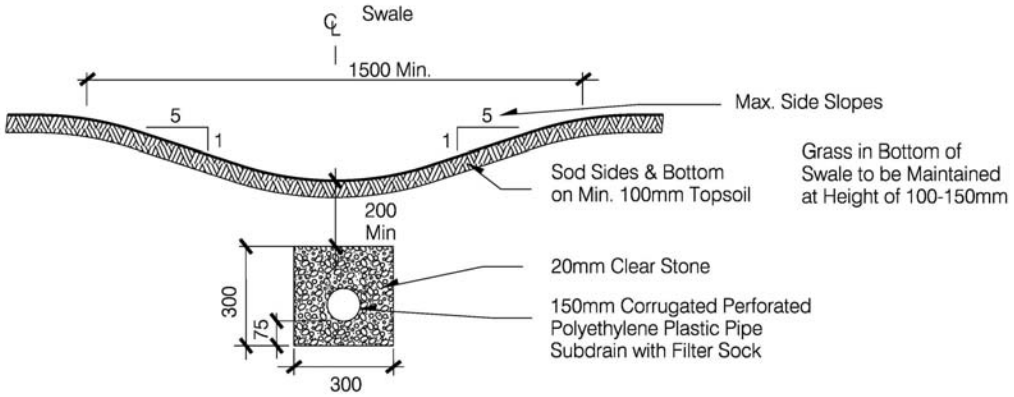


SWALE WITH SUBDRAIN

1:20

NOTE:

1. Longitudinal Slopes Shall be Min. 1.5% to Max. 10%.
2. Discharge Water to On-Site Catch Basin or Adjacent Open Water Course.
3. Do Not Convey Water Over Municipal Sidewalks.

Figure 9: Grassed Swales

7.2.2.2 Pocket Detention Storage

Within the road right-of-way, there are a number of small areas that are well suited to the implementation of pocket detention facilities or biofilters. Cul-de-sac islands, medians, boulevards, roundabout islands, and in the case of limited access routes, leftover land within interchanges are suitable for consideration as potential sites to detain stormwater, settle out pollutants and infiltrate runoff. These areas can be paved with permeable surfacing materials such as porous interlocking concrete paver systems or landscaped to integrate them into the aesthetics of the streetscape or character of the development. Although the sizes of these facilities are limited, collectively, significant stormwater management benefits can be achieved. An example of pocket detention is provided in Figure 10.0.

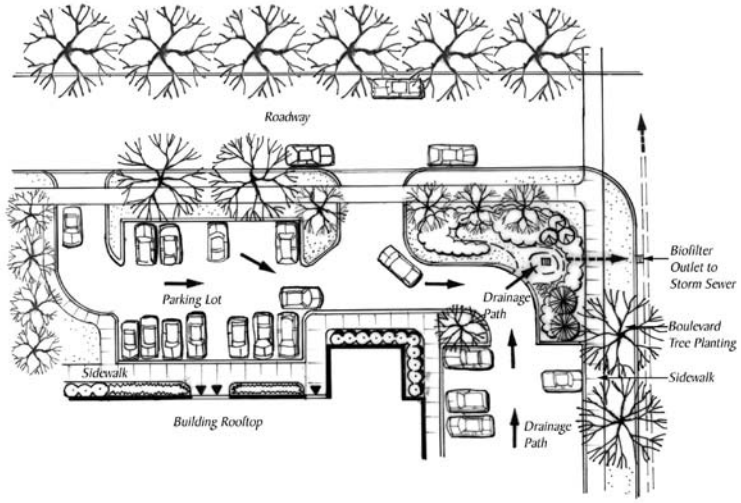


Figure 10: Pocket Detention Storage

7.2.2.3 Parking Lot Attenuation

Parking lots can be utilized to attenuate stormwater runoff for discharge over an extended period of time. This can be accomplished by fitting catchbasins outlets with flow restricting orifice plates that control discharge flow to a prescribed rate. Typically large parking lots are better suited to attenuate stormwater since temporary ponding areas can be located in the areas of the parking lot that are least well used. For convenience purposes, storage areas should not be located nearest the entry points to the building and should be located to avoid handicapped parking areas. Maximum water depths within the parking area should not exceed 300mm. Parking lot attenuation can be utilized to address quantity control requirements but does not provide water quality improvement benefits and may result in an increase in temperature of runoff discharged from the site.

7.2.2.4 Permeable Pavement

Permeable pavement has been proven to be effective in achieving water quality improvement, quantity control and groundwater recharge objectives. Permeable paving

products available in Ontario include porous asphalt, permeable precast concrete pavers and pervious concrete. Each type of permeable paving offers its own distinct set of advantages and disadvantages but all can assist in mitigating the potential impacts of runoff from parking lots, roads, driveways and walkways. Permeable pavement installation consists of porous paving materials in the form of concrete, asphalt or precast concrete paveres with a deep granular sub-base that acts as a reservoir and filtration mechanism. Where sub-soils are conducive, an infiltration medium and tile drains that work as a system can be installed to enhance performance.

Permeable pavements can be decorative and are available in colours that have a high reflectivity index, contributing to the mitigation of urban heat island effect. Permeable pavements can also be used to enhance the rate of survival of street trees, allowing for infiltration and air exchange in the root zone. An example porous pavement detail is provided in Figure 11.0.

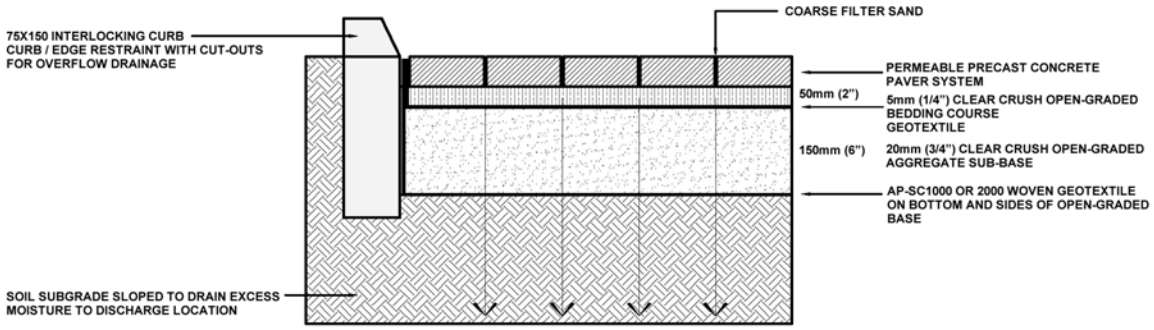


Figure 11: Porous Pavement Detail

7.2.2.5 Lot Configuration and Grading

Street plan layout as well as lot configuration and grading are key factors that affect the potential for implementation and effectiveness of lot level controls such as roof leader disconnection, filter strips and depression storage. Consideration should be given during the planning stage to ensure that roof leader disconnection can occur without impacting neighbouring properties or requiring that runoff be discharged onto hard surfaces such as walkways and driveways. Lot layout and grading should be defined with an emphasis not only on achieving maximum unit yield, but also with the objective of maximizing the potential to implement lot level controls efficiently and effectively. Specific lot grading must conform to City of Hamilton Guidelines.

7.3 OPPORTUNITIES AT THE SITE-SPECIFIC SCALE

Site-specific landscape solutions can be applied on properties held in either public or private ownership. Four tiers of stormwater management solutions should be considered at this scale including lot level, at-source, centralized and end-of-pipe solutions. Landscape techniques are applicable to all four tiers of solutions but are primarily applicable to non-structural and hybrid structural / non-structural facilities.

The implementation of lot level and at-source stormwater management facilities presents unique challenges because these types of facilities are situated on lands held in private ownership. However, significant benefits can be realized through the successful, widespread implementation of lot level controls throughout

a community, particularly in areas where soil permeability is conducive to infiltration. The following sections describe alternative opportunities to implement landscape based stormwater management solutions within each of the four tiers.

7.3.1 Lot Level Solutions

Landscape design solutions are well suited to application at the lot level since attractive landscaping is a desirable component of residential properties. Stormwater management initiatives can be designed to complement or alternately, to be concealed within the residential landscape. Although lot level controls are difficult to implement and maintain because they are situated on private residential properties, opportunities exist to work with homeowners to make them aware of the benefits of using lot level controls and to assist in implementing these initiatives. Section 11.2 provides some direction to assist in maximizing the effectiveness and minimizing the liability of lot level controls.

The application of specific lot level controls will require the approval of the appropriate departments within the City of Hamilton. The implementation of lot level controls is more feasible where residential properties are encompassed within a condominium organization. Under this scenario, lot level controls can be designed to achieve quantifiable stormwater management targets and maintenance can be assured through agreements with utilizing the by-laws that govern the condominium corporation. These agreements provide a legally binding tool to ensure that lot level installations will not be altered and will be regularly maintained to ensure their long-term performance. Because the long-term performance of the lot level installations can be substantiated and assured, the size of the centralized or end-of-pipe facility that would be required to achieve the stormwater management targets for the entire development can be reduced. The incentives for adopting this approach include reduced costs for the construction of the facility

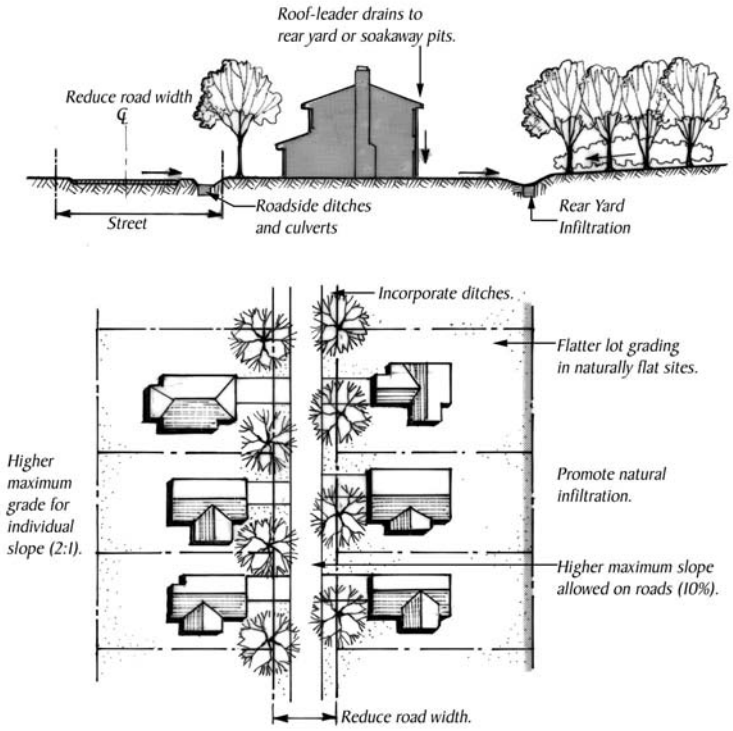


Figure 12: Lot Level Solutions

and a reduction in the area of land required to implement the facility. However, in the process of evaluating the viability of the approach on a particular site, assessments to qualify the performance of the lot level installation must be undertaken to rationalize the reduction in size of the end-of-pipe facility and achieve approval from the regulatory agencies. Refer to Figure 12.0 for a diagrammatic example.

7.3.1.1 Depression Storage

Grading of shallow depressed areas in front, rear and side-yard areas is a simple technique that can be utilized to store and infiltrate runoff where the underlying soils are conducive. Depression storage areas can be located in low areas, planted as gardens or situated beneath decks. Typically, depression storage areas are small and have limited capacity and duration of retention to mitigate homeowner concerns related to insects, damage to structures and convenience. Although their individual effectiveness is limited by their size, cumulatively, depression storage areas can provide significant benefits.

Depression storage systems and infiltration systems are most effective in areas with high soil permeability. Stormwater directed to depression storage or infiltration facilities should be discharged from relatively clean sources including roof leaders and walkways, rather than surfaces prone to the accumulation of sand, oil and grit, to ensure the long term functional performance of the facility. Infiltration facilities should not be proposed in areas where the water table is shallow or where there is the potential for stormwater with high chloride concentrations to infiltrate rapidly. Care must be taken to ensure that infiltration facilities will not impact on aquifers that are the source of drinking water. Depression storage and infiltration facilities should be designed with an overflow outlet to ensure that positive drainage away from the basement of the dwelling is achieved in the event that the function of the installation is compromised or its capacity is exceeded.

7.3.1.2 Storm Gardens

A variation on depression storage, the storm garden is a deliberately designed landscape, with specific plant species and soil media selected to receive and detain, infiltrate and filter runoff discharged from roof leaders. Storm gardens are effective in both new and retrofit situations and can be designed to complement the landscape of most properties (Figure 13.0). The storm garden is constructed on a base of granular material with plant material selected for its rooting characteristics and tolerance of varying soil moisture conditions. The drainage area of the roof plane contributing to the downspout determines the size of the garden.

As with depression storage, storm garden installations are effective in areas where soil permeability is high. In addition, provision must be made to facilitate positive drainage away from the storm garden in the event storm flows exceed capacity. Although storm gardens were initially conceived for implementation on private residential lots under retrofit situations, they are also applicable to larger commercial, industrial, institutional and condominium developments as components of a multi-tiered stormwater management strategy.

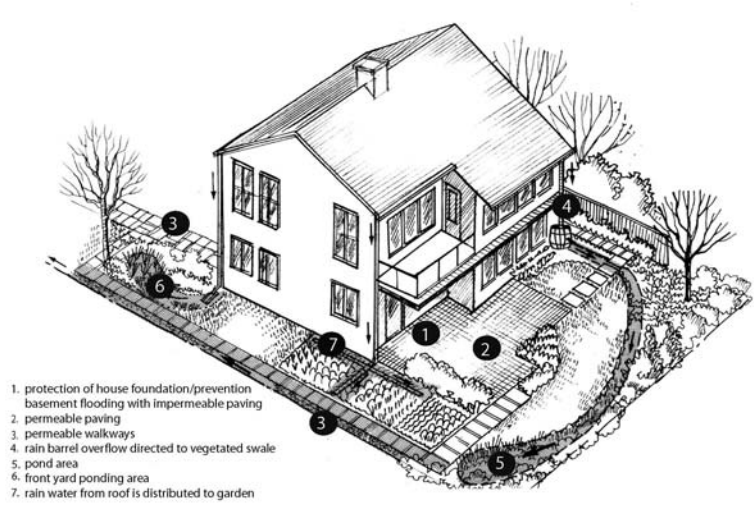


Figure 13: Storm Gardens

7.3.1.3 Bioretention Areas

Bioretention areas are planted depressions that store and filter rainwater to provide pre-treatment of runoff prior to discharge into infiltration systems. Bioretention areas also store excess stormwater when the downstream infiltration system has been surcharged. This allows infiltration to occur over an extended duration of time allowing more runoff to be infiltrated by the system.

Bioretention areas can be integrated into a range of landscape areas including medians and cul-de-sac islands, parking lot medians and boulevards. A variety of planting and landscape treatments can be employed to integrate bioretention areas into the character of the landscape. Biofilters are typically designed as companions to infiltration facilities although they can be effective as standalone detention facilities. Refer to Figure 14.0

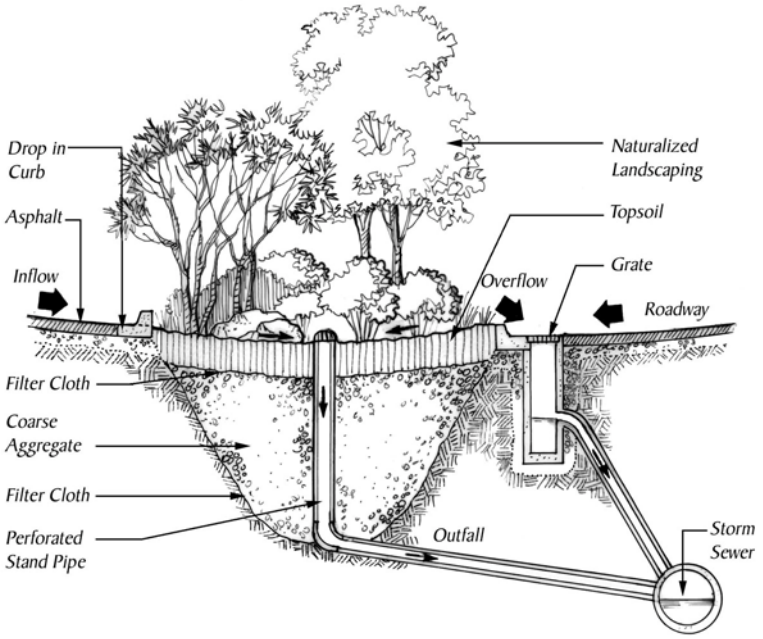


Figure 14: Biofilters

7.3.1.4 Infiltration Galleries

Infiltration galleries are constructed below grade and therefore have little connection to the surface landscape. However, landscape solutions can be used to enhance the effectiveness of this type of facility by pre-treating runoff prior to discharge into the infiltration system, affording the opportunity to install infiltration facilities in a broad range of areas including residential lots, parks and other open spaces within the community. The following are examples of approaches that can be employed to integrate infiltration galleries into the landscape:

- linear infiltration galleries can be designed for installation beneath granular surfaced trail systems. Runoff from the adjacent development can be directed to the infiltration gallery, while the trail network enhances the connectivity of the open space network within the community;

- in new communities that have been designed based upon the principles of new urbanism, infiltration systems can be incorporated into the rear laneways. Runoff from the roof areas of adjacent garages and residences is directed to the infiltration gallery; and

- infiltration galleries can be constructed beneath decks and lawns of residential properties.

7.3.2 Source Controls

Source controls are defined as initiatives that are implemented on public, semi-private or private lands in close proximity to the source of potentially pollutant-laden runoff. Source controls may be structural or nonstructural. Examples of landscape-based source control solutions are described below:

7.3.2.1 Infiltration Systems

Infiltration systems are well suited to at-source applications where soil is predominantly permeable. Landscape-based infiltration solutions include:

- the incorporation of biofilter systems in the islands of parking lots, or in the boulevards of commercial properties; and
- the integration of infiltration systems beneath walkways, in courtyards or other hard surface landscaped areas.

As noted previously, care must be taken to ensure that infiltration systems do not impact groundwater resources. Pre-treatment devices should be utilized to remove coarse sediment, hydrocarbons and contaminants prior to discharge into the infiltration medium. If adequate pre-treatment is implemented, the required frequency of maintenance of the infiltration system is reduced. Filter strips function as effective pre-treatment devices to minimize the influx of fine sediment into the infiltration system.

Opportunities to implement infiltration options are numerous in commercial, institutional and industrial development projects.

7.3.2.2 Detention Storage

Detention storage options are widely available within the context of a new development in areas that have the potential to store stormwater on a temporary basis and that are located well away from structures or other elements that require protection from flooding. Detention storage areas can be incorporated into landscaped buffers, ornamental landscapes, parking lots, parking lot islands and other soft landscaped areas. Detention storage areas may be planted with trees and shrubs or may be hard surfaced. Detention storage areas can be implemented in designated areas of parking lots, playing fields and other functional areas where nuisance flooding can be tolerated on a periodic basis.

Where playing fields are proposed to function as detention storage facilities care must be taken to ensure that public safety objectives are addressed. In addition to the provision of signage that identifies that the playing field may be subject to periodic flooding during and after storm events, care should be taken to ensure that multiple points of access and egress are available so that there is no possibility of user entrapment should flooding occur rapidly.

7.3.2.3 Filter Strips

Filter strips are a simple and effective means of achieving stormwater quality objectives. Filter strips are suitable for application on most sites and can be constructed to blend with the landform of the site. Typically filter strips are surfaced using turf grass, however, wildflowers, trees, shrubs or groundcovers are also suitable for use in this application. Filter strips on relatively flat slopes have been proven to remove TSS and nutrients with studies confirming that a filter strip with a width of 19m will remove approximately 90% of TSS in runoff.

7.3.2.4 Biofilters

Biofilters consist of below grade filtration systems that can be incorporated into most parking lot areas or commercial sites. Runoff is directed to the inlet of the system and is filtered through a granular or organic medium prior to discharge into the storm sewer system or infiltration into subsoil (refer to Figure 15.0). The surface of the biofilter can be landscaped using trees, shrubs and riverstone, or turf and integrated as an amenity within the overall landscape of the development. Biofilters can also be located beneath hard surface landscaped areas, such as courtyards, walkways and patios.

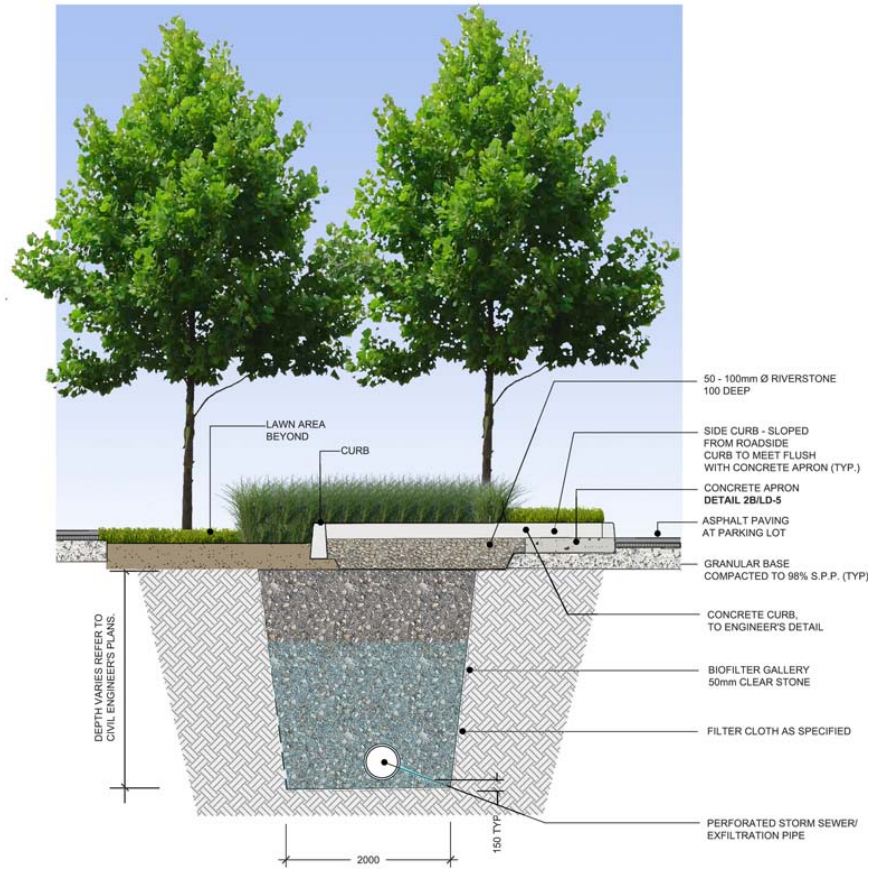


Figure 15: Biofilter Detail

7.3.2.5 Green Roofs

The use of roof top gardens or "green roofs" as a means to moderate the rate of runoff and enhance stormwater quality is a relatively recent innovation in North America. However, in Europe, and in Germany in particular, green roofs have been used for several decades as stormwater management initiatives.

Green roofs are designed to detain water in a lightweight medium that supports the vegetation community. Vegetation utilized in roof top gardens can include sod, groundcovers, trees and shrubs, although specific species selection is contingent upon soil depth anticipated soil moisture and loading limitations. Roof top gardens provide the additional benefit of the reduced requirement for energy to facilitate heating and cooling of the building and minimization of the urban heat island effect.

Green roofs can be implemented as both new and retrofit installations and should be considered as a viable at-source option to achieve stormwater objectives. The use of roof top gardens may result in the opportunity to reduce the size and scale of end-of-pipe facilities while achieving stormwater management targets.

Green roofs require minimal maintenance since stormwater is not subject to contamination by oils and sediments prior to interception, although periodic management of the vegetation community is required to mitigate colonization by undesirable species. Roof greening projects are gaining in popularity in Canada with several prominent

installations currently located on commercial buildings in the Greater Toronto Area. The provision of adequate irrigation is essential to the sustenance of most green roof systems. Rainwater harvesting and recycling should be considered as a potential irrigation water supply source

The advantages of source controls are similar to those identified for lot level solutions, however due to their larger scale and more limited distribution, source controls are easier to monitor, maintain and regulate to ensure efficient long-term performance. Opportunities to overcome constraints related to the implementation and maintenance of various source control techniques are discussed in Section 7.3.2.

Green Roof, Waterloo City Centre

7.3.2.6 Rainwater Harvesting

Rainwater is a resource that can be harvested and recycled for use in irrigation and to service building systems that do not require a potable water supply. Runoff from roof areas is best suited to collection and storage for re-use since roof runoff is relatively clean and free from contaminants such as chlorides that may inhibit plant growth and compromise the capillary action of soils. Rainwater harvesting systems are relatively simple and cost effective to implement, requiring the redirection of roof drainage systems to a cistern or battery of storage tanks. With respect to irrigation, storage volume should be determined based on the requirement to provide a precipitation rate of 25mm/week over the area to be irrigated. This is the minimum precipitation requirement to sustain vegetation growth during drought conditions in the Hamilton area. It is desirable for the system to be designed with the capacity to provide at least 2 weeks of water for irrigation purposes. It is also desirable to have an alternative water source plumbed into the system to ensure that a water supply is available during prolonged drought periods. Figure 16.0 provides an illustration of a rainwater harvesting / irrigation system.

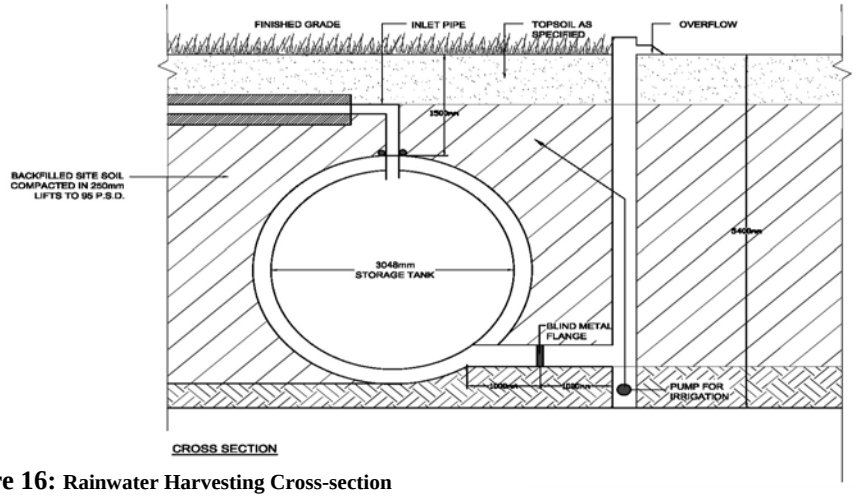


Figure 16: Rainwater Harvesting Cross-section

8.0 SITE-SPECIFIC GUIDELINES

This section sets out guidelines to direct the configuration of various types of stormwater management facilities with a specific focus on integrating ponds, wetlands and other types of nonstructural facilities into the landscape. The City of Hamilton has developed a set of details for each of the landscape treatments described within this section. In general, basic functional design configurations will be based on the criteria set out in the MOE Stormwater Management Design Manual, the City of Hamilton Stormwater Master Plan, and Criteria and Guidelines for Stormwater Management Infrastructure Design. However, to achieve City objectives, the following design guidelines are set out to direct facility configuration, landform, orientation, site design, and the design of specific components of various stormwater management facilities. This section sets out the following guidelines to direct the design of elements common to various types of stormwater management facilities:

Terraview Park SWM Pond Outlet - Toronto.

- ❑ landform and grading;
- ❑ orientation;
- ❑ planting;
- ❑ soil preparation;
- ❑ inlet structures;
- ❑ outlet structures;
- ❑ shoreline treatments;
- ❑ public safety; and
- ❑ maintenance.

Figures 19.0 and 20.0 illustrate conceptual landscape plans for two types of SWM facilities based upon the application of these guidelines.

8.1 GUIDELINES FOR COMMON ELEMENTS

This section provides guidelines to direct the design of elements that are common to various types of stormwater management facilities, including elements related to grading, planting and ensuring public safety.

8.1.1 Landform and Grading

Grading should be designed to reflect the landform character of the surrounding natural landscape (Refer to Figure 17.0). Planar grading with angular transitions and long stretches with standard slope gradients should be avoided (Refer to Figure 18.0).

8.1.2 Orientation

Orient wet ponds and wetlands with their longest axis aligned northwest to southeast, or alternatively, west to east to maximize opportunities to mitigate temperature increases through shading. Orientation should be carefully considered in situations where the stormwater management facility is a tributary to an existing or potential coldwater aquatic community (Refer to Figure 5.0 for a map of the City of Hamilton thermal regimes).

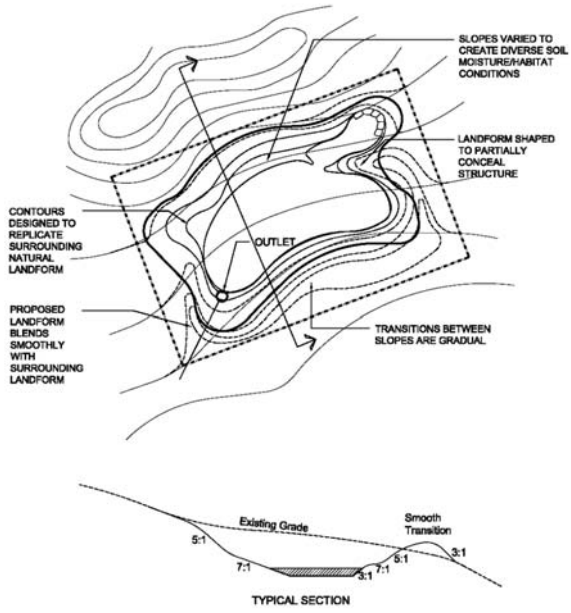


Figure 17: Landform Grading - Preferred Approach

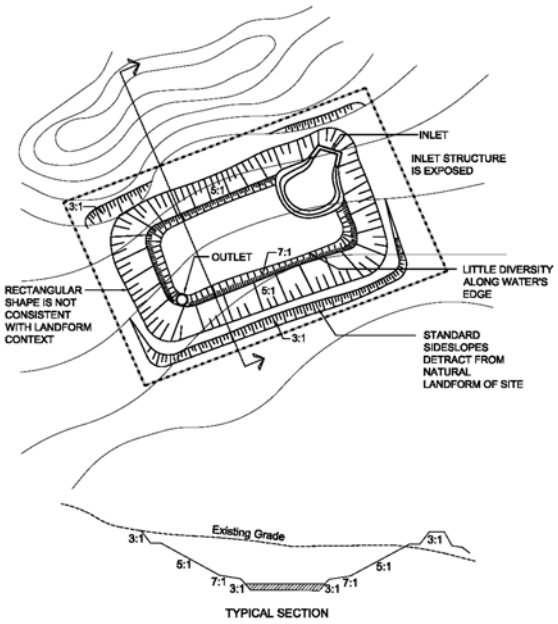


Figure18: Planar Grading Approach

8.1.3 Planting

Plant material is an integral functional component of stormwater management facilities, improving the overall performance of the facility while enhancing slope stability, mitigating public access, minimizing the extent of nuisance waterfowl colonization and contributing to the aesthetic appearance of the facility. In general, stormwater management facilities in the City of Hamilton should be designed with a focus on naturalization and a recognition that intensive vegetation maintenance should not be required to achieve long-term functional and aesthetic objectives. However, in special situations where a stormwater management facility is envisioned as a key focal point or feature in the urban context or as an integral component of a park, the City may, at its discretion, consider the approval of maintained turf areas and/or more formal landscape elements in the design of stormwater management facilities where appropriate. Similarly, where ponds front on streets, the landscape should be designed to integrate with the adjacent streetscape, adopting a more formal structure and employing materials of a complementary type and size. Planting designs for stormwater management facilities should be developed based on the following principles:

Plant material is an important functional component of stormwater management facilities.

- utilize native species indigenous to the bioregion;
- select plant species based upon an understanding of hardiness and habitat requirements, including soil type, soil chemistry, soil moisture, frequency of flooding and microclimatic conditions;

Figure 17: **Demonstration Plan – Hybrid Facility**

Figure 18: **Demonstration Plan – Wet Pond**

- select species in consideration of ancillary benefits, including provision of shelter and nesting habitat for birds and wildlife, potential as a source of food for species present in the area, or rooting characteristics to enhance slope stability or mitigate erosion;
- design plant communities to replicate natural associations with regard for natural successional processes;
- design planting plans with an appropriate mix of trees and shrubs as well as native perennials, wildflowers and aquatics to enhance biodiversity;
- utilize native grasses and wildflowers to restore all disturbed and degraded areas. The use of sod and turfgrass seed with a high percentage of non-native species and Kentucky Bluegrass is discouraged; and
- illustrate the extent of seeded areas as a component of the planting plan for the stormwater management facility. Refer to Appendix A for a list of recommended species for various soil moisture conditions.

Guidelines for the development of Planting Plans are provided below and lists of recommended plant species are provided in Appendix A. All landscaping and service infrastructure will be assumed at the same time by the City, and as such, a separate two-year warranty period for landscape elements is not applicable.

8.1.3.1 Guidelines: Planting Design

To achieve objectives related to pond performance, slope stability, public safety, management of nuisance waterfowl and aesthetics, planting plans for stormwater management ponds are to be developed in accordance with the following guidelines. To mitigate potential thermal impacts, planting design should be focused on maximizing shading through the installation of canopy trees along the south and west perimeters of the pond and along outlet channels.

A. Terrestrial Plantings

Plant areas above the permanent pool water level with a combination of trees and shrubs in accordance with the following requirements:

Plant Material Density

Required planting density for shrubs varies relative to the steepness of slope and was determined based on objectives related to slope stability, requirements for stability of the permanent pool and the need to expand the extent of vegetation cover. Table 4.0 sets out the required minimum densities for shrub plantings for various slope gradients.

Slope	Required Density	Plants / m²
5:1	25%	1
4:1	50%	2
3:1	100%	4

Table 4: Minimum Shrub Planting Density Requirements

Above the permanent pool perimeter and within the limits of the stormwater management pond block, tree density shall be a minimum of 5-7 trees per 100m². Plant species that have a tendency to spread or sucker should not be planted within 3.0 of adjacent property lines.

Plant Material Sizing

With the exception of bare root, live stake and transplanted stock, the following sets out the minimum required sizes of plant material stated in accordance with Canadian Nursery Trades Association Standards.

- deciduous trees – minimum caliper: 40mm
- coniferous trees – minimum height: 1.8m
- deciduous or coniferous shrubs: 0.6m height

However, variable age classes should be utilized to enhance the diversity of the landscape and avoid the establishment of even-aged community. Larger stock should be installed along shoreline areas to maximize the potential for shading with the objective of mitigating solar gain within ponds. In addition, where stormwater management facilities front on streets, the City requires that deciduous trees of a minimum caliper of 70mm to be utilized along the street frontages to complement the adjacent streetscape.

Shrub Material Spacing

Shrub material is typically installed in continuous beds; however, the required spacing for shrub material is contingent upon the proposed function of the planting within the landscape. Generally shrubs shall be planted at the densities stipulated in Table 4.0 above, at a ratio of approximately 5 shrubs per tree. However the following application-specific recommendations should be adhered to:

Barrier Planting

A minimum of two rows of thorn-bearing shrubs that extend 3.0m beyond the limit of the area of concern. A maximum spacing of 0.8m on centre with each row offset from the other.

Living Fences

In accordance with City of Hamilton detail. Refer to detail SW7 in Appendix B.

Planted Weirs

Continuous shrub planting with a spacing of 0.8m on centre across the width of the weir for the length of the crest.

Pond Perimeter

A continuous band of shrubs and aquatic plants with a minimum width of 3.0m, roughly centered on the permanent pool elevation must be achieved. Minimum plant spacing shall be 1.0m on centre.

Use of Bare Root, Live Stake, Harvested and Transplanted Stock

In addition to the container grown stock, there are a number of alternative methods of establishing the vegetation community that may be acceptable contingent upon site-specific conditions and seasonal timing of construction. The following sets out the requirements for utilizing alternative planting methods.

Bare Root Stock

The use of bare root material is acceptable during the early spring and fall planting seasons as stock becomes available from nursery sources. Bare root stock must be planted immediately upon delivery to the site. Where bare root stock is required to be replaced, it shall be replaced with container grown stock. Bare root stock and whip material are suitable for use in restoration and reforestation areas.

Live Stakes

Live stakes may be used to propagate a range of willow species, red osier dogwood and poplar. Live stakes must be installed immediately after harvesting or may be held in cold storage to extend the duration of the planting window. The source of the live stakes must be verified as consisting of native species prior to harvesting and sources should be

proximate to the site where possible. Live stake installations, as with all landscaping, will be required to be warranted until assumption by the City. Live stakes, which do not exhibit growth, shall be replaced on a one for one basis with bare root or container grown stock during the planting season immediately following the date of live stake installation.

Transplanted Stock

In some situations, native trees, shrubs or aquatic plant material may be available for harvest and transplantation for use in a pond or wetland. This approach is particularly effective in establishing aquatic communities. Harvest and transplantation operations shall be undertaken in accordance with the following requirements:

- the maximum size of trees to be transplanted within a stormwater management facility site is 200mm dbh (Diameter Breast Height);
- invasive species are not appropriate for transplantation or salvage (refer to Appendix A for a list of species that are considered to be invasive within the City of Hamilton area);
- species of vegetation proposed for transplantation should be confirmed at the source as native and free from invasive alien species both within the primary community and in the understorey;
- plant material proposed to be relocated shall be confirmed as free from pests and disease;
- plant material shall be transplanted in the appropriate season, with equipment of suitable size and in accordance with approved horticultural practices; and
- transplanted material will be subject to the City's assumption process. Transplanted vegetation that does not survive shall be replaced with nursery grown stock of similar species in accordance with the minimum sizes specified above.

Seeding

All disturbed areas are to be seeded with a mixture of native grasses, wildflowers and groundcovers, dependent upon moisture conditions. No noxious weeds are to be seeded in as per the City's By-Law. Refer to the seed species lists provided in Appendix A. Seed should be installed with straw mulch at a rate of 4 tonnes/hectare to a depth of 25-50mm and an appropriate nurse crop such as annual oats or winter rye to ensure rapid establishment and stabilization of the site. Seeding operations should be undertaken when soil and meteorological conditions are appropriate (Refer to Section 8.1.4 for recommended timing windows). Seeded areas must be prepared with a minimum 100mm of topsoil and scarified prior to seeding. Apply seed in accordance with manufacturer's recommendations related to rate, depth of cover and mulch. Uniform cover over seeded areas must be achieved and evidence of germination of a minimum of 60% of the species comprising the mix must be confirmed prior to assumption.

Seed Banks

Seed banks are comprised of soil and vegetation harvested on a site. The seed bank contains the roots and shoots of vegetation which, once spread over the site, begin to regenerate, quickly establishing cover. The technique is particularly effective in establishing emergent species such as cattails. Guidelines for seed bank harvest and re-use are as follows:

- use local and on-site seed bank material from areas that are proposed to be disturbed. Note that material situated in roadside ditches is not appropriate for re-use as seedbank;
- assess potential seed bank sources to ensure they do not contain invasive, undesirable species, plant material should consist of native, non-invasive species;
- seed bank material must not be stockpiled for a period of more than 4 weeks;

- maintain stockpiled seed bank in moist condition;
- do not compact seed bank material during placement;
- spread seed bank material to a minimum depth of 150mm; and
- overseed mulch and irrigate after placement.

B. Aquatic Plantings

Plant areas below the permanent pool water level with emergent, submergent and strand species around the perimeter of the permanent pool, in pond facilities, and throughout the areas of the basin in wetland facilities.

Plant Material Density

The proposed aquatic plant community should be comprised of a minimum of 4 species including at least 1 submergent, or floating leaved species and at least 1 robust/broad leaved species. Aquatic plants are to be installed at the spacing specified below:

- Wet Pond
  A minimum 1.5m band around the perimeter of the permanent pool and forebay with an average spacing 0.5-1.0m on centre.

- Wetland
  Throughout wetland basin, below the permanent pool elevation to a depth of 0.75m with an average spacing of 0.5-1.0m on centre.

Planting Techniques

Aquatic plants may be installed as nursery grown plugs or transplanted stock. The species composition and health of harvested stock for transplantation must be verified at the source. Stocks collected in areas where invasive species such as Purple Loosestrife are present are not acceptable as a source for transplantation. Aquatic plant material shall be subject to the City's assumption criteria.

8.1.4 Recommended Planting Windows

With the objective of optimizing the rate of survival of the various types of plant material proposed to be utilized in the landscaping of stormwater management facilities, it is important that plant material be installed during the appropriate season and timing window. The following planting windows are recommended:

a) Trees and Shrubs

i. Bare root stock:
Recommended installation windows:
- Spring: from mid-April to mid-May, before bud break
- Fall: approximately 2-3 weeks after leaf drop

ii. Container grown, potted or balled and burlapped stock:
Recommended installation windows:
- mid-April to mid-September

iii. Transplanted stock:
Recommended installation windows:
- Deciduous trees: Fall – after leaf drop or Spring and prior to leaf out
- Coniferous trees: Spring

b) Seed Mixes

Optimal seeding period for dormant wildflower seed is May 15 to June 15. Optimal seeding period for dormant native grass seed is October 15 to November 15 for spring establishment.

8.1.5 Soil Preparation

Proper soil preparation is fundamental to the successful germination and establishment of seed mixes and plantings. With the objective of ensuring that soil conditions will be conducive to support plant growth, the following requirements should be adhered to:

- Topsoil should be stripped off of the site prior to grading works. The stripped topsoil should be stockpiled on site away from creeks and ponds. Silt fencing or equivalent should be erected around the topsoil pile to prevent sediment-laden runoff from reaching watercourses and other ecologically sensitive areas. Sediment control initiatives should be implemented in accordance with City and Conservation Authority requirement;
- Dress all areas of the stormwater management block that are proposed to be seeded or planted with topsoil that has been verified as suitable to support plant growth. Where, upon inspection during the construction or warranty periods, it is evident that seed establishment or plant growth may be inhibited by poor soil quality or compaction, the City of Hamilton may require the replacement or augmentation of topsoil to achieve satisfactory growth requirements;
- Topsoil shall be loose and friable. Topsoil should have a high organic content and should be comprised predominantly of loam. In situ topsoil should be tested for texture, organic content and nutrients and amended or augmented as necessary to optimize plant growth. Where required, subsoiling, scarification or tilling may be necessary to achieve appropriate soil density;
- Topsoil shall be placed to the following minimum depths for various plant communities above the permanent pool water level:
  - seeded areas – minimum depth of 450mm;
  - shrub planting areas – minimum depth of 600mm;
  - tree planting areas – minimum depth of 1000mm; and
  - aquatic planting areas – minimum depth of 300mm for the first 1.0m below the permanent water level around the perimeter of the pond.
- Where the establishment of plant communities with unique soil chemistry, drainage or fertility requirements is necessary, the proposed soil mix shall be specified and the extent of area to be spread with the soil mix is to be indicated on the landscape plan; and
- Care should be taken to ensure that topsoil is not contaminated with the seed bank of non-native and invasive species.

The suitability of both subsoil and topsoil related to both compaction and composition should be reviewed by the design engineer and landscape architect prior to initiation of planting. Careful consideration should be given to the specification of soil mixtures that are appropriate to support the desired plant community to ensure the survival, long-term sustainability and desirable succession of the vegetation community within the stormwater management facility.

8.1.6 Inlet Structures

Two alternative approaches may be adopted to facilitate the design of inlet structures:

1. Inlet structures designed as discrete elements within the overall design of the pond.

. . . or . . .

2. Inlet structures designed as features within the overall design of the pond.

In all cases, inlet structures should employ a plunge pool as a means to dissipate energy and moderate the velocity of stormwater entering the facility rather than chute blocks, gabion mats, rip rap or poured concrete spillways.

The minimum depth of standing water in plunge pools is to be 1.5m. The water level should be maintained using a riverstone control weir. Plunge pools should be lined with riverstone 300mm deep. Riverstone size gradations should be determined based upon anticipated discharge velocities.

i. Design Recommendations for Concealing Inlet Structures

For stormwater management facilities that are proposed as an extension of a natural system, the landscape design should be focused on concealing the inlet structure from view. The following recommendations to achieve this objective are provided:

Terraview Park - Toronto. Inlet structures can be designed to be completely concealed from view.

- locate inlet structures back from the edge of the pond, with the connection to the pond following a narrow embayment or connecting channel;
- where an inlet structure must be located at the pond edge, topography should be sculpted to conceal the structure behind an overlapping land form with extensive planting;
- utilize planted fieldstone to construct wing walls, conceal concrete headwalls and mitigate erosion; and
- in situations where the installation of a barrier is required to provide fall protection, a 1.2m black vinyl coated chainlink fence or OPSD handrails coated with black epoxy should be used. Extensive coniferous planting should be installed to conceal fences and barriers.

ii. Design Recommendations to Integrate Inlet Structures as Landscape Amenities

For facilities proposed in an urban context, the opportunity is presented to design the inlet structure as a key element in the overall landscape through the application of the following:

- consider the relationship between the maintenance access route/trail system and the location of the proposed inlet structure to identify opportunities to position the inlet structure as a node along the trail system or at the terminus of a walkway leading into the facility; and
- design the inlet structure as an overlook, seating area, interpretive station or outdoor classroom (in the event that the pond is in close proximity to a school site).

Refer to Figure 21.0 for an example of inlet structures designed as features in the landscape. Regardless of the design approach adopted, inlet structures should be served by maintenance access routes to facilitate inspection, debris removal and periodic cleaning.

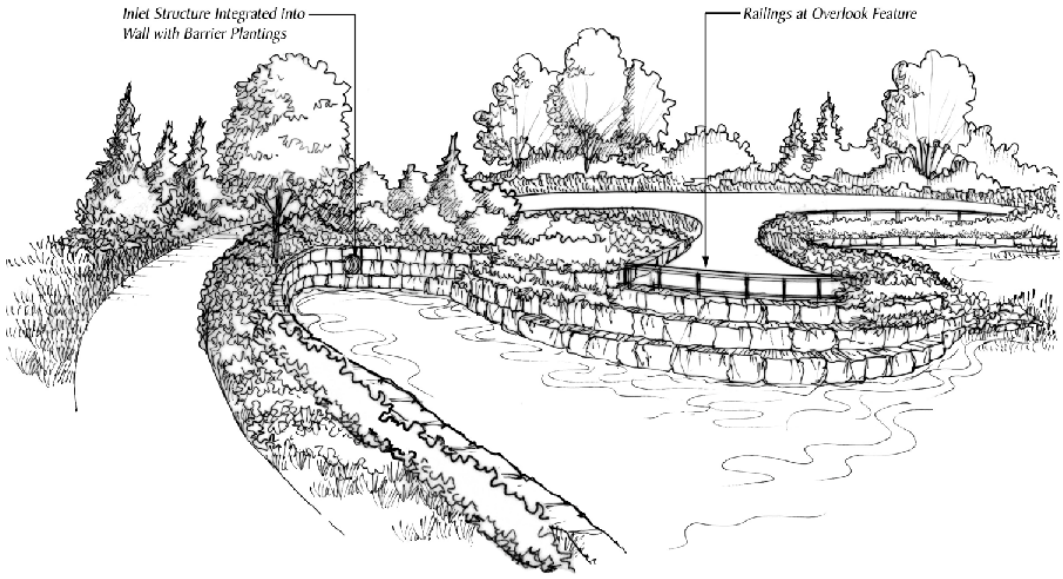


Figure 19: Inlet Structure with Overlook

8.1.7 Outlet Structures

Design outlet structures to achieve water quality and quantity control objectives as well as ecological targets in the receiving watercourse and downstream watershed. In response, designs should be developed in consideration of a range of parameters beyond those related to the regulation of flows discharged from the stormwater management facility, including the following:

- aquatic habitat and fish community targets for the receiving watercourse and sub-watershed:
  - outlet structures must be designed at a minimum to achieve objectives related to water temperature (see Figure 4.0 for coldwater communities).

- watercourse stability and fluvial geomorphological characteristics:
  - outlet structures should be designed, located and oriented based on an understanding of fluvial characteristics of the receiving watercourse to ensure that the installation of the outlet and flows generated do not result in erosion, increased instability or alteration to channel morphology; and
  - if outlet structures are to be placed within environmentally sensitive sites, then the placement and design of such structures should be determined through a site meeting held prior to submission of the engineering drawings.

- groundwater interflow and discharge patterns:
  - groundwater interflow and discharge patterns should be considered in the design process to ensure that groundwater movement to existing discharge areas is not interrupted, as well as to identify opportunities to enhance groundwater discharge where it is appropriate.

- ecological influences:

- influences on adjacent vegetation communities and ecosystems should be understood to ensure that the implementation of outlet structures does not impact adjacent habitats.

8.1.7.1 Alternative Outlet Designs

There is a potential for thermal impacts to occur as a result of increases in the temperature of water attenuated in stormwater management ponds. Consequently, it is important that ponds be designed with the objective of mitigating downstream impacts through the innovative design of the outlet system. Stormwater management facilities that are tributary to first order streams, streams that support coldwater species or streams that are targeted to support coldwater communities are to be fitted with outlet structures that are designed to achieve water temperature targets. The following alternative outlet designs should be considered to mitigate potential thermal impacts. Table 5 demonstrates the functional benefits of optional outlet types and Table 6 shows the suitability of optional outlet types to specific site characteristics.

Plant Material and siting contribute to the concealment of outlet structures.

8.1.7.2 Bottom Draw Outlets

Reductions in the temperature of water discharged from stormwater management ponds, wetland and hybrid facilities can be achieved through the implementation of a bottom draw outlet. To be effective, bottom draw outlets must discharge water from a depth in excess of 2.0m below the normal water level. Deeper outlet depths are desirable, however at greater depths the potential for water to become anoxic increases. Consequently, with very deep outlets, provision should be made to re-aerate water prior to discharge into the receiving watercourse. Cascades, drop structures or mechanical aerating devices such as fountains or bubblers can be used for this purpose. The effectiveness of bottom draw outlets is contingent upon a number of factors including depth of intake, volume and size of permanent pool, duration of detention, ambient temperature and temporal factors.

8.1.7.3 Contact Cooling Trenches

Contact cooling trenches are designed to be located downstream of the pond outlet discharging cooled water to the watercourse downstream. The required dimensions of the trench are determined by:

- facility size;
- release rates;
- temperature of water discharged from the facility;
- downstream temperature targets; and
- distance from the receiving watercourse.

Cooling trenches are constructed at the pond outlet and are typically comprised of a stone filled trench buried below ground. Prolonged contact with the stone media results in a transfer of heat from the water to the stone, effectively reducing the temperature of water discharged at the outlet of the trench. Refer to Figure 22. It is preferred that the cooling trench have multiple outlets with the objective of replicating natural pattern of discharge to the downstream watercourse where predevelopment groundwater inflow patterns result in discharge along a length of the bank of a watercourse.

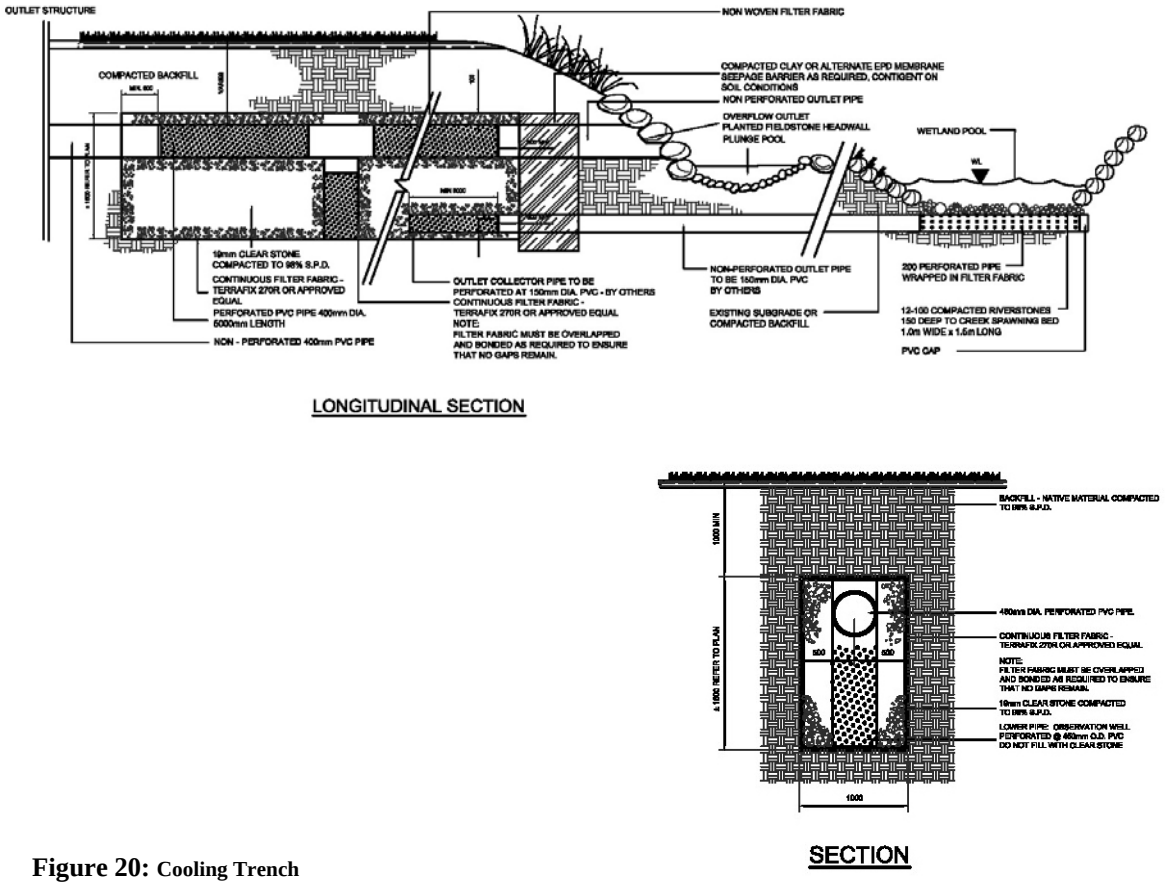


Figure 20: **Cooling Trench**

8.1.7.4 Seepage Outlets

Seepage outlets are designed to achieve temperature reduction objectives through three processes:

- heat transfer with filter medium (similar to the contact cooling trench);
- gradual discharge to densely shaded, well vegetated buffer strips; and
- provision of groundwater recharge and discharge to the watercourse through subsurface interflow.

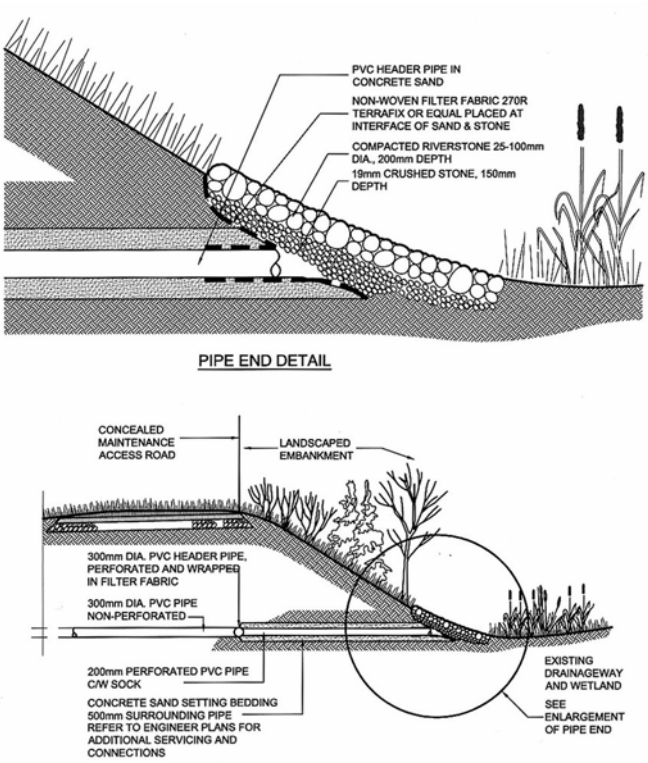


Figure 21: **Seepage Outlet**

Seepage outlets are designed to be situated downstream of the facility outlet and are comprised of the following components:

- a header pipe that feeds a set of small diameter, clear stone or coarse sand filled outlet pipes;
- outlet pipes are spaced apart and are configured to discharge into existing depressions, drainage ways or areas of permeable soil that are set back from the edge of the watercourse;
- clean-outs for each header pipe and outlet pipe to facilitate flushing; and
- a bypass outlet to ensure that the function of the facility is not affected should the function of the seepage outlet system be compromised over time.

The system should be designed with a degree of redundancy to compensate for potential blockage or reduced rates of discharge from one or more of the outlet pipes that may result from the penetration of root systems or other factors. (Refer to Figure 23)

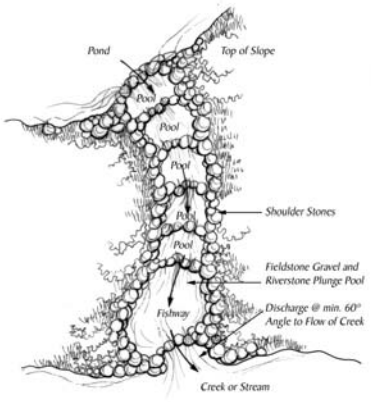


Figure 22: **Stepped Pool Outlet**

8.1.7.5 Outlet Channels

Long, narrow, well-vegetated outlet channels have proven to be effective in mitigating temperature increases through shading, transferring heat to substrate and by encouraging infiltration. Outlet channels should be designed:

- to replicate natural channels in appearance and function;
- as narrow tributaries with width to depth ratios approaching 1:1, contingent upon gradient and conveyance parameters;
- to have a gentle gradient to maximize contact time. Channels should be lined with clear stone substrate with a minimum depth of 200mm; and
- with a continuous band of woody riparian vegetation with a minimum width of 3.0m along each side of the outlet channel to facilitate shading and enhance stream stability. Species such as eastern white cedar and red osier dogwood should be planted in combination with fast-growing riparian pioneer species such as poplar, as well as longer lived, large canopy species such as red maple and hemlock.

(Refer to Figure 24 for an example of Stepped Pool Outlet)

Functional Benefits / Outlet Type	Temperature Mitigation	Water Quality Enhancement	Infiltration	Flow Moderation	Indirect Aquatic Habitat Contribution Downstream	Direct Habitat Contribution	Base flow Augmentation
Bottom Draw Outlet	◑	○	○	○	○	○	○
Contact Cooling Trench	●	●	●	●	●	○	●
Seepage Outlet	●	◑	○	◑	◑	◑	◑
Outlet Channel	◑	◑	○	◑	◑	◑	○
Vegetated Spreader Swale	○	●	◑	●	○	○	◑
Upwelling Outlet	●	◑	◑	◑	●	●	◑
Linear Wetland	◑	●	◑	●	●	◑	●

Table 5: **Functional Benefits of Optional Outlet Types**

● Achieves the Functional Benefit
◑ Partially Achieves the Functional Benefit
○ Does not Achieve the Functional Benefit

Site Characteristics / Outlet Type	Permeable Soils	Flat Topography	Sensitive Downstream Watercourse (Stability)	Sensitive Downstream Habitat	Downstream Coldwater Fishery	Baseflow Augmentation	Steep Topography	Wetland Community Downstream
Bottom Draw Outlet					✓		✓	
Contact Cooling Trench	✓	✓	✓	✓	✓	✓	✓	✓
Seepage Outlet			✓	✓	✓	✓		✓
Outlet Channel		✓	✓	✓		✓		
Vegetated Spreader Swale	✓		✓	✓			✓	
Upwelling Outlet			✓	✓	✓	✓		✓
Linear Wetland		✓	✓	✓	✓	✓		✓

Table 6: **Suitability of Optional Outlet Types to Specific Site Characteristics**

8.1.7.6 Vegetated Spreader Swales

In situations where the stormwater management facility is located adjacent to an existing vegetated area with high soil moisture conditions or a shallow water table, a spreader swale is an effective tool to filter runoff by distributing stormwater over a broad vegetated area (see Figure 25.0). The spreader swale also provides additional benefits related to water quality improvement and moderation of discharge rates. The configuration and design of spreader swales are determined in large part by existing site parameters including:

- topography;
- soil composition; and
- Vegetation community composition.

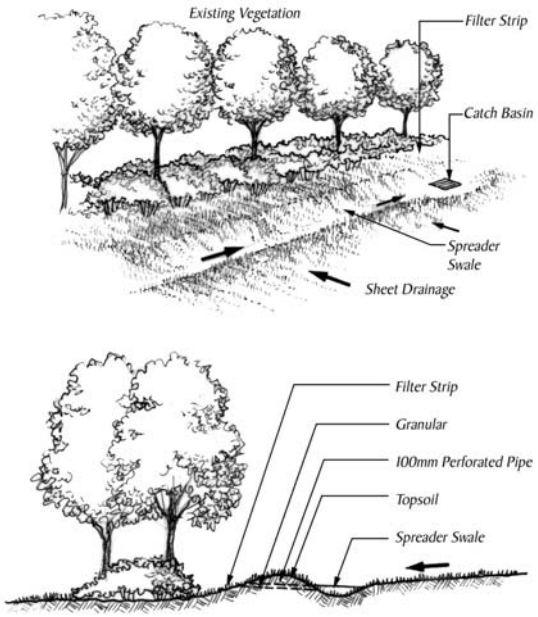


Figure 23: **Vegetated Spreader Swale**

The spreader swale should be planted continuously along its length for a distance extending a minimum of 3.0m from the crest of the swale on all sides to ensure stability and to create dense shade. An overflow outlet or bypass must be incorporated into the design of the spreader swale to ensure that flows do not exceed the conveyance capacity of the level spreader, which would in turn result in rilling and erosion within the adjacent vegetated filter area.

8.1.7.7 Upwelling Outlets

Upwelling outlets are designed to achieve temperature mitigation objectives while enhancing fish habitat by establishing spawning areas for salmonid species such as brook trout. Upwelling outlets are designed to discharge water beneath the substrate of the receiving watercourse. Like the seepage outlet system, a header pipe is linked to a series of outlet pipes, which are designed to distribute flow to various strategically located areas within the receiving watercourse. Typically, pool areas are preferred. Each outlet pipe is terminated in a clear stone bed and its outlet is installed below the invert of the existing watercourse and covered with appropriately sized gravel and cobble to create a discharge upwelling area. The feasibility of implementing upwelling outlets is determined by a number of considerations including:

Headwaters Park Naturalized Swale

- stability and morphology of the receiving watercourse;
- existing fish community characteristics and species targets;
- availability of suitable locations for upwelling outlets related to both stream morphology and the ability to achieve habitat enhancement objectives;
- potential for impact on the existing environment, including riparian vegetation community and fish habitat, which may result from the construction of the upwelling areas; and
- difference in elevation between the stormwater management facility and the proposed upwelling area functions as intended.

As well as the above, it is essential that water discharged from the stormwater management facility through the upwelling area be of adequate quality and temperature to ensure that aquatic habitat benefits are achieved (refer to Figure 6.0 for the location of coldwater aquatic communities in the City of Hamilton).

8.1.7.8 Linear Wetlands

Linear wetlands can be constructed downstream of the outlet from a SWMF to further enhance water quality, moderate flows and mitigate water temperature impacts. Linear wetlands should be required as a series of terraced cells separated by level spreader weirs in order to reduce the potential for the eventual formation of a refined channel within the wetland. Linear wetlands should be heavily planted to increase shade cover and should

be designed to incorporate a diverse palate of plant species selected for their ability to withstand the water level fluctuations and flow velocities anticipated to occur downstream of the outlet. Linear wetlands constructed downstream of SWMFs should not be located outside of the buffer established around an adjacent natural wetland or other natural heritage feature.

8.1.7.9 Thermal Impact Mitigation

By design, stormwater management ponds and wetlands attenuate stormwater for controlled release over a prescribed duration of time. During this attenuation period, particularly during the summer months, water within these facilities is subject to warming. This situation can result in discharges of warm water from the pond into the receiving watercourse or waterbody. Warm water discharges can impact the health and productivity of downstream aquatic habitat, particularly if the receiving watercourse supports a cold water aquatic community. Thermal impacts can be mitigated in part through the configuration and design of the SWM facility in terms of orientation, width to length ratio, and the planting of shade casting trees around the perimeter of the pond as described in previous sections of this document.

To further mitigate thermal impacts, outlet structures that are designed specifically to cool water discharged from SWM facilities can be implemented. Specific examples of outlet designs for thermal impact mitigation include contact cooling trenches, heavily vegetated swales and bottom draw outlet structures. Operationally, selectively timed release of attenuated water can be implemented with discharges managed to occur only during the late night or early morning hours.

Ponds and outlet structures should be designed to minimize thermal impacts, particularly when the habitat for the receiving watercourse is targeted to support cold water species.

8.1.8 Shoreline Treatments

Shoreline areas around stormwater management ponds require special consideration to address the influences of fluctuating water levels while achieving objectives related to public safety, nuisance waterfowl deterrence and enhancement of the performance of the facility. The establishment of a minimum 3.0 wide community of dense, moisture tolerant vegetation around the entire perimeter of the pond is the key to achieving these objectives. Minimum requirements for a relatively flat terrace with a gradient of 7:1 are set out in Table 8.0. However, landform and grading variations within this minimum standard are permitted to enhance shoreline stability, deter nuisance waterfowl colonization, moderate temperature increases and improve the overall appearance of the facility.

8.1.9 Waterfowl Deterrence

Habitat modification is the most practical approach to manage nuisance waterfowl, since this approach requires a reduced commitment of resources on an ongoing basis and can largely be addressed in the process of designing the shoreline areas of stormwater management facilities. Accordingly, shoreline areas should be designed based upon the following guidelines:

- shoreline areas should be undulating and non-uniform to encourage colonization by a range of vegetation types. This will limit access, constrain movement and obscure views of potential predators;
- a minimum 3.0m wide bank of continuous, dense, low branching, woody vegetation should be established around the entire perimeter of the pond. This will constrain goose

movement and obscure sightlines while limiting public access, providing additional shade and enhancing stability;

- in situations where a more formal pond edge is desired to achieve aesthetic or urban design objectives, an alternative shoreline treatment is comprised of stacked boulders with a minimum diameter of 600mm and a minimum vertical installation height of 450mm. Where views are desirable, shoreline areas should be planted with a minimum 6.0m wide band of wildflowers or native meadow grasses. Under no circumstances should areas immediately adjacent to the water's edge consist of maintained turf grass;
- in ponds with an open water area of less than 0.25ha, the planting plan for the shoreline area should be developed with the objective of establishing a continuous tree canopy around the perimeter of the pond to obstruct flight paths and deter geese from landing on the pond. An angle of ascent from the water's edge of greater than 13 degrees is required to impede flight;
- below normal water level, the 7:1 terrace should be planted with emergent species to enhance stability and impede waterfowl movement and sightline to potential predators; and
- plant material for shoreline areas should be determined with a recognition of anticipated water level fluctuations and soil moisture regimes.

Dense communities of moisture-tolerant vegetation are key to achieving water quality

Refer to Appendix A for a comprehensive list of plant material recommended for use in shoreline areas to achieve public safety, stability, water quality enhancement and nuisance waterfowl management objectives.

8.1.10 Public Safety

The installation of full fencing around the perimeter of the pond block to deter public access eliminates the potential to achieve recreational and interpretive objectives that will benefit of the community. Although it is recognized that permanent pools and fluctuating water levels are potential drowning hazards, risk can be minimized through the implementation of design techniques that are focused on mitigating access to specific hazard areas.

Blocks reserved for stormwater management facilities must be of adequate size to ensure that side slopes do not exceed the allowable maximum slopes and that safe public access can be achieved. The following guidelines are set out to address public safety objectives at the site-specific scale:

8.1.10.1 Fencing

- Fencing of the entire perimeter of stormwater management facilities is discouraged;
- 1.5m high black-vinyl-coated chainlink fencing should be installed along the property line where the stormwater management facility block abuts private property, and it should be continuous with no gates permitted. The fence should be located at an offset distance of 0.15m from the property line within the stormwater management block, and chainlink mesh should be affixed to the stormwater management facility side of the posts and rails;
- Fencing is not required along the property line where a stormwater management facility abuts a public park, open space, natural area, or road right-of-way. No gates are permitted with the objective of saving the perimeter of the site where it abuts private property;
- Subject to the approval of the adjacent landowners and the City of Hamilton, a "Living Fence" with boundary delineation markers may be substituted for chainlink fencing where stormwater management facilities abut commercial, industrial, institutional or high density residential land uses; and
- Safety barriers are to be installed along the top edge of headwalls, retaining walls and other structures where the change in vertical elevation exceeds 600mm in height.

Headwaters Park - Richmond Hill. Risk can be minimized through the application of design techniques to mitigate access to hazard areas

8.1.10.2 Signage

Install identification signage in a prominent location along the municipal road frontage or in an appropriate location along the interface between the pond block and the adjacent open space or park block. Signage will indicate the following:

- the name of the pond or facility, and its street address or location within the context of the park and open space system; and
- the City of Hamilton nameplate and logo

The purpose of the signage is to identify the site as a stormwater management facility and establish a reference name and location in the event that a situation arises where emergency maintenance or assistance is required.

- Public Awareness Signage should be erected at the entrances to the pond block or maintenance access route at prominent locations that are highly visible to the public. The purpose of this signage is to identify the site as a stormwater management facility and raise public awareness of the functional aspects and related hazards of the facility.

- Public Awareness Signage should include the following:
  - the name of the facility; and
  - a plan illustration of the facility that identifies the following:
    - the location of inlet and outlet structures;
    - the general configuration of water flow;
    - the key components of the facility i.e. sediment forebay, wet pond, wetland, etc.;
    - the depth of the permanent pools, wetlands etc. under normal conditions;
    - the depths of pools, etc. under high water conditions; and
    - the location of the high water mark around the perimeter of the facility and a description of high water mark indicators.
    - a statement that identities the site as a natural landscape that is not intended to be mown.

- For wetland and wet pond facilities Public Awareness Signage must also include the following statement:

  "Stormwater Management Facility

  This facility has permanent pools of deep water.
  Water levels may increase rapidly during storm events.
  Stormwater is collected in this facility and released slowly over several hours.
  This facility is NOT designed or intended for recreational use.
  Swimming and skating are prohibited."

  In addition, signs should include:

- universal symbols to convey "No Skating" and "No Swimming".
- the telephone number for contacts at City of Hamilton to address maintenance emergencies;
- the telephone number for emergency assistance in the event of an accident; and
- City of Hamilton nameplate and logo.

Public awareness signages are to be installed at each point of public access into the stormwater management pond block.

8.1.10.3 High Water Level Indicators

High water level indicators are required around the perimeter of the detention or retention facilities to make the public aware of the extent of area subject to inundation during storm events. High water indicators should include the following:

- strategically located trees of a specific species;
- boulder clusters;
- permanent markings on headwalls; and

- 150mm diameter cedar posts installed to a depth of 900mm and protruding above ground to a height of 900mm.

High water indicators should be spaced at a maximum spacing of 30.0m around the perimeter of the pond or wetland.

8.1.10.4 Barrier Plantings

Barrier plantings are to be used to deter public access to inlets, outlets and outfalls, plunge pools and deep water areas (see Figure 26.0). Refer to Section 8.1.3 for recommendations related to barrier planting density, species composition and configuration.

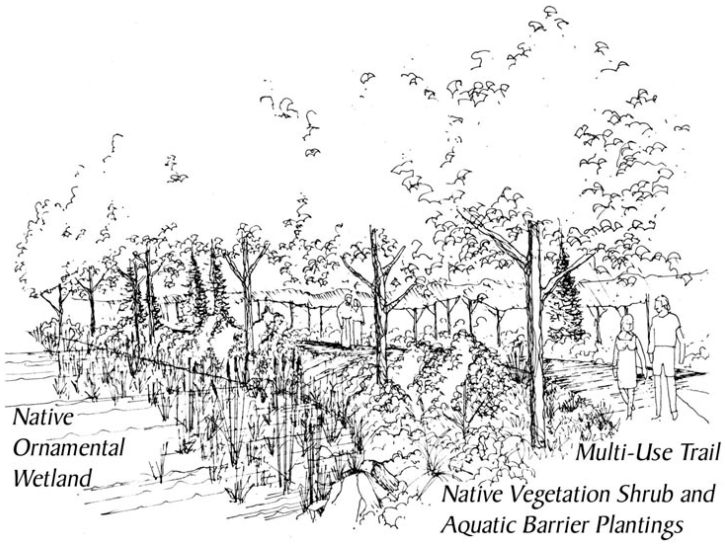


Figure 24: Barrier Planting

8.1.11 Provisions for Maintenance

Regular maintenance is critical to ensure the long-term performance of stormwater management facilities. Routine maintenance, such as litter removal, as well as more extensive long-term maintenance, including sediment removal from wet pond facilities and repair or replacement of flow control structures, should be accommodated in the planning and design processes.

8.1.11.1 Maintenance Access Routes

Access routes for maintenance vehicles shall be provided to inlet and outlet structures and the base of sediment forebays. Maintenance access routes should provide unimpeded access from the adjacent municipal road right-of-way and should be aligned to avoid overland flow routes. Minimum roadway dimensions are set out in the document entitled "Criteria and Guidelines for Stormwater Management Infrastructure Design" (Draft 2007).

Two options are available for the road surface contingent upon the situation of the maintenance access route in the context of the overall facility landscape.

i. Concealed Maintenance Access Route

Where the location and alignment of a maintenance access route does not correspond with a logical recreational trail connection, the surface treatment should be designed to blend into the existing natural landscape.

- surface treatment: 75mm of granular, overlain by a surface layer comprised of limestone screenings mixed with free draining topsoil, with a minimum depth of 500mm with a sub-base of 200mm or greater contingent on sub-soil conditions and load bearing requirements;
- surface to be seeded and mulched. Refer to Appendix A for the recommended seed mixes for maintenance access routes; and
- alignment to be demarcated using boulders placed along both edges of the route with a minimum spacing of 15.0m in an alternating pattern or trees planted at a 1.5m offset from the edge of the route. Demarcation trees should be of a consistent species to aid in identification of the route.

ii. Hybrid Trail / Maintenance Access

Where a maintenance access route is intended to form part of a trail network, the hybrid trail design should be utilized.

- base: 50mm crusher run limestone with a minimum depth of base of 200mm or greater as required to support the City's maintenance vehicles while addressing site specific soil conditions based on the recommendations of a geotechnical engineer;
- surface treatment: 75mm of granular overlaid with a combination of 50mm of either clear limestone screenings, to create the trail component, or limestone screenings mixed with sandy topsoil, to conceal the remainder of the roadway; and
- width of the trail portion should be 2.4m, aligned along the edge of the roadway nearest to the pond or wetland. The edge of the concealed portion of the roadway will be demarcated as described in the previous section.

iii. High Use / Urban Trail

For ponds that are situated in a more urban context or where high levels of trail use are anticipated, a trail should be designed according to the following:

- surface treatment: asphalt or another appropriate hard surface material as required by the City of Hamilton. Trails that are identified in the Community Landscape Concept Plan; and
- major linkages in the community wide trail network must be designed in accordance with the requirements of the Public Works Barrier Free Guidelines, with gradients that do not exceed 5% on multi-use trails and other barrier free access initiatives implemented as required based on site-specific conditions to ensure that the objectives of the Barrier Free Guidelines are achieved.

8.1.11.2 Vehicle Access Barriers

Where maintenance access routes and trails intersect road rights-of-way, barriers are required to restrict unauthorized vehicular access to the facility. Barriers are to be implemented in accordance with the following:

removable metal bollards should be installed;

- maximum spacing of 1.5m;
- where vehicle access is required for maintenance purposes, fixed bollards should be installed at 3.0m apart with a removable bollard installed at the mid-point between the two (at 1.5m from each fixed bollard); and
- boulders and plantings in strategic locations across the frontage of the facility block to discourage off-road access or skirting around the bollards.

Headwater Park – Richmond Hill. This maintenance access route also provides opportunities for the public to overlook the facility (portions of the railing are removable).

8.1.11.3 Provision for Algae Control

Excessive algae growth can be a problem in some SWMFs, particularly in catchment areas subject to high nutrient loads. Excessive algae growth can compromise the quality of water within the pond as well as the functional effectiveness of the pond. Algae can clog outlet structures and can render a pond unsightly. Dead and decaying algae can yield an odour which is offensive to neighbouring residents. To control algae growth, barley straw bags should be installed around the perimeter of the pond prior to commissioning. In the process of decomposition, barley straw releases a chemical that is converted to hydrogen peroxide in the presence of sunlight. Low levels of hydrogen peroxide inhibit the rate of growth of algae but will not harm fish or other aquatic plants. It is important to note that hydrogen peroxide does not eliminate existing algae but does inhibit the growth of new algae. Ten kilograms of barley straw is required for each 1,000m² of pond surface area. The straw should be distributed at a minimum rate of 3kg/bag. The bags are to be installed off shore of the pond edge and anchored with concrete blocks. Fresh barley straw bags are to be installed in the pond in the spring of each of the two years prior to assumption and finally upon assumption of the facility.

9.0 SUBMISSION AND APPROVALS REQUIREMENTS

9.1 PLANS OF SUBDIVISION

9.1.1 Community Landscape Concept Plans / Landscape Feasibility Statement

In order for draft plan approval for a proposed subdivision to be granted, the City of Hamilton must be satisfied that the lot fabric and location, and the configuration and sizing of blocks designated for stormwater management purposes is adequate. As a result, the City requires that an engineering feasibility study be submitted to provide the rationale for the location and sizing of blocks designated to accommodate stormwater management facilities. In addition, at this stage in the planning process, a Community Landscape Concept Plan is to be prepared as a product of the process of refining the Parks and Open Space Master Plan. As a component of this plan, the preliminary design of proposed stormwater management facilities must be illustrated, including location of inlet and outlet structures, general approach to planting, linkages to the adjacent community and treatment of the interface with adjacent natural heritage features. At this stage in the process the size of blocks to accommodate stormwater management facilities should be reconfirmed to ensure that all of the guidelines set out by the City of Hamilton have been implemented. A landscape feasibility statement is to be provided that describes how the proposed plan of subdivision and landscape concept plans meets the intent of the City's Landscape Design Guidelines. It is important that factors such as existing topography and proximity to existing natural heritage features that are designated to be protected are considered in the assessment of the adequacy of block size.

9.1.2 Landscape Drawings

Once the Community Landscape Concept Plan has been reviewed and approved by the City of Hamilton, the preparation of Landscape Drawings for stormwater management facilities can be initiated in conjunction with the development of the Engineering Drawing set. It should also be noted that the Landscape Drawings along with the Engineering Drawings are to be submitted to the City's Public Works Department in accordance with the City's submission requirements. Once received, the landscape drawing set will be circulated for review to the relevant departments within the City of Hamilton and to the appropriate Conservation Authority having jurisdiction. This submission will include the following information:

- limits of the pond block and associated easements;
- dripline of individual trees and woodlots;
- locations of trees to be preserved or removed;
- edge management strategy and details;
- measures to protect trees, vegetation communities and natural heritage features;
- geotechnical and hydrogeological assessments to confirm soil type, depth to water table and groundwater interflow patterns;
- construction staging and sediment control initiatives;
- grading plan, including limits of proposed grading;
- layout plan;
- seeding and site restoration plan;
- details for inlet and outlet structures, trails, fencing and barriers, erosion protection and other elements as stipulated in the guidelines;
- specifications of plant material and seed mixes;

- details for structures and landscape elements;
- receiving watercourse erosion mitigation contingency plan; and
- landscape feasibility statement.

The landscape drawing submission should be prepared by the landscape architect in consultation with the engineer, ecologist, hydrogeologist, geotechnical engineer and structural engineer, as required, to address the complexities of the site and the various elements of the design.

9.1.3 Phase I and Phase II Environmental Site Assessment

The purpose of the Environmental Site Assessment is to ensure that all lands within the draft plan area to be conveyed to the municipality as Stormwater Management lands are free of contaminants that may encumber the lands and render them unsuitable to accommodate stormwater management facilities. In a Phase I Environmental Site Assessment, potential and/or actual site contamination will be identified through the evaluation and reporting of existing information collected through records review, site visits and interviews. The Phase I Environmental Site Assessment will also make recommendations as to the need for a Phase II Environmental Site Assessment including borehole testing or a Phase III Remediation Plan.

The Phase I Environmental Site Assessment must be prepared by a qualified consultant in accordance with the Environmental Protection Act R.S.O. 1990 and CSA Standard Z768-01. CSA Standard Z769-01 specifies the required components and a Phase 1 ESA that includes but is not limited to the following:

- confirmation of the history of land use through review of historical property ownership records, aerial photos, spill reports and interviews;
- visual confirmation of site environmental characteristics;
- identification of potential environmental liabilities; and
- identification of requirements for Phase II Environmental Site Assessment; and Phase III Remediation Plan.

9.1.4 Tree Preservation Plan

The Tree Preservation Plan must provide the following information:

- surveyed location of individual trees over 50mm dbh including dripline and dripline of the edge of woodlots;
- inventory of all trees located within the limits of the site as well as those located on adjacent properties within 3.0m of the property line. The inventory must describe each tree by species (including both common and botanical nomenclature), size, characteristics, health and condition. Rare or significant species should be highlighted;
- overlay illustration of the proposed facility layout, grading and limits of disturbance;
- illustration of the location of trees proposed to be removed as well as a statement of justification for removal;
- tree protection fence plans illustrating the location of proposed tree protection fence. Tree protection fence is to be located a minimum of 1.0m offset from the dripline of the tree to be preserved;
- photographic inventory documenting all of the trees located within the project site;
- mitigation and compensation plan illustrating initiatives to offset the anticipated impacts resulting from tree removal;
- notation describing measures to be implemented to mitigate potential damage from construction machinery including the removal of overhanging limbs prior to construction;

- notation to direct the disposal of limbs, trunks and root fans. Where practical large woody debris should be utilized on site for habitat enhancement purposes; and
- estimate of the cost of mitigation / compensation plantings.

It should be noted that tree removal and canopy management activities should be conducted during the dormant season and prior to the nesting season.

9.1.5 Edge Management Plan

In situations where the facility site abuts a woodlot, an Edge Management Plan is required to be prepared and submitted in conjunction with the Tree Preservation Plan. The Edge Management Plan will include the following drawings and information:

- a drawing illustrating the limit of proposed grading in relation to the dripline of the woodlot;
- an aerial photograph of the woodlot;
- limit of proposed encroachment along the woodlot edge and description of trees proposed to be removed (refer to section 7.1.4: Tree Preservation Plan for specific requirements);
- a description of dominant soil and drainage conditions along the woodlot edge;
- restoration planting / edge enhancement plan illustrating proposed plantings within the woodlot and adjacent the woodlot edge to mitigate edge efforts. All plant material including groundcovers should be regionally native. Turfgrass sod is not acceptable as a groundcover; and
- estimate of the cost of the proposed restoration works.

9.1.6 Receiving Watercourse Erosion Mitigation Contingency Plan

Notwithstanding the fact that stormwater management facilities are designed to achieve specific water quantity control targets, in some subwatersheds, the watercourse downstream of the pond outlet may be particularly vulnerable to increased flows. As a result, erosion may occur as a consequence of the installation and operation of the stormwater management facility. This situation has arisen on frequent occasions in the City of Hamilton, and the City has been obligated to initiate remedial measures to mitigate erosion and to protect receiving watercourses from further destabilization.

In order to ensure that any potential erosion damage resulting from the installation of a stormwater management facility is repaired as a component of the warranty, the preparation of a Receiving Watercourse Erosion Mitigation Contingency Plan is required. This package is to be submitted for approval as a component of the Detailed Landscape Design Drawing Package. The Receiving Watercourse Erosion Mitigation Contingency Plan should be comprised of the following components:

1. Existing Conditions Plan of the watercourse downstream of the site of the proposed outlet that illustrates the following:
    - configuration of the watercourse;
    - bank condition including areas of existing erosion, vegetation and woody debris within the zone of influence;
    - in-stream conditions including the location of pools, riffles, runs and obstructions and general substrate composition within the zone of influence;
    - dimensions of the watercourse including bankfull channel width and depth, low flow channel width and depth and overall bank height;
    - composition of the riparian vegetation community within the zone of influence; and

- key to photographs contained within the required photographic inventory.

2. Photographic Inventory of the watercourse that documents the conditions of the banks, existing erosion areas and the general condition of the watercourse within the zone of influence.

3. Restoration & Erosion Mitigation Plan that illustrates initiatives proposed to stabilize the watercourse in the event that erosion occurs after the commissioning of the stormwater management facility and prior to its assumption. The type and distribution of stabilization initiatives will vary contingent upon the site-specific conditions and erosion vulnerability and may include shrub planting, streambank stabilization or bioengineering. The Restoration and Erosion Mitigation Plan will apply to the entire length of the watercourse within the plan of subdivision and may extend further downstream if the potential for erosion impacts is likely.

9.1.6.1 Zone of Influence

The standard zone of influence to be addressed in the preparation of the Restoration and Erosion Mitigation Plan extends downstream from the outlet of the stormwater management facility and encompasses the entire length of the watercourse within the limit of the plan of subdivision, unless the following conditions are encountered:

- another on-line flow control structure is located within the limit of the plan of subdivision; if this is the case, then the zone of influence ends at the downstream flow control structure;
- a lined, armoured or hardened channel is located within the limit of the plan of subdivision; in this situation, the zone of influence ends at the upstream limit of the hardened channel; and
- the downstream watercourse discharges into a storm sewer within the limit of the plan of subdivision; in this case, the zone of influence extends to the inlet of the storm sewer system.

In certain circumstances, the zone of influence may be extended beyond the limit of the plan of subdivision if the potential for erosion impacts is high, or if the watercourse is sensitive for example:

- if the receiving watercourse is unstable and particularly vulnerable to erosion;
- if the receiving watercourse is situated within silty or sandy parent soils that are prone to erosion;
- if the riparian vegetation community is comprised of maintained turf;
- if the slope of the downstream watercourse exceeds an average of 2%; and
- if the downstream reach supports a coldwater fish community that harbours threatened, vulnerable or endangered fish species; in this situation, the zone of influence encompasses the length of the reach within which the species are resident.

In consideration of the foregoing, limit of the zone of influence should be determined based upon the inventory of the site undertaken to support the initial phases of the design process.

9.1.6.2 Implementation of the Erosion Mitigation Contingency Plan

The Erosion Mitigation Contingency Plan is exactly that – a contingency plan to be implemented in whole or in part as required to mitigate any erosion that occurs prior to

the City's assumption of a stormwater management facility. If erosion is observed, the measures illustrated on the contingency plan should be implemented. Any necessary erosion mitigation measures must be implemented and effective prior to the assumption of the pond and the release of any posted securities.

9.1.6.3 Watercourse Realignment Requirements

Generally, the realignment of a watercourse to facilitate the installation of a stormwater management facility is discouraged. Notwithstanding, in some situations, the realignment of an existing watercourse may be necessary to accommodate the installation of a stormwater management facility due to site specific constraints and functional requirements. In this case, design details for any proposed watercourse realignment should be illustrated within the landscape drawing set as described in section 9.1.7. The following should be considered in the course of generating designs for watercourse realignments:

- for stream realignments, the original position of the stream and the proposed realignment should be shown;
- floodplain plantings and grading should be designed to provide a range of habitat sizes and types (e.g. undulating microtopogaphy);
- the proponent must consider plantings to provide both general and specific fish habitat (e.g. red side dace require long grasses overhanging the stream);
- vegetation should provide shade on 60-80% of the surface of coldwater streams (Plosz et al.);
- all vegetation (100%) must be Regionally native species;
- bioengineering, root wads, etc. along banks is encouraged;
- wildlife habitat should be included (i.e. use species that provide a source of food for wildlife (see Appendix 1 Table 2), install nesting boxes, construct brush piles, etc. where appropriate;
- provide winter habitat for wildlife by clumping conifers and using small shade tolerant conifers as understorey among deciduous trees;
- proposed tree density after planting should be at least 12/100m2. Trees should be planted no closer than 2.5 m on centre;
- shrubs must be planted between 0.75m and 1.5m apart;
- the shrub to tree ratio should be 5:1;
- ground cover application should generally occur through the entire cross-section for intermittent channels and to the approximate low flow limits for permanent channels;
- biodegradable/photodegradable erosion control blankets should cover 50% of bank height for intermittent channels and 75% of the bank height for permanent channels; and
- topsoil should be tapered to a skim layer near the bottom of the bank or low flow limits.

For all proposed watercourse realignments, a permit will be required from the Conservation Authority having jurisdiction. In addition, an authorization from Fisheries and Oceans Canada under the Federal Fisheries Act may also be required. Consultation with the local Conservation Authority is necessary to confirm approval requirements. In addition, it should be noted that in some instances alterations to watercourses, including realignments may not be permitted.

9.1.7 Detailed Landscape Design Drawings

The Public Works Department will conduct a comprehensive review of the detailed design drawings for each stormwater management facility in the process of executing a subdivision agreement. The detailed landscape plan submission should conform with the guidelines set out in this document as well as the following City of Hamilton documents:

- Parks and Open Space Development Manual
- Community Landscape Design Guidelines
- Master Environmental Servicing Plan (MESP) and concurrently prepared Environmental Impact Studies
- City of Hamilton Trail System Master Plan
- City of Hamilton Engineering Standards

Landscape plan submissions must be prepared in accordance with the following requirements:

- all landscape plans are to be prepared and sealed by a landscape architect having full membership in the Ontario Association of Landscape Architects;
- all landscape grading is to be coordinated with the site grading, subdivision grading and drainage plans; and
- all landscape plans are to be prepared in metric and folded to 8 ½“ x 11”;
- landscape site plans will include the following information where appropriate:
  - ❑ key plan;
  - ❑ north arrow;
  - ❑ scale;
  - ❑ existing and proposed contours;
  - ❑ surveyed top of bank;
  - ❑ bottom of bank;
  - ❑ adjacent roads and properties;
  - ❑ finished floor elevations of adjacent buildings;
  - ❑ location and extent of underground structures and services;
  - ❑ surveyed locations and descriptions of all trees on site and within 15m on adjacent lands;
  - ❑ surveyed locations and descriptions of all natural features on site and within 15m on adjacent lands;
  - ❑ existing trees to be protected on site and within 15m on adjacent lands;
  - ❑ location and design details including cross-sections and profiles for all proposed watercourses realignments (where applicable);
  - ❑ location of proposed tree protection hoarding;
  - ❑ existing trees to be transplanted;
  - ❑ existing trees to be removed;
  - ❑ new plantings keyed to plant list;
  - ❑ seeded areas and seed mixed;
  - ❑ location of barley straw bag installation for algae control;
  - ❑ locations of all ground signs;
  - ❑ details for all planting, paving, fencing, structures and railings, etc.;
  - ❑ location and description of seed bank;
  - ❑ Vegetation Monitoring Plan; and
  - ❑ Receiving Watercourse Erosion Mitigation Contingency Plan.

- all landscape submissions are to be forwarded with an accompanying letter of transmittal with a corresponding cost estimate to be used in the calculation of letters of credit for landscape works. The City of Hamilton currently employs a “Global Letter of Credit” as a means of reducing the overall financial impact of letters of credit on any given project.

The cost estimate is used, however, for calculating the value of landscape works associated with the project and the corresponding value of deficiencies;

- submit (4) copies of final plans and one set reduced to 8 ½" x 11";
- all cost estimates must be prepared by the project landscape architect; and
- cost estimates are to include all landscape elements as well as tree protection fencing and 20% contingency for landscape architecture fees

It should be noted that costs for sodding, standard seeding, finish grading, lighting and servicing or stormwater management infrastructure are not to be included in the landscape cost estimate since these elements are addressed in the cost estimates for servicing and engineering works. However, with respect to seeding, costs associated with wildflowers, emergent vegetation, natural grasses and other specialty seed mixes should be included in the landscape cost estimate. An estimate of the cost of implementing the downstream Receiving Watercourse Erosion Mitigation Contingency Plan is to be included in the landscape cost estimate.

The Detailed Landscape Plan submission and cost estimate will be reviewed by City staff to ensure conformity with the guidelines set out in this document and once approved; the drawings and cost estimate will be incorporated into the Subdivision Agreement. Table 7.0 explains the planning process.

Table 7: Planning Process: Submission Requirements & Approval Process

Planning Process	Submission Requirements	Approval Process
Official Plan Amendment, Secondary Plan, Large-Scale Infill (no later than draft plan submission)	Master Environmental Servicing Plan (MESP) - Environmental Inventory - Stormwater Management Strategy - Parks and Open Space Master Plan	- MESP and supporting documents are reviewed by City staff with the objective of confirming conformance with the approach and principles set out in this report - Parks and Open Space Master Plan reviewed and approved by City of Hamilton.
Plans of Subdivision	1. Community Landscape Concept Plan 2. Engineering Drawings 3. Phase 1 and Phase 2 Environmental Site Assessment 4. The Tree Preservation Plan for the SWMF Block is part of the Tree Preservation Plan for the entire subdivision and will be approved prior to Draft Plan approval. 5. Detailed Landscape Design Drawings 6. Detailed Landscape Design Drawings (including Cost Estimate)	1. Community Landscape Concept Plans are submitted for review and approval. 2. Drawings submitted to Public Works Department. 3. Assessment prepared in accordance with CSA Standard Z769-01 and all applicable legislation, regulations and guidelines, including the Ministry of Environment Provincial Guidelines for Cleanup of Contaminated Sites in Southern Ontario 4. The Tree Preservation Plan is a component of the overall Tree Preservation Plan for the entire subdivision and will be approved prior to Draft Plan approval. 5. Package submitted with the Second Submission of the engineering drawing set. The Landscape Design Drawing package should include: - Existing Conditions Plan (tree inventory) - Photographic Inventory - Planting Plan - Restoration & Erosion Mitigation Plan 6. Submission is reviewed by City staff to ensure conformity with the guidelines. - Prepared as set out in the Landscape

		-Design Criteria & Implementation Guideline document -Approved drawings must be in conformance with the checklist submitted with the package. -Approved drawings and cost estimate form part of the Subdivision Agreement.
Assumption of SWM Works & Landscaping	1. Inspection undertaken by proponent's landscape architect, a notification of completion certificate is then issued to the Municipality 2. Once deficiencies have been rectified,	* 1. Inspection concluded by City staff, any deficiencies are recorded and forwarded to project landscape architect. 2. Upon receipt of notification that all deficiencies are rectified, City completes final inspection and notifies finance dept.; City assumes responsibility of facility. (* note: Inspections are to be scheduled between June 1st and September 30th only)

9.2 DESIGN CHECKLIST

Table 8.0 below provides a checklist of landscape components addressed by these guidelines to assist practitioners in ensuring that all of the requirements of the City of Hamilton have been addressed in the design of the proposed stormwater management facility.

Table 8: Design Checklist

Item	Description	Section	Page	Guidelines
1.0	**Landform and Grading**	8.1.1	43	☐ ~ reflects character of surrounding natural landscape ☐ ~ varied slopes and graded transitions
2.0	**Orientation**	8.1.2	43	☐ ~ longest axis aligned northwest to southeast or west to east
3.0	**Planting**	8.1.3	44	☐ ~ native species indigenous to bioregion
3.1	Terrestrial Plantings	8.1.3.1A	47	
	A. Plant Material Density		47	☐ ~ adheres to required densities listed in Table 4.0 ☐ ~ tree density: minimum 5-7 trees/100m²
	B. Plant Material Sizing		47	☐ ~ deciduous trees min. 40mm cal. ☐ ~ coniferous trees min. 1.8m ht. ☐ ~ shrubs min. 0.6m ht.
	C. Shrub Material Spacing		48	
	~ barrier planting		48	☐ ~ 2 rows at 0.8m o.c. extend min. 3.0m beyond area of concern
	~ living fences		48	☐ ~ adhere to details in accordance with City detail
	~ planted weirs		48	☐ ~ continuous shrubs, min. 0.8m across width of weir and along length of crest
	~ pond perimeter		48	☐ ~ continuous band of shrubs and aquatic plants min. width of 3.0m ☐ ~ min. plant spacing 1.0m on centre

	~ bare root ~ live stakes		48 48	☐ ~ during early spring and fall planting ☐ ~ installed immediately after harvesting
	~ seeding		49	☐ ~ no noxious weeds (refer to Appendix A) ☐ ~ installed with straw mulch at a rate of 4 tonnes/hectare to a depth of 25-50mm ☐ ~ undertaken within recommended timing window (refer to Section 8.1.4) ☐ ~ applied seed in accordance with manufacturer's recommendations ☐ ~ min. 100mm of topsoil
	~ seed banks		49	☐ ~ used local and on-site seed bank material ☐ ~ no material situated in roadside ditches ☐ ~ no invasive, undesirable species ☐ ~ maintained stockpiled in moist condition and must not be stockpiled more than 4 weeks ☐ ~ do not compact seed bank material ☐ ~ min. depth of 150mm ☐ ~ overseed mulch and irrigate after placement
3.2	Aquatic Plantings	8.1.3.1B	50	
	Wet Pond		50	☐ ~ 1.5m band around permanent pool & forebay perimeter at max. 1.0m o.c.
	Wetland		50	☐ ~ wetland basin below permanent pool elevation at 0.5-1.0m o.c.
4.0	**Recommended Planting Windows**	8.1.4	50	
4.1	Trees and Shrubs	8.1.4a)	50	
	i. Bare Root Stock		50	☐ ~ Spring: from mid-April to mid-May, before bud break ☐ ~ Fall: approximately 2-3 weeks after leaf drop
	ii. Container Grown, Potted, Balled and Burlapped Stock		50	☐ ~ mid-April to mid-September
	iii. Transplanted Stock		50	☐ ~ Deciduous trees: Fall – after leaf drop or Spring and prior to leaf out ☐ ~ Coniferous trees: Spring
4.2	Seed Mixes	8.1.4b)	51	☐ ~ Dormant wildflower seed: May 15 to June 15 ☐ ~ Dormant native grass seed: October 15 to November 15
5.0	**Soil Preparation**	8.1.5	51	<u>Minimum Depth of Topsoil:</u> ☐ ~ Seeded areas 450mm ☐ ~ Shrub Planting 600mm ☐ ~ Tree Planting 1000mm ☐ ~ Aquatic Plants 300mm

6.0	**Inlet Structures**	8.1.6	51	☐ ~ plunge pools incorporated in all designs ☐ ~ 1.5m min. depth for plunge pools ☐ ~ 300mm deep riverstone to line plunge pools
	i. Concealing Inlet Structures		52	☐ ~ inlet structure located back from pond edge ☐ ~ topography to conceal structure ☐ ~ utilize planted fieldstone to construct wing walls, conceal head wall, mitigate erosion ☐ ~ where barrier required install 1.2m black vinyl coated chainlink fence or ornamented alternative ☐ ~ install coniferous planting to conceal fences & barriers
	ii. Inlet Structures as Landscape Amenities		52	☐ ~ opportunities to incorporate overlook, seating area, interpretive station or outdoor classroom
7.0	**Outlet Structures**	8.1.7	53	
7.1	Alternative Outlet Designs	8.1.7.1	54	☐ ~ Alternative design considered based on downstream requirements
7.2	Bottom Draw Outlets	8.1.7.2	54	☐ ~ water to be discharged in excess of 2.0m below normal water level
7.3	Contact Cooling Trenches	8.1.7.3	54	☐ ~ located downstream of pond outlet
7.4	Seepage Outlets	8.1.7.4	55	☐ ~ located downstream of facility outlet ☐ ~ comprised of a header pipe that feeds a set of small diameter, clear stone or coarse sand filled outlet pipes
7.5	Outlet Channels	8.1.7.5	57	☐ ~ designed to replicate natural channels ☐ ~ width-to-depth ratio of 1:1 ☐ ~ lined with 200mm (min. depth) clear stone substrate ☐ ~ band of wood riparian vegetation
7.6	Vegetated Spreader Swales	8.1.7.6	58	☐ ~ planted a min. 3.0m from crest swale on all sides
7.7	Upwelling Outlets	8.1.7.7	59	☐ ~ utilized where benefits to downstream aquatic communities can be realized ☐ ~ possible time release between 5-7am to mitigate temperature increase
7.8	Linear Wetlands	8.1.7.8	59	☐ ~ constructed to further enhance water quality, moderate flows and mitigate water temperature impacts ☐ ~ heavily planted to increase shade cover
7.9	Thermal Impact Mitigation	8.1.7.9	60	☐ ~ can be mitigated through the configuration and design of SWM facilities ☐ ~ outlet structures specifically for cool water discharged from SWM facilities
8.0	**Shoreline Treatments**	8.1.8	60	☐ ~ min. gradient of 7:1 flat terrace ☐ ~ min. 3.0m wide bank of continuous, dense, low branching woody vegetation around pond perimeter

9.0	**Waterfowl Deterrence**	8.1.9	60	☐ ~ shorelines undulating & non-uniform ☐ ~ alternative shoreline of stacked boulders with min. diameter 600mm & vertical height of 450mm ☐ ~ min. 3.0m wide bank of continuous, dense, low branching woody vegetation around pond perimeter ☐ ~ open water <0.25ha, plant continuous tree canopy ☐ ~ below normal water level 7:1 terrace planted with emergent species
10.0	**Public Safety**	8.1.10	61	
10.1	Fencing	8.1.10.1	62	☐ ~ 1.5m black vinyl coated chain link fence along property line ☐ ~ offset distance of 0.15m from property line
10.2	Signage	8.1.10.2	62	~ identification signage installed in prominent location ☐ ~ Public Awareness Signage installed at entrance of main trail or maintenance access route
10.3	High Water Level Indicators	8.1.10.3	63	☐ ~ high water indicators spaced max. of 30.0m around perimeter of pond/wetland
10.4	Barrier Plantings	8.1.10.4	64	☐ ~ see Section 8.1.3
11.0	**Provisions for Maintenance**	8.1.11	64	
11.1	Maintenance Access Routes			
	i. Concealed Maintenance Access Route	8.1.11.1i	65	☐ ~ min. 75mm granular surface treatment overlaid min. 500mm depth of limestone screenings mixed with free draining topsoil ☐ ~ demarcation of route with boulders spaced 15.0m ☐ ~ min. spacing of trees 1.5m offset from route edge
	ii. Hybrid Trail / Maintenance Access Route	8.1.11.1ii	65	☐ ~ hybrid trail base 50mm crusher run limestone with 200mm depth or ☐ ~ 75mm granular top course overlaid combination of 50mm clear limestone screenings or limestone screenings with sandy topsoil ☐ ~ trail 2.4m wide, aligned to road edge
	iii. High Use / Urban Trail	8.1.11.1iii	65	☐ ~ asphalt or another appropriate hard surface material as required by the City of Hamilton. Trails that are identified in the Community Landscape Concept Plan ☐ ~ gradients do not exceed 5% and other barrier free access initiatives are implemented as required
11.2	Vehicle Access Barriers	8.1.11.2	65	☐ ~ removable metal bollards ☐ ~ max. spacing 1.5m
11.3	Provisions for Algae Control	8.1.11.3	66	☐ ~ 10kg bag of barley straw required for each 1,000m² of pond surface ☐ ~ volume of straw subdivided and placed in mesh bags with a distribution of 3kg/bag

10.0 MAINTENANCE & MONITORING

Adequate maintenance is essential to ensure the long-term achievement of stormwater management performance targets. In recognition of this, the City of Hamilton has developed an operations and maintenance program which sets out maintenance and monitoring objectives and procedures for all of the functional components of stormwater management facilities.

Greenhill Avenue Area Storm Drainage Study, Hamilton.

The following section of this document sets out management and maintenance recommendations that are specific to the landscape components of stormwater management facilities to supplement the City's program.

It is important to note that the maintenance of ponds that are located within the area encompassed by the Niagara Escarpment Plan is subject to Ontario Regulation 828190. Repair or maintenance of an existing pond is permitted if the following conditions are met:

i. The pond is not located within the Escarpment Natural Area of the Niagara Escarpment Plan.
ii. The original surface area and depth is not increased.
iii. The pond does not require the construction or reconstruction of a dam or berm and is not located on a stream or watercourse.
iv. The dredged material is used for landscaping immediately around the pond side and rehabilitated with vegetation.

10.1 MANAGEMENT OBJECTIVES

In developing the recommendations to guide the maintenance of the landscape components of stormwater management facilities, it must be recognized that the landscape is a living system that evolves in response to the environment and natural successionary processes. Consequently, the maintenance program must be implemented with an understanding of the long-term evolution of the landscape and with a view to the desired state of the landscape in the future.

The following are the objectives that served as the basis for developing the landscape maintenance program:

- promote the succession of naturally occurring species and associations;
- support the process of natural succession;
- manage for the control of non-native invasive or undesirable species;
- manage to ensure public safety with respect to preservation of sightlines, removal of hazards and control of noxious species; and
- ensure that the primary stormwater management function of the facility is achieved.

The landscape maintenance program was developed based on the above objectives to facilitate the management of the landscape components of the stormwater management facility and is to be implemented in conjunction with the recommendations of the City's operations and maintenance program.

10.2 MAINTENANCE REQUIREMENTS & RECOMMENDATIONS

The landscape maintenance program is required to be initiated by the proponent upon completion of construction of the stormwater management facility until the expiration of the warranty period.

10.2.1 Landscape Maintenance Program

The developer or his/her agent is required to maintain the stormwater management facility until the time of assumption by the City of Hamilton.

The following describes the maintenance program required to be implemented until the facility is issued by the City of Hamilton:

A. Routine Inspection
After every major storm event to ensure stability and function of the facility (approximately 4 times annually)

B. Litter Removal
Remove all litter from the site on a monthly basis during the period from March to December. This task includes the removal of litter and debris from the permanent pool and sediment forebay.

C. Vegetation Communities

Tree and Shrub Maintenance

i. Adjust stakes and guys to prevent girdling.
ii. Ensure rodent protection remains in contact with the ground.
iii. Prune out any dead or damaged limbs.
iv. Water trees as required to maintain health in consideration of meteorological, soil and site conditions as well as species requirements.
v. Top off mulch to ensure soil moisture is maintained

Seeded Area Maintenance

i. Monitor after initial seeding to ensure that adequate cover density has been achieved.
ii. Overseed as required to eliminate bare patches.
iii. Repair and reseed any rills or gullies that may form during the grow-in period.
iv. Remove weeds that may have become established during the germination and grow-in periods.
v. Monitor to ensure that established species correspond with specified seed mix species composition. Overseed as required to achieve specified composition and distribution.

vi. For areas designed to be maintained, mow to maintain a height of 60-75mm.
vii. Irrigate seeded areas as required to ensure germination and establishment.

Shrubs and Shrub Bed Maintenance
i. Prune out dead or damaged branches.
ii. Remove weeds from mulched beds.
iii. Water shrubs as required to ensure healthy growth in consideration of soil, meteorological and site conditions as well as species requirements.

D. Algae Control
Install barely straw bags in spring of each year and year of assumption.

E. Other Landscape Components

i. Rock works and natural stone flow control structures and spillways:
   a. Overseed as required ensuring that adequate vegetation cover is established in the voids between the stone.
   b. Adjust grades if required to achieve specified water levels.

ii. Fences, Signage and Furnishings
   a. Inspect and repair as required. Repair activities are to include the following as necessary:
      - removal of graffiti;
      - touch up painting;
      - replacement or tightening of loose hardware; and
      - ensuring all elements are securely anchored.

The Maintenance Program should include inspections of the stormwater management facility site on a routine basis to monitor the health of the plant community and the rate of establishment of seed as well as to determine the amount of weed establishment to implement maintenance actions.

10.2.2 Assumption of SWMF Landscaping

After verification and recommendation for assumption of stormwater management structural components and functional performance by the Public Works Department, the assumption of the stormwater management landscape components may proceed. To initiate the landscape assumption process, the project landscape architect will issue a completion notification certificate to the municipality. Upon receipt, a site inspection will be conducted by the Municipality to verify that the landscaping has been installed in conformity with the approved site and landscape plans. Any deficiencies found will be recorded in the City's inspection report and forwarded to the project landscape architect. Upon notification from project landscape architect that the deficiencies have been rectified, the municipality will conduct a final inspection, notify the finance department that the project is complete and assume responsibility for the routine maintenance of the facility. Final landscaping inspections may only be scheduled between June 1 and September 30 to ensure that vegetation can be inspected when it is in leaf. The following conditions must be met prior to City assumption:

10.2.2.1 Trees

a. All trees must be in a healthy growing condition based upon the following:
   – well-developed, full crown;
   – no evidence of disease or stress including defoliation, loss of limbs, discolouration, spotting or perforation of leaves or bark damage; and
   – no evidence of frost cracking or structural damage to the trunk.

b. Limbs pruned as required for form or to remove any dead limbs.
c. All trees stakes and guys removed.
d. Mulch (where required) in place to the specified depth.
e. Rodent guards are installed on all trees as necessary.

10.2.2.2 Shrubs

a. Shrubs are in a healthy growing condition.
b. Mulch (where required) in place to the specified depth.
c. Shrubs are pruned as required to remove any dead branches.

10.2.2.3 Perennials & Aquatics

a. Exhibit satisfactory growth and root development.
b. Mulch (if required) in place to the specified depth.

10.2.2.4 Seeded Areas

a. All seeded areas must exhibit continuous cover.
b. Seeded areas must be comprised predominantly of the species specified.
c. Free from noxious weeds as specified in City By-laws.

10.2.2.5 Algae Control

a. New barley straw bags installed at time of assumption.

10.2.2.6 Trails & Maintenance Access Routes

a. Trails and maintenance access routes must be free draining and free of ruts and rills.
b. Trails and maintenance access routes must be compacted in accordance with the specifications.

10.2.2.7 Downstream Receiving Watercourse Erosion Mitigation Contingency Plan

a. Components of the plan implemented as required to mitigate erosion and ensure the stability of the downstream watercourse within the zone of influence.

10.2.2.8 Signs, Structures & Amenities

a. Signs, structures and other components of the landscape of the stormwater management facility must be in good condition and anchored in accordance with the specifications.
b. All maintenance information or operation manuals must be submitted to the City of Hamilton.

10.3 LANDSCAPE MONITORING PROGRAM

With respect to the landscape components of stormwater management facilities, the monitoring program is focused on gauging the sustainability, performance and evolution of the vegetation community to identify remedial maintenance activities that may be required. A description of the recommended monitoring program is provided in the following section.

Table 9: Vegetation Community Monitoring Program

Vegetation Community	Description	Frequency
Trees and Shrubs	Visual inspection to identify dieback, stress or presence of disease.	Biannually: i. Spring - after leaf out ii. Fall - after leaf drop
Aquatic Vegetation	Visual inspection to confirm desired species composition.	Annually: i. Midsummer
Groundcover	Visual inspection to confirm adequate	Biannually: i. Spring - after leaf out ii. Fall - after leaf drop
Presence of Noxious Weeds/ Invasives	Visual inspection to identify undesirable species and requirements for control	Biannually: i. Midsummer and early fall

Table 10: Landscape Elements Monitoring Program

Landscape Element	Description	Frequency
Riverstone Weirs and Spillways	Visual inspection to identify displacement or erosion.	Biannually: i. Spring ii. Fall
Fieldstone Revetments	Visual inspection to identify displacement or erosion.	Biannually: i. Spring ii. Fall
Trails and Maintenance Access	Visual inspection to identify erosion. Routes	Biannually: i. Spring ii. Fall

The above monitoring program should also include the compilation of a photographic inventory of the site. Photographs should be taken twice yearly corresponding with the spring and fall monitoring sessions. Photographs should be taken from fixed locations that are identified on a site map and should include photographs of the inlet and outlet structures, overflow spillway, trails and maintenance access routes and key components of the vegetation community as well as any noted deficiencies. Subsequent photographic sessions should include areas where deficiencies were previously identified to document the effectiveness of the remedial works. Each photograph should be annotated with a description of the subject matter. The

photo inventory package should be bound with a key map and CD of the digital photographs. This documentation should form part of the monitoring report for the site that will be submitted to the City as a condition of assumption of the facility.

10.4 REPORTING

Monitoring reports must be submitted to the City of Hamilton for review on an annual basis. Reports should include the following information:

- pond name, location, street address and reference number;
- date of completion of construction;
- date of expiration of warranty period;
- general description of the facility;
- observations related to water quality, presence of wildlife and general pond conditions;
- statement of water quality;
- summary of findings of monitoring inspections;
- comparative analysis of data and evaluation in comparison to original design objectives and previous monitoring findings;
- summary of physical status of various components of the facility including vegetation community, inlet and outlet structures, maintenance access routes and other components;
- summary of facility performance including explanation of any discrepancies between performance of the vegetation community, (ie. survival, degree of invasive colonization, etc.);
- photographic inventory; and
- key map that documents photograph locations and the locations of any issues of concern identified.

Where the performance of a vegetation community or other landscape components such as the establishment of groundcover remains deficient over an extended time period, recommendations for improvements to the facility should be made and submitted for review and approval by the City of Hamilton along with an estimate of the cost of the improvements. The improvements should be implemented immediately upon receipt of approval from the City prior to assumption of the facility. The monitoring program must continue after the improvements are implemented until it is confirmed that targets are being achieved over two successive monitoring seasons.

Effective monitoring is essential to ensure that stormwater management objectives are achieved.

10.5 IMPLEMENTATION OF THE MONITORING PROGRAM

The proponent should implement the monitoring program until assumption of the facility by the City of Hamilton. Once assumed, the City of Hamilton will implement the monitoring program. Monitoring reports submitted to the City of Hamilton should be compiled to form a database for each stormwater management facility.

11.0 FACILITY IMPLEMENTATION

11.1 INTERIM STORMWATER MANAGEMENT FACILITIES

In the course of building out a development, it is necessary to implement initiatives to mitigate the potential impacts of stormwater runoff including erosion and sediment control best management practices and the construction of interim stormwater management facilities. The following recommendations are provided to direct the mitigation of potential water quality impacts during the construction period:

- Erosion and sediment control initiatives should be installed in accordance with the requirements of the City of Hamilton and Conservation Authority having jurisdiction prior to commencement of clearing and grubbing and topsoil stripping activities;

- The permanent stormwater management facility should be constructed and stabilized with native groundcovers prior to initiation of grading activities;

- Runoff should be pre-treated in a temporary stormwater management facility prior to discharge into the stabilized permanent facility;

- The removal of accumulated sediments from the permanent facility should be completed once the drainage area is stabilized and prior to final planting of the facility.

It has proven to be extremely beneficial to establish the aquatic vegetation community prior to final commissioning of the pond.

11.2 IMPLEMENTATION ISSUES – PRIVATE RESIDENTIAL PROPERTIES

The advantages of implementing these types of site-specific techniques are numerous. One key advantage is the potential to reduce reliance on end-of-pipe initiatives if a successful program of controls is integrated into the landscape of each lot. In addition, these solutions are relatively low-tech, requiring no operational protocol and no mechanical or active components. If implemented community-wide, solutions such as storm gardens can contribute to the establishment of a unique character or aesthetic for a community.

The disadvantages associated with these solutions are attributed to the fact that they are proposed to be located on private property and therefore the maintenance and effectiveness of the system is contingent on the actions of the private landowner or landowner group. Consequently, the long-term performance of a system of combined lot level initiatives is difficult to quantify, particularly when time is factored in. Over time, if maintenance levels are inadequate, or alternatives to the system are made, the long-term performance of the system could be compromised.

Homeowner education is the key to ensuring that systems remain effective over time. The homeowner education program should be comprised of the following:

- **Pre-sales Information Package**
  This information package should be provided to prospective buyers and made available as a display in the sales office. The package should describe the lot level control to be implemented, its operation and the basic maintenance requirements. It is important that this information package also stipulate clearly that the lot level control is not to be altered.

- **Purchase Agreement Package**
  This information package should form part of the agreement to purchase the property and should describe the system and any maintenance requirements as well, to encourage homeowners to maintain the installation. It is important that this document be focused on encouraging volunteer participation in the maintenance of lot level initiatives. This information package should also be attached to the purchase agreement of subsequent property owners in the event that the property is resold in the future.

- **Homeowner Guide**
  A user-friendly Homeowner Guide should be distributed to residents after they move in. The guide should be simple and informative and should provide a basic description of the lot level control, its function and any maintenance requirements.

- **Newsletter**
  In some communities, periodic newsletters are circulated informing homeowners of the activities which are occurring in their community. Information regarding the function of lot level controls should be included in the newsletter on a periodic basis. This approach serves to remind homeowners about the need to ensure that the function of the installation should be maintained.

The successful application of lot level landscape solutions also requires both the commitment of the municipality and the establishment of creative partnerships between the developer, municipality and homeowner, and the implementation of a homeowner education program that is focused on encouraging voluntary participation in the maintenance of lot level initiatives to realize consistent benefits over the long-term.

12.0 SUMMARY

This report provides the basis and rationale for the siting and design of stormwater management facilities and their associated landscapes and sets out the approach and principles to be applied when developing stormwater management strategies for new developments in the City of Hamilton. The document is focused on ensuring that stormwater management facilities are fully integrated amenities within the landscape and the community. In addition to articulating the City's vision with respect to the planning of the stormwater management systems and the location of stormwater management facilities, the report provides specific recommendations to direct the integration of stormwater management facilities into the environment in consideration of ecological, physiographic and hydrogeological factors and sets out guidelines to direct the site specific design of landscapes associated with stormwater management facilities.

Malton Drive, Hamilton

This document emphasizes an integrated approach to the planning and design of the landscape component of site-specific stormwater management facilities with the objective that these facilities will achieve optimal performance while becoming valued community assets.

The primary objective of these guidelines is to provide a comprehensive and extensive set of directions to guide the physical design, construction, maintenance and monitoring of landscapes associated with stormwater management facilities at a site-specific scale. This document should be utilized in the process of designing the essential requirements of fully integrated site-specific stormwater management facilities.

Founded on a comprehensive understanding of existing site features and functions, and focusing on a multi-disciplinary approach, design solutions are recommended to develop the optimal design for stormwater management facilities, which fully integrate these facilities within the context of its surrounding environment, community and existing ecological conditions.

Fundamentally, the guideline document is founded on the principle that stormwater is a resource and that stormwater management initiatives should be integrated with, and complementary to, the character and function of the community and the environment of which they are a part.

APPENDIX A: PLANT MATERIAL LISTS

Draft Stormwater Management Design Guidelines
Plant List

Recommended Submergent Plant Species

BOTANICAL NAME	COMMON NAME	Recommended for Shoreline and Bank Stabilization	Source
Elodea canadensis	common waterweed		2
Ceratophyllum demersum	coontail		2
Myriophyllum sibiricum	northern milfoil		2
Potamogeton pectinatus	sago pondweed		2
Utricularia vulgaris	common bladderwort		2
Vallisneria americana	water-celery		2

Recommended Emergent Plant Species

BOTANICAL NAME	COMMON NAME	Recommended for Shoreline and Bank Stabilization	Source
Acorus americanus	sweet flag	X	1,2
Alisma plantago-aquatica	water plantain		1,2
Asclepias incarnata	swamp milkweed		2
Calla palustris	water arum		2
Carex bebbii	bebb's sedge		2
Carex comosa	bristly sedge		2
Carex crinita	fringed sedge		2
Carex hystericina	porcupine sedge		2
Carex lacustris	lake-bank sedge		2
Carex lurida	lurid sedge		2
Carex pseudo-cyperus	cyperus-like sedge		2
Carex stipata	awl-fruited sedge		2
Carex stricta	tussock sedge		2
Carex utriculata	beaked sedge		2
Carex vulpinoidea	fox sedge		2
Chelone glabra	turtlehead		2
Cyperus esculentus	yellow nutsedge		2
Dulichium arundinaceum	three-way sedge		2
Eleocharis spp.	spike rushes		1
Eleocharis obtusa	spike rush		1,2
Eleocharis smallii	spike rush		1,2

Equisetum fluviatile	water horsetail		1,2
Iris versicolor	blue flag iris		1,2
Juncus articulatus	jointed rush		2
Juncus balticus	baltic rush		2
Juncus canadensis	canada rush		2
Juncus effusus	soft rush	X	1,2
Juncus pelocarpus	brown-fruited rush		2
Juncus tenuis	path rush		2
Juncus torreyi	torrey's rush		2
Pontederia cordata	pickerelweed		1
Sagittaria latifolia	(broad-leaved) arrowhead		1,2
Sagittaria rigida	stiff arrowhead		2
Scirpus acutus	hard-stemmed bulrush	X	1,2
Scirpus atrovirens	green bulrush		1,2
Scirpus cyperinus	wool-grass		1,2
Scirpus fluviatilis	river bulrush		2
Scirpus pendulus	pendulus bulrush		2
Scirpus pungens	common three-square		2
Scirpus validus	softstem bulrush	X	1,2
Sparganium americanum	american bur-reed		2
Sparganium chlorocarpum	green fruited bur-reed		1
Sparganium eurycarpum	giant bur-reed		1
Typha spp.- Narrow leaved more salt tolerant	cattails		1
Typha angustifolia	narrow-leaved cattail		2
Typha latifolia	broad-leaved cattail		2

Recommended Shoreline Plant Species

BOTANICAL NAME	**COMMON NAME**	**Recommended for Shoreline and Bank Stabilization**	**Source**
Acorus americanus	sweet flag		2
Alisma plantago-aquatica	water plantain		2
Calla palustris	water arum		2
Carex lacustris	lake-bank sedge		2
Carex utriculata	beaked sedge		2
Equisetum fluviatile	water horsetail		2
Sagittaria latifolia	broad-leaved arrowhead		2
Sagittaria rigida	stiff arrowhead		2
Scirpus acutus	hardstem bulrush		2
Scirpus fluviatilis	river bulrush		2

Scirpus pungens	common three-square		2
Scirpus validus	softstem bulrush		2
Sparganium americanum	american bur-reed		2
Typha angustifolia	narrow-leaved cattail		2
Typha latifolia	broad-leaved cattail		2
Polygonum amphibium	water smartweed		2
Sparganium eurycarpum	common bur-reed		2
Glyceria borealis	northern manna grass		2
Zizania aquatica	wild rice		2

Recommended Wetland Fringe Plant Species

BOTANICAL NAME	**COMMON NAME**	**Recommended for Shoreline and Bank Stabilization**	**Source**
Emergent Vegetation			
Asclepias incarnata	swamp milkweed		2
Bromus ciliatus	fringed brome		1
Carex aquatalis	aquatic sedge		1
Carex bebbii	bebb's sedge	x	1,2
Carex comosa	bristly sedge		2
Carex crinita	fringed sedge		1,2
Carex grayi	gray's sedge		1
Carex hystericina	porcupine sedge		1,2
Carex lacustris	lake sedge		1
Carex lupulina	hop sedge		1
Carex lurida	lurid sedge		2
Carex pedunculata	peduncled sedge		1
Carex plantaginea	plantain-leaved sedge		1
Carex platyphylla	broad-leaved sedge		1
Carex pseudo-cyperus	cyperus-like sedge		2
Carex stipata	awl-fruited sedge	x	1,2
Carex stricta	tussock sedge		1,2
Carex vulpinoidea	fox sedge	x	1,2
Chelone glabra	turtlehead		2
Cyperus esculentus	yellow nutsedge		2
Dulichium arundinaceum	three-way sedge		2
Eleocharis obtusa	spike rush		2
Eleocharis smallii	spike rush		2
Elymus hystrix	bottle-brush grass		1
Elymus riparius	river-bank wild rye	x	1

Elymus virginicus	virginia wild rye	x	1
Iris versicolor	wild blue flag		2
Juncus articulatus	jointed rush		2
Juncus balticus	baltic rush		2
Juncus canadensis	canada rush		2
Juncus effusus	soft rush		2
Juncus pelocarpus	brown-fruited rush		2
Juncus tenuis	path rush		2
Juncus torreyi	torrey's rush		2
Luzula acuminata	wood-rush		1
Scirpus atrovirens	green bulrush		1,2
Scirpus cyperinus	wool grass bulrush		1,2
Scirpus pendulus	pendulus bulrush		2
Spartina pectinata	prairie cordgrass	x	1
Equisetum arvense	field horsetail		2
Matteuccia struthiopteris	ostrich fern		2
Onoclea sensibilis	sensitive fern		2
Osmunda cinnamomea	cinnamon fern		2
Osmunda regalis	royal fern		2
Polystichum acrostichoides	christmas fern		2
Pontamogeton natans	floating pondweed		1
Thelypteris palustris	marsh fern		2
Calamagrostis canadensis	canada bluejoint		2
Glyceria striata	fowl manna grass		2
Leersia oryzoides	rice cut-grass		2
Wildflowers			
Anemone canadensis	canada anemone		2
Angelica atropurpurea	great angelica		2
Aster novae-angliae	new england aster		2
Aster puniceus	swamp aster		2
Aster umbellatus	flat topped aster		2
Bidens cernua	nodding bur-marigold		2
Bidens frondosa	common beggar-ticks		2
Cicuta maculata	water hemlock		2
Decodon verticillatus	swamp loosestrife		2
Eupatorium maculatum	joe pye-weed		2
Eupatorium perfoliatum	boneset		2
Galium palustre	marsh bedstraw		2
Gentiana andrewsii	bottle gentian		2
Hypericum ascyron	great st. john's-wort		2
Impatiens capensis	spotted touch-me-not		2

Impatiens pallida	pale touch-me-not	2
Lilium michiganense	michigan lily	2
Lobelia cardinalis	cardinal flower	2
Lobelia siphitica	blue lobelia	2
Lycopus americanus	water horehound	2
Lysimachia ciliata	fringed loosestrife	2
Lysimachia terrestris	swamp candles	2
Mimulus ringens	monkey flower	2
Penstemon digitalis	white beardtongue	2
Penthorum sedoides	ditch stonecrop	2
Potentilla palustris	marsh cinquefoi	2
Rudbeckia hirta	black-eyed susan	2
Rudbeckia laciniata	green-headed coneflower	2
Rumex orbiculatus	great water dock	2
Scutellaria galericulata	marsh skullcap	2
Sium sauve	water parsnip	2
Solidago canadensis	canada goldenrod	2
Solidago rugosa	rough-stemmed goldenrod	2
Thalictrum pubescens	tall meadow rue	2
Triadenum fraseri	marsh st.jonh's-wort	2
Urtica dioica sp. gracilis	stinging nettle	2
Verbena hastata	blue vervain	2

Recommended Sedge Species

BOTANICAL NAME	**COMMON NAME**	**Recommended for Shoreline and Bank Stabilization**	**Source**
Carex aquatalis	aquatic sedge		1
Carex bebbii	bebb's sedge	x	1,2
Carex comosa	bristly sedge		2
Carex crinita	fringed sedge		1,2
Carex grayi	gray's sedge		1
Carex hystericina	porcupine sedge		1,2
Carex lacustris	lake-bank sedge (lake sedge)		2,(1)
Carex lupulina	hop sedge		1
Carex lurida	lurid sedge		2
Carex pedunculata	peduncled sedge		1
Carex plantaginea	plantain-leaved sedge		1
Carex platyphylla	broad-leaved sedge		1
Carex pseudo-cyperus	cyperus-like sedge		2

Carex stipata	awl-fruited sedge	x	1,2
Carex stricta	tussock sedge		1,2
Carex utriculata	beaked sedge		2
Carex vulpinoidea	fox sedge	x	1,2
Chelone glabra	turtlehead		2
Cyperus esculentus	yellow nutsedge		2
Dulichium arundinaceum	three-way sedge		2

Recommended Lowland Tree Species

BOTANICAL NAME	**COMMON NAME**	**Recommended for Shoreline and Bank Stabilization**	**Source**
Acer saccharinum	silver maple		1
Celtis occidentalis	hackberry		2
Fraxinus pennsylvanica	red ash, green ash		1
Larix laricina	tamarack		1
Populus deltoides	eastern cottonwood		1
Platanus occidentalis	sycamore		1
Quercus bicolor	swamp white oak		1
Salix amygdaloides	peach-leaved willow		1
Salix bebbiana	bebb's willow		1
Salix discolor	pussy willow		1
Salix lucida	shining willow		1
Salix nigra	black willow		1,2
Populus balsamifera ssp. Balsamifera	balsam poplar		1
Populus deltoides ssp. Deltoids	cottonwood		1
Ulmus americana	white elm		1
Ulmus thomasii	rock elm		1
Thuja occidentalis	white cedar		1

Recommended Upland Tree Species

BOTANICAL NAME	**COMMON NAME**	**Recommended for Shoreline and Bank Stabilization**	**Source**
Acer saccharum	sugar maple		2
Betula papyrifera	paper birch		2
Carpinus caroliniana	american hornbeam		2
Fagus grandifolia	american beech		2

Fraxinus americana	white ash	2
Juniperus virginiana	eastern red cedar	2
Ostrya virginiana	ironwood	2
Picea glauca	white spruce	2
Pinus resinosa	red pine	2
Pinus strobus	eastern white pine	2
Populus tremuloides	trembling aspen	2
Prunus serotina	black cherry	2
Quercus alba	white oak	2
Quercus rubra	red oak	2
Tsuga canadensis	eastern hemlock	2

Recommended Upland Shrub Species

BOTANICAL NAME	**COMMON NAME**	**Recommended for Shoreline and Bank Stabilization**	**Source**
Amelanchier alnifolia	service-berry		2
Amelanchier arborea	juneberry		2
Amelanchier laevis	saskatoon-berry		2
Amelanchier sanguinea	round-leaved serviceberry		2
Amelanchier spicata	shadbush serviceberry		2
Arctostaphylos uva-ursi	bearberry		2
Ceanothus americanus	new jersey tea		2
Cornus alternifolia	alternate-leaved dogwood		2
Cornus rugosa	round-leaved dogwood		2
Corylus americana	american hazelnut		2
Corylus cornuta	beaked hazelnut		2
Crataegus spp.	hawthorn		2
Diervilla lonicera	bush honeysuckle		2
Hamamelis virginiana	witch hazel		2
Lonicera dioica	wild honeysuckle		2
Physocarpus opulifolius	ninebark		2
Prunus pensylvanica	pin cherry		2
Prunus virginiana	choke cherry		2
Rhus aromatica	fragrant sumac		2
Rhus typhina	staghorn sumac		2
Ribes americanum	wild black currant		2
Ribes cynosbati	prickly gooseberry		2
Ribes triste	swamp red currant		2
Rosa blanda	smooth wild rose		2

Rubus allegheniensis	common blackberry	2
Rubus odoratus	purple-flowering raspberry	2
Salix humilis	upland willow	2
Sambucus pubens	red-berried elder	2
Shepherdia canadensis	buffalo-berry	2
Symphoricarpos albus	snowberry	2
Viburnum acerifolium	maple-leaved viburnum	2
Viburnum dentatum	arrowwood	2
Viburnum rafinesquianum	downy arrow-wood	2
Zanthoxylum americanum	prickly ash	2

Recommended Upland Meadow Wildflower Species

BOTANICAL NAME	**COMMON NAME**	**Recommended for Shoreline and Bank Stabilization**	**Source**
Anaphalis margaritacea	pearly everlasting		2
Anemone canadensis	canada anemone		2
Anemone cylindrica	long-fruited anemone		2
Anemone virginiana	tall anemone		2
Antennaria neglecta	pussy-toes		2
androsaemifolium	spreading dogbane		2
Aquilegia canadensis	wild columbine		2
Asclepias tuberosa	butterfly-weed		2
Aster cordifolium	heart-leaved aster		2
Aster ericoides	heath aster		2
Aster laevis	smooth aster		2
Aster macrophyllus	large-leaved aster		2
Aster serceus	silky aster		2
Clintonia borealis	bluebead lily		2
Coreopsis lanceolata	lance-leaved coreopsis		2
Desmodium canadense	showy tick-trefoil		2
Epilobium angustifolium	fireweed		2
Erythronium americanum	trout lily		2
Eupatorium rugosum	white snakeroot		2
Fragaria virginiana	common strawberry		2
Helianthus divaricatus	woodland sunflower		2
Helianthus giganteus	tall sunflower		2
Lespedeza capitata	round-headed bush clover		2
Liatris spicata	prairie blazing star		2
Lilium philadelphicum	wood lily		2

Lupine perennis	wild lupines		2
Mitchela repens	partridgeberry		2
Monarda fistulosa	wild bergamot		2
Oenothera biennis	yellow evening primrose		2
Oenothera parviflora	evening primrose		2
Penstemon digitalis	white beardtongue		2
Penstermon hirsutus	hairy beardtongue		2
Polygonatum pubescens	soloman's seal		2
Pycnanthemum virginianum	virginia mountain mint		2
Ratibida pinnata	gray-headed coneflower		2
Rudbeckia hirta	black-eyed susan		2
Solidago bicolor	silverrod		2
Solidago caesia	blue-stemmed goldenrod		2
Solidago juncea	early goldenrod		2
Solidago nemoralis	grey goldenrod		2
Solidago rigida	stiff-leaved goldenrod		2
Solidago rugosa	rough-stemmed goldenrod		2
Spiranthes cernua	nodding ladies-tresses		2
Trientalis borealis	star flower		2
Verbena urticifolia	white vervain		2

Recommended Tableland Species - Non-Invasive Grasses

BOTANICAL NAME	**COMMON NAME**	**Recommended for Shoreline and Bank Stabilization**	**Source**
Andropogon gerardii	big bluestem		2
Andropogon scoparius	little bluestem		2
Agrostis stolonifera	creeping bentgrass		2
Bromus ciliatus	fringed brome		
Bouteloua gracilis	blue grama		2
Bouteloua curtipendula	side oats grama		2
Elymus canadensis	canada wild rye		2
Elymus hystrix	bottle-brush grass		
Elymus riparius	river-bank wild rye	x	1,2
Elymus virginicus	virginia wild rye	x	1,2
Hystrix patula	bottle-brush grass		2
Luzula acuminata	wood-rush		1
Milium effusum	wood millet		
Panicum virgatum	switchgrass		2
Poa palustris	fowl bluegrass		2

Pontamogeton natans	floating pondweed		
Sisyrinchium montanum	common blue-eyed grass		2
Scirpus atrovirens	dark green bulrush		
Scirpus cyperinus	wool-grass		
Sorghastrum nutans	indiangrass		2
Sporobolus cryptandrus	sand dropseed		2
Spartina pectinata	prairie cord grass	x	1,2

Recommended Valleyland Species - Semi-moist Conditions

BOTANICAL NAME	**COMMON NAME**	**Recommended for Shoreline and Bank Stabilization**	**Source**
Grasses			
Calamagrostis canadensis	canada bluejoint		2
Glyceria striata	fowl manna grass		2
Leersia oryzoides	rice cut-grass		2
Wildflowers			
Anemone canadensis	canada anemone		2
Angelica atropurpurea	great angelica		2
Asclepias incarnata	swamp milkweed	x	1
Aster novae-angliae	new england aster		2
Aster puniceus	swamp aster (purple-stemmed aster)	x	2,(1)
Aster umbellatus	flat topped aster		2
Bidens cernua	nodding bur-marigold		2
Bidens frondosa	common beggar-ticks		2
Chelone glabra	turtlehead		
Cicuta maculata	water hemlock		2
Decodon verticillatus	swamp loosestrife		2
Eupatorium maculatum	joe pye-weed (spotted joe-pye-weed)	x	2,(1)
Eupatorium perfoliatum	boneset		1,2
Eupatorium purpureum	purple joe-pye-weed		1
Eupatorium rugosum	white snakeroot		
Galium palustre	marsh bedstraw		2
Gentiana andrewsii	bottle gentian (closed gentian)		2,(1)
Helenium autumnale	sneezeweed		1
Hibiscus moscheutos	swamp rose-mallow		
Hypericum ascyron	great st. john's-wort		2

Impatiens capensis	spotted touch-me-not		2
Impatiens pallida	pale touch-me-not		2
Lilium michiganense	michigan lily		1,2
Lobelia cardinalis	cardinal flower		1,2
Lobelia siphitica	blue lobelia (great lobelia)		1,2
Lycopus americanus	water horehound		2
Lysimachia ciliata	fringed loosestrife		2
Lysimachia terrestris	swamp candles		2
Mimulus ringens	monkey flower		1,2
Penstemon digitalis	white beardtongue		2
Penthorum sedoides	ditch stonecrop		2
Potentilla palustris	marsh cinquefoi		2
Rudbeckia hirta	black-eyed susan		2
Rudbeckia laciniata	green-headed coneflower	x	1,2
Rumex orbiculatus	great water dock		2
Scutellaria galericulata	marsh skullcap		2
Sium sauve	water parsnip		2
Solidago canadensis	canada goldenrod		2
Solidago rugosa	rough-stemmed goldenrod		2
Thalictrum pubescens	tall meadow rue		2
Triadenum fraseri	marsh st.jonh's-wort		2
Urtica dioica sp. gracilis	stinging nettle		2
Verbena hastata	blue vervain	x	1,2

Recommended Wetland Species

BOTANICAL NAME	**COMMON NAME**	**Recommended for Shoreline and Bank Stabilization**	**Source**
Glyceria borealis	northern manna grass		2
Zizania aquatica	wild rice		2

Recommended Floodline Fringe/Wet Riparian Vine Species

BOTANICAL NAME	**COMMON NAME**	**Recommended for Shoreline and Bank Stabilization**	**Source**
Clematis virginiana	virgin's bower		2
Echinocystis lobata	wild cucumber		2
Menispermum canadense	canada moonseed		2

Parthenocissus inserta	woodbine	2
Smilax hispida	bristly greenbrier	2
Vitis riparia	riverbank grape	

Recommended Shoreline Shrub Species

BOTANICAL NAME	COMMON NAME	Recommended for Shoreline and Bank Stabilization	Source
Alnus rugosa	speckled alder		2
Cephalanthus occidentalis	buttonbush		2
Cornus stolonifera	red osier dogwood		2
Salix exigua	sandbar willow		2
Celtis occidentalis	hackberry		2
Populus deltoides	eastern cottonwood		2
Salix nigra	black willow		2

Recommended Lowland Shrubs and Wildflowers

BOTANICAL NAME	COMMON NAME	Recommended for Shoreline and Bank Stabilization	Source
Alnus incana spp. rugosa	speckled alder		1
Anaphalis margaritacea	pearly everlasting		2
Anemone canadensis	canada anemone		2
Anemone cylindrica	long-fruited anemone		2
Anemone virginiana	tall anemone		2
Angelica atropurpurea	great angelica		2
Antennaria neglecta	pussy-toes		2
Apocynum androsaemifolium	spreading dogbane		2
Aquilegia canadensis	wild columbine		2
Asclepias syriaca	common milkweed		2
Asclepias tuberosa	butterfly-weed		2
Aster cordifolium	heart-leaved aster		2
Aster ericoides	heath aster		2
Aster laevis	smooth aster		2
Aster macrophyllus	large-leaved aster		2
Aster novae-angliae	new england aster		2
Aster puniceus	swamp aster		2
Aster serceus	silky aster		2
Aster umbellatus	flat topped aster		2

Bidens cernua	nodding bur-marigold	2
Bidens frondosa	common beggar-ticks	2
Cephalanthus occidentalis	buttonbush	1
Cicuta maculata	water hemlock	2
Clintonia borealis	bluebead lily	2
Coreopsis lanceolata	lance-leaved coreopsis	2
Decodon verticillatus	swamp loosestrife	2
Desmodium canadense	showy tick-trefoil	2
Epilobium angustifolium	fireweed	2
Erythronium americanum	trout lily	2
Eupatorium maculatum	joe pye-weed	2
Eupatorium perfoliatum	boneset	2
Eupatorium rugosum	white snakeroot	2
Fragaria virginiana	common strawberry	2
Galium palustre	marsh bedstraw	2
Gentiana andrewsii	bottle gentian	2
Salix eriocephala	heart-leaved willow	1
Helianthus divaricatus	woodland sunflower	2
Helianthus giganteus	tall sunflower	2
Hypericum ascyron	great st. john's-wort	2
Ilex verticillata	winterberry	1
Impatiens capensis	spotted touch-me-not	2
Impatiens pallida	pale touch-me-not	2
Lespedeza capitata	round-headed bush clover	2
Liatris spicata	prairie blazing star	2
Lilium michiganense	michigan lily	2
Lilium philadelphicum	wood lily	2
Lobelia cardinalis	cardinal flower	2
Lobelia siphitica	blue lobelia	2
Lupine perennis	wild lupines	2
Lycopus americanus	water horehound	2
Lysimachia ciliata	fringed loosestrife	2
Lysimachia terrestris	swamp candles	2
Mimulus ringens	monkey flower	2
Mitchela repens	partridgeberry	2
Monarda fistulosa	wild bergamot	2
Nemopanthus mucronatus	mountain holly	1
Oenothera biennis	yellow evening primrose	2
Oenothera parviflora	evening primrose	2
Penstemon digitalis	white beardtongue	2
Penstermon hirsutus	hairy beardtongue	2

Penthorum sedoides	ditch stonecrop	2
Polygonatum pubescens	soloman's seal	2
Potentilla palustris	marsh cinquefoi	2
Pycnanthemum virginianum	virginia mountain mint	2
Ratibida pinnata	gray-headed coneflower	2
Rudbeckia hirta	black-eyed susan	2
Rudbeckia laciniata	green-headed coneflower	2
Rumex orbiculatus	great water dock	2
Scutellaria galericulata	marsh skullcap	2
Salix petiolaris	slender willow	1
Sium sauve	water parsnip	2
Solidago bicolor	silverrod	2
Solidago caesia	blue-stemmed goldenrod	2
Solidago canadensis	canada goldenrod	2
Solidago juncea	early goldenrod	2
Solidago nemoralis	grey goldenrod	2
Solidago rigida	stiff-leaved goldenrod	2
Solidago rugosa	rough-stemmed goldenrod	2
Spiranthes cernua	nodding ladies-tresses	2
Thalictrum pubescens	tall meadow rue	2
Triadenum fraseri	marsh st.jonh’s-wort	2
Trientalis borealis	star flower	2
Urtica dioica sp. gracilis	stinging nettle	2
Verbena hastata	blue vervain	2
Verbena urticifolia	white vervain	2
Viburnum lentago	nannyberry	1

Source 1: Niagara Peninsula Conservation Authority

Source 2: Halton Region Conservation Authority

Invasive Species

Invasive Aquatic Species

BOTANICAL NAME	COMMON NAME	Source
The following species are not to be planted anywhere.		
Hydrocharis morsus-ranae	european frog-bit	2
Myriophyllum spicatum	eurasian watermilfoil	2
Nymphoides peltatum	floating heart	2
Potamogeton crispus	curly pondweed	2
The following species are permitted provided that they are not adjacent to natural areas >50m and include a physical barrier:		
Rorippa amphibia	marsh cress	2
The following species are permitted provided that they are not adjacent to natural areas >50m:		
Cabomba caroliniana	fanwort	2
Egeria densa	water weed	2
Hydrilla verticillata	hydrilla	2
Isoetes tinctoria	quillwort	2
Najas minor	minor naiad	2
Nasturtium microphyllum	water cress	2
Typha spp.	exotic cattail species	2

Invasive Herbaceous Species (Forbs/Herbs)

BOTANICAL NAME	COMMON NAME	Source
The following species are not permitted to be planted anywhere:		
Acinos arvensis	spring savory	2
Artemisia absinthium	absinth	2
Berteroa incana	hoary alyssum	2
Hesperis matronalis	dame's-rocket	2
Hieracium aurantiacum	orange hawkweed	2
Hieracium caespitosum	yellow hawkweed	2
Hieracium vulgatum	common hawkweed	2
Impatiens glandulifera	himalayan balsam	2
Lythrum salicaria	purple loosestrife	2
Ranunculus repens	creeping buttercup	2
Saponaria officinalis	soapwort	2
Tanacetum vulgare	tansy	2

The following species are permitted provided that they are not adjacent to natural areas >50m and include a physical barrier:

Convallaria majalis	lily-of-the-valley	2
Convolvulus arvensis	field bindweed	2
Polygonum cuspidatum	japanese knotweed	2
Ranunculus repens	creeping buttercup	2
Scilla sibirica	scilla	2
Sedum acre	mossy stonecrop	2
Thymus praecox	creeping thyme	2
Vinca minor	periwinkle	2

The following species are permitted provided that they are not adjacent to natural areas >50m:

Ajuga reptans	creeping bugleweed	2
Artemisia vulgaris	common mugwort	2
Campanula rapunculoides	creeping bellflower	2
Euphorbia esula	leafy spurge	2
Glechoma hederacea	ground-ivy	2
Hemerocallis fulva	orange day-lily	2
Humulus lupulus	common hop	2
Hypericum perforatum	common st. john's-wort	2
Inula helenium	elecampane	2
Iris pseudacorus	yellow flag	2
Lapsana communis	nipplewort	2
Malva moschata	musk mallow	2
Medicago lupulina	black medic	2
Medicago sativa	alfalfa	2
Mentha piperita	peppermint	2
Myosotis scorpioides	true forget-me-not	2
Nepeta cataria	catnip	2
Origanum vulgare	oregano	2
Pachysandra terminalis	japanese spurge	2
Primula veris	european cowslip	2
Rumex acetosella	sheep sorrel	2
Vincetoxicum rossicum	dog-strangling vine	2
Viola odorata	sweet violet	2

Invasive Herbaceous Species (Grass Species)

BOTANICAL NAME	**COMMON NAME**	**Source**
Butomus umbellatus	flowering rush	2
Dactylis glomerata	orchard grass	2

Glyceria maxima	rough manna grass	2
Miscanthus sinensis	silver grass	2
Phragmites australis	common reed	2
Phragmites communis	giant reed	2

The following species are permitted provided that they are not adjacent to natural areas >50m and include a physical barrier:

Elymus repens	quack grass	2
Festuca arundinacea	tall fescue	2
Poa pratensis	kentucky blue grass	2

The following species are permitted provided that they are not adjacent to natural areas >50m:

Bromus inermis	smooth brome grass	2
Lolium perenne	perennial rye-grass	2
Panicum miliaceum	common millet	2
Phalaris arundinacea	reed canary grass	2
Setaria glauca	yellow foxtail	2
Setaria viridis	green foxtail	2

Invasive Tree Species

BOTANICAL NAME	**COMMON NAME**	**Source**
The following species are not permitted to be planted anywhere:		
Acer Negundo	manitoba maple	2
Acer platanoides	norway maple	2
Acer pseudoplatanus	sycamore maple	2
Ailanthus altissima	tree of heaven	2
Betula pendula	european birch	2
Pinus sylvestris	scots pine	2
Populus alba	white poplar	2
Robinia pseudoacacia	black locust	2
Ulmus pumila	siberian elm	2
The following species are permitted provided that they are not adjacent to natural areas >50m:		
Acer ginnala	amur maple	2
Aesculus hippocastanum	horse chestnut	2
Fraxinus excelsior	european ash	2
Populus tremula	european aspen	2
Populus x canadensis	carolina poplar	2
Prunus avium	sweet cherry	2
Prunus mahaleb	perfumed cherry	2

Tilia cordata	european linden	2
Ulmus glabra	scotch elm	2

Invasive Shrub Species

BOTANICAL NAME	**COMMON NAME**	**Source**
Alnus glutinosa	black alder	2
Berberis thunbergii	japanese barberry	2
Berberis vulgaris	common barberry	2
Elaeagnus angustifolia	russian olive	2
Elaeagnus umbellata	autumn olive	2
Euonymus europaeus	spindle-tree	2
Lonicera maackii	amur honeysuckle	2
Lonicera morrowi	morrow's honeysuckle	2
Lonicera tatarica	tatarian honeysuckle	2
Lonicera xylosteum	european fly honeysuckle	2
Morus alba	white mulberry	2
Rhamnus cathartica	common buckthorn	2
Rhamnus frangula	glossy buckthorn	2
Rosa multiflora	multiflora rose	2
Salix alba	white willow	2
Salix fragilis	crack willow	2
Salix X rubens	hybrid willow	2
Solanum dulcamara	bittersweet	2

The following species are permitted provided that they are not adjacent to natural areas >50m and include a physical barrier:

Crataegus monogyna	English hawthorn	2
Euonymous alatus	burning bush	2
Sorbaria sorbifolia	false spirea	2
Syringa vulgaris	lilac	2

The following species are permitted provided that they are not adjacent to natural areas >50m:

Alnus incana incana	european white alder	2
Ampelopsis brevipedunculata	porcelain berry	2
Daphne mezereum	mezer's daphne	2
Ligustrum vulgare	privet	2
Salix caprea	goat willow	2
Salix purpurea	purple willow	2
Sambucus racemosa	european red elderberry	2

Sorbus aucuparia	european mountain ash	2
Symphytum albus var. laeviga	western snowberry	2
Viburnum opulus	guelder-rose	2

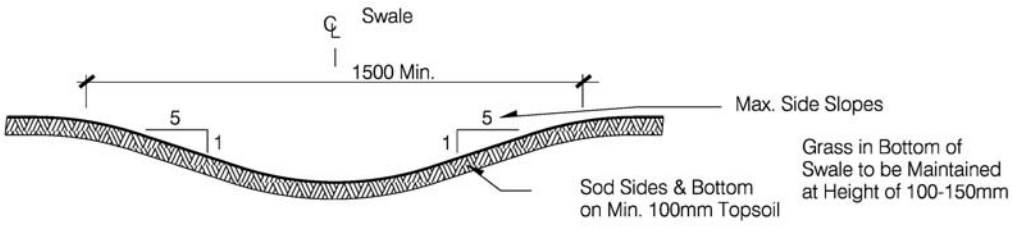
Invasive Vine Species

BOTANICAL NAME	**COMMON NAME**	**Source**
Celastrus orbiculatus	oriental bittersweet	2
Hedera helix	english ivy	2
Lonicera japonica	japanese honeysuckle	2

Source 1: Niagara Peninsula Conservation Authority

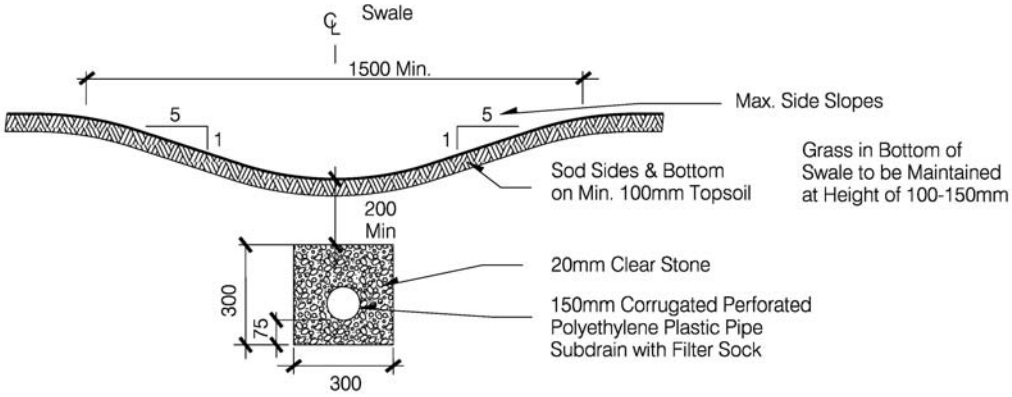
Source 2: Halton Region Conservation Authority

APPENDIX B: LANDSCAPE DETAILS



TYPICAL SWALE CROSS SECTION

1:20



SWALE WITH SUBDRAIN

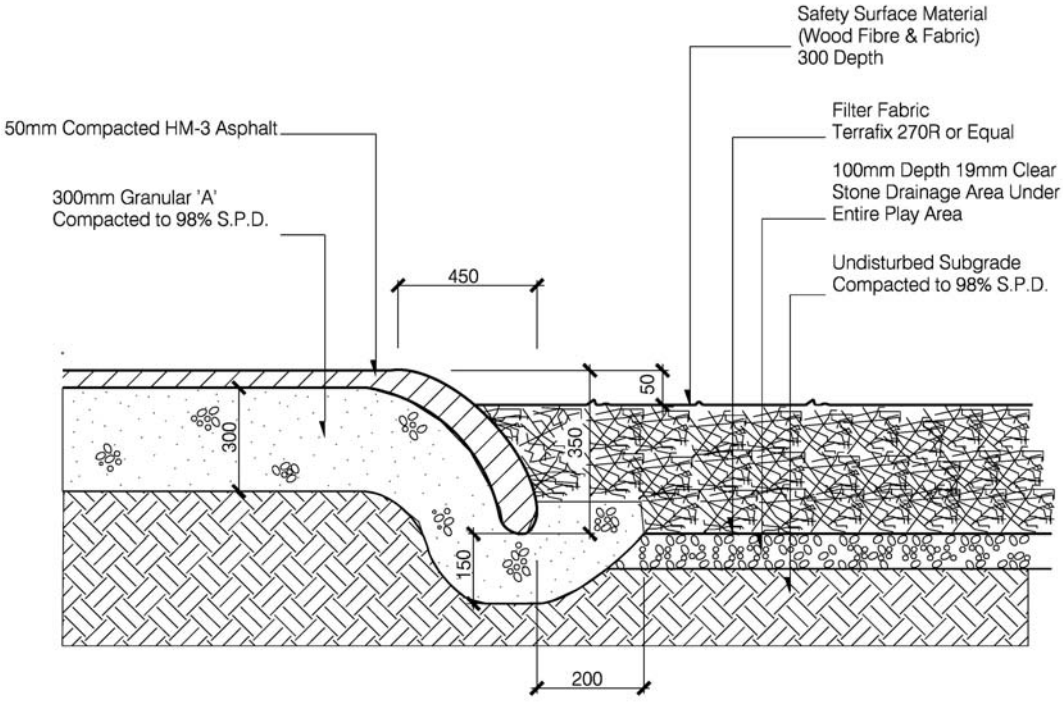
1:20

NOTE:

1. Longitudinal Slopes Shall be Min. 1.5% to Max. 10%.
2. Discharge Water to On-Site Catch Basin or Adjacent Open Water Course.
3. Do Not Convey Water Over Municipal Sidewalks.

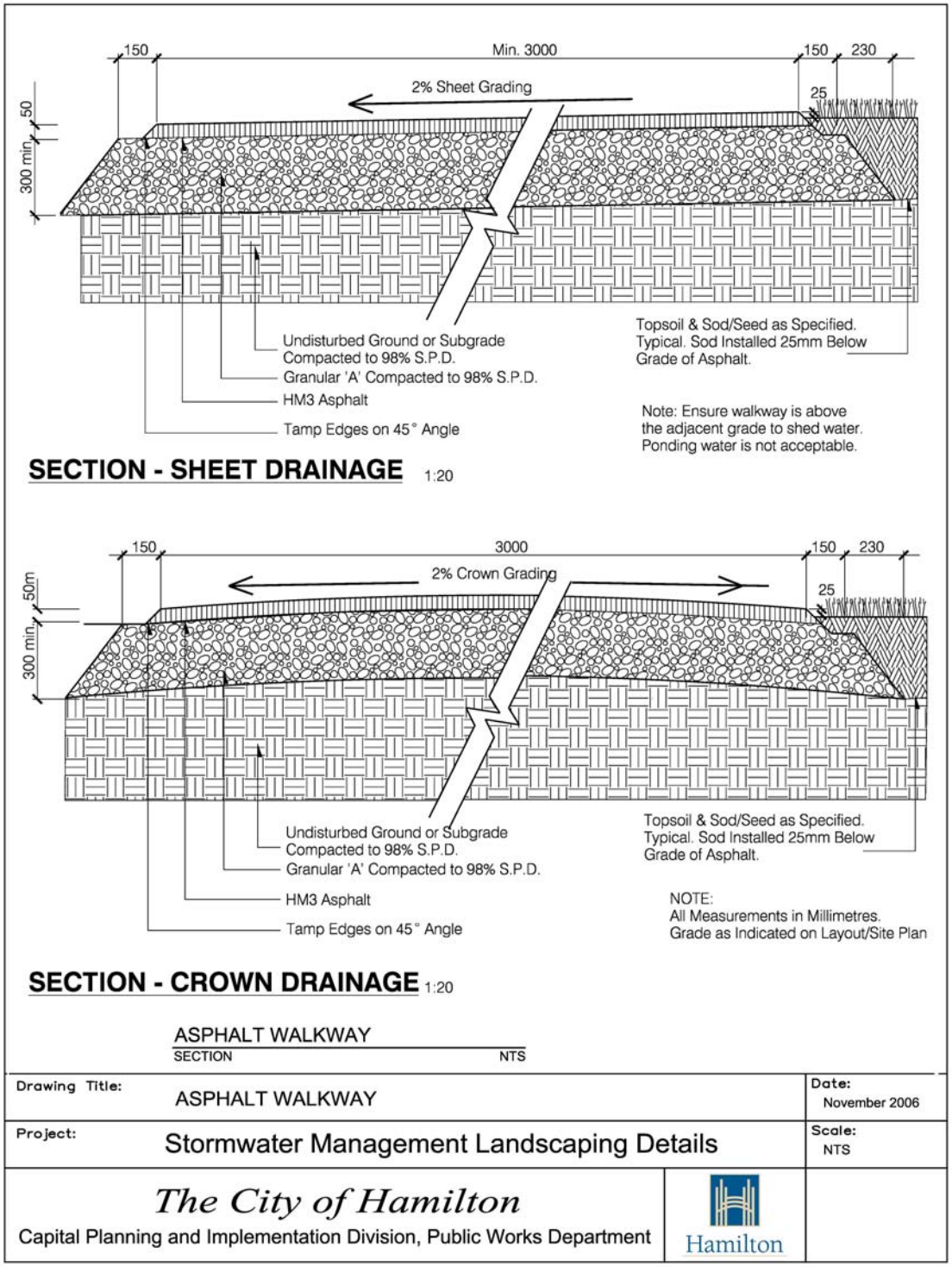
SWALE
SECTION NTS

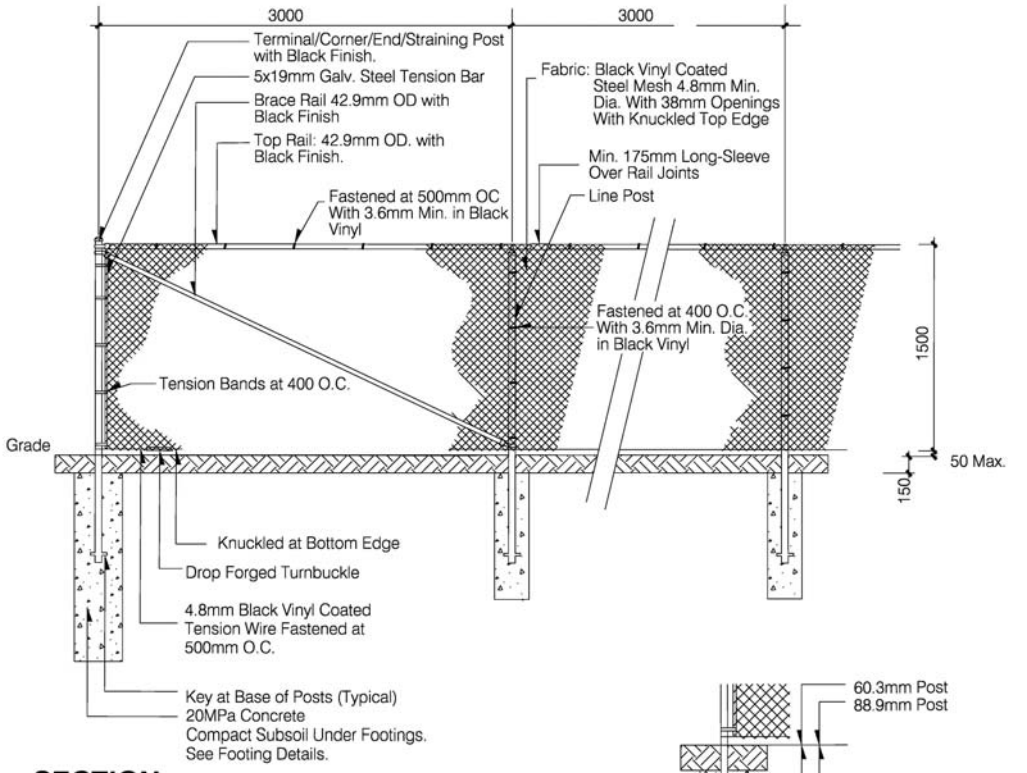
Drawing Title: SWALE		Date: November 2006
Project: Stormwater Management Landscaping Details		Scale: NTS
The City of Hamilton Capital Planning and Implementation Division, Public Works Department	Hamilton	



PLAY AREA ROLLED ASPHALT EDGE
SECTION NTS

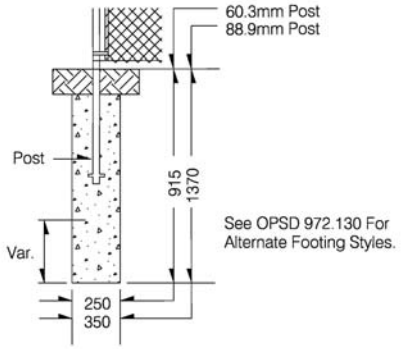
Drawing Title: PLAY AREA ROLLED ASPHALT EDGE		Date: May 2007
Project: Stormwater Management Landscaping Details		Scale: NTS
The City of Hamilton Capital Planning and Implementation Division, Public Works Department	Hamilton	


150
Min. 3000
150
230
2% Sheet Grading
25
50
300 min
Undisturbed Ground or Subgrade Compacted to 98% S.P.D.
Granular 'A' Compacted to 98% S.P.D.
HM3 Asphalt
Tamp Edges on 45° Angle
Topsoil & Sod/Seed as Specified. Typical. Sod Installed 25mm Below Grade of Asphalt.
Note: Ensure walkway is above the adjacent grade to shed water. Ponding water is not acceptable.
SECTION - SHEET DRAINAGE 1:20
150
3000
150
230
2% Crown Grading
25
50m
300 min
Undisturbed Ground or Subgrade Compacted to 98% S.P.D.
Granular 'A' Compacted to 98% S.P.D.
HM3 Asphalt
Tamp Edges on 45° Angle
Topsoil & Sod/Seed as Specified. Typical. Sod Installed 25mm Below Grade of Asphalt.
NOTE:
All Measurements in Millimetres.
Grade as Indicated on Layout/Site Plan
SECTION - CROWN DRAINAGE 1:20
ASPHALT WALKWAY
SECTION NTS
Drawing Title: ASPHALT WALKWAY
Date: November 2006
Project: Stormwater Management Landscaping Details
Scale: NTS
The City of Hamilton
Capital Planning and Implementation Division, Public Works Department
Hamilton



SECTION N.T.S.

Post Details		
Post Type	OD (mm)	Post Length Standard (m)
Line Post	60.3	2.3
End, Corner or Straining Post	88.9	2.6



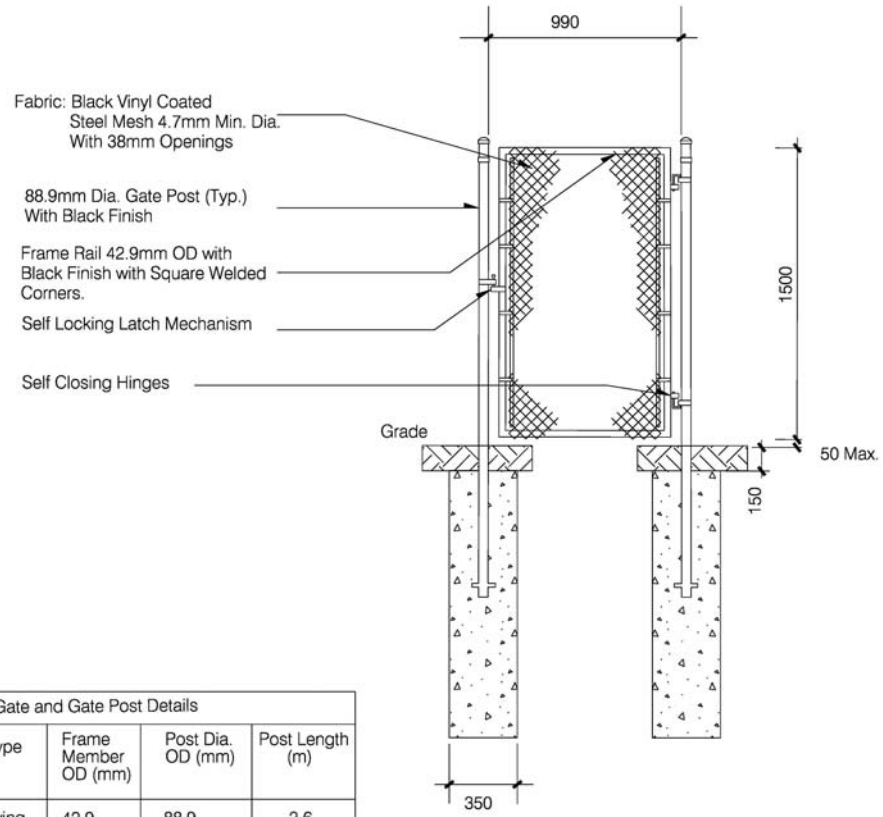
FOOTING IN EARTH
N.T.S.

Notes:

1. Fences Shall Conform to City of Hamilton By-Law 01-264.
2. To Be Used in Conjunction With But Taking Precedence Over OPSD 972.130.
3. All Posts, Rails and Hardware Shall be Black.
4. All Dimensions are in Millimetres Unless Otherwise Noted.

PARK CHAIN LINK FENCE BLACK VINYL - 1500MM HIGH
SECTION NTS

Drawing Title: PARK CHAIN LINK FENCE BLACK VINYL - 1500MM HIGH	Date: January 2007
Project: Stormwater Management Landscaping Details	Scale: NTS
The City of Hamilton Capital Planning and Implementation Division, Public Works Department	



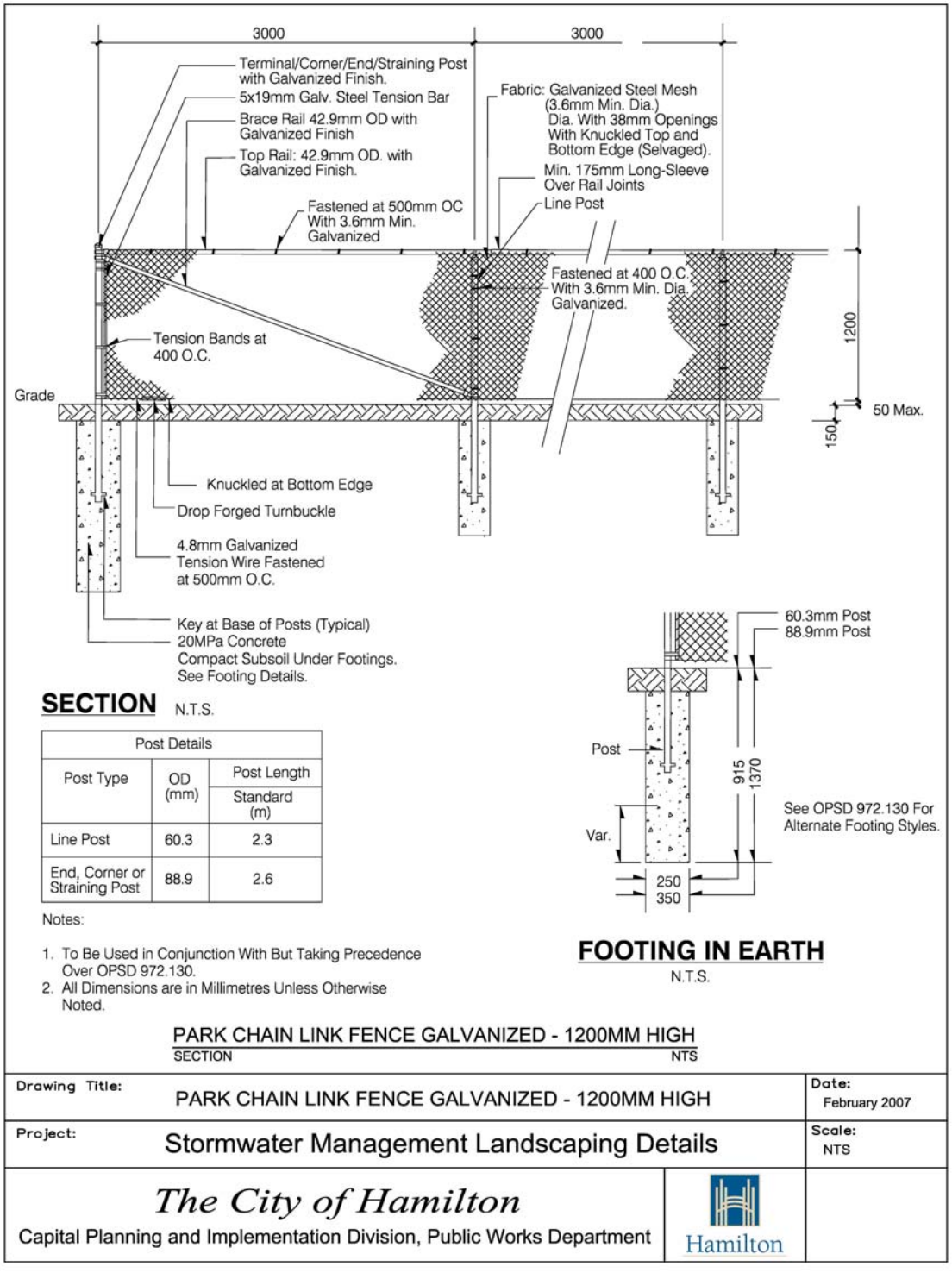
Gate and Gate Post Details			
Gate Type	Frame Member OD (mm)	Post Dia. OD (mm)	Post Length (m)
Single Swing	42.9	88.9	2.6

To Be Used in Conjunction With But Taking Precedence Over OPSD 972.130.
See OPSD 972.130 For Alternate Footing Styles.

All Dimensions are in Millimetres Unless Otherwise Noted.

PARK CHAIN LINK FENCE GATE - NEW DEVELOPMENT
SECTION NTS

Drawing Title: PARK CHAIN LINK FENCE GATE - NEW DEVELOPMENT		Date: January 2007
Project: Stormwater Management Landscaping Details		Scale: NTS
The City of Hamilton Capital Planning and Implementation Division, Public Works Department	Hamilton	



SECTION N.T.S.

Post Details		
Post Type	OD (mm)	Post Length Standard (m)
Line Post	60.3	2.3
End, Corner or Straining Post	88.9	2.6

Notes:

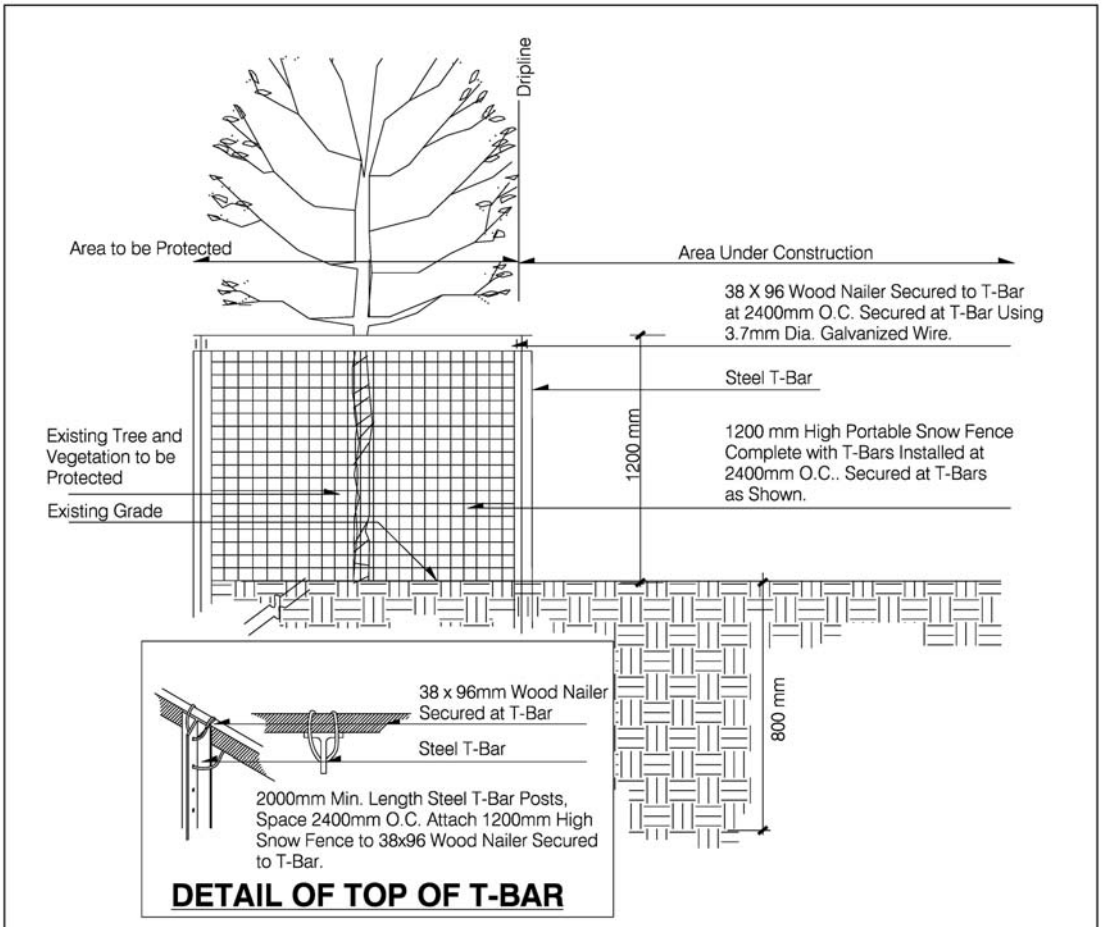
1. To Be Used in Conjunction With But Taking Precedence Over OPSD 972.130.
2. All Dimensions are in Millimetres Unless Otherwise Noted.

FOOTING IN EARTH
N.T.S.

PARK CHAIN LINK FENCE GALVANIZED - 1200MM HIGH
SECTION NTS

Drawing Title: PARK CHAIN LINK FENCE GALVANIZED - 1200MM HIGH	Date: February 2007
Project: Stormwater Management Landscaping Details	Scale: NTS

The City of Hamilton
Capital Planning and Implementation Division, Public Works Department

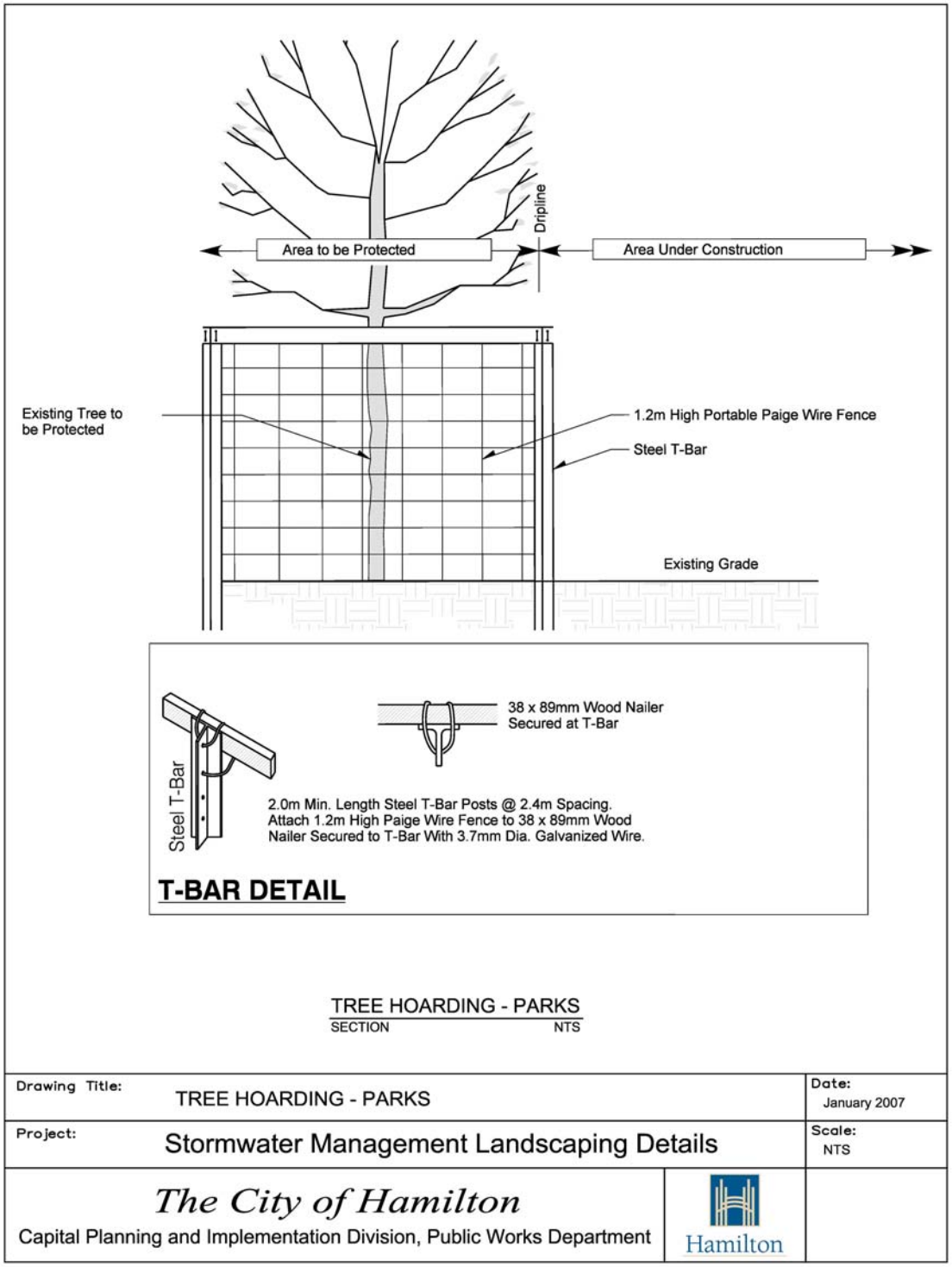


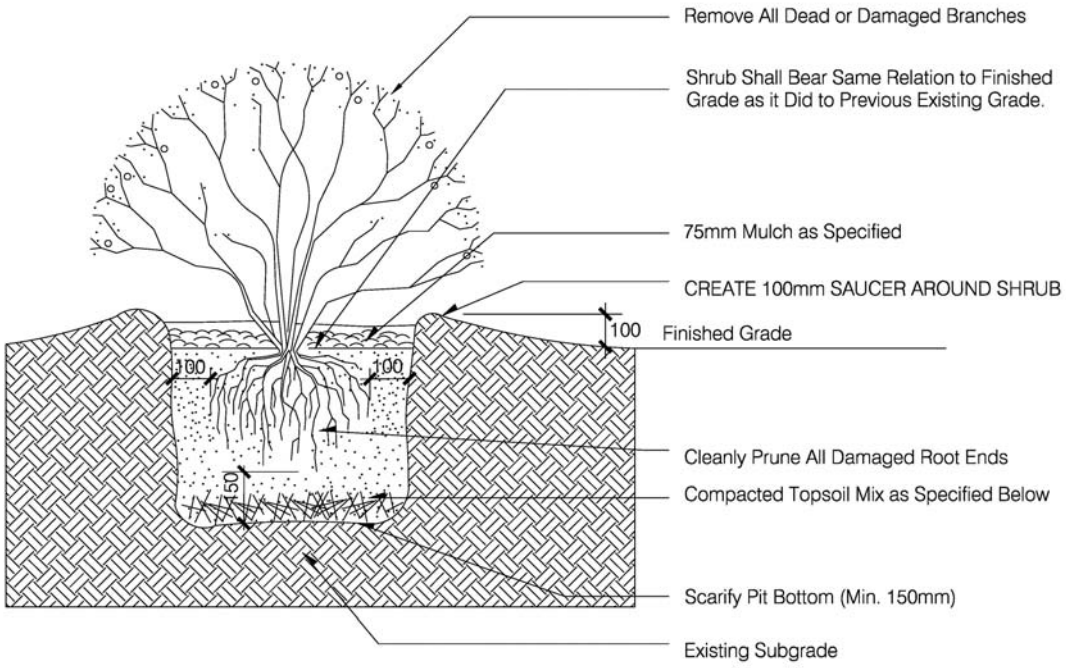
NOTES:

1. Attachment of Fence to Trees to be Preserved is Not Allowed.
2. Ensure Fence is Located Beyond the Drip Line of Trees to be Preserved.
3. Fencing to be Installed Prior to Start of Construction and Remain in Place Until the Completion of All Work.

TREE HOARDING - STREETS
SECTION NTS

Drawing Title: TREE HOARDING - STREETS		Date: January 2007
Project: Stormwater Management Landscaping Details		Scale: NTS
The City of Hamilton Capital Planning and Implementation Division, Public Works Department	Hamilton	


Dripline
Area to be Protected
Area Under Construction
Existing Tree to be Protected
1.2m High Portable Paige Wire Fence
Steel T-Bar
Existing Grade
38 x 89mm Wood Nailer Secured at T-Bar
Steel T-Bar
2.0m Min. Length Steel T-Bar Posts @ 2.4m Spacing.
Attach 1.2m High Paige Wire Fence to 38 x 89mm Wood Nailer Secured to T-Bar With 3.7mm Dia. Galvanized Wire.
T-BAR DETAIL
TREE HOARDING - PARKS
SECTION NTS
Drawing Title: TREE HOARDING - PARKS
Date: January 2007
Project: Stormwater Management Landscaping Details
Scale: NTS
The City of Hamilton
Capital Planning and Implementation Division, Public Works Department
Hamilton

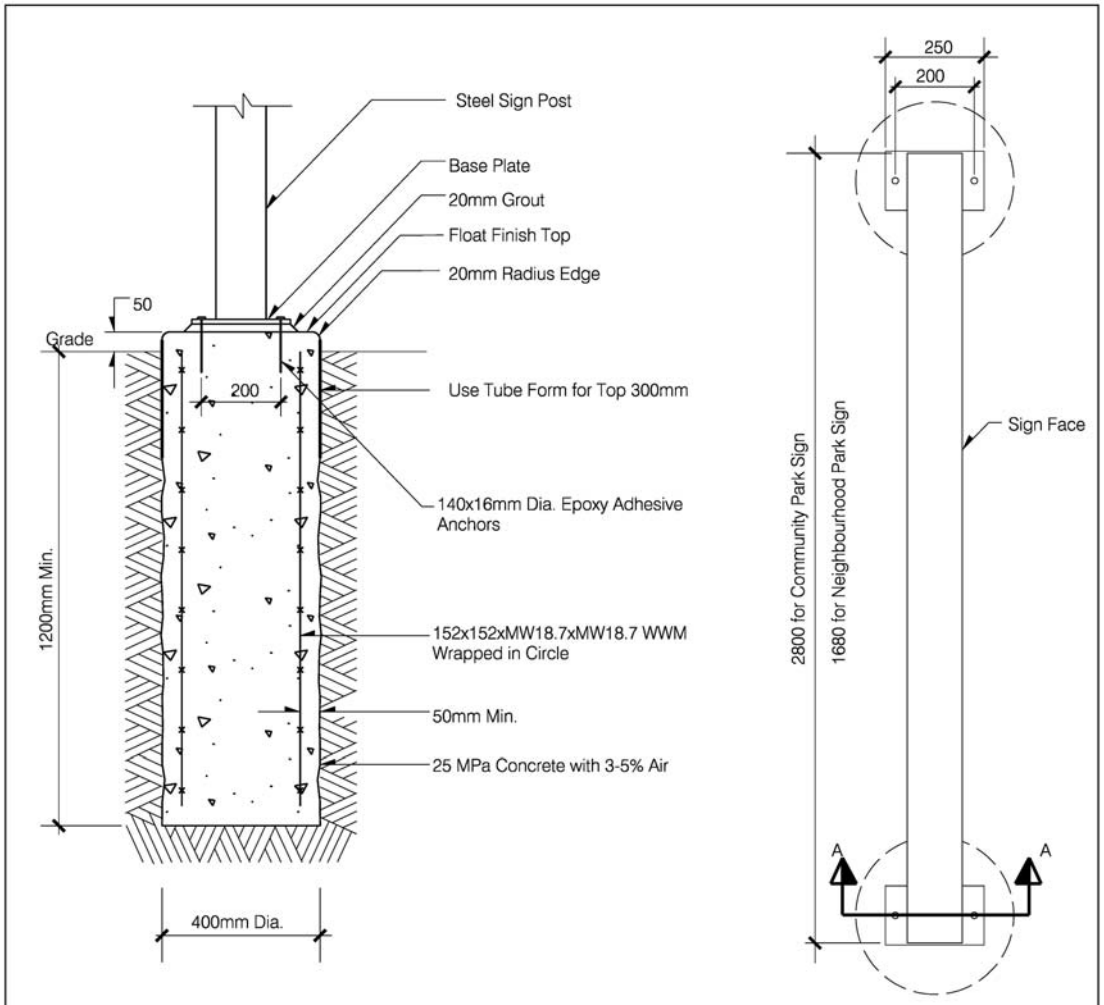


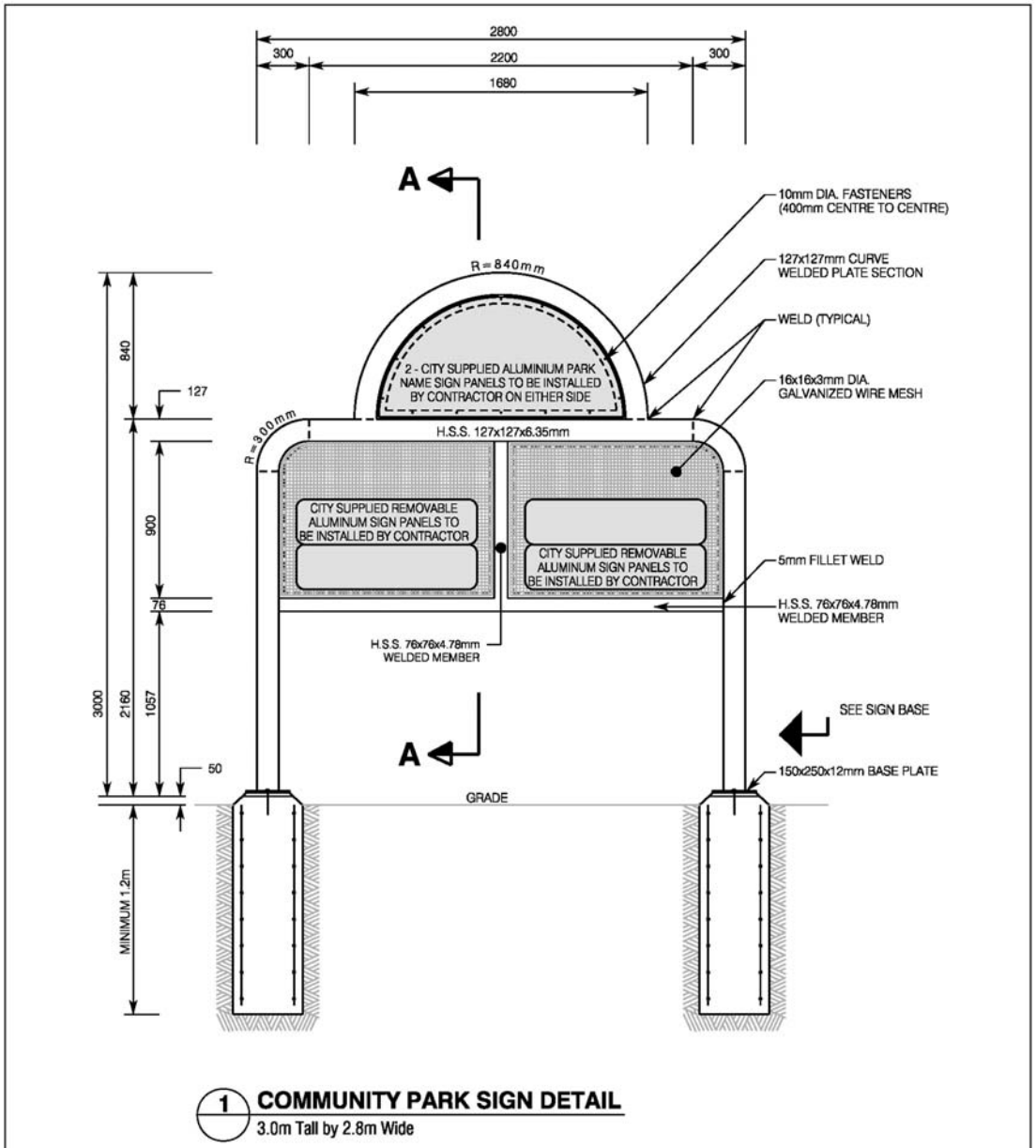
NOTES:

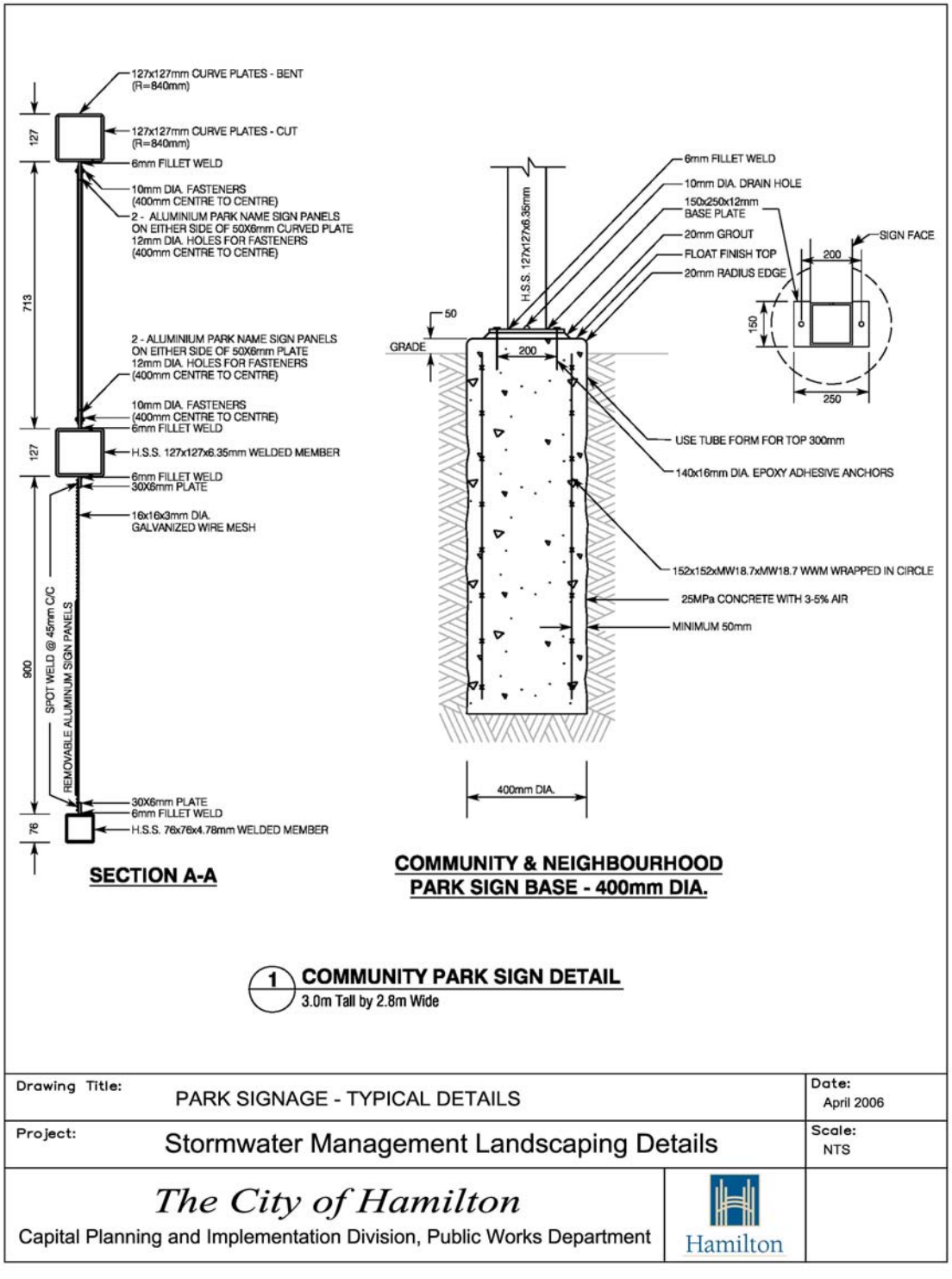
1. See Specifications for Top Soil Mix.
2. Water Thoroughly After Installation
3. Excavate Entire Shrub Bed as Shown on Plans.
4. Planting Pit Shall be 2X the Width of the Root Ball.

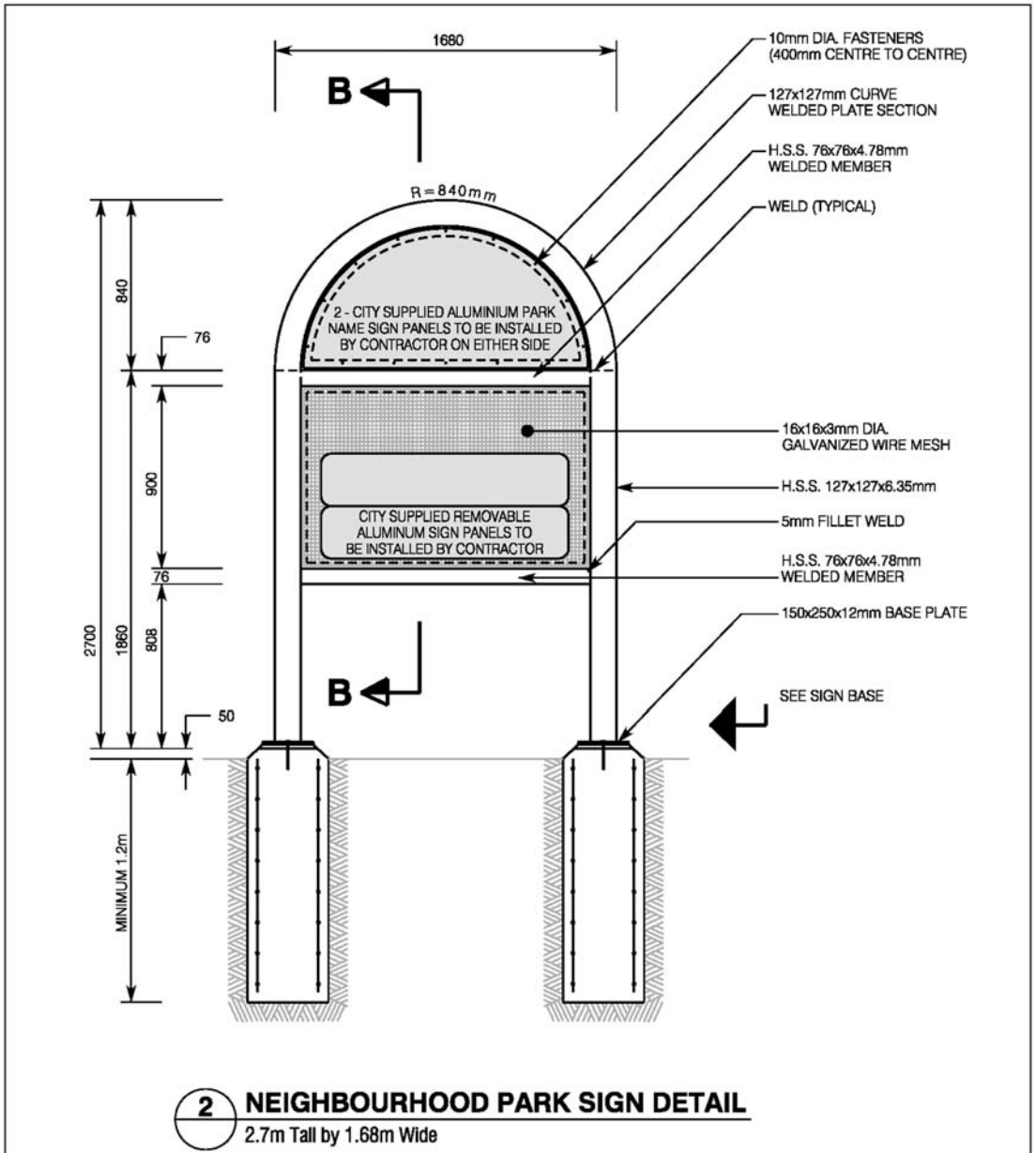
BARE ROOT SHRUB PLANTING
SECTION NTS

Drawing Title: BARE ROOT SHRUB PLANTING		Date: April 2007
Project: Stormwater Management Landscaping Details		Scale: NTS
The City of Hamilton Capital Planning and Implementation Division, Public Works Department	Hamilton	


Steel Sign Post
Base Plate
20mm Grout
Float Finish Top
20mm Radius Edge
50
Grade
200
Use Tube Form for Top 300mm
140x16mm Dia. Epoxy Adhesive Anchors
1200mm Min.
152x152xMW18.7xMW18.7 WWM Wrapped in Circle
50mm Min.
25 MPa Concrete with 3-5% Air
400mm Dia.
250
200
Sign Face
2800 for Community Park Sign
1680 for Neighbourhood Park Sign
A
A
SECTION A-A
PLAN
Notes:
1. 2 Footings Per Sign.
2. Install Sign Level and Plumb in All Directions.
3. Remove All Tube Forms After Concrete is Set.
NEIGHBOURHOOD AND COMMUNITY PARK SIGN FOOTING
SECTION
NTS
Drawing Title:
NEIGHBOURHOOD AND COMMUNITY PARK SIGN FOOTING
Date:
March 2007
Project:
Stormwater Management Landscaping Details
Scale:
NTS
The City of Hamilton
Capital Planning and Implementation Division, Public Works Department
Hamilton

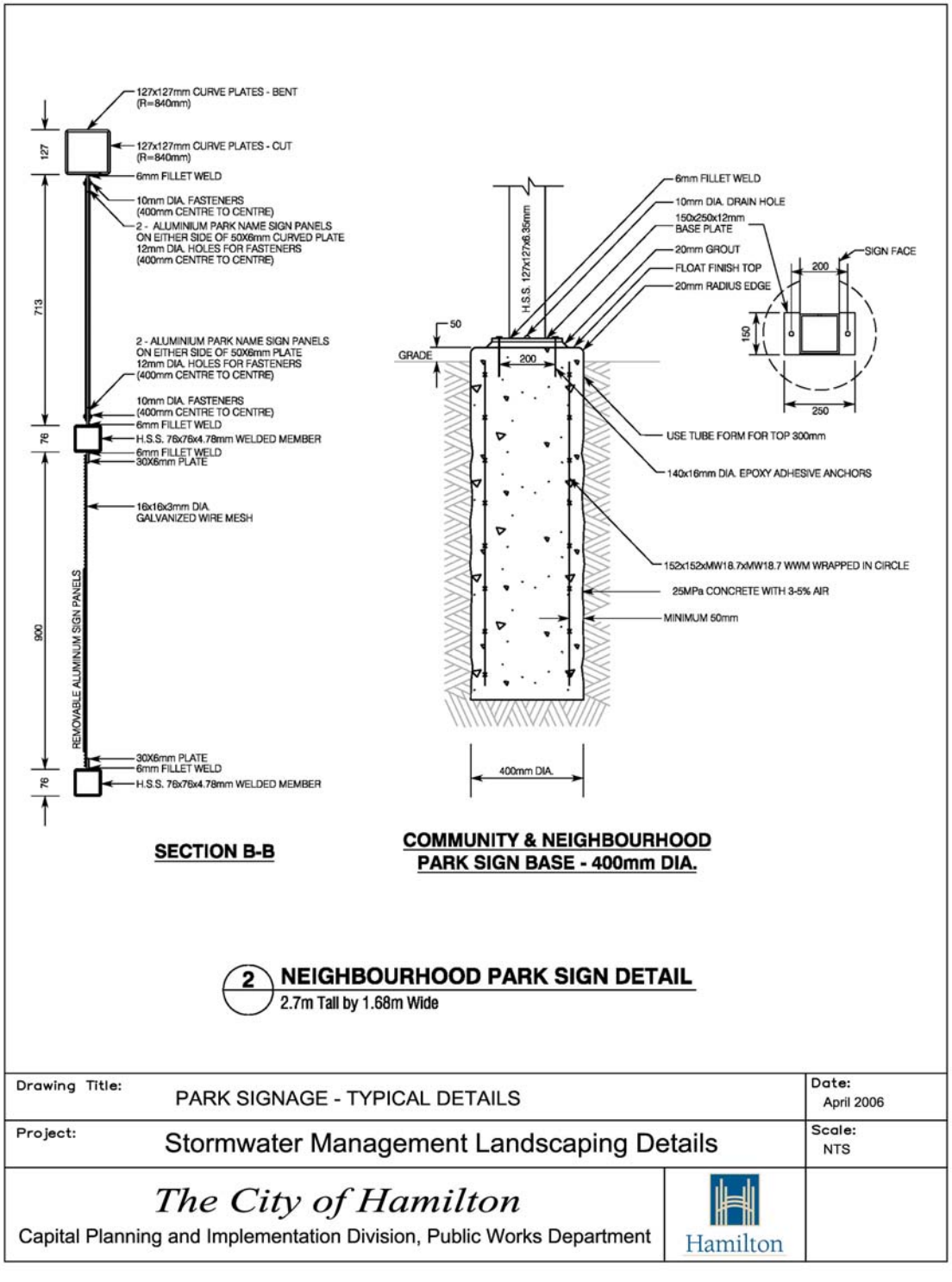

2800
300
2200
300
1680
A
10mm DIA. FASTENERS
(400mm CENTRE TO CENTRE)
127x127mm CURVE
WELDED PLATE SECTION
WELD (TYPICAL)
16x16x3mm DIA.
GALVANIZED WIRE MESH
R = 840mm
2 - CITY SUPPLIED ALUMINIUM PARK
NAME SIGN PANELS TO BE INSTALLED
BY CONTRACTOR ON EITHER SIDE
H.S.S. 127x127x6.35mm
R = 300mm
CITY SUPPLIED REMOVABLE
ALUMINUM SIGN PANELS TO
BE INSTALLED BY CONTRACTOR
CITY SUPPLIED REMOVABLE
ALUMINUM SIGN PANELS TO
BE INSTALLED BY CONTRACTOR
5mm FILLET WELD
H.S.S. 76x76x4.78mm
WELDED MEMBER
H.S.S. 76x76x4.78mm
WELDED MEMBER
840
127
900
76
3000
2160
1057
50
MINIMUM 1.2m
A
SEE SIGN BASE
150x250x12mm BASE PLATE
GRADE
1
COMMUNITY PARK SIGN DETAIL
3.0m Tall by 2.8m Wide
Drawing Title:
PARK SIGNAGE - TYPICAL DETAILS
Date:
April 2006
Project:
Stormwater Management Landscaping Details
Scale:
NTS
The City of Hamilton
Capital Planning and Implementation Division, Public Works Department
Hamilton

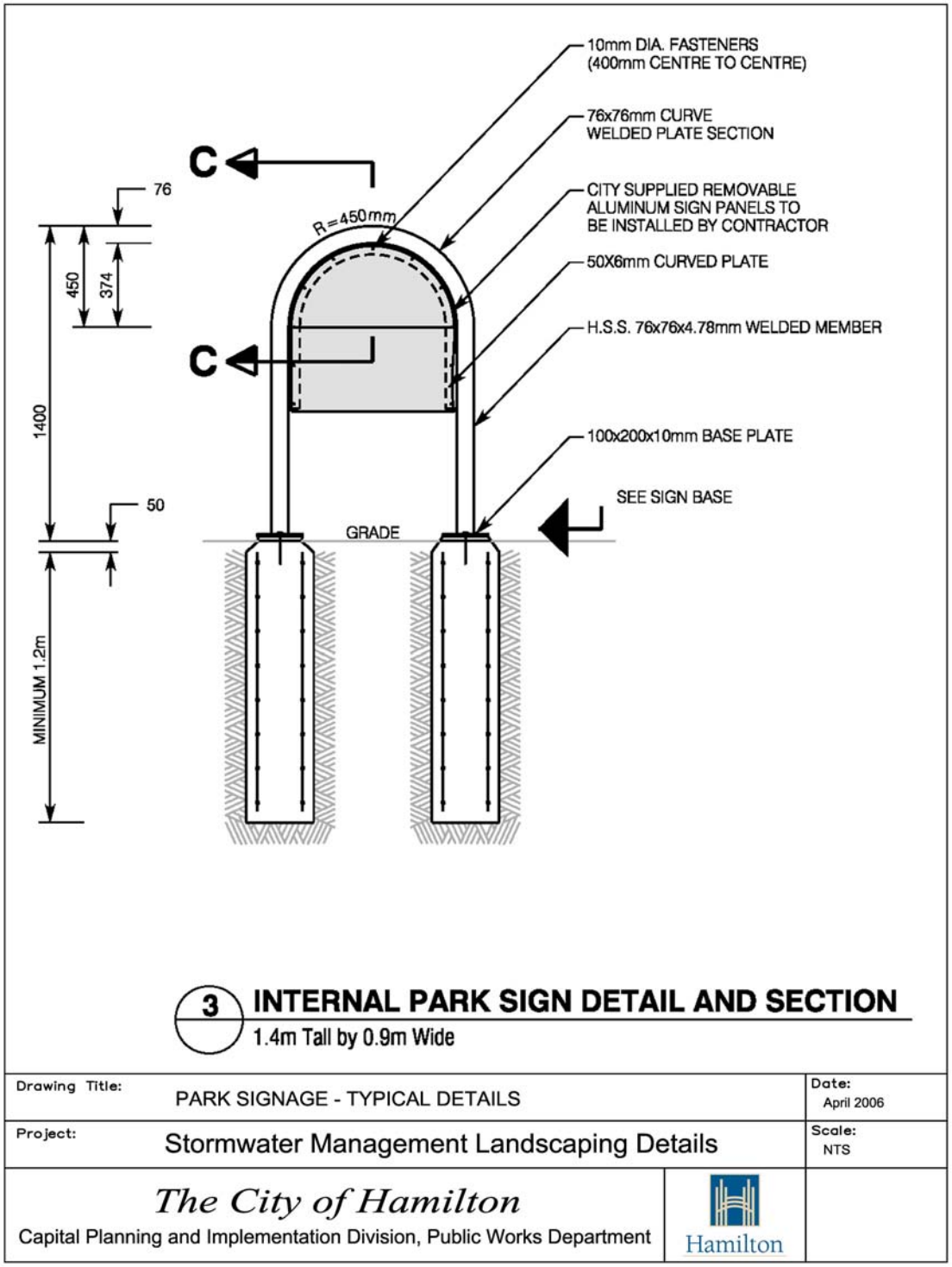

127x127mm CURVE PLATES - BENT (R=840mm)
127x127mm CURVE PLATES - CUT (R=840mm)
6mm FILLET WELD
10mm DIA. FASTENERS (400mm CENTRE TO CENTRE)
2 - ALUMINIUM PARK NAME SIGN PANELS ON EITHER SIDE OF 50X6mm CURVED PLATE 12mm DIA. HOLES FOR FASTENERS (400mm CENTRE TO CENTRE)
2 - ALUMINIUM PARK NAME SIGN PANELS ON EITHER SIDE OF 50X6mm PLATE 12mm DIA. HOLES FOR FASTENERS (400mm CENTRE TO CENTRE)
10mm DIA. FASTENERS (400mm CENTRE TO CENTRE)
6mm FILLET WELD
H.S.S. 127x127x6.35mm WELDED MEMBER
6mm FILLET WELD
30X6mm PLATE
16x16x3mm DIA. GALVANIZED WIRE MESH
SPOT WELD @ 45mm C/C
REMOVABLE ALUMINUM SIGN PANELS
30X6mm PLATE
6mm FILLET WELD
H.S.S. 76x76x4.78mm WELDED MEMBER
127
713
127
900
76
SECTION A-A
6mm FILLET WELD
10mm DIA. DRAIN HOLE
150x250x12mm BASE PLATE
20mm GROUT
FLOAT FINISH TOP
20mm RADIUS EDGE
SIGN FACE
H.S.S. 127x127x6.35mm
50
GRADE
200
150
250
USE TUBE FORM FOR TOP 300mm
140x16mm DIA. EPOXY ADHESIVE ANCHORS
152x152xMW18.7xMW18.7 WWM WRAPPED IN CIRCLE
25MPa CONCRETE WITH 3-5% AIR
MINIMUM 50mm
400mm DIA.
COMMUNITY & NEIGHBOURHOOD PARK SIGN BASE - 400mm DIA.
1 COMMUNITY PARK SIGN DETAIL
3.0m Tall by 2.8m Wide
Drawing Title: PARK SIGNAGE - TYPICAL DETAILS
Date: April 2006
Project: Stormwater Management Landscaping Details
Scale: NTS
The City of Hamilton
Capital Planning and Implementation Division, Public Works Department
Hamilton

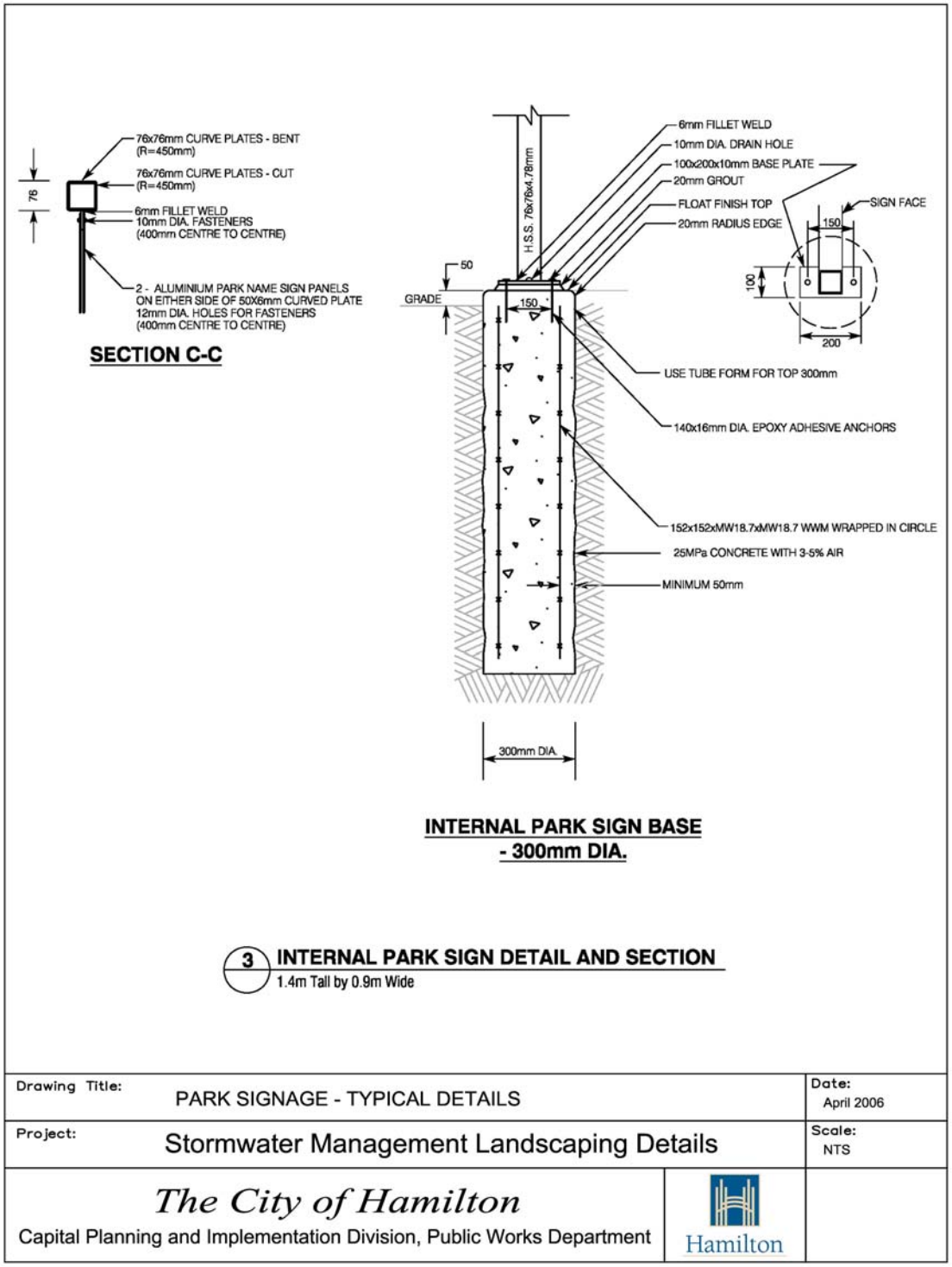


2 NEIGHBOURHOOD PARK SIGN DETAIL
2.7m Tall by 1.68m Wide

Drawing Title:	PARK SIGNAGE - TYPICAL DETAILS	Date: April 2006
Project:	Stormwater Management Landscaping Details	Scale: NTS
The City of Hamilton Capital Planning and Implementation Division, Public Works Department	Hamilton	


127x127mm CURVE PLATES - BENT (R=840mm)
127x127mm CURVE PLATES - CUT (R=840mm)
6mm FILLET WELD
10mm DIA. FASTENERS (400mm CENTRE TO CENTRE)
2 - ALUMINIUM PARK NAME SIGN PANELS ON EITHER SIDE OF 50X6mm CURVED PLATE 12mm DIA. HOLES FOR FASTENERS (400mm CENTRE TO CENTRE)
2 - ALUMINIUM PARK NAME SIGN PANELS ON EITHER SIDE OF 50X6mm PLATE 12mm DIA. HOLES FOR FASTENERS (400mm CENTRE TO CENTRE)
10mm DIA. FASTENERS (400mm CENTRE TO CENTRE)
6mm FILLET WELD
H.S.S. 76x76x4.78mm WELDED MEMBER
6mm FILLET WELD
30X6mm PLATE
16x16x3mm DIA. GALVANIZED WIRE MESH
REMOVABLE ALUMINUM SIGN PANELS
30X6mm PLATE
6mm FILLET WELD
H.S.S. 76x76x4.78mm WELDED MEMBER
127
713
76
900
76
SECTION B-B
6mm FILLET WELD
10mm DIA. DRAIN HOLE
150x250x12mm BASE PLATE
20mm GROUT
FLOAT FINISH TOP
20mm RADIUS EDGE
H.S.S. 127x127x6.35mm
SIGN FACE
200
150
250
50
GRADE
200
USE TUBE FORM FOR TOP 300mm
140x16mm DIA. EPOXY ADHESIVE ANCHORS
152x152xMW18.7xMW18.7 WWM WRAPPED IN CIRCLE
25MPa CONCRETE WITH 3-5% AIR
MINIMUM 50mm
400mm DIA.
COMMUNITY & NEIGHBOURHOOD PARK SIGN BASE - 400mm DIA.
2 NEIGHBOURHOOD PARK SIGN DETAIL
2.7m Tall by 1.68m Wide
Drawing Title: PARK SIGNAGE - TYPICAL DETAILS
Date: April 2006
Project: Stormwater Management Landscaping Details
Scale: NTS
The City of Hamilton
Capital Planning and Implementation Division, Public Works Department
Hamilton


10mm DIA. FASTENERS
(400mm CENTRE TO CENTRE)
76x76mm CURVE
WELDED PLATE SECTION
CITY SUPPLIED REMOVABLE
ALUMINUM SIGN PANELS TO
BE INSTALLED BY CONTRACTOR
50X6mm CURVED PLATE
H.S.S. 76x76x4.78mm WELDED MEMBER
100x200x10mm BASE PLATE
SEE SIGN BASE
GRADE
C
C
R=450mm
76
450
374
1400
50
MINIMUM 1.2m
3 INTERNAL PARK SIGN DETAIL AND SECTION
1.4m Tall by 0.9m Wide
Drawing Title: PARK SIGNAGE - TYPICAL DETAILS
Date: April 2006
Project: Stormwater Management Landscaping Details
Scale: NTS
The City of Hamilton
Capital Planning and Implementation Division, Public Works Department
Hamilton


76x76mm CURVE PLATES - BENT (R=450mm)
76x76mm CURVE PLATES - CUT (R=450mm)
76
6mm FILLET WELD
10mm DIA. FASTENERS (400mm CENTRE TO CENTRE)
2 - ALUMINIUM PARK NAME SIGN PANELS ON EITHER SIDE OF 50X6mm CURVED PLATE 12mm DIA. HOLES FOR FASTENERS (400mm CENTRE TO CENTRE)
SECTION C-C
6mm FILLET WELD
10mm DIA. DRAIN HOLE
100x200x10mm BASE PLATE
20mm GROUT
FLOAT FINISH TOP
20mm RADIUS EDGE
H.S.S. 76x76x4.78mm
SIGN FACE
150
100
200
50
GRADE
150
USE TUBE FORM FOR TOP 300mm
140x16mm DIA. EPOXY ADHESIVE ANCHORS
152x152xMW18.7xMW18.7 WWM WRAPPED IN CIRCLE
25MPa CONCRETE WITH 3-5% AIR
MINIMUM 50mm
300mm DIA.
INTERNAL PARK SIGN BASE
- 300mm DIA.
3
INTERNAL PARK SIGN DETAIL AND SECTION
1.4m Tall by 0.9m Wide
Drawing Title:
PARK SIGNAGE - TYPICAL DETAILS
Date:
April 2006
Project:
Stormwater Management Landscaping Details
Scale:
NTS
The City of Hamilton
Capital Planning and Implementation Division, Public Works Department
Hamilton

NOTES:

CONCRETE

- CONCRETE SHALL HAVE MINIMUM 28 DAY COMPRESSIVE STRENGTH OF 25 MPa, 3-5% AIR ENTRAINMENT AND MAX. 100mm SLUMP.
- WIRE MESH REINFORCEMENT AS PER C.S.A. G 30.5 WITH MINIMUM 400 MPa YIELD STRENGTH.
- CONCRETE ANCHORS SHALL BE "HILTI HVA" OR APPROVED EQUAL, EPOXY RESIN ANCHORS INSTALLED AS PER MANUFACTURER'S SPECIFICATIONS. ANCHOR SHALL BE HOT-DIP GALVANIZED.
- CONCRETE GROUT SHALL BE "STERNSON'S M-BED SUPERFLOW" OR APPROVED EQUAL INSTALLED AS PER MANUFACTURER'S SPECIFICATIONS.

METALS

- STRUCTURAL STEEL SHALL CONFORM TO G40.21-M81, MINIMUM YIELD STRENGTH OF 300 MPa (REGULAR SHAPES) AND 350 MPa (H.S.S. SECTIONS).
- STRUCTURAL STEEL DETAILING AND CONNECTIONS AS PER CSA CAN3-S16. 1-M84.
- WELDING SHALL UTILIZE MINIMUM E480XX ELECTRODES AND BE AS PER C.S.A. W59-M1984 & W47.1-1983.
- WOVEN WIRE MESH SHALL BE MILD STEEL, 3mm dia. GALVANIZED WIRE MANUFACTURED IN A 16x16mm WOVEN, CENTRE TO CENTRE PATTERN.

METAL FINISHING

FINISHING SPECIFICATIONS I - GALVANIZING

- FINISH ALL PARK SIGN FRAMES IN THE SHOP.
- AFTER FABRICATION, GRIND SMOOTH ALL CUT EDGES, WELDS AND BURRS TO RENDER THEM SAFE. CLEAN FERROUS METALS OF ALL RUST, DIRT, OIL, GREASE AND SCALE.
- PREPARE AND HOT DIP GALVANIZE PARK SIGN FRAME, (EXCLUDING WOVEN MESH OF GALVANIZED WIRE), IN THE SHOP AS PER CSA G164-M92 (R2003). MINIMUM MASS OF ZINC COATING AS PER CSA G164-M92 (R2003).
- TOUCH UP FINISH WORK AS REQUIRED TO THE SATISFACTION OF THE CITY. APPLY ORGANIC ZINC BASED PAINT TO ALL NON-GALVANIZED FERROUS METAL SURFACES INCLUDING CUTS AND WELDS. PAINT TO BE APPROVED BY CITY AND AS PER MANUFACTURER'S SPECIFICATIONSS.
- TOP COAT ALL TOUCHED-UP AREAS WITH ALUMINIUM COLOURED PAINT TO THE SATISFACTION OF THE CITY.
- EXPOSED AND COATED AREAS SHALL BE FREE OF SCRATCHES OR DEFECTS THAT COMPROMISE CORROSION PROTECTION AND BE FREE OF ANY RUNS OR DRIPS.

METAL FINISHING CONT.

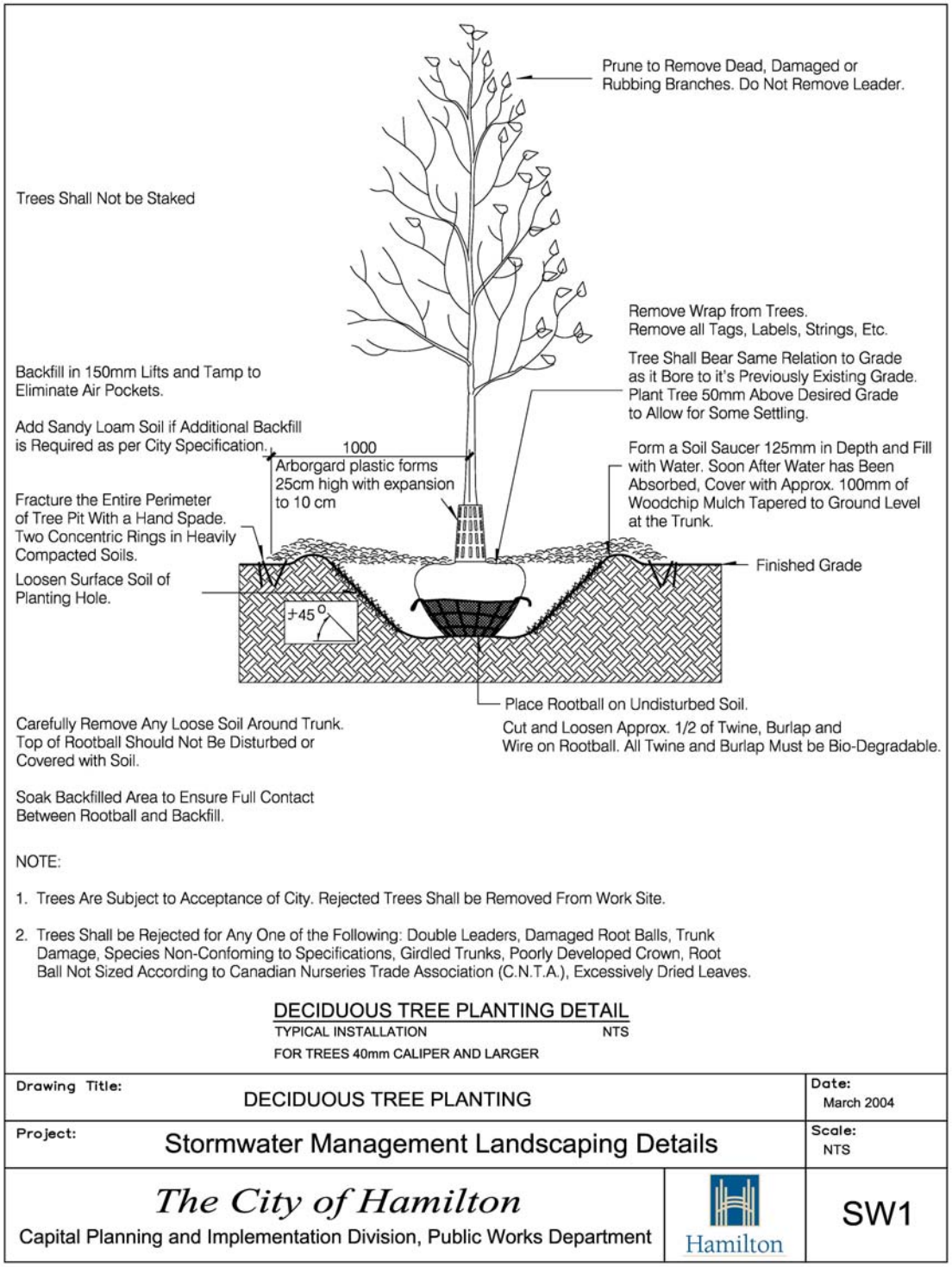
FINISHING SPECIFICATIONS II - POWDER COATING

- FINISH ALL PARK SIGN FRAMES IN THE SHOP.
- AFTER FABRICATION, PREPARE STEEL FOR APPLICATION OF POWDER COAT USING MULTI-STEP PROCESS OF ALKALINE HOT WASH, RINSE, HOT ETCHING, RINSE, HOT ZINC PHOSPHATE TREATMENT, RINSE AND HOT SEALER. SEALER SHALL BE CHROME FREE.
- APPLICATION OF POWDER COATING SHALL BE MIN. 3.0-4.0 MILS THICKNESS. GLOSSY ROUGH TEXTURED FINISH. POWDER COAT PAINT SHALL BE TGIC (TRIGLYCIDYL ICOCYANURATE) FREE.
- COLOUR SHALL BE GREEN (RAL #6001 (Emerald Green) OR PANTONE MATCHING SYSTEM #349 OR BENJAMIN MOORE INDUSTRIAL MAINTENANCE COATING #3147).
- TOUCH UP WORK AS REQUIRED TO THE SATISFACTION OF THE CITY

INSTALLATION

- SIGNS SHALL BE INSTALLED PERPENDICULAR TO TRAVEL DIRECTION OF ROAD.
- CITY SHALL FABRICATE PARK NAME SIGN PANELS. CONTRACTOR SHALL PICK UP PANELS FROM CITY SIGN SHOP AND INSTALL ON SIGN FRAME.

Drawing Title: PARK SIGNAGE - TYPICAL DETAILS		Date: April 2006
Project: Stormwater Management Landscaping Details		Scale: NTS
The City of Hamilton Capital Planning and Implementation Division, Public Works Department	Hamilton	



NOTE:

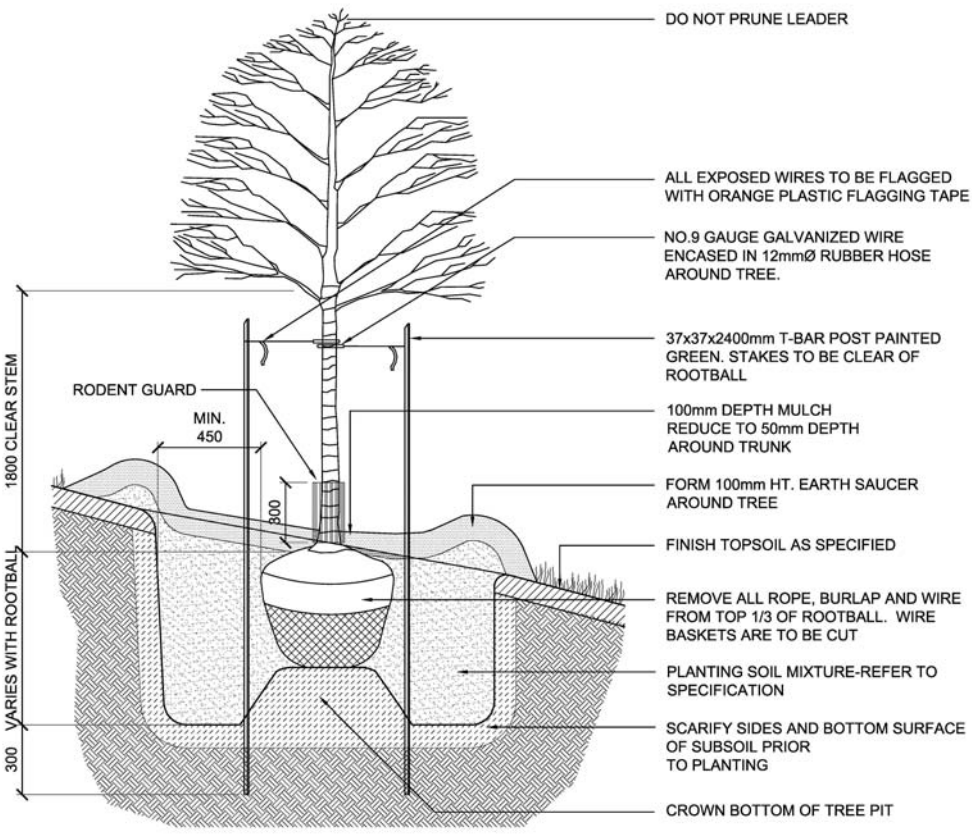
1. Trees Are Subject to Acceptance of City. Rejected Trees Shall be Removed From Work Site.
2. Trees Shall be Rejected for Any One of the Following: Double Leaders, Damaged Root Balls, Trunk Damage, Species Non-Confoming to Specifications, Girdled Trunks, Poorly Developed Crown, Root Ball Not Sized According to Canadian Nurseries Trade Association (C.N.T.A.), Excessively Dried Leaves.

DECIDUOUS TREE PLANTING DETAIL

TYPICAL INSTALLATION NTS

FOR TREES 40mm CALIPER AND LARGER

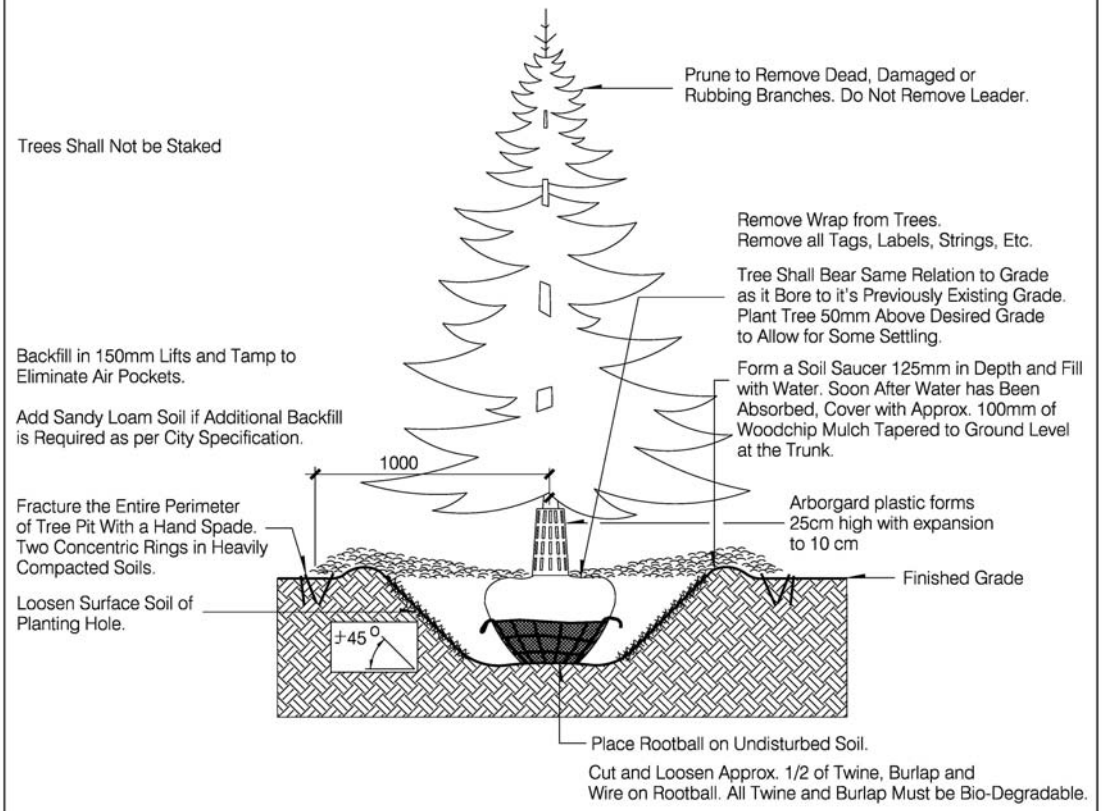
Drawing Title: DECIDUOUS TREE PLANTING		Date: March 2004
Project: Stormwater Management Landscaping Details		Scale: NTS
The City of Hamilton Capital Planning and Implementation Division, Public Works Department	Hamilton	SW1



NOTES:
1. ALL DIMENSIONS SHOWN IN MILLIMETRES
2. THIS DETAIL IS TO BE USED IN CONJUNCTION WITH SPECIFICATION SECTION:
   PLANTING
   TOPSOIL AND FINISH GRADING
3. THIS DETAIL DOES NOT REPRESENT ANY PARTICULAR TREE SPECIES
4. SET TREE 50mm HIGHER THAN ADJACENT FINISHED GRADE TO ALLOW FOR SETTLEMENT
5. TREES UNDER 70mm REQUIRE TWO STAKES. TREES 70mm CALIPER AND OVER REQUIRE THREE STAKES
6. ALL TREES GREATER THAN 70mm CAL. TO BE WRAPPED WITH BURLAP TO 1200 HEIGHT.

DECIDUOUS TREE PLANTING ON SLOPE
SECTION NTS

Drawing Title: DECIDUOUS TREE PLANTING ON SLOPE		Date: March 2004
Project: Stormwater Management Landscaping Details		Scale: NTS
The City of Hamilton Capital Planning and Implementation Division, Public Works Department	Hamilton	SW2



Carefully Remove Any Loose Soil Around Trunk. Top of Rootball Should Not Be Disturbed or Covered with Soil.

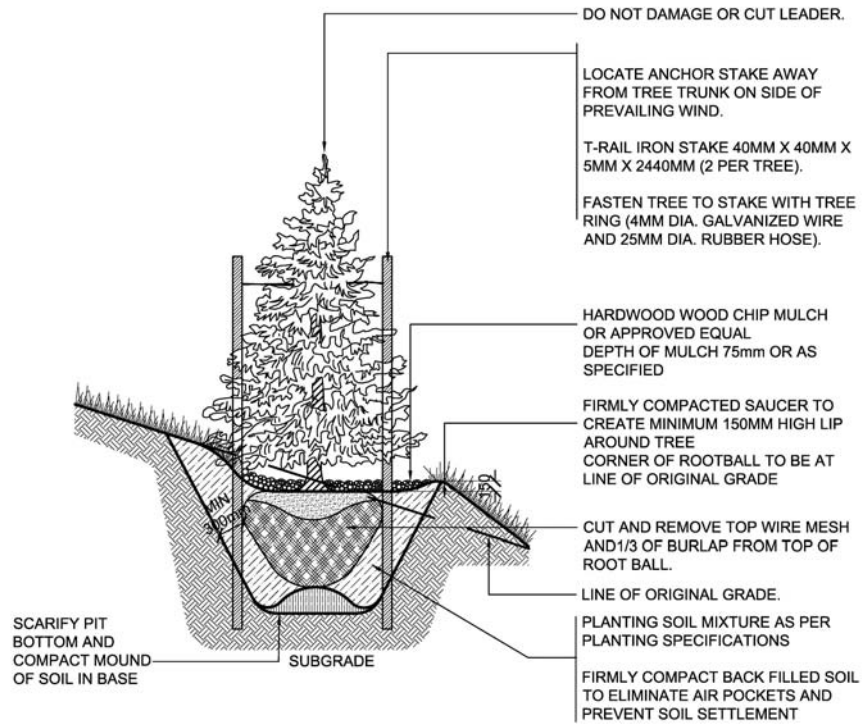
Soak Backfilled Area to Ensure Full Contact Between Rootball and Backfill.

NOTE:

1. Trees Are Subject to Acceptance of City. Rejected Trees Shall be Removed From Work Site.
2. Trees Shall be Rejected for Any One of the Following: Double Leaders, Damaged Root Balls, Trunk Damage, Species Non-Conforming to Specifications, Girdled Trunks, Poorly Developed Crown, Root Ball Not Sized According to Canadian Nurseries Trade Association (C.N.T.A.), Excessively Dried Needles.

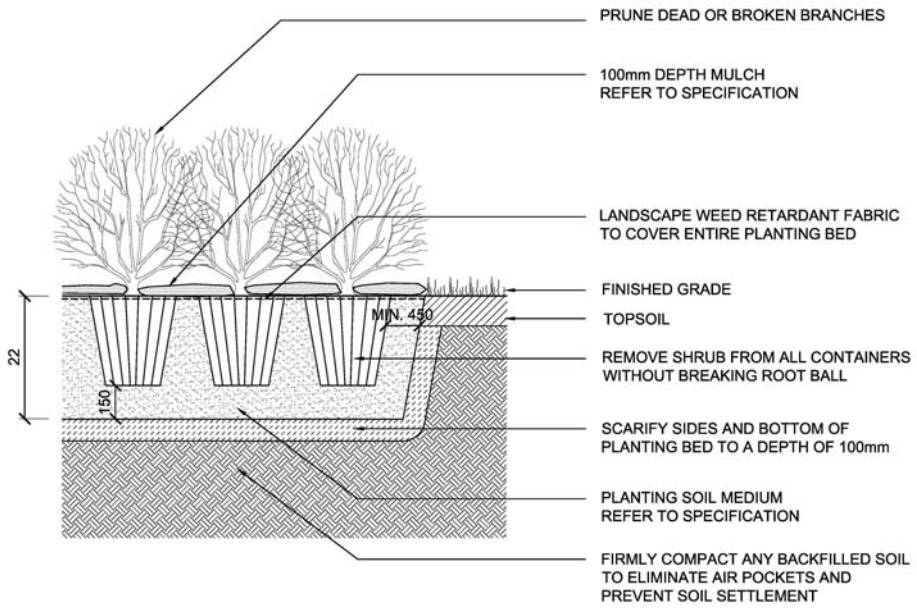
CONIFEROUS TREE
TYPICAL INSTALLATION NTS

Drawing Title: CONIFEROUS TREE PLANTING		Date: November 2006
Project: Stormwater Management Landscaping Details		Scale: NTS
The City of Hamilton Capital Planning and Implementation Division, Public Works Department	Hamilton	SW3



CONIFEROUS TREE PLANTING ON SLOPE
SECTION NTS

Drawing Title: CONIFEROUS TREE PLANTING ON SLOPE		Date: March 2004
Project: Stormwater Management Landscaping Details		Scale: NTS
The City of Hamilton Capital Planning and Implementation Division, Public Works Department	Hamilton	SW4

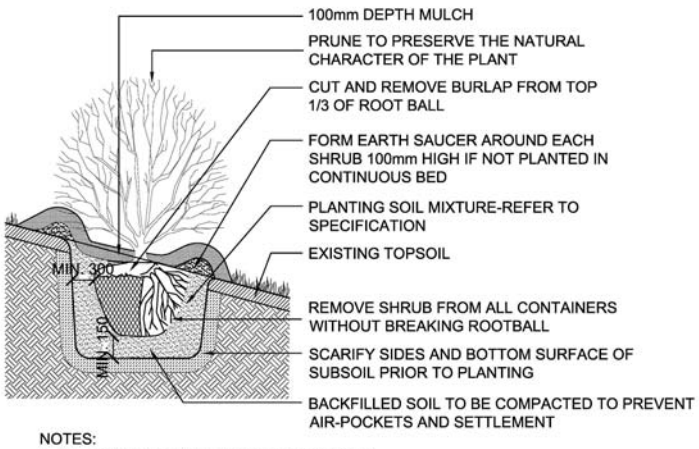


NOTES:

1. ALL DIMENSIONS SHOWN IN MILLIMETRES
2. ALL SHRUBS TO BE PLANTED IN CONTINUOUS BEDS
3. THIS DETAIL DOES NOT REPRESENT ANY PARTICULAR SHRUB SPECIES
4. THIS DETAIL IS TO BE USED IN CONJUNCTION WITH SPECIFICATION SECTION:
   PLANTING
   TOPSOIL AND FINISH GRADING

SHRUB PLANTING
SECTION NTS

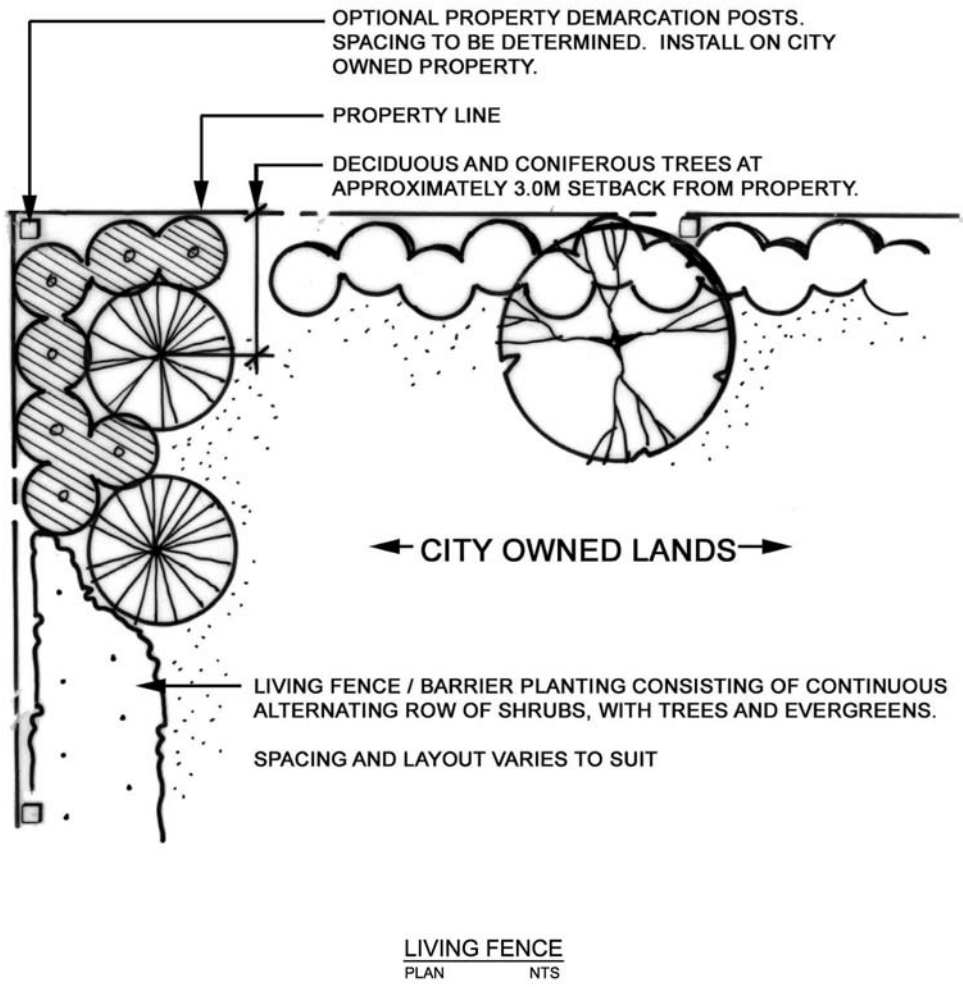
Drawing Title: SHRUB PLANTING		Date: March 2004
Project: Stormwater Management Landscaping Details		Scale: NTS
The City of Hamilton Capital Planning and Implementation Division, Public Works Department	Hamilton	SW5



NOTES:
1. ALL DIMENSIONS SHOWN IN MILLIMETRES
2. THIS DETAIL IS TO BE USED IN CONJUNCTION WITH SPECIFICATION SECTION:
   PLANTING
   TOPSOIL AND FINISH GRADE
3. THE ABOVE DETAIL DOES NOT REPRESENT ANY PARTICULAR SPECIES
4. LANDSCAPE FABRIC TO COVER ENTIRE PLANTING BED
5. ALL SHRUBS TO BE PLANTED IN CONTINUOUS BEDS
6. PLANTING METHOD ILLUSTRATED SHALL APPLY EQUALLY TO BARE ROOT STOCK AND BALLED STOCK
7. SHRUBS PLANTED IN GROUPS SHALL BE SET IN CONTINUOUS BEDS

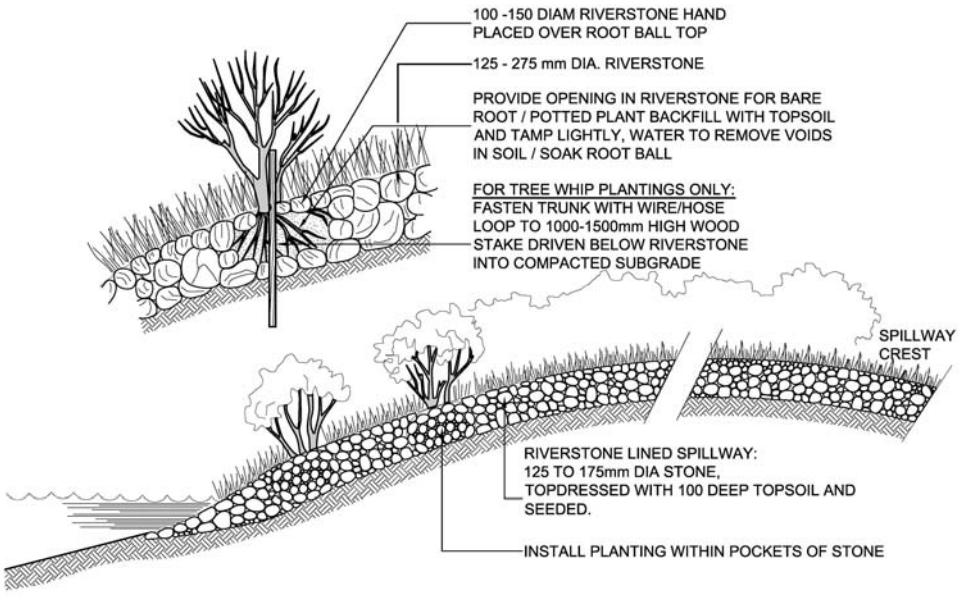
SHRUB PLANTING ON SLOPE
SECTION NTS

Drawing Title: SHRUB PLANTING ON SLOPE		Date: March 2004
Project: Stormwater Management Landscaping Details		Scale: NTS
The City of Hamilton Capital Planning and Implementation Division, Public Works Department	Hamilton	SW6



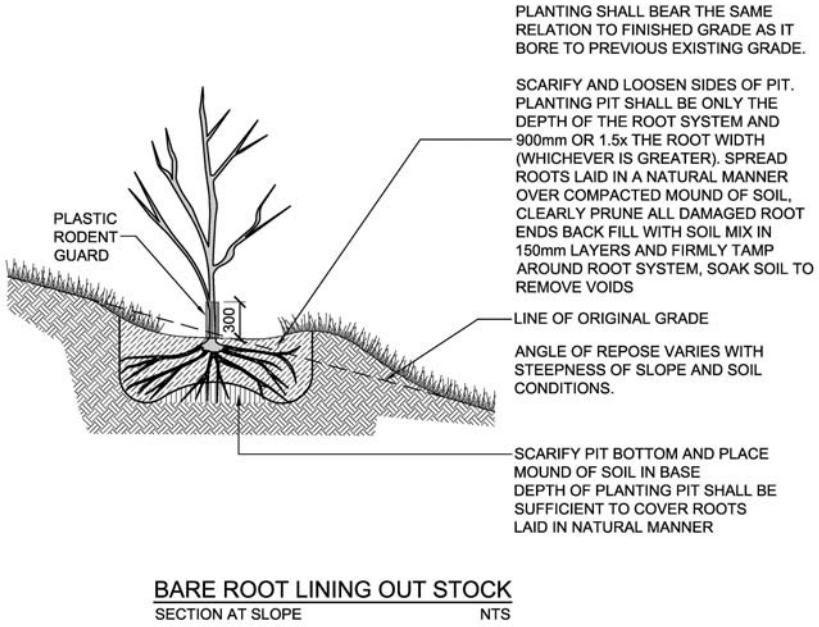
LIVING FENCE
PLAN NTS

Drawing Title: LIVING FENCE		Date: March 2004
Project: Stormwater Management Landscaping Details		Scale: NTS
The City of Hamilton Capital Planning and Implementation Division, Public Works Department	Hamilton	SW7



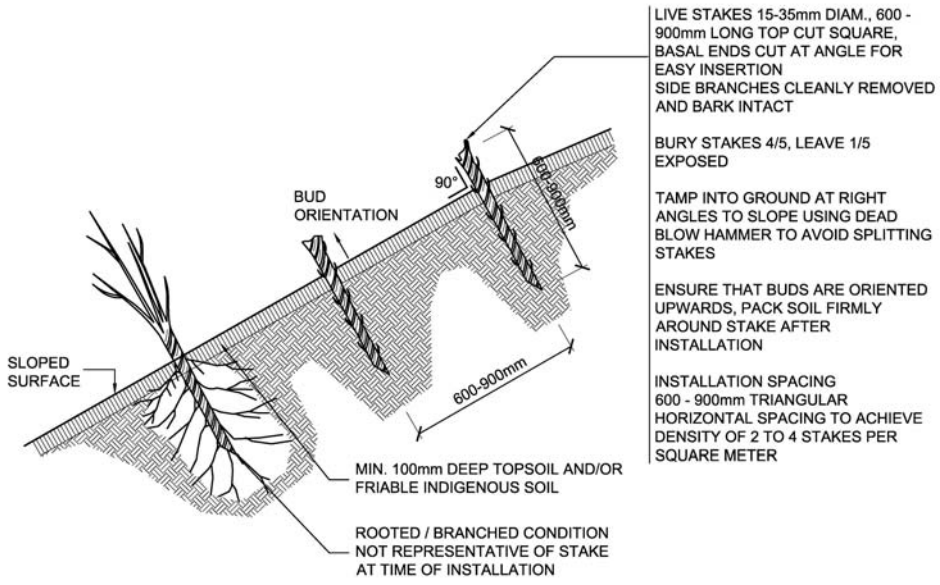
PLANTED WEIR / SPILLWAY
SECTION NTS

Drawing Title: PLANTED WEIR / SPILLWAY		Date: March 2004
Project: Stormwater Management Landscaping Details		Scale: NTS
The City of Hamilton Capital Planning and Implementation Division, Public Works Department	Hamilton	SW8



BARE ROOT LINING OUT STOCK
SECTION AT SLOPE NTS

Drawing Title: BARE ROOT LINING OUT STOCK		Date: March 2004
Project: Stormwater Management Landscaping Details		Scale: NTS
The City of Hamilton Capital Planning and Implementation Division, Public Works Department	Hamilton	SW9



LIVE STAKE PLANTING
SECTION NTS

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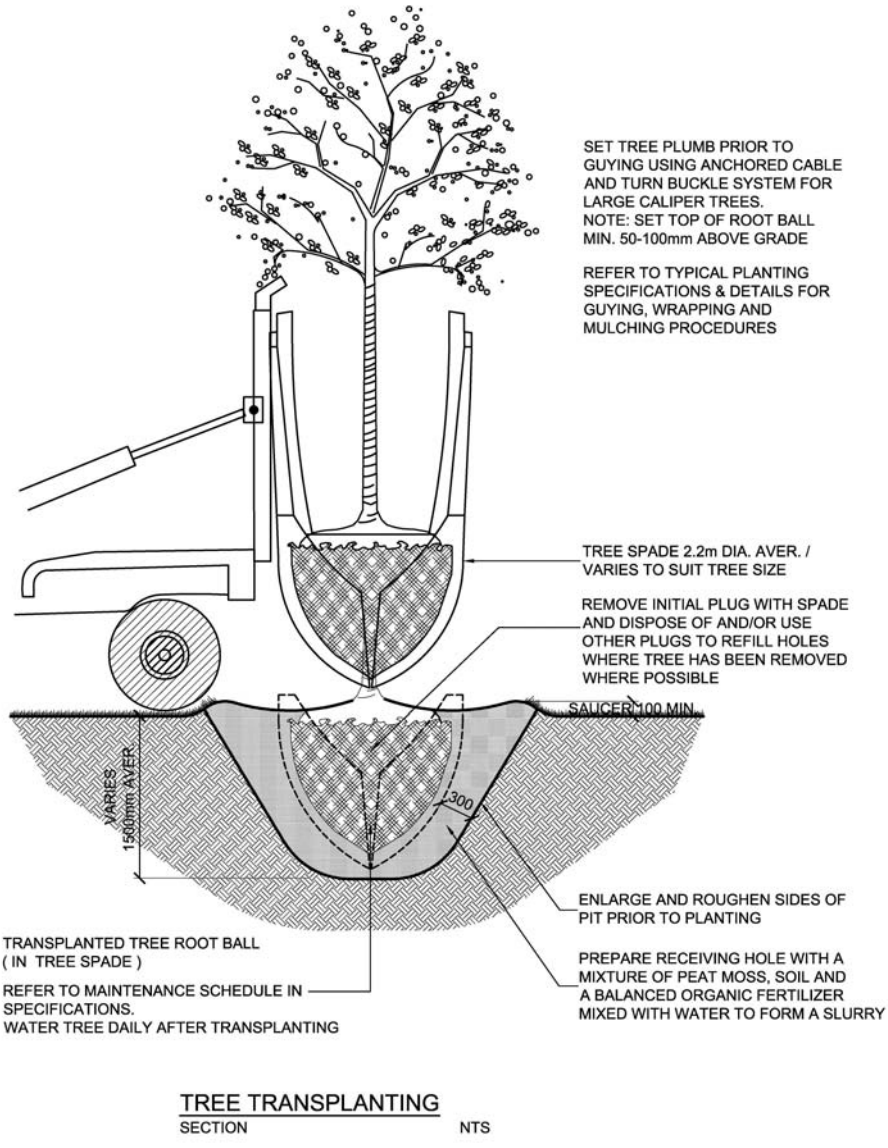
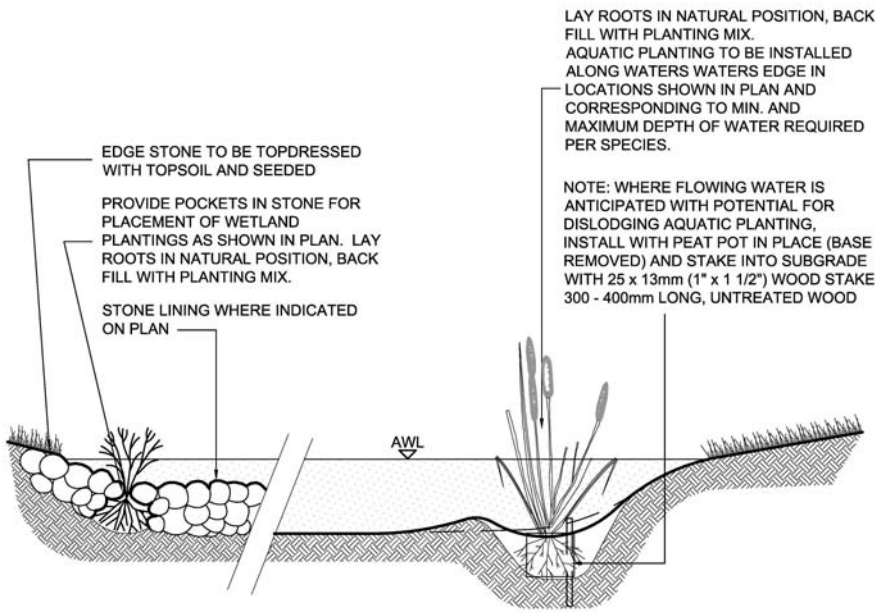
Project: Stormwater Management Landscaping Details		Scale: NTS
The City of Hamilton Capital Planning and Implementation Division, Public Works Department	Hamilton	SW10



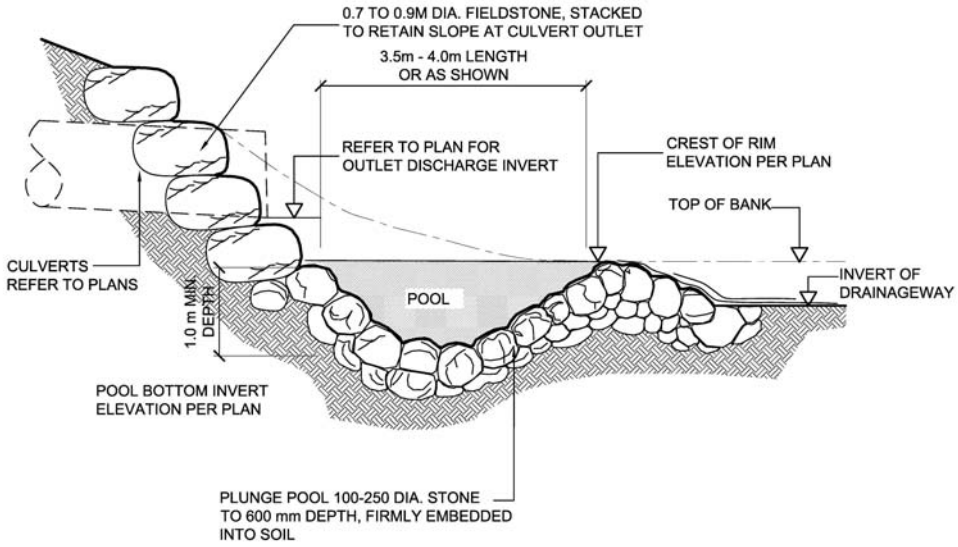
TREE TRANSPLANTING
SECTION NTS

Drawing Title: TREE TRANSPLANTING		Date: March 2004
Project: Stormwater Management Landscaping Details		Scale: NTS
The City of Hamilton Capital Planning and Implementation Division, Public Works Department	Hamilton	SW11



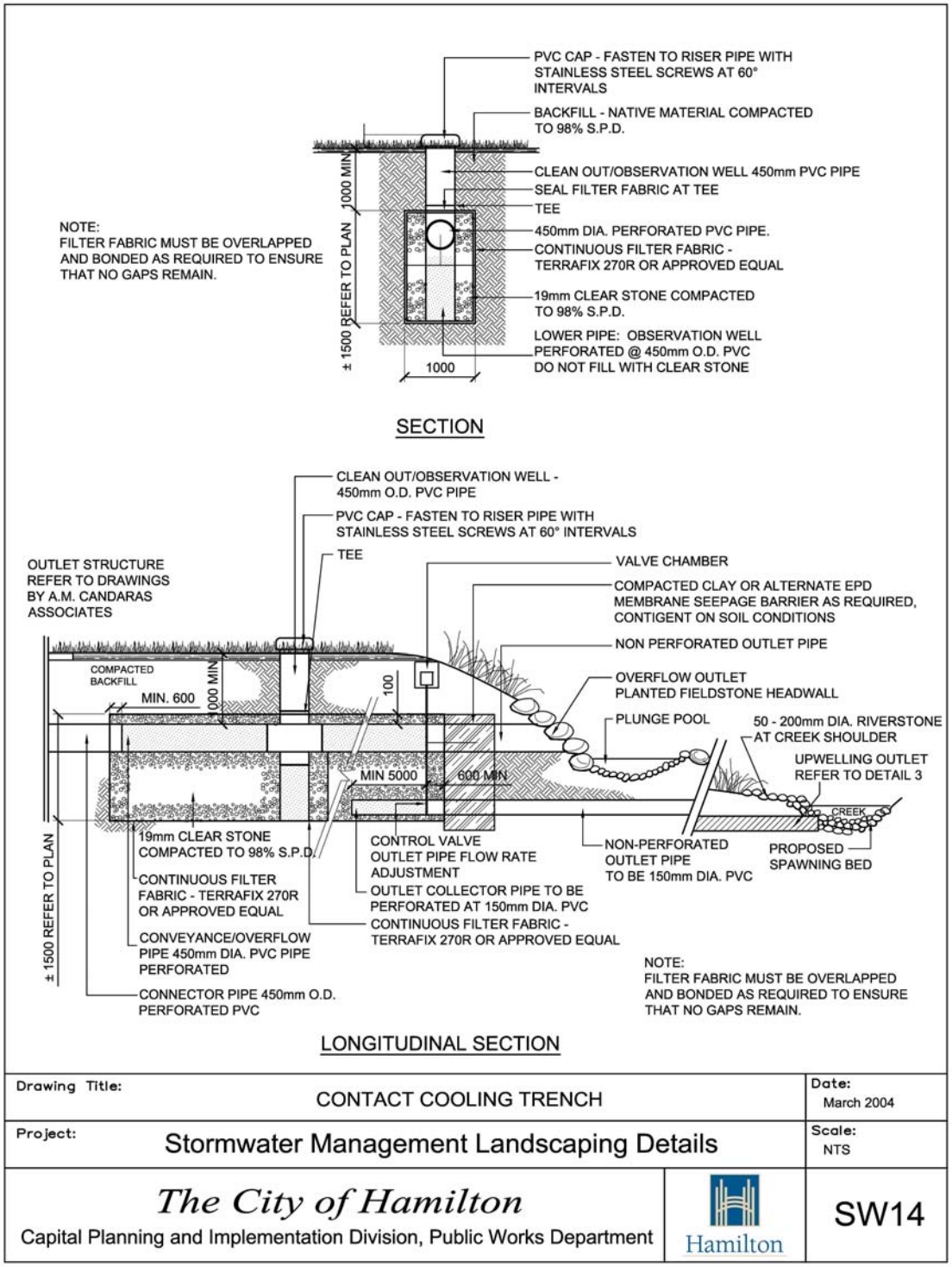
AQUATIC PLANTING
SECTION NTS

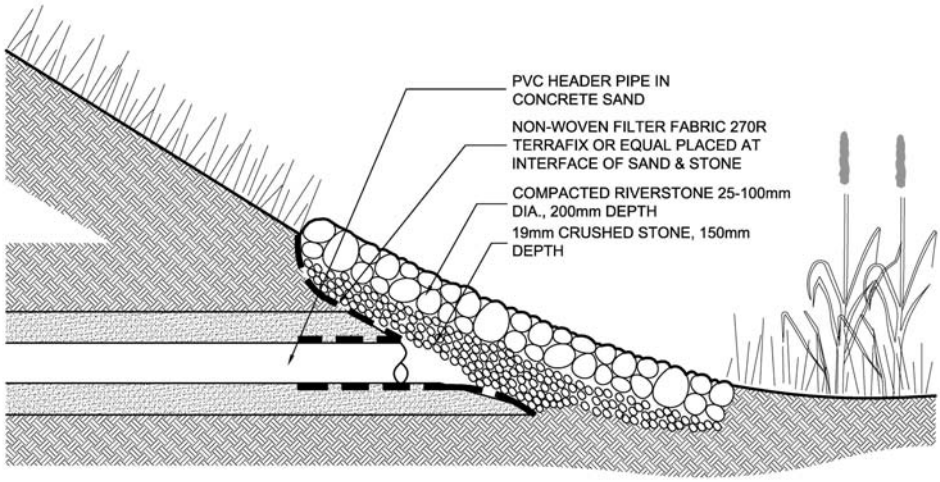
Drawing Title: AQUATIC PLANTING		Date: March 2004
Project: Stormwater Management Landscaping Details		Scale: NTS
The City of Hamilton Capital Planning and Implementation Division, Public Works Department	Hamilton	SW12



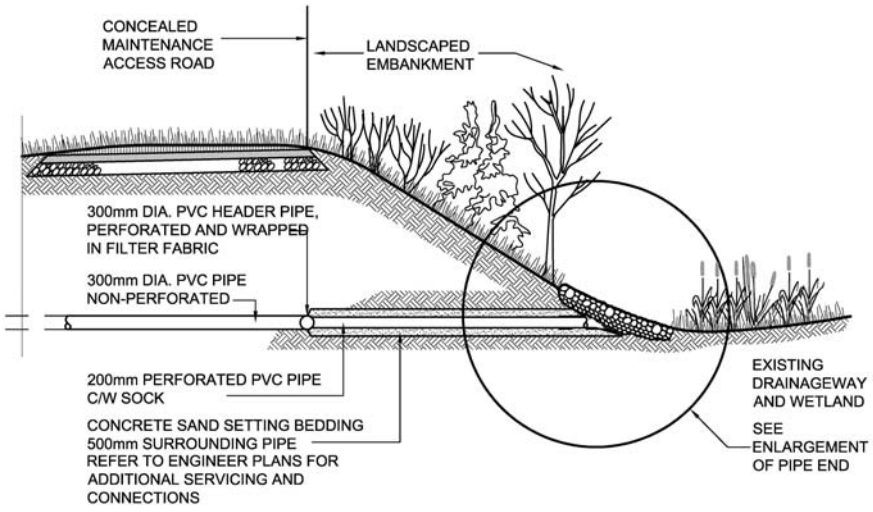
PLUNGE POOL
SECTION NTS

Drawing Title: PLUNGE POOL		Date: March 2004
Project: Stormwater Management Landscaping Details		Scale: NTS
The City of Hamilton Capital Planning and Implementation Division, Public Works Department	Hamilton	SW13


PVC CAP - FASTEN TO RISER PIPE WITH STAINLESS STEEL SCREWS AT 60° INTERVALS
BACKFILL - NATIVE MATERIAL COMPACTED TO 98% S.P.D.
CLEAN OUT/OBSERVATION WELL 450mm PVC PIPE
SEAL FILTER FABRIC AT TEE
TEE
450mm DIA. PERFORATED PVC PIPE.
CONTINUOUS FILTER FABRIC - TERRAFIX 270R OR APPROVED EQUAL
19mm CLEAR STONE COMPACTED TO 98% S.P.D.
LOWER PIPE: OBSERVATION WELL PERFORATED @ 450mm O.D. PVC DO NOT FILL WITH CLEAR STONE
NOTE:
FILTER FABRIC MUST BE OVERLAPPED AND BONDED AS REQUIRED TO ENSURE THAT NO GAPS REMAIN.
1000 MIN
± 1500 REFER TO PLAN
1000
SECTION
CLEAN OUT/OBSERVATION WELL - 450mm O.D. PVC PIPE
PVC CAP - FASTEN TO RISER PIPE WITH STAINLESS STEEL SCREWS AT 60° INTERVALS
TEE
VALVE CHAMBER
OUTLET STRUCTURE REFER TO DRAWINGS BY A.M. CANDARAS ASSOCIATES
COMPACTED BACKFILL
MIN. 600
1000 MIN
100
COMPACTED CLAY OR ALTERNATE EPD MEMBRANE SEEPAGE BARRIER AS REQUIRED, CONTIGENT ON SOIL CONDITIONS
NON PERFORATED OUTLET PIPE
OVERFLOW OUTLET PLANTED FIELDSTONE HEADWALL
PLUNGE POOL
50 - 200mm DIA. RIVERSTONE AT CREEK SHOULDER
UPWELLING OUTLET REFER TO DETAIL 3
MIN 5000
600 MIN
CREEK
19mm CLEAR STONE COMPACTED TO 98% S.P.D.
CONTINUOUS FILTER FABRIC - TERRAFIX 270R OR APPROVED EQUAL
CONVEYANCE/OVERFLOW PIPE 450mm DIA. PVC PIPE PERFORATED
CONNECTOR PIPE 450mm O.D. PERFORATED PVC
± 1500 REFER TO PLAN
CONTROL VALVE OUTLET PIPE FLOW RATE ADJUSTMENT
OUTLET COLLECTOR PIPE TO BE PERFORATED AT 150mm DIA. PVC
CONTINUOUS FILTER FABRIC - TERRAFIX 270R OR APPROVED EQUAL
NON-PERFORATED OUTLET PIPE TO BE 150mm DIA. PVC
PROPOSED SPAWNING BED
NOTE:
FILTER FABRIC MUST BE OVERLAPPED AND BONDED AS REQUIRED TO ENSURE THAT NO GAPS REMAIN.
LONGITUDINAL SECTION
Drawing Title: CONTACT COOLING TRENCH
Date: March 2004
Project: Stormwater Management Landscaping Details
Scale: NTS
The City of Hamilton
Capital Planning and Implementation Division, Public Works Department
Hamilton
SW14



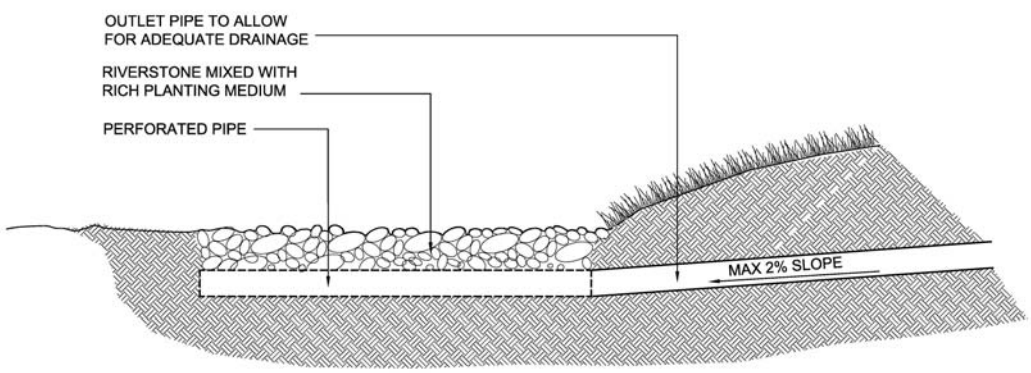
PIPE END DETAIL



SEEPAGE OUTLET SYSTEM
SECTION NTS

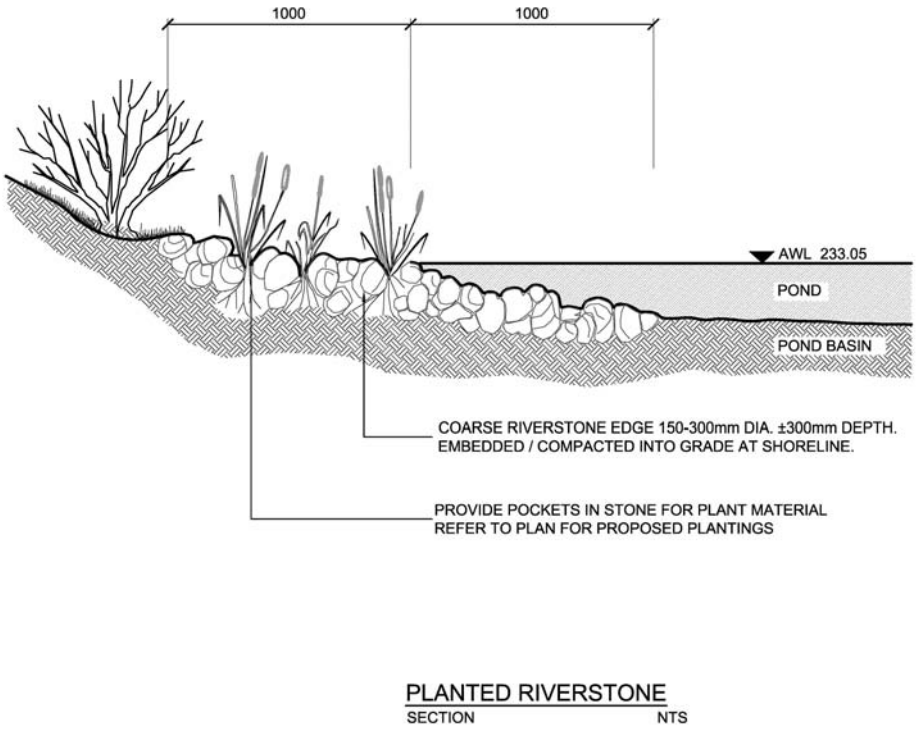
Drawing Title: SEEPAGE OUTLET		Date: March 2004
Project: Stormwater Management Landscaping Details		Scale: NTS
The City of Hamilton Capital Planning and Implementation Division, Public Works Department	Hamilton	SW15

NOTE:
CHANGE IN ELEVATION MUST PROVIDE SUFFICIENT HEAD TO SURCHARGE THE UPWELLING PIPE



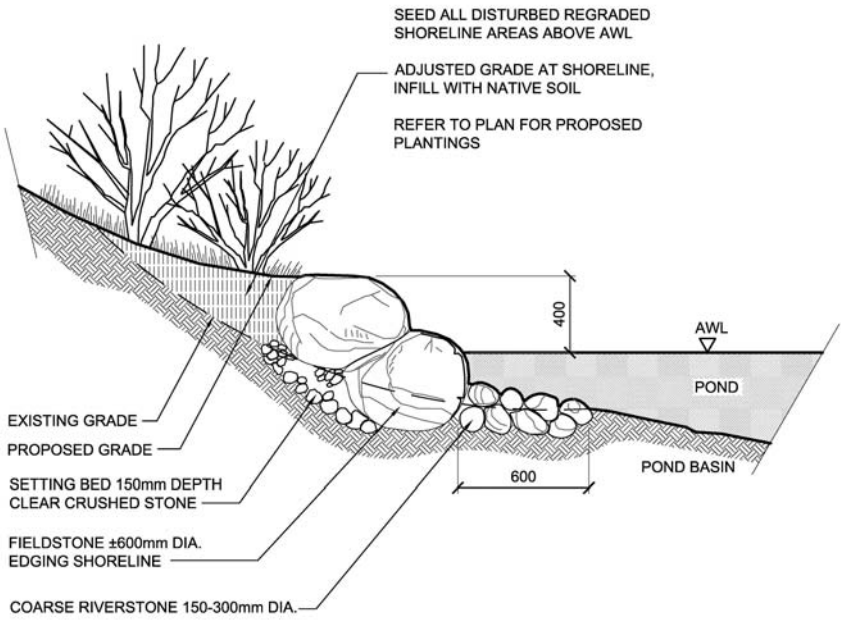
UPWELLING OUTLET
SECTION NTS

Drawing Title: UPWELLING OUTLET		Date: March 2004
Project: Stormwater Management Landscaping Details		Scale: NTS
The City of Hamilton Capital Planning and Implementation Division, Public Works Department	Hamilton	SW16



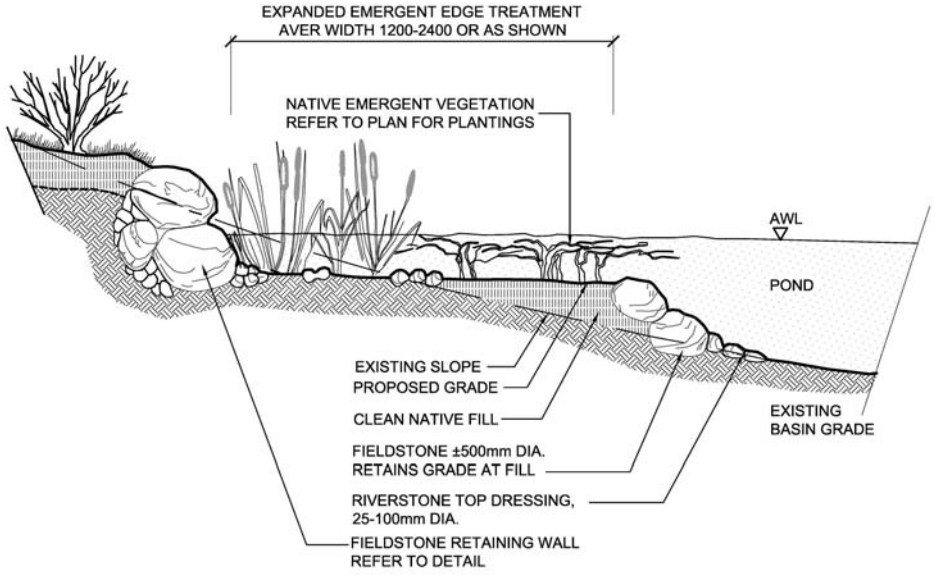
PLANTED RIVERSTONE
SECTION NTS

Drawing Title: PLANTED RIVERSTONE		Date: March 2004
Project: Stormwater Management Landscaping Details		Scale: NTS
The City of Hamilton Capital Planning and Implementation Division, Public Works Department	Hamilton	SW17



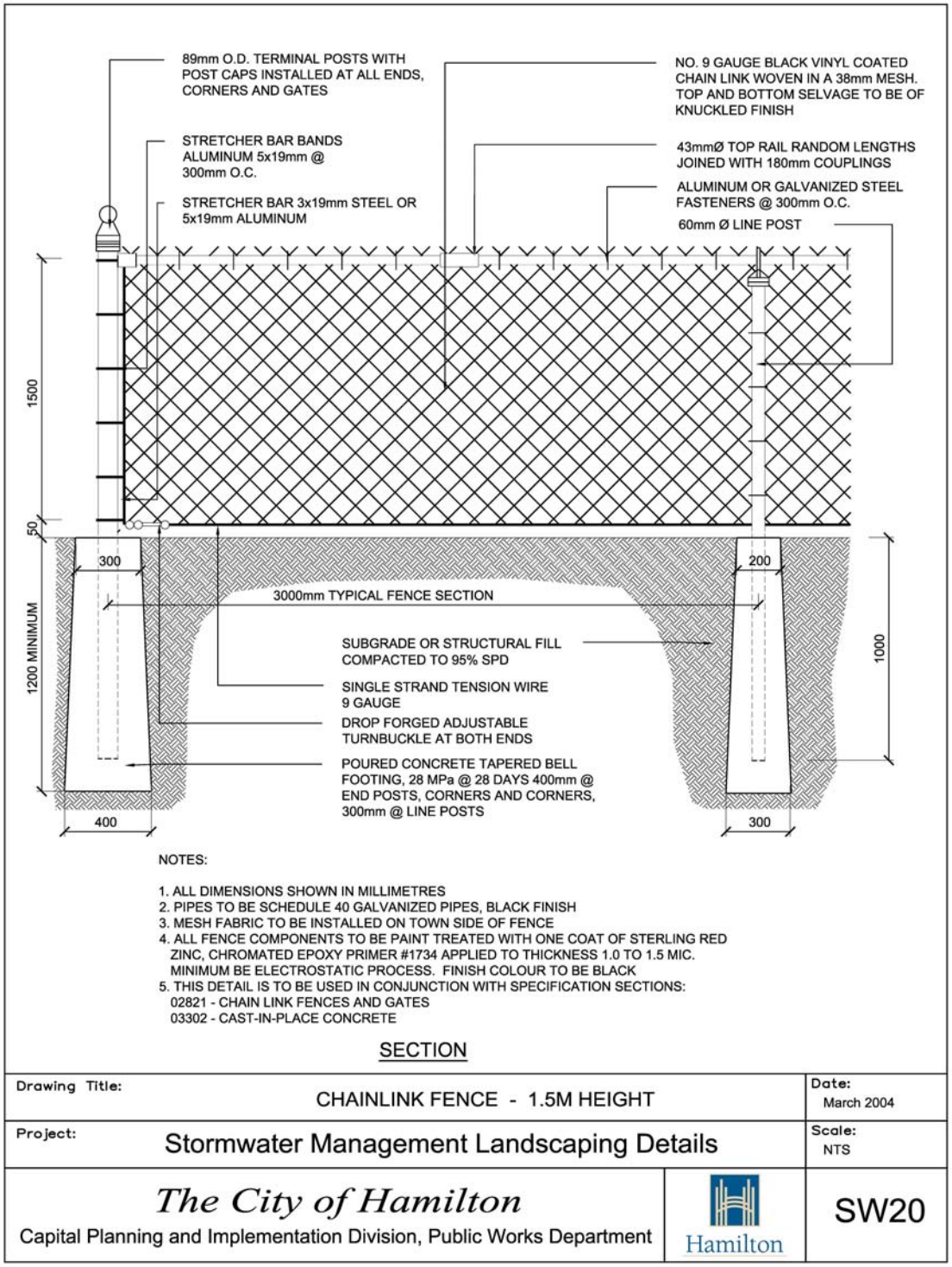
FIELDSTONE SHORELINE TREATMENT
SECTION NTS

Drawing Title: FIELDSTONE SHORELINE TREATMENT		Date: March 2004
Project: Stormwater Management Landscaping Details		Scale: NTS
The City of Hamilton Capital Planning and Implementation Division, Public Works Department	Hamilton	SW18



EXPANDED EMERGENT EDGE TREATMENT
SECTION NTS

Drawing Title: EXPANDED EMERGENT EDGE TREATMENT		Date: March 2004
Project: Stormwater Management Landscaping Details		Scale: NTS
The City of Hamilton Capital Planning and Implementation Division, Public Works Department	Hamilton	SW19

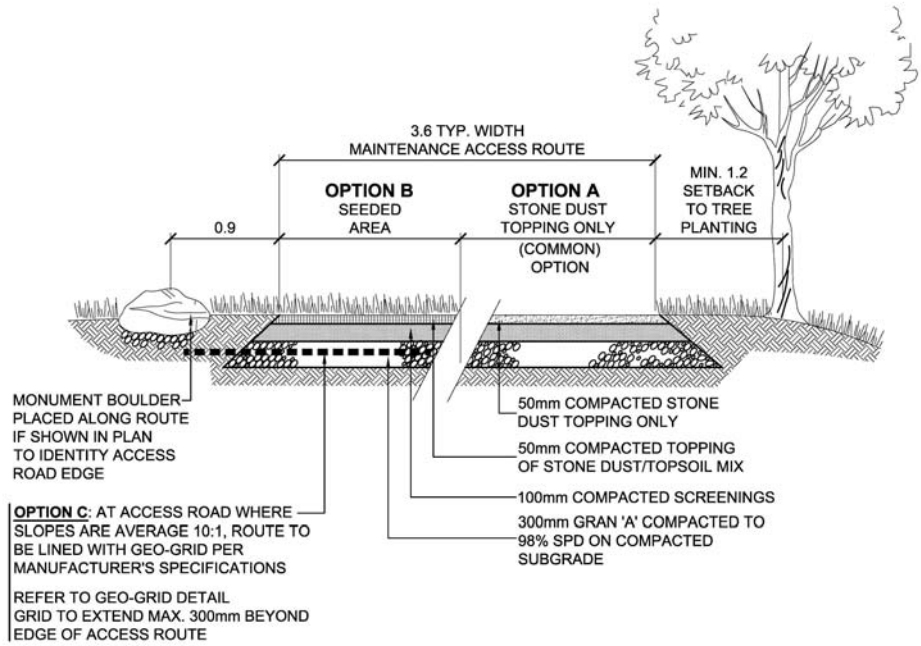


NOTES:

1. ALL DIMENSIONS SHOWN IN MILLIMETRES
2. PIPES TO BE SCHEDULE 40 GALVANIZED PIPES, BLACK FINISH
3. MESH FABRIC TO BE INSTALLED ON TOWN SIDE OF FENCE
4. ALL FENCE COMPONENTS TO BE PAINT TREATED WITH ONE COAT OF STERLING RED ZINC, CHROMATED EPOXY PRIMER #1734 APPLIED TO THICKNESS 1.0 TO 1.5 MIC. MINIMUM BE ELECTROSTATIC PROCESS. FINISH COLOUR TO BE BLACK
5. THIS DETAIL IS TO BE USED IN CONJUNCTION WITH SPECIFICATION SECTIONS:
   02821 - CHAIN LINK FENCES AND GATES
   03302 - CAST-IN-PLACE CONCRETE

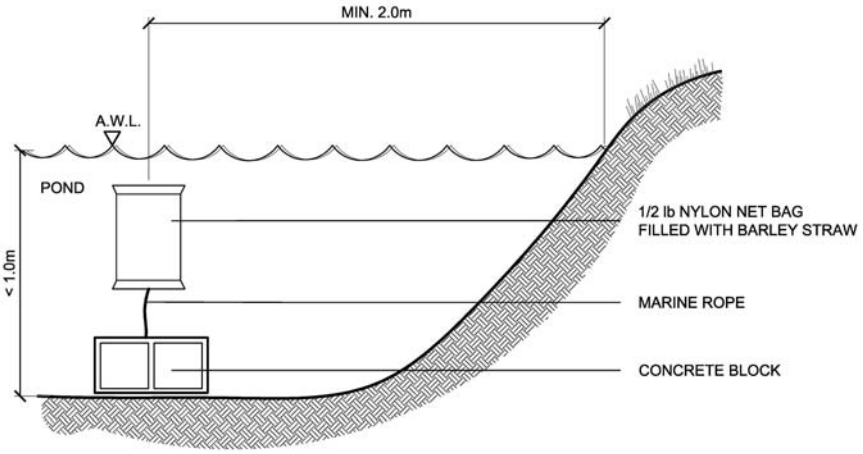
SECTION

Drawing Title: CHAINLINK FENCE - 1.5M HEIGHT		Date: March 2004
Project: Stormwater Management Landscaping Details		Scale: NTS
The City of Hamilton Capital Planning and Implementation Division, Public Works Department	Hamilton	SW20



MAINTENANCE ACCESS ROUTE
SECTION AT VARIOUS OPTIONS NTS

Drawing Title: MAINTENANCE ACCESS ROUTE		Date: March 2004
Project: Stormwater Management Landscaping Details		Scale: NTS
The City of Hamilton Capital Planning and Implementation Division, Public Works Department	Hamilton	SW21

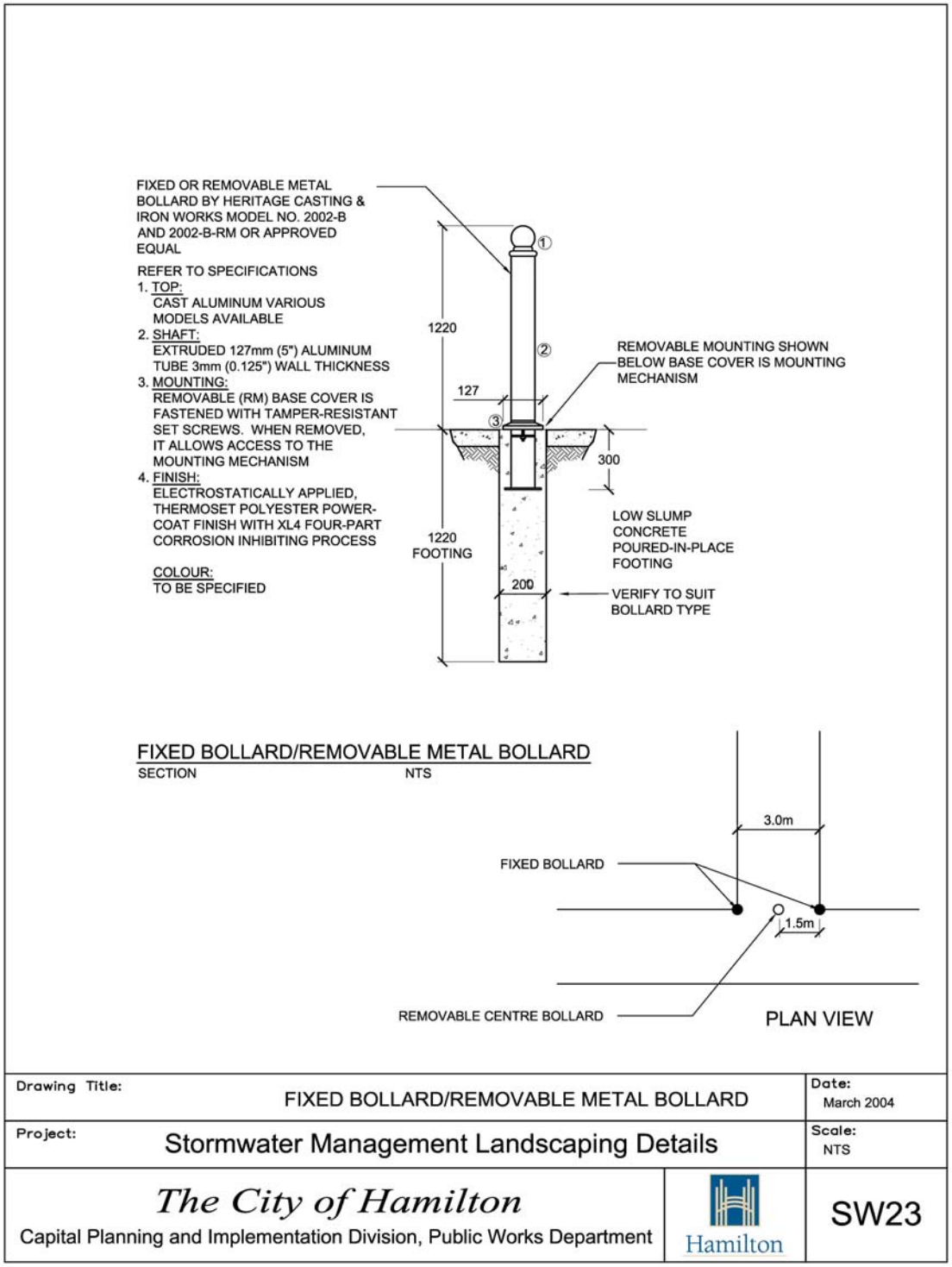


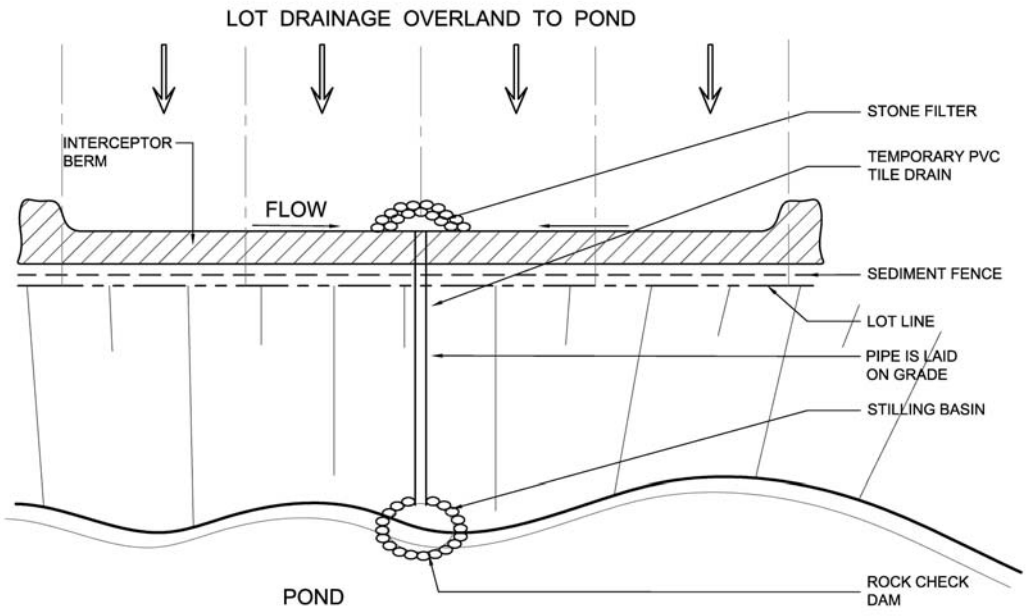
NOTES:

1. NYLON NET BAG MINIMUM 2.0m FROM POND EDGE.
2. WATER DEPTH MUST BE 1.0m DEEP OR LESS.
3. SPACE BAGS EQUIDISTANTLY AROUND PERIMETER OF POND.

ALGAE CONTROL BAGS
SECTION NTS

Drawing Title: ALGAE CONTROL BAGS		Date: March 2004
Project: Stormwater Management Landscaping Details		Scale: NTS
The City of Hamilton Capital Planning and Implementation Division, Public Works Department	Hamilton	SW22


FIXED OR REMOVABLE METAL BOLLARD BY HERITAGE CASTING & IRON WORKS MODEL NO. 2002-B AND 2002-B-RM OR APPROVED EQUAL
REFER TO SPECIFICATIONS
1. TOP: CAST ALUMINUM VARIOUS MODELS AVAILABLE
2. SHAFT: EXTRUDED 127mm (5") ALUMINUM TUBE 3mm (0.125") WALL THICKNESS
3. MOUNTING: REMOVABLE (RM) BASE COVER IS FASTENED WITH TAMPER-RESISTANT SET SCREWS. WHEN REMOVED, IT ALLOWS ACCESS TO THE MOUNTING MECHANISM
4. FINISH: ELECTROSTATICALLY APPLIED, THERMOSET POLYESTER POWER-COAT FINISH WITH XL4 FOUR-PART CORROSION INHIBITING PROCESS
COLOUR: TO BE SPECIFIED
1220
127
300
1220 FOOTING
200
REMOVABLE MOUNTING SHOWN BELOW BASE COVER IS MOUNTING MECHANISM
LOW SLUMP CONCRETE POURED-IN-PLACE FOOTING
VERIFY TO SUIT BOLLARD TYPE
FIXED BOLLARD/REMOVABLE METAL BOLLARD
SECTION NTS
3.0m
FIXED BOLLARD
1.5m
REMOVABLE CENTRE BOLLARD
PLAN VIEW
Drawing Title: FIXED BOLLARD/REMOVABLE METAL BOLLARD
Date: March 2004
Project: Stormwater Management Landscaping Details
Scale: NTS
The City of Hamilton
Capital Planning and Implementation Division, Public Works Department
Hamilton
SW23



TEMPORARY TILE DRAIN OUTLET AND INTERCEPTOR BERM
PLAN (SCHEMATIC) NTS

Drawing Title: TEMPORARY TILE DRAIN OUTLET AND INTERCEPTOR BERM		Date: March 2004
Project: Stormwater Management Landscaping Details		Scale: NTS
The City of Hamilton Capital Planning and Implementation Division, Public Works Department	Hamilton	SW24

APPENDIX C: REFERENCES

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Other Potential Photos

Mountain Brow Blvd. Bridge and Stormwater Management Facility

Client: City of Hamilton
www.city.hamilton.on.ca
Project Manager:
Philips Engineering Ltd.
www.philipseng.com

http://www.hjoc.com/hjoc.php?section=clients&id=12

Location: Hamilton, Ontario

In August 2004 the City of Hamilton awarded a contract to O'Connell Construction Ltd. for the Road Realignment, Bridge Replacement and Stormwater Management Facility on Mountain Brow Boulevard at Albion Falls. The project was completed on time and on budget at a cost of 1.8 million dollars. The project was named 2004 Project of the Year in the Environmental Category by the Ontario Society of Professional Engineers.