SECTION 8 – STORM DRAINAGE DESIGN REQUIREMENTS

Table of Contents

8.0 Introduction 1
8.1 Storm Sewer Design 2
8.1.1 Run-off Calculations 2
8.1.2 Storm Sewer Requirements 4
8.1.3 Manhole Requirements 9
8.1.4 Catchbasin Requirements 11
8.1.5 Roof Leaders, Foundation Drains and Storm Connections 13
8.2 Channel, Culvert and Overland Flow 16
8.2.1 Culverts and Bridges 16
8.2.2 Outfall Channels 16
8.2.3 Watercourse Erosion and Bank Stability 17
8.2.4 Overland Flow Routes 17
8.2.5 Inlet/Outlet Structures 18
8.3 Stormwater Management Requirements 19
8.3.1 Stormwater Quality Control 20
8.3.2 Stormwater Runoff Volume Reduction 21
8.3.3 Storm Water Quantity Control 23
8.3.4 Stormwater Management Reports 36
8.3.5 Low Impact Development 37
8.4 Groundwater Management 39
8.4.1 Requirements 39
8.4.2 Groundwater Quality 39
8.4.3 Groundwater Quantity 40
8.5 Storm Sewer Discharge Authorization 41
Appendix 1 – Watershed Boundaries 42

List of Tables

Table 1: Stormwater Quantity Control Requirements 26
Table 2: Stormwater Quantity Control Requirements (continued) 28
Table 3: Stormwater Quantity Control Requirements (continued) 30
Table 4: Stormwater Quantity Control Requirements (continued) 32
Table 5: Stormwater Quantity Control Requirements (continued) 34
Table 6: Etobicoke Creek Unit Flows 35

8.0 Introduction

The following are the City's storm drainage design requirements for all applications. The following subsections cover the topics of stormwater management, groundwater management, storm sewer design and channel/ overland flow. While this design criteria outlined in this document can be used to apply for Stormwater Charge Credit, it does not cover details on the application process; to see additional details please see our Stormwater Charge webpage.

8.1 Storm Sewer Design

8.1.1 Run-off Calculations

Storm sewers shall be designed to drain all lands based on the Rational Method. The Rational Method calculations must be checked using a model approved by the Development Engineering & Construction team where the drainage area is greater than 10 hectares. The larger of the flows is to be used in the design of the sewer system.

$$Q = 0.0028CIA$$

Where: Q = Flow in cubic metres per second (m^3/s)

A = Area in Hectares (ha)

C = Run-off coefficient

I = Intensity in millimetres per hour (mm/hr)

Intensity of Rainfall: The intensity of rainfall is to be determined from the most recent City of Mississauga standard INTENSITY – DURATION – FREQUENCY – RAINFALL CURVES. These curves were originally derived from rainfall data taken from the Pearson International Airport (City Standard Drawing No. 2111.010). The equations for these curves are as follows:

2 Year Storm $I = \frac{610}{(T.C. + 4.6)^{0.78}}$

5 Year Storm $I = \frac{820}{(T.C. + 4.6)^{0.78}}$

10 Year Storm $I = \frac{1010}{(T.C. + 4.6)^{0.78}}$

25 Year Storm $I = \frac{1160}{(T.C. + 4.6)^{0.78}}$

50 Year Storm $I = \frac{1300}{(T.C. + 4.7)^{0.78}}$

100 Year Storm $I = \frac{1450}{(T.C. + 4.9)^{0.78}}$

Time of Concentration: The minimum initial time of concentration is to be 15 minutes.

Pre-Development: To calculate the initial time of concentration (t_c) for upstream, undeveloped lands, the following formulae may be used: Bransby Williams, HYMO/OTTHYMO, SCS Upland Method, etc. The most appropriate method will be determined at the discretion of the Development Engineering & Construction team.

Post-Development: To calculate the initial external time of concentration (t_c) for external lands that are scheduled for future development, a straight line is to be drawn from the furthest point within the watershed to the proposed inlet. The top 50 metres shall have an initial (t_c) of 15

minutes and the remainder shall have a (t_c) as if the velocity in the sewer is 2m/s. The summation of the two (t_c)'s will give the future external time of concentration.

If the upstream area has adequate storm sewers, channels, or culverts, the velocity of the flow through these sewers, channels, or culverts shall supersede the 2m/s calculation.

Runoff Coefficient: Unless otherwise demonstrated, the runoff coefficients noted below are to be used.

	Runoff Coeff
• Residential – single family, semi-detached	0.55
• Compact or dense housing (e.g. townhouses)	0.65
• High-rise residential	0.90
• Industrial and Commercial	0.90
• Neighbourhood Park	0.30
• Permeable Pavements	0.50
• Sodded Area	0.25
• All Other Surfaces	0.90

A minimum runoff coefficient of 0.55 is to be used for undeveloped upstream area external to the subdivision where future residential development is expected and 0.90, where future industrial or commercial development is expected.

To account for the increase in runoff due to saturation of the catchment surface that would occur for larger, less frequent storms, the adjustment factor below shall be used for pre and post development conditions:

	Adjustment Factor
• 10 – Year	1.0
• 25 – Year	1.1

- 50 – Year 1.2
- 100 – Year 1.25

Drainage Area: Drainage systems must be designed to accommodate all upstream drainage areas for interim and ultimate conditions, as determined by contour mapping and drainage plans.

Climate Change: Where storm sewers are being planned inclusive of a direct outlet to a receiving stream or watercourse, the City may consider an adjustment to the design flows (e.g. a +20% adjustment for IDF curves) to account for future climate change scenarios.

Hydraulic Grade Line: In infill scenarios the City may require a hydraulic grade line analysis (e.g. spreadsheet analysis based on sewer design). The purpose would be to demonstrate that existing properties and the subject development would not be impacted by any proposed changes.

8.1.2 Storm Sewer Requirements

Storm Sewer System

A storm sewer system shall be defined as the upper part of a drainage system draining areas less than 100 ha of land. Storm sewer systems shall be designed to accommodate a 10-year storm.

Trunk Sewer System

A trunk sewer system shall be defined as part of a drainage system that drains an area of 100 ha of land or greater. Trunk storm sewer systems shall be designed to accommodate a 25-year storm.

Inlets

The designed storm sewers inlets must model conditions of no inlet restriction, and a 50% inlet restriction at any depressions or roadway sags.

Pipe Capacities

Manning's formula shall be used in determining the capacity of all storm sewers. The capacity of the sewer shall be determined on the basis of the pipe flowing full.

The value of the roughness coefficient 'n' used in the Manning's formula shall be as follows:

- Concrete Pipe 0.013
- Concrete Box Culverts 0.013

- Corrugated Metal 68 x 13mm corrugations 0.024
- Corrugated Metal 25% paved invert 0.020
- PVC Pipe 0.013

Design flow calculations must be completed on City of Mississauga forms shown on City Standard Drawing No.'s 2112.020 and 2112.030, for this purpose.

Flow Velocities (Flowing full)

For circular concrete pipes the:

- Minimum acceptable velocity is 0.75m/s and the
- Maximum acceptable velocity is 4.0m/s.

For velocities that exceed 3m/s, additional protection against erosion, scouring, and pipe displacement must be provided by a licensed Engineering Practitioner. Slopes greater than 20 percent shall include concrete anchors or an equivalent tool and will vary by sewer material and size. This shall be verified by a Licensed Engineering Practitioner.

In certain circumstances, velocities less than 0.75m/s may be accepted if site conditions do not allow for deepening of the storm sewer. Special measures such as frequent flushing must be considered and would be responsibility of the property owner.

Minimum Sizes

The minimum size for an on-street storm sewer shall be 300mm.

Depth of Storm Sewers:

The obvert of the storm sewer shall be located a minimum of one (1) metre below basement floor elevations to allow for the installation of foundation and weeping tile connections. Maximum depth should be obtained as per manufacturer recommendations.

Storm Sewers shall be installed at sufficient depth 1.2m (greater than frost penetration). If install is not available at this depth, pipes should be insulated to protect from freezing. Insulation must be designed/verified by a Licensed Engineering Practitioner.

Unless the Consultant is sure of the types of buildings to be incorporated along a street, it is suggested that storm sewers be placed with 3.2 metres of cover below the centre line of the road to ensure compliance with City requirements 8.1.5.

For Storm Sewers that are subject to traffic loading, a loading factor must be considered. This shall be in accordance with regulations, codes and by-laws of authorities having jurisdiction, which may include but is not limited to: Highway Bridge Design Code (for vehicular traffic), Railway Safety Act, and Transport Canada Act.

Location

The storm sewers shall be located as shown on the standard City of Mississauga road cross section drawings. This standard location is generally 1.5 metres south or west of the centre line of the right of way.

A minimum setback of 500mm between the obvert of the sanitary sewer and the invert of the storm sewer must be provided if the sanitary sewer connections are required to go under the storm sewer.

A minimum 0.5m vertical setback, and 2.5m horizontal setback must be maintained from other utility services.

Radius Pipes

Radius pipe shall be allowed for storm sewers 975mm in diameter and larger provided that a manhole is located at the beginning or at the end of the radial section. The minimum centre line radius allowable shall be in accordance with the minimum radii table as provided by the manufacturers.

Limits of Construction

Sewers shall be terminated with a manhole at the subdivision limits when external drainage areas are considered in the design. The design of the terminal manholes must allow for the future extension of the sewer.

When external areas are not included in the sewer design, the sewer shall extend at least halfway across the frontage and/or flankage of any lot or block in the subdivision.

Sewer Alignment

Storm sewers shall be laid in a straight line between manholes unless radius pipe has been designed. Joint burial (common trenching) with sanitary sewers will be considered when supported by the recommendations of a soils report prepared by a qualified Geotechnical Engineering Company.

Changes in Pipe Size

No decrease of pipe size from a larger upstream to a smaller size downstream will be allowed regardless of the increase in grade.

Easement Requirements

The minimum width of easements for storm sewers shall be in accordance with the following guidelines:

Size of Pipe	Depth of Invert	Minimum Width of Easement
250 to 375mm	3.0 m maximum	3.0 m
450 to 675mm	3.0 m maximum	4.5 m
750 to 1500mm	3.0 m maximum	6.0 m
1650mm and up	4.0 m maximum	4.0 m plus 3 times O.D. of Pipe

Regardless of the above, all situations will be reviewed and judged on individual cases at the discretion of the Development Engineering & Construction team.

In some cases, development may be proposed adjacent to an existing storm sewer easement. Depending on the development's design and proximity to the easement limit, the City may request a geotechnical engineer to certify the proposed excavation limit, slope of excavation and line of influence.

Pipe Classification and Bedding

The type and classification of storm sewer pipe and the sewer bedding type shall be clearly indicated on all profile drawings for each sewer length.

All material used in the addition, modification, replacement, or extension of Storm Sewers including pipes, fittings, valves, devices and materials used for the rehabilitation shall meet all applicable quality adopted by the Ontario Provincial Standards for Roads and Public Works. The class of pipe and the type of bedding shall be selected to suit loading and proposed construction conditions. Details are illustrated in the City of Mississauga Standard Drawings 2112.040. In general, the Type "B" bedding (crushed stone base with granular over the sewer) shall be used for storm sewers in new developments, and the class of pipe will be selected to suit this bedding detail.

The use of City of Mississauga Standard No. 2112.110 “Sewer Bedding (6mm Washed Crushed Gravel)” is allowed on a per project basis. Approval in writing is required in advance before this material may be used.

The width of trench at the top of the pipe must be carefully controlled to ensure that the maximum trench width is not exceeded unless additional bedding or higher strength pipe is used.

Polyvinyl Chloride (PVC) Pipe

Manning's 'n' that will be used for the sizing of PVC pipes shall be 0.013. The Manning's 'n' that will be used to determine velocity and time of concentration is 0.009.

Pipe Manufacturer must be approved by the Development Engineering & Construction team.

Maximum allowable deflection of main line sewer is 5% Deformation gauge (Pig) test may be required prior to acceptance.

Pipe shall meet the Canadian Standard Association requirement as noted within OPSS 1841. The basic material used in manufacturing of this pipe shall have a cell classification of 12454-B or 12454-C or ASTM Standard D-3034 and OPSS 1841.

Maximum PVC pipe size that will be allowed to be installed for the City of Mississauga shall be 450mm diameter. This maximum pipe size may increase based upon result of CSA test or CSA certification and City approval.

Bedding for all PVC pipes shall be in accordance with City Standard Drawing No. 2112.080, Detail A-A with the exception of material above the pipe, will be 19mm stone sewer bedding as well, not concrete. Sewer bedding shall conform with OPSS 1010 for Granular ‘A’ or City Standard Drawing No. 2112.110 or 2112.140 and sand cover shall conform with City Standard Drawing No. 2112.100. The compaction of all bedding and cover materials shall be a minimum of 95% Standard Proctor. Maximum cover shall be in accordance with OPSD 806.04 and 806.06. Special care must be given to contouring the bedding material to conform with the pipe bottom and projecting bells, along with proper compaction of the haunches in order to provide even support throughout the pipe. The use of any bedding material or backfill material with diameters larger than 4 cm will not be permitted around any flexible pipe. Backfill of all flexible pipes shall be in accordance with the manufacturers’ specifications and City standards and OPSS 514.07.08.

Sewer service connection shall be in accordance with OPSD 1006.02.

Engineering Consultants are to provide the City with calculations and a certificate that an analysis has been completed, given:

(a) The site conditions
(b) Water table elevation

(c) Trench width
(d) Proposed bedding
(e) Manufacturer H.D.B. rating identifying that pipe materials are stress rated

To ensure that all forms of flexible pipe failure have been addressed and that a factor of safety of 1.75 has been achieved. The typical types of pipe failure are as follows:

(i) Wall thrust, i.e., buckling of walls at spring line
(ii) Ring buckling - caused by hydrostatic pressures, normally identified as collapsing in the bottom quadrants of the pipe
(iii) Joint failure
(iv) Wall distress, i.e., strain cracking
(v) Wall deformation
    a. Ring deflection, i.e., 5% elliptical deflection
    b. Irregular distortion normally identified as inverse curvature within the top of the pipe

8.1.3 Manhole Requirements

Manholes may either be precast or poured in place and shall be designed and constructed in accordance with the most recent Ontario Provincial Standard Drawings and Specifications.

Location and Spacing

Manholes shall be located at each change in alignment, grade or pipe material, at all pipe junctions, at the beginning or end of radius pipe sections and at intervals along the pipe to permit entry for maintenance to the sewer.

Pipe Diameter	Maximum Maintenance Manhole Spacing
600mm or less	120m
675mm or grater	170m

Maximum spacing of manholes shall be 120m for sewers 600mm or less in diameter and 170m for sewers 675mm or greater in diameter.

Manhole Types

O.P.S.D. standard manhole details shall be used for manhole design. Although these standard drawings provide details for manholes up to certain maximum depths and sizes, the Consulting Engineer shall analyse, individually, each application of the standards related to soil conditions, loading and other pertinent factors to determine structural suitability. In all cases where the standard drawings are not applicable, the manholes shall be individually designed and detailed.

A reference shall be made on all profile drawings to the type and size of storm manholes.

Manhole Details

- Manhole chamber openings shall be located on the side of the manhole parallel to the flow for straight run manholes, or on the upstream side of the manhole at all junctions.
- The change in direction of flow in any manhole shall not be less than 90 degrees.
- Safety gratings shall be provided in all manholes when the depth of the manhole exceeds 5m. The maximum spacing between safety gratings shall not exceed 4.5m.
- The obverts on the upstream side of manholes shall not be lower than the obvert of the outlet pipe.
- Where the difference in elevation between the obvert of the inlet and outlet pipes exceed 1.2m, a drop pipe as indicated on City Standard Drawing No. 2113.010 shall be placed on the inlet pipe.
- Granular backfill material shall be placed to a minimum thickness of 300mm all around the manhole structure.
- Storm sewer manholes shall be benched to the obvert of the outlet pipe on a vertical projection from the spring line of the sewer.
- Manholes shall be located, wherever possible, a minimum of 1.5m away from the face of curb and/or any other service.

Head Losses and Drops

Suitable drops shall be provided across manholes to compensate for the loss in energy due to the change in flow velocity and for the difference in the depth of flow in the sewers.

In order to reduce the amount of drop required, the designer shall, wherever possible, restrict the change in velocity between the inlet and outlet pipes to 0.6m/s.

Hydraulic calculations shall be submitted for junction and transition manholes on sewers where the outlet is 1050mm diameter or greater. In addition, hydraulic calculations may be required for manholes where the outlet pipe is less than 1050 mm diameter if, in the opinion of the Development Engineering & Construction team, there is insufficient invert drop provided across any manhole.

Regardless of the invert drop across a manhole as required by calculations, the obvert of the outlet pipe shall not be higher than the obvert of the inlet pipe at any manhole location.

The minimum drops across manholes shall be as follows:

Change of Direction	Minimum Drop (mm)
0°	20
1° to 45°	50
46° to 90°	80

8.1.4 Catchbasin Requirements

Catchbasins may be either precast or poured in place and shall be designed and constructed in accordance with the most recent O.P.S.D. and O.P.S.S. requirements.

Location and Spacing

Catchbasins shall be selected, located and spaced in accordance with the conditions of design. The design of the catchbasin location and type shall take into consideration the lot areas, the lot grades, pavement widths, road grades and intersection locations.

The maximum area to be served by any catchbasin shall be 2000m^2 of paved area or 5000m^2 of sodded area.

Maximum spacing for catchbasins shall be as follows:

Road grade @ 0.5%	70m
Road grade @ 0.5% to 3%	90m
Road grade greater than 3%	70m

NOTE: For cul-de-sacs the distance is to be measured along the gutter.

Catchbasins shall be generally located upstream of sidewalk crossings at intersections and upstream of all pedestrian crossings. Catchbasins shall not be located in driveway curb depressions.

Catchbasins Types

Typical details for the single, double and rear lot type catchbasins are shown on City standard 2851.07, and in the O.P.S.D. Standards.

Any special catchbasins and inlet structures proposed must be fully designed and detailed by the Consulting Engineer for approval by the Development Engineering & Construction team.

Double catchbasins are to be installed at the low point of any road as a minimum but the design should demonstrate sufficient protection to ensure the 100-year storm is contained within the municipal right-of-way.

Catchbasin Connection

For single catchbasins including rear lot catchbasins, the minimum size of connection shall be 250mm and the minimum grade shall be 1.0%.

- Where storm mainline sewer sizes are such that a connection of the 250mm lead can not be achieved, alternative means of stormwater mitigation are to be proposed for review. Acceptance of alternatives are at the city's sole discretion.

For double catchbasins, the minimum size of connection shall be 300mm and the minimum grade shall be 1.0%.

In general, catchbasins located in close proximity to a downstream manhole shall have their leads connected to the storm sewer. Long catchbasin connections (in excess of 20m) shall be connected to a manhole.

Rear lot catchbasin leads shall be installed as follows:

- Where the concrete pipe lead goes between houses, concrete encase the lead between the front building line and the rear building line.
- Where PVC pipe is used, concrete encase the entire line from the main sewer to the rear lot catchbasin.

Frame and Grate

The frame and cover for catchbasins shall be as detailed in the O.P.S.D. Standards. In general, the "bicycle proof" catchbasin grate shall be required for catchbasins located in roadway or walkway areas.

Catchbasins located within the travelled portion of a roadway, shall have the frame elevation wet flush with the surface of the future course asphalt. The adjustment and setting of the frame and cover shall be completed in accordance with the details provided in the O.P.S.D. Standards.

Catchbasins in urban areas may be subject to nonstandard frame and grate use as part of community initiatives. Coordination of this nature will be initiated as part of development application review process.

8.1.5 Roof Leaders, Foundation Drains and Storm Connections

Roof Leaders

All roof leaders must not be connected directly to the storm sewer system, and the following conditions must be complied with:

(1) Roof leader down spout locations are to be indicated on site grading plans.
(2) Roof leaders are to discharge onto concrete splash pads.
(3) Split drainage lots are not permitted to discharge through adjacent lots which have back to front drainage. The roof leader must be located at the house corner closest to the catchbasin.
(4) Houses located on corner lots have roof leaders(s) located at the corner(s) of the house, closest to the street lines.
(5) The appropriate clauses for the conditions listed below are to be included in Schedule C of the Servicing Agreement, under Consulting Engineer.
    a. The Consultant is to certify, as part of the preliminary lot grading certificate, that the roof leader(s) are not connected directly to the storm sewer and are located in accordance with City of Mississauga standards.
    b. The Consultant is to certify as part of the final lot grading certificate, that the roof leader(s) have been installed in accordance with the preliminary lot grading certificate.
(6) For further consideration on managing runoff volume on a site, please reference Section 8.3.2 – Stormwater Runoff Volume Reduction.

Foundation Drains

It is the City's policy to connect foundation drains by gravity to the storm sewer system provided that the elevation of the basement floor is at least 1.0 metre above the elevations of the storm sewer obvert at that point. If a gravity connection meeting the City's requirements is available it must be utilized.

Where the above provisions for gravity connection of foundation drains cannot be met, a sump pump system must be installed in the building and discharge to surface at a location which is satisfactory to the City. The method of managing sump pump discharge is to be noted on all site/ grading plans. The Applicant shall acknowledge on the plans (i.e. provide a note) that the sump pump discharge will be managed within the site without a detrimental effect to adjoining lands including City ditches.

In cases of high ground water table where a sump pump could run continuously if a sump pump was implemented, the applicants should consider raising the basement elevation to be at least 1.0 metre above the elevation of the storm sewer obvert.

Storm Connections

Storm connections for foundation drains are to be sized in accordance with the following:

Sizes:	
Single family and semi-detached residential areas	Minimum size 150mm diameter
Multiple family residential block, commercial areas and, industrial areas	To be designed in accordance Section 8.1.2 Min. size 300mm diameter

Joints and Bedding:

Joints and Bedding for connections are to be equivalent to joints and bedding as specified for storm sewer pipe.

Connections of Services to Main Sewer:

A storm connection may be mandated under the discretion of a City Reviewer. Connections to storm sewers may be mandated due to various criteria such as site size, capacity of receiving infrastructure. If you are required to connect to a City sewer, then a drainage proposal will be required.

Double connections may be acceptable in residential areas where all other utilities can be accommodated and where the difference in the two connecting basement elevations does not exceed 600mm.

Manufacture of service tees at the main sewer shall be as follows:

- For storm main sewer pipe sizes 600 mm or smaller, pre fabricated tees from the plant shall be utilized.
- For storm main sewer pipe sizes 675 mm to 900 mm, tees shall be manufactured in the field on top of the trench with the proper saddles and shall be inspected by the Consulting Engineer prior to installation.
- For storm main sewer pipe sizes 975 mm and larger, tees shall be manufactured in the trench with proper saddles.
- All connections are to be made between springline and pipe obvert

In the cases above, the storm sewer shall be drilled or scribed at the plant rather than breaking through the pipe wall on site.

50mm x 50mm wooden markers placed from the invert of the service to 600mm above ground level shall be placed at the ends of each residential connection (at the street line).

The top 600mm of the markers are to be painted white.

Connection Application Requirements:

The connection application must be submitted electronically.

The following are to be depicted on the site servicing drawings:

- Inverts of the connection at the street (property) line and at the main storm sewer system.
- The connection size, slope and class of pipe
- Information on the main storm sewer system (invert, obvert, size, slope and direction of flow).
- Municipal address, lot and registered plan number.
- A Key Plan
- A North Arrow
- Existing street services, sanitary, storm, water, manholes, etc. (obtainable from plan and profile drawings available in the Drafting section).
- A professional engineer must approve and stamp the design of the storm sewer connection.

If development infrastructure has not been assumed by the City, the consulting engineer for the development must certify the site servicing drawings.

Any basement elevation of a site **must** be one metre above the obvert of the adjacent municipal sewer system. If this criterion is not met, the installation of a sump pump will be required.

Connection invert(s) at the street/ property line **must** be equal to or greater than the obvert of the main sewer.

If the diameter of the connection exceeds one-half the diameter of the main sewer, then the connection must go into a new manhole or existing one if available and suitable to the City.

All storm connections are to be designed to City of Mississauga storm sewer standards.

8.2 Channel, Culvert and Overland Flow

For channel, culvert, bridge and/or erosion control projects the proponent is responsible for obtaining all necessary approvals from the governing agencies, such as the Conservation Authority, Ministry of Natural Resources and/or the Ministry of the Environment, Conservation and Parks (MECP).

8.2.1 Culverts and Bridges

Road Classification	Design Flood Frequency
Arterial	1:100 Year to Regional
Collector	1:50 Year
Urban Local	1:50 Year
Rural Local	1:25 Year
Temporary Detour	1:10 Year
Driveway	1:10 Year

Driveway culverts must have a minimum size of 200mm PVC (or approved equivalent) with headwall.

Bridges and other major drainage structures shall require special designs as determined by the Development Engineering & Construction team. Hydraulic calculations will be required.

The frequency and magnitude of flooding or erosion should not be increased on upstream or downstream properties.

8.2.2 Outfall Channels

The proposed criteria for an open channel design shall be submitted to the City for approval prior to the actual design being undertaken.

Outfall channels shall be defined as major system overland flow channels, minor system outfall channels or natural channels.

Major system overland flow channel designs should accommodate the greater of the Regional storm or the 100 year storm for new development.

8.2.3 Watercourse Erosion and Bank Stability

Where erosion or bank instability is already evident in an area to be developed or re-developed, the City of Mississauga requires that the situation be stabilized by appropriate remedial and restoration measures and include proposed preventative measures as part of the application's engineering review process. Where a proposed development will increase downstream erosion, the City requires the Developer to propose efforts to mitigate further damage by incorporating remedial improvement details as part of the development design.

Watercourse dynamics and natural valley aesthetics govern, and the recommended scope of works must be minimized/ localized to the area such that achievement of a sound technical solution is at a reduced or eliminated impact to the surrounding naturalized area. Natural channel design principles and bio engineering should be used wherever feasible. A normal bank flow channel has a capacity of about the 1:2 year flood. Protection to this level will be adequate provided care is taken to prevent any damage by higher floods and provided that the channel bank is not coincident with a higher valley bank. In this latter case, it may be necessary to protect the bank to a level as high as the 1:100 year flood or even the flood resulting from the Regional Storm.

The proposed criteria for an erosion or bank stability design shall be submitted to the City for consideration and approval prior to the actual design being undertaken.

8.2.4 Overland Flow Routes

An overland flow route continuous to the nearest major channel must be established through all areas and shall be contained within either the road right-of-way or by easements. Positive major system overland flow is a paramount consideration to ensure a safe conveyance route is provided away from buildings.

The depths of flooding permitted on streets and at intersections during the 1:100 year storm are as follows:

- No building shall be inundated at the ground line, unless the building has been flood proofed.
- For all classes of roads, the product of depth of water (m) at the gutter times the velocity of flow (m/s) shall not exceed 0.65 m^2/s.
- For arterial roads, the depth of water shall not exceed the crown of the road.

Flow across road intersections shall not be permitted for minor storms (generally 1:10 year). To meet the criteria for major storm run-off, low points in roads must have adequate provision for the safe overland flow.

Analysis shall be submitted that demonstrates the above criteria have been met. Examples of this analysis include:

- a spreadsheet style overland flow analysis such as that shown on City Standard Drawing No. 2112.031
  or
- in more complicated situations, a dual drainage modelling approach.

Dependent on the condition of the downstream drainage system, the City may also require smaller developments to submit a dual drainage analysis. In all cases, the analysis is to be fully documented, prepared and signed by a Professional Engineer.

8.2.5 Inlet/Outlet Structures

Inlet and outlet structures shall be fully designed on the engineering drawings. The details provided shall include the existing topography, proposed grading and the works necessary to protect against erosion.

Adequate structural details and details outlining erosion control features to mitigate erosion and direct overland flow impact may include but is not limited to; baffle blocks, surficial treatments, cable concrete, gabions, rip-rap, plunge pools, other calming measures etc. shall be provided at all inlets/ outlets to protect against erosion and to sufficiently channel/ direct the flow at the inlet/ outlet structure.

The extent of the erosion protection shall be indicated on the engineering drawings and shall be dependent upon the velocity of the flow in the storm sewer outlet, the soil conditions, the flow in the existing watercourse and site conditions.

The inlets and outlets must be protected to prevent unauthorized access and debris accumulation. In addition, backwater valves should be considered to prevent impacts of high-water levels impacting sewer function.

Outfall structures to existing channels or watercourses shall be designed to minimize impact/damage in the vicinity of the outfall from maximum flows in peak flow conditions, as a result of potential erosion.

The obvert of the outlet pipe is to be above the 25 year flood elevation of the receiving channel/ watercourse.

All basements and/or parking lot structures must be situated above the 100 year storm elevation of the watercourse.

8.3 Stormwater Management Requirements

Stormwater management is required to control the changes in the pattern of runoff that occur after development to mitigate urban impacts to receiving watercourses. The measures adopted to achieve these requirements have advanced through the years. A development site that may have used a simple flow control device to meet quantity control requirements in the 1980's may now incorporate a number of measures such as enhanced grassed swales and infiltration galleries to meet runoff volume reduction requirements. An integrated design approach is now more prominent whereby engineers collaborate with landscape architects and other professionals from the onset. This collaboration makes it possible for small changes in site design to allow for larger benefits.

This evolution reflects the state of stormwater management and the importance of the treatment train approach where stormwater runoff is captured and treated at the source, in conveyance and at the end-of-pipe. The City's stormwater management requirements have also evolved in response to the changing industry standards as well as for consideration of other matters such as:

- Stormwater management criteria updates by the City's partner Conservation Authorities
- Coordination with the City's requirements outside of the Conservation Authority regulated areas
- Climate change and associated extreme weather events
- Infrastructure resiliency
- Ongoing maintenance considerations
- Introduction of the Stormwater Charge
- Consolidated Linear Infrastructure Environmental Compliance Approval
- SWMF Operations & Maintenance Manual from the Designing Engineer

In the context of development, these criteria are pertinent to provision of practices at the site level, in other words, at the source. The sub-sections that follow outline the City's stormwater management requirements which are summarized under the following elements:

- Stormwater Quality Control
- Stormwater Runoff Volume Reduction
- Stormwater Quantity Control
- Low Impact Development Practices
- Stormwater Management Reports

Applicants are advised that while these requirements are necessary for implementation at the site development stage, there is leverage for applications toward future credit on the stormwater

charge that would be applicable to non-residential and multi-residential sites. The stormwater charge does acknowledge requirements on non-residential and multi-residential sites that are imposed by the City's development process.

The City will continue to review the stormwater management requirements in light of the above considerations on an ongoing basis. For clarifications on the requirements applicable to a particular site, call 311 to be directed to the Environmental Services Section with respect to stormwater management requirements.

8.3.1 Stormwater Quality Control

CONTEXT

The discussion of stormwater quality control in this section relates to the traditional definition which addresses total suspended solids (TSS) removal. Urban runoff carries surficial sediments and debris into receiving streams and watercourses which degrades water quality and impacts aquatic habitat conditions. In addition, metals and other pollutants adhere to particulate matter found in the stormwater runoff column which further degrades water quality. The importance of stormwater runoff quality in Mississauga is underscored by the fact that it quickly finds its way to Lake Ontario which is the source of our drinking water.

REQUIREMENT

At a site level, applicants are required to provide a minimum treatment of 80% total for the removal of TSS for the 90th percentile rainfall event. Treatment devices must be Canadian ETV Program Verified.

If a site drains to an existing downstream stormwater management facility designed to provide enhanced (Level 1) protection and has capacity to treat flows from the proposed site, treatment would not be required and on-site control measures are voluntary. Should a site drain to an existing facility that provides less than enhanced protection or the facility does not have capacity to treat the flows, then some on-site best management practice (BMP) is/are required to contribute to improving overall water quality. Where a site could involve potential spill (e.g. gas station, fulling station) then an on-site device shall be provided for spill control regardless of any existing downstream stormwater management facility. If the development site is within a Conservation Authority's regulated area the applicant is to confirm their requirements are also met. A depiction of the areas covered by existing municipal stormwater quality control facilities is shown on Appendix 1.

The exemption to this requirement is for individual single-family dwellings, in these cases the applicants are encouraged to provide best efforts to improve stormwater quality from their development runoff.

CONSIDERATIONS

The city will not recognize Oil Grit Separators (OGS) performance claims greater than 50% total suspended solids (TSS) removal. A maximum credit of 50% TSS Removal will be provided to OGS units with claims created the 50% TSS removal.

The City encourages the applicant to ensure the site's tenant or property manager is aware of any stormwater quality control measures installed on-site and where possible, are provided with an operation and maintenance document outlining the protocols for upkeep.

8.3.2 Stormwater Runoff Volume Reduction

CONTEXT

Stormwater runoff from developed sites impacts streams and watercourses by introducing erosive forces during frequent storms. In addition, the alteration of the hydrologic regime from raw land reduces the amount of water that would naturally evaporate, transpire or infiltrate essentially generating more runoff volume. These impacts are the target of the requirement outlined within this section with the goal being to reduce stormwater runoff volume from developing sites, which is separate from quantity control volume requirements. Practices implemented to address this criterion may assist in mitigating erosion and water balance to address Conservation Authority requirements.

REQUIREMENT

The first 27mm of runoff, or the 90th percentile storm for the geographical area (whichever is greater), shall be managed on site by way of on-site retention (infiltration, evapotranspiration, or reuse), filtration or detention. Applicants must prioritize on site retention measures, however, if site conditions do not allow for adequate retention, filtration may be considered as a secondary measure. If the retention and filtration measures are not adequate in achieving the runoff volume requirement, detention can be considered as a final alternative. The total runoff volume is calculated as the product of impervious site area times 27mm excluding initial abstraction. It is not permitted to use 1mm abstraction in the calculations.

Reuse measures are subject to Building Code Compliance and can include, but are not limited to, grey water reuse such as toilet flushed or laundry, cooling towers, car washes, or irrigation. Proposed measures are subject to planner approval. Please see below section 8.3.5 'Low Impact Development' for specific criteria regarding LID practices.

The 90th percentile storm is a minimum retention requirement, whereas applicable Master Drainage Plans or Subwatershed Plans may carry a higher minimum requirement. The exemption to this requirement is for individual single-family dwellings, although even in this case the applicants are encouraged to do best efforts to reduce stormwater runoff from their

lands. Recognizing that the City requires roof leader downspouts to be disconnected, other measures that can be implemented include:

- Incorporation of rain barrels at the roof leader downspouts or rain gardens to absorb flows
- Use of infiltration galleries, if soil conditions are conducive, located on the property considering Ontario Building Code requirements
- Incorporation of permeable materials within the driveway where permitted by applicable zoning by-law
- Increase of topsoil depth around the property to 300mm to allow for greater absorption

CONSIDERATIONS

LONG TERM OPERATION

To re-iterate the introductory statement relating to the stormwater charge, it is noted here that the credit process considers requirements on the site that are imposed by the City's development process. However, the category of runoff volume reduction allows for credit even greater than 5mm. In other words, despite the City's requirement for 5mm the applicant may wish to look at opportunities for designing in larger on-site retention volumes as there is potential financial benefit in the longer-term life cycle for the site tenant or property manager.

DESIGN

When considering the engineering design of the site to meet the runoff volume reduction requirements, the applicant will consider the following:

- Fundamental drainage principles continue to apply so "self-containing" site drainage is still required to meet standard City grading and drainage requirements. Within the site itself, the conventional drainage system may be adjusted to integrate the low impact development measures utilized to meet the runoff volume reduction requirement so there remains the potential for infrastructure reduction dependent on the site grading and configuration
- The need for cost-effective back-ups should be included to ensure failure of the system would not create a drainage concern. A notable example would be an overflow pipe in a bottomless infiltration catchbasin or simply a safe overland flow route in case of blockage
- For design requirements that are not included in this document, the City endorses the Low Impact Development Stormwater Management Planning and Design Guide (CVC & TRCA, 2010) as a design guidance document and would recommend its use by applicants in keeping with the commentary provided here

- While rain gardens are encouraged, particularly as noted above for individual residential properties, the City discourages draining large impervious surfaces (e.g. parking lot from commercial property) to any measure that promotes surficial ponding immediately adjacent to residential dwellings. In this instance, infiltration and other systems should be considered as an alternative

APPROVAL PROCESS & "VOLUMETRIC" CREDIT POTENTIAL

- Surficial works (e.g. "soft" treatments such as ground cover, shrubs, plants, etc.) on any low impact development measure on private lands are subject to the approval of Planning and Building – Development & Design. "Hard" elements of proposed low impact development measures (e.g. piping, soil medium, gravel/granular, etc.) are approved by Development Engineering & Construction – Environmental Services team. The City circulates submissions internally in order that the appropriate parties provide comment.
- Securities are typically informed through the provision of an estimate by the applicant and taken by the City to ensure measures are suitably installed. "Soft" treatments would be secured by Planning & Building. "Hard" elements relating to low impact development measures would be taken by Development Engineering & Construction as part of a grading deposit. Certification is required upon request for release of securities.

An integrated design approach involving multiple disciplines (e.g. civil engineer & landscape architect) is considered beneficial to facilitating design decisions from the onset of a project which could allow stormwater management criteria to be more easily met. With respect to optimizing the infrastructure if site grading and configuration allow, there may be the potential to replicate the stormwater quantity control storage typically provided by way of "superpipes" within the low impact development measures. If this is the case, the City would consider a "volumetric" credit if:

- Engineering design demonstrates technical adequacy and sufficient storage such that pipe or surface storage are redundant, and;
- A stormwater charge credit application is submitted which obliges the site tenant or property manager to maintain the infrastructure and allows the City ability to inspect and enforce should there be any concerns particularly since the credit discussed here links back to flood resiliency.

8.3.3 Storm Water Quantity Control

CONTEXT

Flooding that occurs through the storm drainage network, whether it be through a surcharged storm sewer or excess of flows backing up a creek, can cause impacts to large areas of public and private property. To help mitigate this and reduce the risk that this may occur the City

imposes stormwater quantity control requirements, which echo the Conservation Authority flood control requirements in many cases, in efforts to reduce stormwater peak flow runoff from developing sites impacting surrounding systems.

REQUIREMENT

The stormwater quantity control requirement varies depending upon the watershed; all pertinent watersheds within Mississauga and corresponding requirement is found below in Tables 1 to 5 (Stormwater Quantity Control Requirements) and an illustration of the watershed boundaries is found within Appendix 1 (Watershed Boundaries). These requirements account for the most recent updates adopted by the Toronto Region Conservation Authority (TRCA), Conservation Halton (CH) and Credit Valley Conservation (CVC).

CONSIDERATIONS

The following points are to be considered in conjunction with the quantity control requirement:

- In all cases, the storm sewer capacity constraints or downstream concerns may govern. In some instances the City may request analysis of the downstream sewer capacity to verify any constraints for quantity control
- Where “pre-development” is listed as part of the requirement, it is implied as raw land for which the run-off co-efficient is equal to 0.25 but will not exceed 0.50 for a site that may already be developed
- The “unit rates” prescribed to calculate pre-development flows for the pertinent branches of Etobicoke Creek are excerpted in Table 6 from TRCA’s Hydrology Study: Etobicoke Creek Hydrology Update (MMM Group, 2013)
- Runoff coefficients utilized for the development shall be justified based on impervious cover (as noted earlier in the Storm Drainage Section 8.1.1)

DESIGN

In undertaking the engineering design of the site to meet the stormwater quantity control requirement, the applicant will consider the following:

- The modified rational method, or equivalent, is to be used for the analysis
    - A coefficient of 0.8 for orifice tubes, or 0.6 for orifice plates. The City will prefer the use of orifice tubes or pipes where appropriate. If site constraints require the use of an orifice plate, it shall be inspected annually to ensure it is operating as designed.
- A control device (orifice) must have a diameter of no less than 75mm in order to prevent clogging of the opening and shall preferably be an orifice tube or pipe. Ponding limits and available storage are to be depicted on the engineering drawings, and the maximum ponding depth in parking areas is not to exceed 250mm

An overland flow route shall be clearly marked and the grading of parking lots and landscaped areas must provide a safe overland flow path to the surrounding municipal right of way during storms exceeding the design storm event

FOR INSTITUTIONAL/COMMERCIAL/INDUSTRIAL SITES

- Flow control devices shall be installed on the upstream side of the manhole
- Storm connections from the building roof and foundation drains must be made downstream of the manhole and/or catchbasin inlet controls
- Roof drains should be selected to give a maximum discharge of 42 L/s/ha of roof area.

Table 1: Stormwater Quantity Control Requirements

Subwatershed Name (Conservation Authority)	Quantity Control Criteria	References & Notes
Applewood Creek (CVC)	100 Year Post to 2 Year Pre-development Control	-
Avonhead Creek (CVC)	100 Year Post to 2 Year Pre-development Control	Southdown District Master Drainage Plan (Totten Sims Hubicki, 2000)
Birchwood Creek (CVC)	100 Year Post to 2 Year Pre-development Control	-
Carolyn Creek (CVC)	Provide post to pre control for all storms (i.e. 2,5,10,25,50 & 100 year)	Master Drainage Study (Winter Associates, 1987)
Cawthra Creek (CVC)	100 Year Post to 2 Year Pre-development Control	Drainage diversion to Cooksville Creek and a very small area draining to creek.
Chappell Creek (CVC)	10 Year Post to 2 Year Pre-development Control	-
Clearview Creek (CVC)	100 Year Post to 2 Year Pre-development Control	Southdown District Master Drainage Plan (Totten Sims Hubicki, 2000)
Cooksville Creek (CVC)	100 Year Post to 2 Year	Revised development standards via Mississauga Staff report to City Council

	Pre-development Control	
Credit River - Norval to Port Credit (CVC)	No control required	Subwatershed Study in progress (partially complete)
Cumberland Creek (CVC)	No control required	-
Etobicoke Creek - Main Branch & Lower Etobicoke (TRCA)	No control required in the City of Mississauga	Hydrologic Model: VISUAL OTTHYMO- Return period peak flows based on the AES - 12-hour design storm Hydrology Study: Etobicoke Creek Hydrology Update (MMM Group, 2013)
Etobicoke Creek - West Branch (TRCA)	Provide post to pre control for all storms (i.e. 2,5,10,25,50 & 100 year) using unit rates	Hydrologic Model: VISUAL OTTHYMO- Return period peak flows based on the AES - 12-hour design storm Hydrology Study: Etobicoke Creek Hydrology Update (MMM Group, 2013)

Note 1: In all cases, storm sewer capacity constraints or downstream concerns may govern

Note 2: Where “pre-development” is listed as part of the requirement, it is implied as raw land for which the run-off co-efficient=0.25 but will not exceed 0.50 for a site that may already be developed

Note 3: CVC-Credit Valley Conservation, TRCA-Toronto Region Conservation Authority, CH-Conservation Halton

Table 2: Stormwater Quantity Control Requirements (continued)

Subwatershed Name (Conservation Authority)	Quantity Control Criteria	References & Notes
Fletcher's Creek (CVC)	No control required in the City of Mississauga	Fletchers Creek Subwatershed Study Report (Paragon Engineering Limited, 1996) Subwatershed Management Strategy and Implementation Plan (AMEC Earth & Environmental, 2012)
Joshua Creek (CH)	100 Year Post to 2 Year Pre-development Control	Commentary from Conservation Halton in lieu of 1992 Watershed Plan
Kenollie Creek (CVC)	10 Year Post to 2 Year Pre-development Control	-
Lakeside Creek (CVC)	100 Year Post to 2 Year Pre-development Control	Southdown District Master Drainage Plan (Totten Sims Hubicki, 2000)
Levi Creek (CVC)	Provide post to pre control for all storms (i.e. 2,5,10,25,50 & 100 year) & Regional Storm	Hydrologic Model: GAWSER Model- Return period peak flows based on 24-hour SCS Type II distribution Gateway West Subwatershed Study (Gartner Lee Limited & Cosburn Patterson Mather, 1999)

		Gateway West Subwatershed Study Update by Kidd Consulting (Update in Progress)
Little Etobicoke Creek (TRCA)	Provide post to pre control for all storms (i.e. 2,5,10,25,50 & 100 year) using unit rates	Hydrologic Model: VISUAL OTTHYMO- Return period peak flows based on the AES - 12-hour design storm Hydrology Study: Etobicoke Creek Hydrology Update (MMM Group, 2013)
Lornewood Creek (CVC)	100 Year Post to 2 Year Pre-development Control	-

Note 1: In all cases, storm sewer capacity constraints or downstream concerns may govern

Note 2: Where “pre-development” is listed as part of the requirement, it is implied as raw land for which the run-off co-efficient=0.25 but will not exceed 0.50 for a site that may already be developed

Note 3: CVC-Credit Valley Conservation, TRCA-Toronto Region Conservation Authority, CH-Conservation Halton

Table 3: Stormwater Quantity Control Requirements (continued)

Subwatershed Name (Conservation Authority)	Quantity Control Criteria	References & Notes
Loyalist Creek (CVC)	East of Winston Churchill Blvd - Provide post to pre control for only 10-year design storm	Loyalist Creek Watershed Study (CBCL Limited, 1980)
	West of Winston Churchill Blvd - Provide post to pre control for all storms (i.e. 2,5,10,25,50 & 100 year)	Erin Mills West Loyalist Creek Drainage Report (Proctor & Redfern Group, 1985)
Mary Fix Creek (CVC)	10 Year Post to 2 Year Pre-development Control	-
Mimico Creek (TRCA)	Provide post to pre control for all storms (i.e. 2,5,10,25,50 & 100 year)	Hydrologic Model: VISUAL OTTHYMO- Return period peak flows based on the AES - 12-hour design storm Hydrology Study: Mimico Hydrology Update (Marshall Macklin Monaghan, 2009)
Moore Creek (CVC)	No control required	-
Mullet Creek (CVC)	Provide post to pre control for all storms (i.e. 2,5,10,25,50 & 100 year) & Regional storm	Hydrologic Model: GAWSER Model- Return period peak flows based on 24-hour SCS Type II distribution

	Consider storm sewer constraints outlined in Streetsville Area Drainage Study (Dillon, 1994)	Gateway West Subwatershed Study (Gartner Lee Limited & Cosburn Patterson Mather, 1999) Gateway West Subwatershed Study Update by Kidd Consulting (Update in Progress)

Note 1: In all cases, storm sewer capacity constraints or downstream concerns may govern

Note 2: Where “pre-development” is listed as part of the requirement, it is implied as raw land for which the run-off co-efficient=0.25 but will not exceed 0.50 for a site that may already be developed

Note 3: CVC-Credit Valley Conservation, TRCA-Toronto Region Conservation Authority, CH-Conservation Halton

Table 4: Stormwater Quantity Control Requirements (continued)

Subwatershed Name (Conservation Authority)	Quantity Control Criteria	References & Notes
Sawmill Creek (CVC)	Provide post to pre control for all storms (i.e. 2,5,10,25,50 & 100 year)	Hydrologic Model: GAWSER Model- Return period peak flows based on 24-hour SCS Type II distribution Sawmill Creek Subwatershed Study (Proctor & Redfern Limited, 1993)
Serson Creek (CVC)	100 Year Post to 2 Year Pre-development Control	Large number of buildings (> 150) in the regulated flood plain
Sheridan Creek (CVC)	100 Year Post to 2 Year Pre-development Control	-

Sixteen Mile Creek (CH)	East of Ninth Line, north of CN Rail (North 16 District) – Flows draining to a North 16 District stormwater quality/erosion control facility (Ponds Q1 & Q2) are to be controlled on-site to 75 l/s/ha for the 5-year storm event	North 16 District Scoped Subwatershed Study and Ninth Line District Floodplain Mapping (Philips, 2004); recommended Scenario 2B (Recommendation (v) on page 50)
	East of Ninth Line, north of CN Rail (North 16 District north-west quadrant) – Flows draining to Ponds Q3a & Q3b are required to provide storage for 25mm and 2-year storms at 300m3/imp.ha and 380m3/imp.ha, respectively, as well as release rates of 1.5L/s/imp.ha for the 25mm storm and 5L/s/imp.ha for the 2-year storm	Master Servicing Study for the Mississauga Fire and Emergency Services Training Centre (Sernas, 2008) Detailed Design – Sanitary, Water & Storm Services, Mississauga Fire and Emergency Services Training Centre (Sernas, 2009); recommendations in Section 4.2 (page 13)

Note 1: In all cases, storm sewer capacity constraints or downstream concerns may govern

Note 2: Where “pre-development” is listed as part of the requirement, it is implied as raw land for which the run-off co-efficient=0.25 but will not exceed 0.50 for a site that may already be developed

Note 3: CVC-Credit Valley Conservation, TRCA-Toronto Region Conservation Authority, CH-Conservation Halton

Table 5: Stormwater Quantity Control Requirements (continued)

Subwatershed Name (Conservation Authority)	Quantity Control Criteria	References & Notes
Sixteen Mile Creek (CH)	East of Ninth Line between CN Rail and Britannia (Lisgar and surrounding area) - Provide post to pre flow control for all storms (i.e. 2,5,10,25,50 & 100 year) and volume control to pre-development conditions. No connections to FDC permitted.	-
	East of Ninth Line, south of Britannia Road (Churchill Meadows) - No connections to FDC permitted. No controls otherwise	Stormwater Management Design Report – Churchill Meadows Stormwater Management Facilities – Sixteen Mile Creek Watershed (RAND Engineering, 1997)
	West of Ninth Line - to be established through Ninth Line Lands-East Branch Subwatershed Study (ongoing)	-
Spring Creek (TRCA)	Provide post to pre control for all storms (i.e. 2,5,10,25,50 & 100 year) using unit rates	Hydrologic Model: VISUAL OTTHYMO- Return period peak flows based on the AES - 12-hour design storm Hydrology Study: Etobicoke Creek Hydrology Update

		(MMM Group, 2013)
Stavebank Creek (CVC)	10 Year Post to 2 Year Pre-development Control	-
Tecumseh Creek (CVC)	100 Year Post to 2 Year Pre-development Control	-
Turtle Creek (CVC)	10 Year Post to 2 Year Pre-development Control	-
Wolfedale Creek (CVC)	10-year post to 2-year pre	-

Note 1: In all cases, storm sewer capacity constraints or downstream concerns may govern

Note 2: Where “pre-development” is listed as part of the requirement, it is implied as raw land for which the run-off co-efficient=0.25 but will not exceed 0.50 for a site that may already be developed

Note 3: CVC-Credit Valley Conservation, TRCA-Toronto Region Conservation Authority, CH-Conservation Halton

Table 6: Etobicoke Creek Unit Flows

Subwatershed Name	**Unit Flow Rates** *($m^3/s/ha$)*					
	2-year	**5-year**	**10-year**	**25-year**	**50-year**	**100-year**
Etobicoke Creek – West Branch	0.03241	0.04412	0.05220	0.06250	0.07021	0.07799
Spring Creek	0.03168	0.04318	0.05114	0.06135	0.06903	0.07679
Little Etobicoke Creek	0.03575	0.04746	0.05546	0.06559	0.07315	0.08075

8.3.4 Stormwater Management Reports

CONTEXT

The stormwater management report accompanying the submission may be provided as a letter brief but must be stamped and signed by a licensed Professional Engineer. The engineering drawings that accompany the report must similarly be stamped and signed by a licensed Professional Engineer.

REQUIREMENT

The report itself should, at a minimum, document the following:

- Description and illustration of existing and proposed conditions including a figure showing drainage areas, existing storm drainage infrastructure and justification for the proposed runoff coefficient values being utilized
- Summarize the City's stormwater management requirements
- Provide a section outlining how each requirement has been met
- For Stormwater Runoff Volume Reduction: describe the measure(s) being proposed to meet the requirement and include supporting calculations and documentation
- For Stormwater Quantity Control: specify what criteria governs (e.g. storm sewer constraints or stormwater quantity control requirements), document the required stormwater storage and compare to the storage provided
- Describe how external flows will be accommodated, if applicable
- Hydraulic Grade Line and Overland Flow analyses
- Include or reference the engineering plans that depict the proposed measures

CONSIDERATIONS

In some instances, the City may request a Drainage Proposal to identify an appropriate outlet for the development. The Drainage Proposal should identify the proposed drainage scheme and its effects on the downstream sewer capacity. The analysis of the downstream sewer capacity must be performed for pre and post development conditions.

When required, hydrologic studies shall employ an appropriate modelling technique with defensible parameter values. The study shall describe the modelling parameters and the criteria for their selection as well as input and output data. The consultant is to assume full responsibility for the proper application of the hydrologic models. The City recommends that the Consultant follow the *M.T.O. Drainage Management Technical Guidelines*.

In general, the SCS design storms should be used for determining the hydrographs for undeveloped watersheds and for checking detention storages required for quantity control. The Chicago design storms should be used for determining hydrographs in urban areas and also for

checking detention storage. In many cases, the consultant will be required to run both sets of design storms to make sure that the more stringent is used for each individual element of the drainage system. The time step for discretization of the design storm can vary according to the size of the sub-watershed but must not exceed the estimated time of concentration. To aim for consistency, ideally the models used in site design would be the same platform and use the same storm distribution as the watershed model.

In detailed design of storage structures, the operation must be checked for spring flood conditions due to combined snowmelt and rain. Wet ponds are to be checked for evaporative losses. Temperature data is to be submitted with these calculations. Operation of storage facilities must also be checked in order to verify that a sequence of storms is not more critical than a design storm.

8.3.5 Low Impact Development

Low Impact development (LID) measures can be used in a variety of scenarios to help meet criteria identified in Sections 8.3.1-8.3.4. All LID's must be designed in accordance with the identified design criteria in Section 8.3. The City of Mississauga has identified guidelines for applicants on both private and public property when designing LID's on their properties.

Private LID's

All LID's on private property must be designed/ stamped by a professional engineer. Through the ECA process, private property owners are expected to meet their legislated requirements and/or maintain their infrastructure.

If a private property applies for a Stormwater Charge credit (for more details on this please see relevant Stormwater Charge Credit reports), the site will be subject to inspections from the city to ensure the LID is operating as designed.

Reuse measures are subject to Building Code Compliance and can include, but are not limited to, grey water reuse such as toilet flushed or laundry, cooling towers, car washes, or irrigation.

Public LID's

If an LID is to be assumed by the City of Mississauga , the following conditions must be met.

- The LID must be designed and stamped by a professional engineer
- The LID must be designed in accordance with the latest industry standards and guidelines such as STEP LID Stormwater Management Planning and Design Guide or MECP LID Stormwater Management Guidance Manual.
- The designer must confirm that the local soil and groundwater conditions are acceptable for the purpose of the proposed LID

- All LID pipes should have a minimum diameter of 250mm with access points and/or clean out points installed at each change of alignment, grade, material and at the start and end of each radius pipe
- LID's should be located in such an area that it meets the following conditions
    - Should not be located on top of buried infrastructure, unless otherwise approved
    - Should have a minimum setback of 1m from private properties and 4m from any buildings or structures
    - LID setbacks should align with other buried utility such as storm sewers mentioned in Section 8.1.2
- All caps and access lids used in the design should accommodate equivalent generic alternatives (i.e. no exclusive patents/ name-brand products to be used), unless otherwise approved
- The city is **not** in favour of permeable pavements within the municipal Right-of-Way, unless otherwise approved
- All vegetation in an LID must: drought tolerant species and comply with current traffic safety guidelines
- Any manufactured treatment devices (e.g. OGS) should be designed such that maintenance is not required more than once a year and are in locations with good access for inspections and maintenance; preferred locations would also have minimal traffic control measures
- Any manufactured treatment devices should not have a unit depth greater than 6m
- Drainage area to LID footprint must range between 5:1 to 20:1 for optimal performance.

8.4 Groundwater Management

In recent years, many municipalities have adopted groundwater management standards, due to the increase of high-density development. Many buildings now extend below the water table, and therefore need to manage groundwater through all stages of the project. Foundation drainage systems are installed below the foundation of a structure to move water away from the structure, often to storage or reuse systems for the site.

Once the specified conditions for groundwater are met, the water is discharged into the municipal storm sewers. The sections below provide detail regarding our groundwater quantity and quality criteria; failure to meet the conditions will withhold the approval of an application.

8.4.1 Requirements

If the proposed development includes an underground parking structure, then a Hydrogeological report must be completed and submitted for review. All foundation drainage systems must be equipped with a sampling port, and a flow meter within the building. If a foundation drainage system is constructed without a sampling port and flow meter, then it must have the possibility of adding one at a later date, if requested by the City.

For specifics regarding groundwater dewatering to the municipal storm sewer during construction, please refer to Section 8.5 below.

8.4.2 Groundwater Quality

Groundwater entering the municipal storm sewers must be compliant with the City of Mississauga Storm Sewer Use By-Law 0046-2022, Schedule A, '*Limits for Storm Sewer Discharge*' criteria. A representative sample must be compared to the criteria outlined in the By-law by the City. This sample must be taken from a well that is located within the footprint of the proposed structure and the well screen must intersect the depth at which the foundation drain collector for the structure will be located. The sample must be analyzed at an accredited laboratory for all the parameters outlined in the By-law.

If any of the criteria exceed the values outlined in the by-law, then a Groundwater Treatment Plan, completed by a consultant, must be submitted. The recommendations from the city approved Groundwater Treatment Plan must be included in the Building Permit Mechanical Drawings of the proposed building.

Once construction commences and dewatering measures are in place, there will be an opportunity for applicants to resubmit the groundwater found in the foundation collector system for lab testing. If the groundwater quality is found to differ from the pre-construction testing to support the hydrogeological report, amendments can me be made to the proposed

Groundwater Treatment Plan, which also must be amended on the applicable Mechanical Drawings.

8.4.3 Groundwater Quantity

Each site will have a maximum allowable flow rate of groundwater that can be discharged. The maximum allowable discharge of groundwater combined with stormwater should not exceed the stormwater quantity target for the site. Stormwater quantity targets can be found in Tables 1-5. During wet weather events, temporary storage of groundwater may be required on site if the allowable amount of discharge from the site is less then the discharge during that particular storm event. Other reuse solutions such as grey water or irrigation will be considered.

8.5 Storm Sewer Discharge Authorization

For any construction project requiring dewatering works, any water being discharged into the City's storm sewer system must comply with the Storm Sewer Use By-law No. *0046-2022* and the applicant must obtain approval prior to discharge. For further information, please submit the application from the City's Storm Sewer Temporary Discharge Approval webpage and submit it to Env.Inquiries@mississauga.ca.

Appendix 1 – Watershed Boundaries

