2025 – Storm and Stormwater Management Guidelines

Engineering and Corporate Assets

Kawartha Lakes
Jump In

City of Kawartha Lakes Infrastructure Guidelines – Storm and Stormwater Management

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1.0 Introduction

This document does not supersede, nor replace any legislation governing the design of Storm water systems. Designers, Consultants, Engineers and Contractors must be fully familiar with legislation such as the Ministry of Environment, Conservation and Parks (MECP), Conservation Authority Regulation and the City's Consolidated Linear Infrastructure Environmental Compliance Approval (CLI ECA). This document shall be used in conjunction with the other City of Kawartha Lakes Infrastructure Guidelines (roads, sanitary sewers, water, and lot grading). Other information may be found in the resources listed below in section 1.1.

Accessible formats are available upon request. The City of Kawartha Lakes is committed to accessibility for persons with disabilities. Please contact deveng@kawarthalakes.ca if you have an accessible accommodation request.

1.1 Useful Resources

Outside Resources

- The Sustainable Technologies Evaluation Program (STEP) website (Link)
- The Sustainable Technologies Evaluation Program (STEP) LID SWM Planning and Design Guide (Link)
- Ministry of the Environment, Conservation and Parks (MECP): Stormwater Management Plan and SWMP Design, 2003 (Link)
- The City of Kawartha Lakes Environmental Compliance Approval For a Municipal Stormwater Management System, 2023 (Link)
- Ontario Provincial Standards (OPS), their most recent editions or revisions thereof.
- City of Kawartha Lakes By-Law 2017-151, A By-law to Regulate Access to Municipal Right of Ways in the City of Kawartha Lakes, 2017, as amended (Link)
- The Canadian Standards Association (CSA)
- American Standard and Testing Materials (ASTM)

City of Kawartha Lakes Standard Details – Storm and Stormwater

Standard Drawing Number	Description
CKL-112	Service Connection Location Single Detached Residential Lots 9 Metres (30') to 11.9 Metres (39') (New Connection)
CKL-112B	Service Connection Location Single Detached Residential Lots 12 Metres (40') and Greater (New Connection)

Standard Drawing Number	Description
CKL-402	20 Meter Urban Local ROW Pathway on One Side
CKL-403	20 Metre Urban Local ROW Sidewalk on One Side
CKL-404	20 Metre Urban Local ROW Sidewalk on Both Sides
CKL-405	26 Metre Urban Collector Right of Way
CKL-406	26 Metre Urban Collector ROW Pathway on One Side
CKL-407	Typical Rural Road Cross Section 7 Metre Pavement Width 20 Metre Right of Way
CKL-502	Stormwater Management Pond Warning Sign

City of Kawartha Lakes Supporting Documentation – Storm and Stormwater (Available on the City's Development Engineering Page)

Form SW1 – Record of Future Alteration Authorized for Storm Sewers/Ditches/Culverts

Form SW2 – Record of Future Alteration Authorized for Stormwater Management Facilities

Form SW3 – Record of Future Alteration Authorized for Third Pipe Collection Systems

List of Acceptable Tree Species for City of Kawartha Lakes Planting

Storm Sewer Design Sheet

Conservation Authorities

- Kawartha Region Conservation Authority (Link)
- Lake Simcoe Region Conservation Authority (Link)
- Otonabee Region Conservation Authority (Link)
- Ganaraska River Conservation Authority (Link)

1.2 Purpose

The City of Kawartha Lakes Infrastructure Guidelines for Storm and Stormwater management are intended to provide an engineering basis for storm and stormwater management design, to establish minimum standards, and to improve the processing speed of subdivision plan applications for approval within the City. These guidelines may be used for private property and site plans design; however, with respect to private property, the Ontario Building Code governs. The plan of subdivision

development review process involves multiple review agencies, each having their own guidelines, policies and criteria for completing the storm drainage and stormwater management design. Where a discrepancy exists between the guidelines presented in this document and other agency guidelines, this document will govern in completing the City's Development Engineering Division's review of storm and storm water applications; otherwise, the guidelines of other review agencies will govern.

1.3 Storm and Stormwater Design Requirements

The Storm and Stormwater Design process has adopted a streamlined review process to ensure that qualified input and representation from the consultants, agencies and public is provided at the appropriate time. Different Storm and Stormwater Plans are required at different stages of the development process.

1.3.1 Stormwater Management Plan (Preliminary/Conceptual Design)

A Preliminary SWM (Stormwater Management) Report detailing proposed storm drainage, stormwater quality and quantity control facilities **or** a Functional Servicing Report (FSR) is required at the preliminary/conceptual design stage providing:

- All background site information including location, size of parcel, etc.;
- Pre- and post-development storm drainage areas, including estimated imperviousness and runoff values and existing SWM infrastructure on and adjacent to the site;
- Total estimated servicing demand for the site;
- Proposed ESC measures during and after construction;
- Preliminary storm drainage system layout and stormwater management facility design, including outlet design and supporting sizing calculations;
- A hydrogeological report providing soil infiltration rates and depth to groundwater to support the proposed stormwater management and LID design;
- And all other relevant preliminary design details.

1.3.2 Stormwater Management Plan (Detailed Design)

A separate standalone Detailed SWM Report is required for Plan of Subdivision Approval and Registration providing:

- All information from the Preliminary SWM Report or FSR, updated to match all detailed design elements;
- A description of how all of the City's stormwater management requirements have been achieved, including water quality and balance requirements and all supporting calculations;

- Location, design, and efficacy of all proposed stormwater management and LID measures;
- An internal drainage plan showing flood ponding levels during the 100 year storm; and
- An Operations, Monitoring and Maintenance Manual (OM&M Manual) for all proposed stormwater management and LID devices installed on public property and a Homeowner's Operations, Monitoring and Maintenance Guide for all LID devices installed on private property;
- And all other relevant preliminary design details.

2.0 Stormwater Management System Layout

This section discusses the requirements for designing the layout of a proposed municipal stormwater drainage system.

2.1 Blocks

The design of a storm sewer system must ensure that all proposed municipal storm sewers are located on municipal property. Block conveyance is the required method of land transfer through the development process for any new development.

Table 2.1: Minimum Block Requirements

If service, size, and depth is	**The required block width is**
Single sewer less than 600mm in diameter, and less than 3.7 metres deep	6 metres
Single sewer larger than 750mm in diameter and/or in excess of 3.7 metres deep	9 metres
A combination of two mains less than 3.7 metres deep	9 metres
A combination of two mains greater than 3.7 metres deep	12 metres
Major trunk sewer	20 metres (Sewer main will be located off centre in the easement for future infrastructure.)

2.2 Minor System Layout Design

Storm sewers shall be designed to convey, as a minimum, the 5 year design storm. The connection of sanitary sewers to the storm sewer is strictly prohibited. The passage of any storm sewers under or through a body of surface water is strictly prohibited unless

if trenchless construction methods are used or the local Conservation Authority has authorized an alternative construction method.

2.2.1 Service Area

The drainage system shall be designed to accommodate all upstream drainage areas plus any external area tributary to the system for the existing, interim and ultimate development conditions, as determined by mapping derived from a topographic survey and drainage plans.

2.2.2 Minimum Slope

The minimum storm sewer slope shall be not less than 0.5% unless a lifetime cost estimate is provided and the proposed slope is specifically approved in writing by the Director of Engineering and Corporate Assets.

2.2.3 Sewer Alignment

The storm sewers shall be laid in a straight line between maintenance holes unless curved pipe (radius pipe) has been designed. Radius pipe shall be allowed for storm sewers 1200mm in diameter and larger. The minimum centreline radius allowable for radius pipe shall be in accordance with the minimum radii table provided by the manufacturer.

2.2.4 Depth of Storm Sewers

A minimum 1.5 metres of cover between the crown of the road and the pipe obvert shall be provided for storm sewers. Shallow insulated pipes may be permitted in accordance with OPSD 1109.030 Insulation for Sewers and Watermains in Shallow Trenches. All insulated pipes must be clearly documented for review and approval. In general, the thickness of the insulation shall be a minimum of 50mm for every 300mm reduction in depth of cover.

2.2.5 Pipe Crossing, Bedding, and Clearance

The type and classification of the storm sewer pipe and the sewer bedding type shall be clearly indicated on all profile drawings for each sewer length. Bedding type selection shall be based on the depth of sewer, sewer material, trench width, and configuration and soil conditions. Pipe loading calculations shall accompany the design submission. Storm sewers shall be constructed with bedding as per the current OPSS.MUNI 410 Pipe Sewer Installation in Open Cut – and applicable OPSD therein (Granular "A" embedment material) for flexible pipes and Class B (Granular "A" bedding material) for rigid pipe unless otherwise approved by the Director of Engineering and Corporate Assets.

The minimum clearing at a storm sewer and sanitary sewer crossing shall be sufficient to allow proper bedding for the higher pipe.

The minimum horizontal clearance from a storm sewer to a watermain shall be 2.5 metres. The minimum vertical clearance shall be 0.5 metres in cases where the sewer passes over the watermain, and sufficient separation to allow for bedding in cases

where the watermain passes over the sewer. Refer to MECP procedure F-6-1 – Procedures to Govern Separation of Sewers and Watermains – for more information.

2.2.6 Joints

All concrete and PVC pipes shall have rubber gasket joints.

2.2.7 Maintenance Holes

Maintenance holes shall be provided at each top end or dead end of a sewer line, change in alignment, grade, material, and at all junctions except where radius pipe is used in sizes 1200mm in diameter and larger.

Maintenance holes shall be located a minimum of 1.5 metres off the road centre line as per City Standard drawings.

Maintenance holes shall be located, whenever possible, with a minimum of 1.5 metre clearance away from the face of curb and/or any other service.

For maintenance holes, precast concrete adjustment units shall be as per OPSD 704.010 Precast Concrete Adjustment Units for Maintenance Holes, Catch Basins, and Valve Chambers. Adjustment units shall be set in full bed of mortar at structure and frame. A layer of blueskin waterproofing membrane or approved equivalent, shall be adhered to the outside surface of the adjustment units with primer and overlapped a minimum 300mm over structure and at joints.

All maintenance holes that have a deviation in excess of 10mm from surface asphalt elevation shall be milled, re-adjusted, and re-paved to suit final grades.

Benching within maintenance holes shall be completed per OPSD 701.021 Maintenance Hole Benching And Pipe Opening Alternatives.

The maximum maintenance hole spacing shall be 100m for pipe diameters less than 1200mm and 150m for pipe diameters 1200mm or larger.

The maximum change in direction is 90 degrees for pipes 900mm in diameter and smaller and 45 degrees for pipes over 900mm in diameter. The City requires the use of two 45 degree changes in direction over one 90 degree change wherever feasible.

The minimum allowances for hydraulic losses incurred at maintenance holes shall be as follows:

Table 2.2: Required Pipe Elevation Drop in Maintenance Holes

Change in Direction	Minimum Required Drops
0 degrees	30mm
>0 – 45 degrees	80mm
46 – 90 degrees	150mm

Where the difference in elevation between the obverts of the inlet and outlet pipes exceeds 0.9 metres, a drop structure shall be designed in accordance with current City standards. Obverts of inlet pipes shall not be lower than obverts of outlet pipes.

A flexible joint shall be installed at all maintenance hole structures 300mm from the outside face of the maintenance hole in accordance with OPSD 708.020 – Support for Pipe at Catch Basin or Maintenance Hole.

All PVC inlet and outlet pipes, including outlets for future extensions shall be securely set into the structure's concrete base and walls using factory installed rubber gaskets (boots) and shall be water tight.

The outlet for future extensions is to have a watertight plug installed.

2.2.8 Catch Basins

Catch basins shall be located upstream of pedestrian crossings at street intersections to avoid driveways, sidewalks and walkways.

For catch basins, precast concrete adjustment units shall be as per OPSD 704.010 Precast Concrete Adjustment Units for Maintenance Holes, Catch Basins, and Valve Chambers. Adjustment units shall be set in full bed of mortar at structure and frame. A layer of blueskin waterproofing membrane or approved equivalent, shall be adhered to the outside surface of the adjustment units with primer and overlapped a minimum 300mm over structure and at joints.

All catch basins that have a deviation in excess of 10mm from surface asphalt elevation shall be milled, re-adjusted, and re-paved to suit final grades.

Types:

Single (CB), double (DCB) and rear lot (RLCB) catch basins shall be designed based on OPS. Any proposed special catch basins and inlet structures must be approved by the City.

Wherever possible, site grading should be designed in such a way that RLCBs are not required. The City will not be responsible for maintenance and operation of RLCBs on private property. If deemed necessary, RLCBs are to be concrete encased for the full length of the lot and to the back of the street curb.

Capacity Design:

DCBs are to be installed at the low point of any road, where drainage is collected from two or more directions. CBs may be acceptable at low points approaching intersections where drainage is mostly from one direction.

The maximum CB spacing shall be in accordance with the following:

Table 2.3: Catch Basin Spacing

Road Pavement Width	Slope	Maximum Spacing
≥ 10m	> 4.5%	60 metres
≥ 10m	≤ 4.5%	75 metres
< 10m	> 4.5%	75 metres
< 10m	≤ 4.5%	90 metres

The maximum drainage area for any catch basin shall be 2000m^2 of paved area or 5000m^2 of grassed area.

Additional catch basins may be required at road intersections, elbows, and cul-de-sacs to facilitate satisfactory drainage.

Leads:

The lead size for catch basins shall be as follows:

- 250mm in diameter with a minimum slope of 2% for CBs;
- 300mm in diameter with a minimum slope of 2% for DCBs; and
- 250mm in diameter with a minimum slope of 0.5% for RLCBs.

3.0 Stormwater Management Design Guidelines

This section describes the stormwater management design guidelines for the sizing of stormwater management systems.

3.1 Water Balance

All new developments with a contributing drainage area > 5ha shall provide pre-to-post infiltration on-site where soils permit and unless otherwise established at the secondary plan stage. The water balance requirements apply to the property limit of the development and do not necessarily need to be achieved on a lot-by-lot basis (i.e. communal infiltration facilities that service multiple lots may be acceptable). Sites ≤ 5ha (e.g. site plans or infill sites) shall minimize any anticipated changes in the water balance between pre-development and post-development conditions and shall provide a minimum infiltration equivalent to the first 5mm of any given rainfall event.

3.2 Minor System Design Guidelines

3.2.1 Designed Flow and Flow Calculations

Storm sewer systems shall be designed to convey at minimum the 5 year design storm using the Rational Method and the City's IDF (Intensity Duration Frequency) regression equation for rainfall intensity. All storm sewer systems shall be designed at ≤80% capacity. The design of the storm sewers shall be computed using the City of Kawartha Lakes' Storm Sewer Design Sheet as provided on the City of Kawartha Lakes Development Engineering Web Page.

All storm sewers shall be designed according to the Rational Formula where:

$$Q = \frac{(C)(i)(A)}{360}$$

And,

Q = the design flow in (m^3/s)

C = the site specific runoff coefficient

A = the drainage area (ha)

I = rainfall intensity (mm/hr)

The rainfall intensity shall be calculated in accordance with the following table and equation:

Table 3.1: Lindsay Filtration Plant IDF Curve Parameters

Parameter	2 Year Return Period	5 Year Return Period	10 Year Return Period	25 Year Return Period	50 Year Return Period	100 Year Return Period
A	858	1214	1487	1898	2110	2518
B	6.8	9.0	10.2	11.7	12	13.2
C	0.822	0.847	0.858	0.871	0.870	0.882

$$i = \frac{A}{(t_d + B)^C}$$

where,

i = the rainfall intensity (mm/hr)

t_d = the storm duration (minutes)

A, B, C = a function of the local intensity-duration data

The storm duration is set to the time of concentration (i.e. the sewer inlet time plus the time of travel in the pipe or channel) for the total cumulative drainage area to the node of interest. The maximum inlet time for the first pipe of a storm sewer system is 10 minutes.

The runoff coefficient shall be calculated in accordance with the following table:

Table 3.2: Runoff Coefficients (5 year to 10 year)

Land Use	Runoff Coefficient
Cultivated and Pasture Land	0.35
Low density residential	0.50
Medium density residential	0.60
Industrial and Commercial	0.75
Parkland	0.25
Hard Surface (i.e. Buildings, Pavement, Gravel)	0.95

An approximation of the runoff coefficient can be calculated based on the following relationship with:

$$c = (0.7)(\text{TIMP}) + 0.2$$

where,

c = runoff coefficient

TIMP= total impervious fraction (dimensionless)

The runoff coefficient shall be adjusted for return period events greater than the 10 year storm per the following table:

Table 3.3: Runoff Coefficient Adjustment for 25 year to 100 year Storms

Return Period	Runoff Coefficient "C"
25 years	C25 = 1.1*C5
50 years	C50 = 1.2*C5
100 years	C100 = 1.25*C5

Adapted from Design Chart 1.07, Ontario Ministry of Transportation,

"MTO Drainage Management Manual," MTO. (1997).

Note: When applying the runoff coefficient adjustment, the maximum c value should not exceed 1.0.

Given that the direct connection of foundation drains to the storm sewer is not permitted, a detailed Hydraulic Grade Line (HGL) analysis is typically not required unless deemed otherwise by the City due to special circumstances.

3.2.2 Pipe Capacity and Size

The storm sewer capacity shall be calculated using the Manning's equation (assuming the pipe is flowing full) as follows:

$$Q = \left[\frac{1}{0.013}\right] A(R)^{\frac{2}{3}} (S)^{\frac{1}{2}}$$

where,

Q = pipe capacity (m^3/s)

R = hydraulic radius (m)

S = sewer pipe slope (m/m)

A = cross-sectional area of pipe (m^2)

A maximum inlet time of 10 minutes shall be used for the first pipe of a storm sewer system.

The velocity of flow in the storm sewer (assuming full pipe flow) shall be calculated as follows:

$$v = \left[\frac{Q}{A}\right]$$

where,

Q = flow in the pipe when flowing full (m^3/s)

A = cross sectional area of the pipe (m^2)

All pipes in the storm sewer system shall be designed with a minimum full flow velocity of 0.75m/s and a maximum full flow velocity of 6.0m/s.

The minimum size of a storm sewer (within a street) shall be 300mm in diameter, and the maximum size shall be 2400mm in diameter. No decrease of pipe size from a larger size upstream to a smaller size downstream shall be allowed regardless of the increase in grade.

3.2.3 Sewer Materials, Catch Basin and Maintenance Hole Types

Polyvinyl Chloride (PVC) sewers can be used for either residential or industrial use conforming to CSA Standard B182.1, ASTM D3034 for pipe sizes 100mm to 150mm in diameter, CSA Standard B182.2, ASTM D3034 for pipe sizes 200mm to 375mm in diameter, and CSA Standard 182.4, ASTM F-794 for pipe size greater than 450mm in diameter.

Concrete pipes must comply with CSA Standard A257.1 (concrete sewer, storm drain and culvert pipe), CSA Standard A257.2 (reinforced concrete culvert storm drain and sewer pipe), and CSA Standard A257.3 (joints for concrete sewer and culvert pipe using flexible water tight rubber gaskets), ASTM C14, C76, C655.

Minimum maintenance hole size shall be 1200mm in diameter. Catch basin design shall be per the OPSD standard drawings using precast concrete.

Total capture inlet grates shall be sized with a minimum 2.0 factor of safety (i.e. assume 50% blockage) and shall be designed as per OPSD.

3.3 Major System Design Guidelines

The major system shall be designed to safely convey flow in excess of the minor system via streets, open channels, storm sewers, walkways, and approved drainage blocks to a safe outlet without flooding private property. The 2 year, 5 year, 10 year, 25 year, 50 year, 100 year and Regional Storms shall be applied for quantity control and the 25mm 4 hour Chicago storm shall be applied for erosion control as required. In order to determine the critical design storms, the SCS Type II (6 hour, 12 hour and 24 hour durations) and the 4 hour Chicago storm distributions for the 2 year through 100 year return period shall be applied. The critical design storm will be confirmed as the Design Storm.

Unless otherwise directed by the City, Regional Timmins Storm shall be applied throughout the City as the Regional storm for the sizing of municipal infrastructure

associated with storm drainage and stormwater management. The limits of the 100 year storm flooding shall be shown on all grading plans.

3.3.1 Drainage Area

The drainage area shall include all upstream drainage areas for the interim and ultimate conditions including any external area tributary to the system, as determined by suitable topographic mapping, site survey, and drainage plans.

3.3.2 External Drainage

All areas which may become tributary due to re-grading shall be included in the site drainage plans.

3.3.3 Lot Grading and Drainage

The lot grading around houses and buildings, including all side and rear lot swales, shall be a minimum grade of 2%. All swales are to be a minimum depth of 0.15m with a maximum side slope of 3:1. All grading design shall be completed in accordance with the City's Lot Grading and Drainage Guidelines.

3.3.4 Overland Flow Routes

An overland flow route must be established to safely convey Design Storm runoff to the nearest major open channel. Overland flows may be routed over the curb and boulevard provided sufficient hydraulic capacity be demonstrated using the broad-crested weir equation. The flow route from the boulevard into the SWM facility or open channel must be stabilized to prevent slope erosion.

Overland flow must be captured and piped at the major system low point(s) on the roadway unless it can be demonstrated that the flow can be conveyed by other means to the satisfaction of the City.

3.3.5 Channel and Overland Flow Calculations

Appropriate flow route stabilization shall be provided to protect against velocity conditions experienced during the Design Storm and calculations shall be provided to the City for review and approval. The maximum velocities during the 5 year and the Design Storm shall be 1.5m/s and 2.5m/s, respectively, for sod lined channels. Channels expected to experience higher flow velocities shall be stabilized using other measures approved by the City, such as soil reinforcement or stone lining. Calculations, using the Maximum Permissible Tractive Force method (MTO Drainage Management Manual, Section 5), shall be provided to the City and Conservation Authority for review.

The equation for Manning's Overland flow (assuming a wide plane with shallow flows such that R is approximately equal to the channel bottom width) is:

$$Q_o = \left[\frac{1}{n}\right](S_o)^{\frac{1}{2}}(y_o)^{\frac{5}{3}}$$

where,

Q_o = the overland flow per unit width of overland flow ($m^3/s/m$)

n = the Manning roughness value for overland flow

S_o = the average overland flow slope (m/m)

Y_o = the mean depth of overland flow (m)

A = the cross-sectional flow area (m^2)

The Manning's equation for channel flow is:

$$Q = \left[\frac{1}{n}\right](A)(R)^{\frac{2}{3}}(S_o)^{\frac{1}{2}}$$

where,

Q = the channel flow (m^3/s)

n = the Manning roughness value for channel routing

A = cross-sectional flow area (m^2)

R = the hydraulic radius (area/wetted perimeter) (m)

S_o = the channel slope (m/m)

and

$$V = \left[\frac{1}{n}\right](R)^{\frac{2}{3}}(S)^{\frac{1}{2}}$$

where,

V = the channel velocity (m/s)

n = the Manning roughness value for channel routing

R = the hydraulic radius (area/wetted perimeter) (m)

S_o = the channel slope (m/m)

For channel flows, use a Manning roughness value of 0.03 for grass-lined channels or a value of 0.013 for rip rap lined channels.

3.3.6 Roads

Road grading must direct flows from the right-of-way to a protected outlet at specified low points. Outlets can be walkways or open sections of road leading to open spaces or river valleys. Roads may be used for major system overland flow conveyance during the Design Storm subject to the following depth constraints:

Table 3.4: Maximum Allowable Flow Depth for Roads

Location	Maximum Ponding Depth
Local Road	0.2 metres above crown of road

Location	Maximum Ponding Depth
Collector and Industrial Road	0.1 metres above crown of road
Arterial Roads	Single lane to remain open

3.3.7 Outfall Channels

The following general principles are to be applied when designing storm sewer or FDC outfalls to a natural watercourse:

- Headwall designs shall conform to OPSD. Pipes 900mm in diameter or greater shall be complemented by armour stone wing walls. Headwall grates, as per OPSD, shall be specified for all headwalls.
- Outfall inverts are to be located at or above the 2 year storm flood level in the receiving watercourse.
- Headwalls shall be protected by a 1200mm high black vinyl chainlink fence per CKL-609. Fence posts shall be cored into the concrete headwall and/or armour stone wing walls.
- All outfalls to a watercourse require a permit from the Conservation Authority and/or Trent-Severn Waterway, as applicable.

Tailwater impacts to the natural watercourse shall be accounted for in the design of the outfall channel, control structures and upstream storm sewer/FDC systems.

3.4 Culverts

Culverts shall be designed so there is no increase in the Design Storm flood conditions of the watercourse.

All culverts shall be supplied with headwall end protection constructed of interlocking wall systems, concrete, armour stone, or other material approved by the City.

3.4.1 Road Crossings

For local roads, the maximum allowable overflow depth over the gutter elevation shall be 300mm and must not cause damage to private property. Road crossing culverts shall be a minimum of 600mm (2.0mm CSP gauge) in diameter with headwall.

Culverts crossing arterial roads must be designed to prevent overtopping during the 100 year storm. Under certain circumstances, the City may request protection from overtopping for the Regional storm.

3.4.2 Roadside Ditches and Culverts

When designing a rural road cross section, the design of roadside ditches shall consider the following:

- Ditch inverts shall be located a minimum of 0.3 metres below the roadway granular/subgrade elevation. Where the minimum of 0.3 metres cannot be met,

a ditch subdrain is required which shall outlet to the ditch once the minimum depth criterion is met.

- The minimum ditch gradient shall be 1.0%. Ditches with grades greater than 3.0% shall have staked sod protection and ditches with grades greater than 5.0% shall have hand laid rip rap protection.
- Ditches are to receive 150mm of topsoil and sod.
- All roadside ditches shall transport runoff to a protected outlet, such as a stormwater management facility or natural watercourse, approved by the City.
- The use of concrete channels in place of ditches is prohibited.

The design of roadside culverts shall consider the following:

- Entrance or driveway culverts must have a minimum size of 450mm (1.6mm CSP gauge) in diameter with appropriate end treatment and be sized to convey the 10 year event (minimum) without overtopping.
- All driveways are to have independent culverts, shared culverts will not be permitted.
- Sufficient distance is required between culverts to allow for 3:1 front and back slope.
- A minimum of 300mm cover shall be provided at the edge of the shoulders.
- End protection shall be provided on all driveway culverts where it is deemed necessary to protect against flow velocities, in accordance with the City's current entrance by-law.

3.4.3 Design Flow Capacity

The following design flood frequency shall apply to road crossings unless otherwise directed by the City. Culverts and road elevations shall be designed accordingly to meet the flood design guidelines.

Table 3.5: Flow Design Guidelines for Road Crossing

Road Classification	Design Flood Frequency
Arterial	100 Year or Design (Timmins) if directed by the City
Collector	50 Year
Urban Local	50 Year
Rural Local	25 Year
Driveway	10 Year

Modified from MTO Directive B-100 and the Highway Drainage Design Standards (MTO, Jan 2008).

3.4.4 Headwalls / Endwalls

Headwall and endwall structures shall conform to the current OPSD and City Guidelines and shall be included on the engineering drawings. The details provided shall include the existing topography, proposed grading and the works necessary to protect against erosion.

3.4.5 Erosion Protection

Armour stone, river stone and/or concrete shall be provided at all inlets and outlets to protect against erosion of the watercourse and provide embankment stability. The maximum allowable target channel velocity shall be in accordance with the MTO Drainage Management Manual (Section 5).

3.5 Environmental Protection Guidelines

3.5.1 Water Quality and Erosion Control

Measures shall be implemented to minimize the impact of erosion and sediments from sites to receiving watercourses. On-site erosion should be minimized by stripping only the sections of a site that are to be the location of imminent development. Control measures during construction shall be designed in accordance with the Erosion and Sediment Control Guidelines for Urban Construction (GGHA CAs, 2019).

All new SWM facilities should provide as a minimum the Enhanced level of protection as specified in the Stormwater Management Planning and Design Manual (MECP, 2003). In addition, it shall be demonstrated through an evaluation of anticipated changes between pre-development and post-development conditions that phosphorus loading shall not increase.

Unless otherwise directed by the City or Conservation Authority, developments shall require erosion control measures to be implemented whereby the 25mm 4 hour Chicago storm shall be stored and released over a minimum 24 hour period. Detailed watercourse erosion analyses may be based on continuous modeling and/or field based analyses to determine critical flow thresholds.

3.5.2 Quantity Control (Flood Protection)

Quantity control shall be provided to meet pre-development conditions unless otherwise directed by the City or Conservation Authority.

3.5.3 Water Balance

All new developments shall control groundwater recharge to meet pre-development conditions on-site OR control runoff from the 90th percentile storm where soils permit and unless otherwise established at the secondary plan stage. Water balance shall be

achieved on a lot-by-lot basis and all water shall be filtrated into the lot on which it falls.

3.5.4 Flow Diversions

Unless approved by the City and the Conservation Authority, the re-direction of flow between drainage basins is not permitted.

3.5.5 Receiving Watercourses

All watercourses shall remain in their natural state and base flow and velocity shall be maintained. Any alterations required must consider the form and function of the watercourse, including requirements to convey water and sediment and the provision of aquatic habitats.

3.5.6 Wetlands

Wetlands can help control flooding by regulating flow and providing surface water storage during spring snowmelt and periods of high rainfall. Development within a portion of the adjacent buffer area may be permitted subject to an approved Environmental Impact Study.

3.6 Stormwater Control Measures

3.6.1 Quality Control

On-site water quality controls shall be provided that achieve the Enhanced level of protection per the Stormwater Management Planning and Design Manual (MECP, 2003). Annual runoff values and pollutant load removal may be calculated using the STEP (Sustainable Technologies Evaluation Program) Low Impact Development Treatment Train Tool (LID TTT), found at the following Link.

On-site quantity controls shall be provided per requirements and agreement with the City and Conservation Authority.

Review Minor System Design Capacity

It shall be demonstrated that the there is residual capacity in the minor system to safely convey the 5 year flow from the site and not exceed 80% system capacity. The consultant shall assess the ability of the downstream facility to accommodate additional storm runoff and to maintain the same level of quality and quantity control.

On-site quantity controls (e.g. rooftop, parking, landscape storage and outlet controls) shall be provided for the proposed development to the pre-development peak flow from the site. On-site quantity controls shall adhere to the guidelines provided in **Sections 5** and **6**.

Review Major System Design Capacity and Flow Route

It shall be demonstrated that the major system overland flow from the proposed site will be safely conveyed. Drainage to the major system outlet shall not exceed 0.3 metres in depth, and velocities shall not exceed 0.65m/s.

The proposed major system design for the development site must be designed to identify and incorporate any existing external flows into the proposed design of the system.

3.7 Storm System Maintenance

In order to ensure the optimal and long term continued operation of a storm drainage system, it is important that the storm drainage system be regularly maintained once constructed. Some of the key components of an effective maintenance program include:

- Regular street sweeping and catch basin cleaning.
- Regular inspections of the storm sewer system including inlet grates and catch basins and periodic flushing and cleaning as required.
- Regular inspections of the overland drainage system including ditches, culverts and bridges and removal of accumulated sediment and debris as required.
- Regular inspections of total capture inlet grates and the removal of debris as required.
- Regular inspections of storm drainage system components for structural degradation and repair or replacement of degraded components as required.

The Developer must certify the storm drainage system complies with the CLI ECA, City Guidelines and provide notice to the City as owner of the system. The City will then notify the Director of the MECP within 30 days of placing into service or completion of any alteration to the authorized storm system.

4.0 Requirements for Erosion and Sediment Control during Construction

The SWM report shall address the following list of erosion and sediment controls:

- Erosion and Sediment Control Plans
- Erosion and Sediment Control Phasing
- Worksite Isolation Plan for In-stream Construction
- Spill Control and Response Plan
- De-watering plan
- Storm Drain Outfall Protection
- Storm Drain Inlet Protection
- Seeding/Sodding
- Heavy Duty Sediment/Silt Control Fence (to be double layered when placed adjacent to sensitive receivers, water courses, and homeowners)

- Interception/Diversion Swales and Dykes
- Vehicle Tracking Control/Mud Mats
- Sediment Traps
- Rock Check Dams
- Temporary Sediment Control Ponds/Basins
- Topsoil Stockpiles
- Construction Access Mud Mats
- Restoration

The design of erosion and sediment control measures shall be in accordance with the STEP's Erosion and Sediment Control Guideline for Urban Construction (2019) and to the satisfaction of City of Kawartha Lakes and Conservation Authority. Therefore the following general steps should be employed at minimum:

- **Erosion prevention measures shall be prioritized over sediment control measures**.
- Phased development shall be used to limit topsoil stripping and grading activities to the currently active development phase.
- Sediment control practices.

Inspections of ESC measures must be performed after significant rainfall and snowfall events and any other extreme weather events.

5.0 Source and Conveyance Controls (LID)

The following source and conveyance controls are not given credit in quality and quantity control calculations within the City of Kawartha Lakes:

- Pervious pipe systems (for untreated runoff);
- Pervious catch basins (for untreated runoff or with exfiltration pit located underneath the CB); or
- Additional depth of topsoil.

With the exception of the guidelines identified in the sections below, the guidelines for the design of source and conveyance controls shall be in accordance with the Stormwater Management Planning and Design Manual (MECP, 2003) as a minimum requirement. All proposed source and conveyance controls require support from acceptable geotechnical and hydrogeological investigations.

Operation and maintenance requirements for all source and conveyance controls shall be identified in the SWM report for the site and shall be implemented by the owner to ensure that the continued performance of the unit as designed is achieved. Additionally, all source and conveyance controls proposed on public property shall require life cycle and routine maintenance cost estimates to allow the City to estimate upkeep costs.

An Operations, Monitoring, and Maintenance Manual (OM&M Manual) is required for all proposed source and conveyance control measures. In cases where these measures are being proposed on future private property, Homeowner Operations, Monitoring and Maintenance Guides are also required for all impacted homeowners.

5.1 Emerging Technologies

The City of Kawartha Lakes will consider the use of emerging technologies for stormwater management. Some existing emerging technologies that have demonstrated an ability to provide water quality and quantity benefits include:

- Greenroofs (vegetated roofs);
- Subsurface infiltration tanks;
- Infiltration drainfields;
- Subsurface infiltration beds;
- Phosphorus removal technologies; and
- Phoslock.

Due to the nature of emerging technologies, there is typically a lack of available monitoring data or design guidelines. As such, the proponent or Consulting Engineer must provide complete supporting calculations when submitting stormwater management designs utilizing emerging technologies. A pre-consultation meeting with the City and governing Conservation Authority to discuss the use of emerging technologies is recommended to review the proposed design and to establish any specific requirements. All submissions employing stormwater management designs with emerging technologies will be reviewed by the City and other review agencies on a site-by-site basis.

5.2 Lot Level Source and Conveyance Controls

The City is not responsible for ownership, maintenance or monitoring of individual lot level devices used for private property controls. These devices are not considered to be part of the City's CLI ECA, the purpose of source and conveyance control devices is to achieve the quality and quantity requirements for the development.

5.2.1 Source and Conveyance Control for Residential Lots

The following Lot Level Control device is considered a best effort measure by the City for use on residential lots. Any other lot level source or conveyance control device not listed below is subject to approval on a site-by-site basis.

Soakaway Pits

In order to be considered acceptable by the City, a Soakaway Pit must:

- Be limited to individual lots and must not be continuous or contiguous with other soakaway pits;

- Attach directly to the roof leader;
- Consist of a trench of 50mm clear stone wrapped in non-woven filter cloth;
- Be less than 1.5 metres deep; and
- Have at least 5 metres of separation from buildings with basements and at least 1 metre of separation from each bedrock and the seasonal high groundwater level.

Soakaway pits shall not be proposed on public property. Their maximum drawdown times should be less than 48 hours, soils permitting. Length, width, and depth of soakaway pits shall depend on necessary storage volume. Depth shall be less than 1.5m.

5.2.2 Source and Conveyance Control for Commercial Sites

The following Lot Level Control devices are considered best effort measures by the City for use on Commercial Site Plans. The design requirements for these devices can be found below in subsequent sections.

- Manufactured Treatment Devices (MTD) (Section 5.4).
- Enhanced Grass Swales (Section 5.5.1).
- Infiltration Trenches (Section 5.6).
- Underground storage/ Underground storage with infiltration (Section 5.7).

5.2.3 Source and Conveyance Control for Industrial Sites

The Ministry of the Environment Conservation and Parks (MECP) require an Environmental Compliance Approval (ECA) for proposed stormwater management works on the industrial properties. The designer/consultant should contact the MECP directly to confirm the requirements for the site.

5.3 Roof Leaders

Roof leaders should be directed to front or rear yard pervious (grassed) areas wherever possible to promote infiltration and shall not discharge to impervious areas directly connected to the storm sewer (e.g. driveways, parking areas) unless there is no other feasible option. Roof leaders shall discharge to the ground surface via splash pads or extension pipes and flows shall be directed a minimum of 0.6 metres away from buildings such as to prevent ponding or seepage into the weeping tile. Rear lot ponding or other areas of extended ponding on residential lots are not permitted. Roof leader outlet locations shall be identified on the lot grading and drainage plan.

5.4 Manufactured Treatment Devices (MTDs)

MTDs are only permitted as a pre-treatment in a treatment train approach in conjunction with other stormwater management options approved by the City in compliance with the CLI ECA.

When completing sizing calculations for MTDs, the following guidelines shall apply:

- MTDs shall be tested and certified to meet the requirements of the Canadian ETV Program for OGS Performance Testing Protocol for Canada;
- The City requires a lifecycle, regular maintenance requirements and associated cost analysis to support any proposed design;
- MTDs should be assumed to have a maximum efficacy of 50% for TSS removal;
- When MTDs are installed in series, no additional sediment removal credit shall be applied beyond the sediment removal credit of the largest device in the series;
- MTDs are to be sized based on 90% of annual runoff.

5.5 Grass Swales

The use of grass swales to promote infiltration is preferable to the use of pipes wherever possible. All grass swales must be free flowing and designed to convey runoff without ponding. The use of grass swales for extended stormwater detention is not permitted by the City.

5.5.1 Enhanced Grass Swales

According to the City of Kawartha Lakes' definition, to be considered an **Enhanced Grass Swale** a grass swale must:

- Limit maximum flow velocity to 0.3m/s during a 4 hour, 25mm Chicago storm;
- Provide check dams spaced at least 5 metres apart;
- Have a slope of between 0.5% and 6.0%;
- Be topped with a layer of vegetated, uncompacted topsoil.

5.5.2 Bioretention Swales (Bioswales)

According to the City of Kawartha Lakes' definition, to be considered a **Bioretention Swale** a grass swale must:

- Have three layers of filter and storage material for their base, as following:
    - A top 0.6-1.25 metre thick filter layer consisting of a mixture of 3 parts sand to 1 part organic material;
    - A thin middle choker layer of 100mm pea stone;
    - A bottom storage layer consisting of ≥300mm of 50mmØ clear stone with an embedded perforated 200mm HDPE pipe;

- Have a slope of between 0.5% and 6%, with check dams recommended for slopes over 3%;
- Be vegetated with grass or perennial plants;
- Have at least 1 metre of separation from each bedrock and the seasonal high groundwater level.

5.6 Infiltration Trenches

According to the City of Kawartha Lakes' definition, an **Infiltration Trench** must:

- Consist of an excavated trench filled with a storage and filter medium;
- Contain three layers: a 75mm-150mm thick gravel cover layer, a ≤3.5 metres thick storage layer of geotextile wrapped 25mm-50mm clear stone, and a 150mm-300mm thick sand filter base layer;
- Have at least 5 metres of separation from buildings with basements and at least 1 metre of separation from each bedrock and the seasonal high groundwater level.

5.7 Underground Storage and/or Infiltration

Underground storage may be considered where it meets the design requirements outlined in the CLI ECA. If the underground storage facility is designed for infiltration of road or parking lot runoff, a pre-treatment structure shall be provided. The outlet structure shall be designed to meet the SWM control requirements. Any such facilities shall be readily accessible for any required maintenance activities.

6.0 End of Pipe Control

The design of all stormwater end of pipe treatment devices shall conform to per the City's CLI ECA. All Stormwater Management Facilities and other outlets newly established or replaced within the City's stormwater management system shall be inspected within one year of being placed into service. They must additionally be inspected after this as often as is required by the Operations, Monitoring and Maintenance Manual.

Retaining walls are strictly prohibited within all stormwater management blocks.

Warning signs shall be clearly visible and erected at all access points to all SWM facilities. Warning signs shall be supplied and installed by the developer matching City of Kawartha Lakes standard CKL-502.

6.1 Common End of Pipe Design Elements

The elements in this section are required in all end of pipe controls. All installed wet ponds, dry ponds, and wetlands require these elements.

6.1.1 Sediment Drying Area

Sediment drying areas are required. Sediment drying areas must be placed adjacent to both the maintenance access roadway and the forebay. They shall be sized for at least 10 years of sediment accumulation at a maximum height of 1.5 metres and a sediment slope of 10%. They must be located at or above the predicted 5 year water level of the forebay and must be set back a minimum of 6m from all property lines.

6.1.2 Maintenance Access Roadways

All end-of-pipe stormwater controls require maintenance access roadways leading to all inlets, outlet structures, forebays, and sediment drying areas within the SWM facility. Access roads must have a minimum width of 5 metres with a maximum grade of 8%. All curves shall have a maximum centreline radius of 12 metres. When two access points and a looped design cannot be provided, roads shall be designed with turning areas consisting of a minimum hammerhead width of 17 metres with a 12 metre centreline turning radius.

Maintenance access roads shall consist of a minimum 300mm of compacted granular "A" with a surface treatment of 50mm of topsoil and Native Seed Mixture. In areas where access roads are also to be used as trails or where heavy use is anticipated, an asphalt trail surface treatment may be used consisting of 40mm of HL3 and 50mm of HL8.

6.1.3 Outlet

All stormwater outfalls shall be directed to a protected outlet. Outlet control structures shall be designed with a flow regulating device to control the flow and drawdown time. A perforated riser should be installed at the intake associated with the bottom draw pipe connected to the outlet control structure. All outlet pipes require anti-seepage collars. Reverse sloped outlet pipes with baffle plates shall have a minimum size of 150mm in diameter; all other outlet pipes shall have a minimum size of 450mm in diameter.

Suitable erosion control and energy dissipation treatment shall be provided at outfalls where it discharges to the receiving body. Rip rap or river stone at the outfall shall be sized based on appropriate erosive velocity calculations. The outlet structure should be

designed to operate under free-flowing conditions where feasible. The return period surface elevations of the receiving body must be determined and verified to ensure the proper operation of the outlet structure. If the receiving body is identified as a cold water fishery, thermal mitigation measures such as shoreline planting, tree shading, bottom draw outlet pipes from deeper pools, or cooling trenches shall be implemented to minimize thermal loading to the receiving watercourse.

6.1.4 Fencing

Black vinyl chain link fencing matching City of Kawartha Lakes standard CKL-609 is required surrounding all end of pipe devices except in cases where other safety measures have be demonstrated to the City's approval. It is also required in all cases wherever SWM blocks abut private property.

6.2 Wet Pond with Extended Detention

Wet ponds may be used as end-of-pipe treatments to provide both quality and quantity control for drainage areas larger than 5 hectares.

6.2.1 Sizing

All wet pond permanent pools shall have mean length-to-width ratios of at least 3:1, measured from forebay spillway to pond outlet. They shall have maximum depths of 3 metres. A 0.3 metre freeboard is required above the maximum routed water level (i.e. the maximum water level to control the storm for which the pond has been designed).

6.2.2 Safety

Pond side slopes shall be a maximum of 7:1 for 3 metres on either side of the permanent pool and a maximum of 4:1 everywhere else.

6.2.3 Inlet

Whenever possible, all stormwater servicing shall be conveyed to the pond by one inlet. The minimum size for an inlet pipe is 450mm in diameter. The invert of the inlet structure shall be set to the normal water level or higher; a submerged inlet shall only be permitted if the obvert of the pipe lies at least 150mm below the maximum anticipated ice level. A headwall with safety grating shall be installed at the inlet per OPSD.

6.2.4 Emergency Spillway

An emergency spillway must be provided that has been designed to convey the Design Storm. A freeboard of 0.3 metres shall be provided above the maximum routed water

level under this storm. The spillway shall be adequately designed to withstand the erosive velocity associated with the uncontrolled governing flow. This erosion protection shall be integrated with an aesthetically pleasing natural vegetated surface treatment. Spillway side slopes shall not be steeper than 3:1 and shall be no steeper than 8% when incorporated into the maintenance access road. The spillway shall not be located with a minimum clearance of 3 metres from the outlet control structure

6.2.5 Forebay

All wet ponds require a forebay. Forebays shall be sized to hold 20% to 33% of the volume of the permanent pool and shall have length-to-width ratios of at least 2:1, measured from forebay inlet to permanent pool spillway. They shall be separated from the permanent pool by a minimum 2 metre wide berm with a spillway constructed at the normal water level. Spillways must have erosion protection and must enable the flow of a 25mm rain event without overtopping any other part of the forebay into the main cell of the facility. A dewatering sump shall be installed to enable drawdown of the permanent pool for maintenance and sediment removal, via gravity drain whenever possible. Forebay bottoms shall be lined with 300mm of 50mm diameter crusher run rock unless if it can be demonstrated that the native soils on the bottom of the forebay can support maintenance machinery for the removal of sediment.

6.3 Constructed Wetlands with Extended Detention

Constructed wetlands are acceptable stand-alone end-of-pipe control facilities for both quality and quantity control.

6.3.1 Sizing

Wetland permanent pools shall have a mean length-to-width ratio of at least 3:1, measured along the designed flow path through the wetland. They shall have a maximum permanent pool depth of 150mm to 300mm and maximum active storage depths of 1 metre.

6.3.2 Safety

Side slopes near the permanent pool should be 5:1 or flatter, with slopes in the extended detention portion not exceeding 3:1.

6.3.3 Inlet

Whenever possible, all stormwater servicing shall be conveyed to the wetland by one inlet. The minimum permitted size for an inlet pipe shall be 450mm in diameter. The

inlet structure invert shall be set to the normal water level or higher; submerged inlets are not permitted. Headwalls and safety grating shall be installed at all inlets per OPSD.

6.3.4 Forebay

All wetlands require a forebay. A forebay shall be sized with an area at most 20% the size of the main pool and shall have length-to-width ratios of at least 2:1, measured from forebay inlet to permanent pool spillway. Forebays shall be at least 1 metre deep and shall be separated from the main pool by a minimum 2 metre wide berm. Berms shall be set between 150mm and 300mm above the height of both the forebay permanent pool and the wetland permanent pool and shall be designed to act as a level spreader to the main wetland pool during storm events. A dewatering sump shall be installed in the wetland forebay (connected to the main wetland pond with a control valve when possible) to allow maintenance and sediment removal.

6.4 Hybrid Wet Pond / Wetland with Extended Detention

Hybrid wet pond/constructed wetlands are acceptable stand-alone end-of-pipe control facilities. Hybrid wet pond/wetlands shall follow guidelines outlined in sections 6.2 and 6.3 with the following additional requirements:

- The wet pond shall comprise 50% of the total permanent pool volume
- A forebay is required for the wet pond only and shall be sized based only on the size of the wet pond
- Active storage depth restrictions shall apply to the entire system unless a terraced overflow configuration is adopted
- Designed detention time for the system shall be 24 hours
- The length-to-width ratio of the wet pond may be reduced to 2:1 (though higher ratios are still preferred)

6.5 Dry Pond with Extended Detention

Dry ponds shall not be permitted as stand-alone treatment systems or as end-of-pipe quality control facilities. Dry ponds are permitted solely as quantity control measures. Dry ponds may be used as the last step of a treatment train approach, provided the Enhanced level of water quality treatment is achieved.

6.5.1 Sizing

All dry pond main bays shall have a mean length-to-width ratio of at least 3:1, measured from forebay spillway to pond outlet. They shall have maximum depth of 3 metres.

6.5.2 Safety

Pond side slopes shall be terraces with a maximum average slope of 4:1 or flatter.

6.5.3 Inlet

Whenever possible, all stormwater servicing shall be conveyed to the pond by one inlet. The invert of the inlet pipe shall be set at the maximum design water level in the forebay. Stone blocks or other mechanisms are recommended at the inlet to minimize erosion potential.

6.5.4 Emergency Spillway

An emergency spillway must be provided that has been designed to convey the Design Storm. A freeboard of 0.3 metres shall be provided above the maximum routed water level under this storm. The spillway shall be treated for erosion protection that is adequately designed to withstand the erosive velocity associated with the uncontrolled governing flow. This erosion protection shall be integrated with an aesthetically pleasing natural vegetated surface treatment. Spillway side slopes shall not be steeper than 3:1 and shall be no steeper than 8% when incorporated into the access road. The spillway shall not be located directly above the outlet control structure and a minimum clearance of 3 metres shall be provided.

6.5.5 Forebay

All dry ponds require a forebay. Forebays shall be separated from the permanent pool by a minimum 2 metre wide berm with a spillway constructed at the normal water level. Spillways must have erosion protection and must enable the flow of a 25mm rain event without overtopping any other part of the forebay into the main cell of the facility. Forebay bottoms shall be lined with 300mm of 50mm diameter crusher run rock unless if it can be demonstrated that the native soils on the bottom of the forebay can support maintenance machinery for the removal of sediment.

7.0 Assumption Protocol for Storm Sewers and SWM Ponds

7.1 Performance Evaluation of Storm Sewers Prior to Assumption

Prior to assumption of the storm sewer by the City, the following protocol shall be followed to ensure that the storm sewer system is operating per the design:

- A survey shall be completed for the storm sewer including maintenance holes and as-constructed drawings shall be prepared.
- The storm sewer design sheets shall be revised as required to verify adequate design capacity.
- A video inspection of the storm sewer including maintenance holes shall be undertaken by the developer/owner with City staff in attendance to identify any deficiencies (including damages). A digital and hardcopy record of the video inspection along with written certification from the developer's consulting engineer confirming that the storm system has been constructed as per the approved design drawings and approved plans must also be provided.
- A deformation test (PEGG Test) shall be completed on all PVC storm pipe to identify pipe sections that may require replacement. Pipe sections that do not allow the "pig" to pass freely shall be replaced.
- The storm sewer and catch basins shall be thoroughly flushed and cleaned to remove all sediments as required.

All inspections shall be conducted in compliance with the Occupational Health and Safety Act (OHSA) (e.g. confined space entry protocol).

7.2 Performance Monitoring of SWM Ponds Prior to Assumption

All new SWM facilities shall undergo a 1 year performance monitoring evaluation and shall meet the design requirement to the satisfaction of the City. Prior to assumption, the performance evaluation shall include, as a minimum requirement, the following items:

- Complete inspection and verification of hydraulic structure design, dimensions and elevations.
- Bathymetry to determine the volume of sediment accumulation within the facility (Wet Ponds).

- Water quality (phosphorus) monitoring.
- Plant monitoring: any plants found to die or become diseased during the performance monitoring period shall be replaced prior to assumption.
- Provide and maintain a log book noting all inspection and monitoring activities since the completed construction of the pond.

7.3 SWM Pond Assumption Protocol

Prior to assumption of any SWM facilities by the City, the following steps shall be taken:

- A complete pond performance evaluation.
- Complete inspection of facilities and provide ongoing inspection and monitoring Log Book.
- Bathymetry, including removal, testing, and safely disposing of any accumulated sediments at a suitable offsite location, if required (Wet Ponds).
- As-constructed survey of SWM pond block and all key pond elements and hydraulic structures.
- Written clearance from a Landscape Architect that all pond plantings are as approved on the design drawings and are established. Pond plantings must be shown to be healthy and complete. Any dead, diseased or missing material must be replaced prior to assumption inspection.

Appendix A – CLI ECA Stormwater Management Criteria

1.0 Applicability of Criteria

1.1 The criteria listed under Table A1 of this Appendix applies to all drainage areas greater than 0.1 ha, with the construction erosion and sediment control criteria applying also to sites <0.1 ha;

1.2 Despite condition 1.1 of Appendix A, if some or all of the criteria listed under Table A1 of this Appendix have been assessed for and addressed in other adjacent developed lands to the project site through a subwatershed plan or equivalent study, then those criteria may not be applicable to the project site.

Table A1. Performance Criteria

Performance Category	**Performance Criteria**
Water Balance [1]	**FOR DEVELOPMENT SCENARIOS** [2] **Assessment Studies:** i) Control [3] as per the criteria identified in the water balance assessment completed in one or more of the following studies [15], if undertaken: a watershed/subwatershed plan; Source Protection Plan (Assessment Report component); Master Stormwater Management Plan, Master Environmental Servicing Plan; Class EA, or similar approach that transparently considers social, environmental and financial impacts; or local site study including natural heritage, Ecologically significant Groundwater Recharge Areas (EGRA), inflow and infiltration strategies. The assessment should include sufficient detail to be used at a local site level and consistent with the various level of studies; OR **IF Assessment Studies in i) NOT completed:** ii) Control [3] the recharge [4] to meet Pre-development [5] conditions on property; **OR**

Performance Category	Performance Criteria
	iii) Control [3] the runoff from the 90th percentile storm event. **Lake Simcoe Watershed Municipalities:** iv) Control [3] as per the evaluation of anticipated changes in water balance between Pre-development and post-development assessed through a Stormwater management plan in support of an application for Major Development [6]. The assessment should include sufficient detail to be used at a local site level. If it is demonstrated, using the approved water balance estimation methods [7], that the site's post to Pre-development water balance cannot be met, and Maximum Extent Possible [8] has been attained, the proponent may use Lake Simcoe and Region Conservation Authority's (LSRCA) Recharge Compensation Program [9]. **FOR RETROFIT SCENARIOS [10]** **Assessment Studies:** i) Control as per criteria identified in the water balance assessment completed in one or more of the following studies: a watershed/subwatershed plan, Source Protection Plan (Assessment Report component), Master Stormwater Management Plan, Master Environmental Servicing Plan, Class EA, or local site study including natural heritage, EGRA, inflow and infiltration strategies, if undertaken. The assessment should include sufficient detail to be used at a local site level and consistent with the various level of studies; OR ii) If constraints [11] identified in i), then control [3] as per Maximum Extent Possible [8] based on environmental site feasibility studies or address local needs[14]. **IF Assessment Studies in i) NOT completed:**

Performance Category	Performance Criteria
	iii) Control [3] the recharge [4] to meet Pre-development [5] conditions on property; **OR** iv) Control [3] the runoff from the 90th percentile storm event.
Erosion Control (Watershed) [1]	**FOR DEVELOPMENT SCENARIOS [8]** i) As per erosion assessment completed in watershed/subwatershed plan, Master Stormwater Management Plan, Master Environmental Servicing Plan, Drainage Plan, Class EA, local site study, geomorphologic study, or erosion analysis; **OR** ii) As per the Detailed Design Approach or Simplified Design Approach methods described in the Stormwater Management Planning and Design Manual: a. The Detailed Design Approach may be selected by the proponent for any development regardless of size and location within the watershed provided technical specialists are available for the completion of the technical assessments; or considered more appropriate than the simplified approach given the size and location of the development within the watershed and the sensitivity of the receiving waters in terms of morphology and habitat function. b. The Simplified Design Approach may be adopted for watersheds whose development area is generally less than twenty hectares AND either one of the following two conditions apply: 1) The catchment area of the receiving channel at the point-of-entry of Stormwater drainage from the development is equal to or greater than twenty-five square kilometres; **OR** 2) Meets the following conditions: ▪ The channel bankfull depth is less than three quarters of a metre; ▪ The channel is a headwater stream;

Performance Category	Performance Criteria
	▪ The receiving channel is not designated as an Environmentally Sensitive Area (ESA) or Area of Natural or Scientific Interest (ANSI) and does not provide habitat for a sensitive aquatic species; ▪ The channel is stable to transitional; and ▪ The channel is slightly entrenched; **OR** iii) In the absence of a guiding study, detain at minimum, the runoff volume generated from a 25mm storm event over 24 to 48 hours. **FOR RETROFIT SCENARIOS** [10] i) If approaches i-iii) under 'Development Scenarios' are not feasible as per identified constraints [11], then improve the level of erosion control [3] currently provided on site to Maximum Extent Possible [8] based on environmental site feasibility studies or address local needs[14].
Water Quantity (Minor and Major System) [1]	i) As per municipal standards, Master Stormwater Management Plan, Class EA, Individual EA and/or ECA, as appropriate for the type of project [13]
Flood Control (Watershed Hydrology) [1]	**FOR DEVELOPMENT SCENARIOS** [2] i) Manage peak flow control as per watershed/subwatershed plans, municipal criteria being a minimum 100-year return storm (except for site specific considerations and proximity to receiving water bodies), municipal guidelines and standards, Individual/Class EA, ECA, Master Plan, as appropriate for the type of project [13]. **FOR RETROFIT SCENARIOS** [10]

Performance Category	Performance Criteria
	i) If approaches i) under 'Development Scenarios' are not feasible as per identified constraints [11], then improve the level of flood control [3] currently provided on site to Maximum Extent Possible [8] based on environmental site feasibility studies.
Construction Erosion and Sediment Control	i) Manage construction erosion and sediment control through development and implementation of an erosion and sediment control (ESC) plan. The ESC plan shall: a. Have regard to Canadian Standards Association (CSA) W202 Erosion and Sediment Control Inspection and Monitoring Standard (as amended); OR b. Have regard to Erosion and Sediment Control Guideline for Urban Construction 2019 by TRCA (as amended). ii) Be prepared by a QP for sites with drainage areas greater than 5 ha or if specified by the Owner for a drainage lower than 5 ha. iii) Installation and maintenance of the ESC measures specified in the ESC plan shall have regard to CSA W208:20 Erosion and Sediment Control Installation and Maintenance (as amended). iii) For sites with drainage areas greater than 5 ha, a QP shall inspect the construction ESC measures, as specified in the ESC plan.
Footnote	1. Where the opportunity exists on your project site or the same subwatershed, reallocation of development elements may be optimal for management as described in footnote [3]. 2. Development includes new development, redevelopment, infill development, or conversion of a rural cross-section into an urban cross-section. 3. Stormwater volumes generated from the geographically specific 90th percentile rainfall event on an annual average basis from all surfaces on the entire site are targeted for control. Control is in the following hierarchical order, with each step exhausted before proceeding to the next: 1) retention (infiltration, reuse, or evapotranspiration), 2) LID filtration, and 3) conventional Stormwater management. Step 3, conventional Stormwater management, should proceed only once Maximum Extent Possible [8] has been attained for Steps 1 and 2 for retention and filtration.

Performance Category	Performance Criteria
	4. Recharge is the infiltration and movement of surface water into the soil, past the vegetation root zone, to the zone of saturation, or water table. 5. Pre-development is defined as the more stringent of the two following scenarios: 1) a site's existing condition, or 2) as defined by the local municipality. 6. Major Development has the same meaning as in the Lake Simcoe Protection Plan, 2009. 7. Currently, the approved tool by LSRCA for calculating the water balance is the Thornthwaite-Mather Method. Other tools agreed upon by relevant approval agencies (e.g., LSRCA, municipality, or Ministry) may also be acceptable, subject to written acceptance by the Director. 8. Maximum Extent Possible means maximum achievable Stormwater volume control through retention and LID filtration engineered/landscaped/technical Stormwater practices, given the site constraints [11]. 9. Information pertaining to LSRCA's Recharge Compensation Program and Phosphorus Offsetting Policy is available on LSRCA's website (lsrca.on.ca), or in "Water Balance Recharge Policy for the Lake Simcoe Protection Plan", dated July 2021, and prepared by Lake Simcoe Region Conservation Authority and "Phosphorus Offsetting Policy", dated July 2021, and prepared by Lake Simcoe Region Conservation Authority. 10. Retrofit means: 1) a modification to the management of the existing infrastructure, 2) changes to major and minor systems, or 3) adding Stormwater infrastructure, in an existing area on municipal right-of-way, municipal block, or easement. It does not include conversion of a rural cross-section into an urban cross-section. 11. Site constraints must be documented. A list of site constraints can be found in Table A2. 12. Tools for calculating phosphorus budgets may include the Ministry's Phosphorus Tool, the Low Impact Development Treatment Train Tool developed in partnership by TRCA, LSRCA, and Credit Valley Conservation (CVC), or other tools agreed upon by the LSRCA and other relevant approval agencies including the municipality. 13. Possible to look at combined grey infrastructure and LID system capacity jointly.

Performance Category	Performance Criteria
	14. Local needs include requirements for water quality, erosion, and/or water balance retrofits identified by the owner through ongoing operation and maintenance of the stormwater system, including inspection of local receiving systems and the characterization of issues requiring remediation through retrofit controls. 15. All studies shall conform with Ministry policies. If any conclusions in the studies negate policy, then the project will require a direct submission to the Ministry for review through an application pertaining to a Schedule C Notice. 16. All studies shall conform with Ministry policies. If any conclusions in the studies negate policy, then the project will require a direct submission to the Ministry for review through an application pertaining to a Schedule C Notice.

Table A2 – Site Constraints
a) Shallow bedrock [1], areas of blasted bedrock [2], and Karst;
b) High groundwater [1] or areas where increased infiltration will result in elevated groundwater levels which can be shown through an appropriate area specific study to impact critical utilities or property (e.g., susceptible to flooding);
c) Swelling clays [3] or unstable sub-soils;
d) Contaminated soils (e.g., brownfields);
e) High Risk Site Activities including spill prone areas;
f) Prohibitions and or restrictions per the approved Source Protection Plans and where impacts to private drinking water wells and /or Vulnerable Domestic Well Supply Areas cannot be appropriately mitigated;

Table A2 – Site Constraints
g) Flood risk prone areas or structures and/ or areas of high inflow and infiltration (I/I) where wastewater systems (storm and sanitary) have been shown through technical studies to be sensitive to groundwater conditions that contribute to extraneous flow rates that cause property flooding / Sewer back-ups;
h) For existing municipal rights-of-way infrastructure (e.g., roads, sidewalks, utility corridor, Sewers, LID, and trails) where reconstruction is proposed and where surface and subsurface areas are not available based on a site-specific assessment completed by a QP;
i) For soiu within partially separated wastewater systems where reconstruction is proposed and where, based on a site-specific assessment completed by a QP, can be shown to: i. Increase private property flood risk liabilities that cannot be mitigated through design; ii. Impact pumping and treatment cost that cannot be mitigated through design; or iii. Increase risks of structural collapse of Sewer and ground systems due to infiltration and the loss of pipe and/or pavement support that cannot be mitigated through design.
j) Surface water dominated or dependent features including but not limited to marshes and/or riparian forest wetlands which derive all or a majority of their water from surface water, including streams, runoff, and overbank flooding. Surface water dominated or dependent features which are identified through approved site specific hydrologic or hydrogeologic studies, and/or Environmental Impact Statements (EIS) may be considered for a reduced volume control target. Pre-consultation with the MECP and local agencies is encouraged;
k) Existing urban areas where risk to water distribution systems has been identified through assessments to meet applicable drinking water requirements, including Procedures F-6 and F-6-1, and substantiated by a QP through an appropriate area specific study and where the risk cannot be reasonably mitigated per the relevant design guidelines;
l) Existing urban areas where risk to life, human health, property, or infrastructure has been is identified and substantiated by a QP through an appropriate area specific study and where the risk cannot be reasonably mitigated per the relevant design guidelines;

Table A2 – Site Constraints
m) Water reuse feasibility study has been completed to determine non-potable reuse of Stormwater for on-site or shared use;
n) Economic considerations set by infrastructure feasibility and prioritization studies undertaken at either the local/site or municipal/system level [4].

Footnote:

1. May limit infiltration capabilities if bedrock and groundwater is within 1m of the proposed Facility invert per Table 3.4.1 of the LID Stormwater Planning and Design Guide (2010, V1.0 or most recent by TRCA/CVC). Detailed assessment or studies are required to demonstrate infiltration effects and results may permit relaxation of the minimum 1m offset.
2. Where blasting is more localized, this constraint may not be an issue elsewhere on the property. While infiltration-based practices may be limited in blasted rock areas, other forms of LID, such as filtration, evapotranspiration, etc., are still viable options that should be pursued.
3. Swelling clays are clay soils that is prone to large volume changes (swelling and shrinking) that are directly related to changes in water content.
4. Infrastructure feasibility and prioritization studies should comprehensively assess Stormwater site opportunities and constraints to improve cost effectiveness, environmental performance, and overall benefit to the receivers and the community. The studies include assessing and prioritizing municipal infrastructure for upgrades in a prudent and economically feasible manner.