



City of Orillia

Engineering Design Criteria: Stormwater



Revision Record
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1.0 INTRODUCTION

The City of Orillia Engineering Design Criteria: Stormwater manual is intended to provide stakeholders, including City staff, consultants, developers, contractors, and the public with common design reference standards to facilitate consistent application of stormwater management design practices within the City of Orillia (City).

These standards are to be read in conjunction with the latest editions of the Ontario Provincial Standard Specifications (OPSS), the Ontario Provincial Standard Drawings (OPSD) and the City of Orillia Standard Drawings. In the case of a discrepancy, the City Standards shall prevail unless otherwise directed by the City.

It is the applicant's responsibility to obtain and check with the City of Orillia for new revisions to the design standards. Copies are available from the City of Orillia or can be downloaded from the web site at www.orillia.ca.

The criteria outlined in this manual is intended to be updated on a regular basis to remain consistent with other reference documents. Comments or questions regarding the Engineering Design Criteria can be submitted to infrastructureplanning@orillia.ca.

2.0 DEFINITIONS AND ABBREVIATIONS

The following definitions and abbreviations for terms are used throughout the Engineering Design Criteria manuals.

Definitions

Arborist	The person(s) responsible for the care and maintenance of trees, qualified to provide arboriculture services and holding either an ISA Certified Arborist or Ontario Journeyperson professional certification.
City	City of Orillia.
City Representative / City Engineer	Any person, company, or organization, assigned to a project by the City to carry out work on their behalf. The name of the Representative shall be specified prior to the start of construction on any project.
Contractor	An independent company or individual acting as the Contractor and having entered into a legal contract to supply labour, material, equipment, management to construct, repair or install services.

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Developer(s)/Owner(s)	The person(s) entering into the subdivision agreement / site plan agreement with the Corporation of the City of Orillia.
Engineering Consultant	A competent Professional Engineer or Geoscientist or firm of engineers or Geoscientists employed by the Developer or City which is registered with Professional Engineers Ontario and/or Professional Geoscientists Ontario, possessing a current Certificate of Authorization to practice professional engineering or geoscience.
Intersection	Means the area embraced within the prolongation or connection of the lateral curb lines or, if none, then of the lateral boundary lines of two or more highways which join one another at an angle, whether or not one crosses the other.
Professional Engineer	A person licensed by Professional Engineers Ontario (PEO) under the Professional Engineers Act and legally authorized to practice professional engineering, use the protected title "Professional Engineer" or the designation "P.Eng.", and take public responsibility for engineering works.
Standard Drawings	Formal technical documents that use universally accepted conventions to communicate the specifications of a design.
Turning Radius	Minimum radius required for a vehicle to turn around.

Abbreviations

CHBDC	Canadian Highway Bridge Design Code.
CSA	Canadian Standards Association.
DFO	Department of Fisheries and Oceans, Canada.
LSRCA	Lake Simcoe Region Conservation Authority.
MECP	Ontario Ministry of the Environment, Conservation and Parks.
MNR	Ontario Ministry of Natural Resources
MTO	Ontario Ministry of Transportation.
OBC	Ontario Building Code.
OLS	Ontario Land Surveyor.

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OPSD	Ontario Provincial Standard Drawings.
OPSS	Ontario Provincial Standard Specification.
STEP	Sustainable Technologies Evaluation Program

3.0 REFERENCE DOCUMENTS

All storm sewers, associated appurtenances, and stormwater management design elements shall be designed and constructed in accordance with the latest version of this manual as well as industry standards and best practices including, but not limited to:

- Ontario Provincial Standard Specifications (OPSS) and Ontario Provincial Standard Drawings (OPSD)
- Ministry of Environment, Conservation and Parks (MECP) Design Guidelines for Sewage Works (2008)
- Ministry of Environment, Conservation and Parks (MECP) Stormwater Management Planning and Design Manual (March 2003)
- Ministry of Environment, Conservation and Parks (MECP) Design Criteria for Sanitary Sewers, Storm Sewers and Force mains for alterations authorized under Environmental Compliance Approval (May 31, 2023)
- Lake Simcoe Region Conservation Authority (LSRCA) Technical Guidelines for Stormwater Management Submissions (April 2022)
- Lake Simcoe Region Conservation Authority (LSRCA) Lake Simcoe Climate Data: A Reference Document to Support the Completion of Water Balance Assessments
- MTO Highway Drainage Design Standards
- Sustainable Technologies Evaluation Program (STEP) Low Impact Development Stormwater Management Planning and Design Guide
- City of Orillia Official Plan
- Municipal Consolidated Linear Infrastructure Environmental Compliance Approval (CLI ECA)
- MNR Adaptive Management Manual
- MNR Hazards Technical Guidelines
- TRCA's Erosion and Sediment Control Guide 2019
- NVCA's Procedural Guidelines for the placement of large quantities of fill (2011)
- NVCA's Stormwater Management Pond Planting (2006)
- Hydrogeological Assessment Submissions – CA Guidelines for Development Applications (2013)
- LSRCA's Comprehensive Stormwater Management Master Plan Guidelines (2011)

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3.1 Industry Standards and Specifications

All storm sewer and appurtenances materials and components shall comply with the latest version of all applicable industry standards and specifications for quality management and quality control, including but not limited to:

- The Canadian Standards Association (CSA)
- The American Society for Testing and Materials (ASTM)

3.2 Applicable Acts

This section outlines the various acts and legislation that apply to the design and construction of linear municipal infrastructure, specifically sewers. Compliance with these regulations is mandatory to ensure safety, quality, and legal adherence in all projects. The relevant acts and legislation include, but are not limited to:

- Municipal Act
- Ontario Water Resources Act
- Environmental Assessment Act
- Environmental Protection Act
- Ontario Drainage Act
- Ontario Environmental Bill of Rights
- Accessibility for Ontarians with Disabilities Act (AODA)
- Conservation Authorities Act – O Reg. 41/24: Prohibited Activities, Exemptions and Permits (2024)
- Provincial Planning Statement
- Planning Act

4.0 USE OF MANUAL

The intent of the City's Engineering Design Criteria manuals is to facilitate consistent engineering design and construction practices within the City. Moreover, the manuals are intended to:

- Integrate industry standards and best practices;
- Prioritize the health and safety of the public; and
- Reduce impacts to the natural environment and protect resources.

Each section of the manual should be read in conjunction with one another.

- City of Orillia Engineering Design Criteria: General Guidance
- City of Orillia Engineering Design Criteria: Wastewater
- City of Orillia Engineering Design Criteria: Water Distribution
- City of Orillia Engineering Design Criteria: Stormwater
- City of Orillia Engineering Design Criteria: Transportation

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5.0 SERVICING DESIGN

5.1 General Requirements

This section outlines the minimum design requirements for major and minor stormwater management systems within the City of Orillia.

5.2 Storm Design Criteria

5.2.1 Design Flows

Storm sewers shall be designed to capture and convey runoff from a project site based on the Rational Method. Once estimated with the Rational Method, it should be verified using a hydrological model, approved by the City, where the drainage area is greater than 5 hectares. The Rational Method relationship should be applied as per the following:

$$Q = 0.0028 \times C \times I \times A$$

where:

- Q = Flow (m³/s)
- C = Run-off coefficient (refer to section 5.2.4)
- I = Average Rainfall Intensity (mm/hr)
- A = Drainage Area (Hectares)

The larger of the estimated flows (Rational Method or Hydrological Model) is to be used in the design of the sewer system unless approved otherwise. The design of storm sewers using the Rational Method shall include a storm sewer design sheet and a storm sewer catchment plan that identifies the catchment areas, runoff coefficients, and appropriate catchment identification numbers.

Storm sewers shall be designed to accommodate the 5-year design storm and be designed to a maximum of 80 % pipe capacity.

5.2.2 Rainfall Intensity

The intensity of rainfall is to be determined from the Intensity-Duration-Frequency values from the Atmospheric Environment Services Orillia Station.

$$I = A \times t^B$$

- I = Average Rainfall Intensity (mm/hr)
- t = Time of concentration (hr)
- A & B = As follows:

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Storm Return Period	A	B
2 year	22.5	-0.728
5 year	29.9	-0.725
10 year	34.8	-0.724
25 year	40.9	-0.723
50 year	45.5	-0.722
100 year	50.0	-0.722

5.2.3 Time of Concentration

Time of Concentration is defined as the duration needed for water to travel from the farthest point of the drainage area to a specific point in the sewer system. It encompasses both the travel time within the sewers and the inlet time, which is the time required for water to flow overland into the sewer system.

The minimum initial time of concentration within an urban area is to be 10 minutes.

For predevelopment areas, the initial time of concentration (t_c) for upstream, undeveloped lands, the following formulas may be used:

Bransby-Williams Formula:

$$t_c = \frac{0.057 \times L}{S_w^{0.2} \times A^{0.1}}$$

where:

- t_c = Time of concentration (minutes)
- L = Catchment length (m)
- S_w = Catchment slope (%)
- A = Catchment area (ha)

Airport Method Formula:

$$t_c = \frac{3.26 \times (1.1 - C) \times L^{0.5}}{S_w^{0.33}}$$

where:

- t_c = Time of concentration (minutes)
- C = Runoff coefficient, (refer to section 5.2.4)
- L = Catchment length (m)
- S_w = Catchment slope (%)

The Airport formula should be used when the composite runoff coefficient is < 0.40 while the Bransby Williams Formula should be applied when the composite runoff is > 0.40 .

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5.2.4 Run-off Coefficient

Run-off coefficients to be used in storm sewer design with the Rational Method shall be determined as per Table 1, below, which is in accordance with the MECP CLI Design Requirements.

Table 1: Runoff Coefficients

Landcover	C
Parks over 4 ha, Forested Areas	0.20
Parks 4 ha and under	0.25
Single-family Residential (Urban)	0.45
Single-family Residential (Suburban)	0.4
Semi-detached Residential	0.6
Townhouses, Maisonettes, Row Houses, etc.	0.7
Apartments	0.75
Schools and Churches	0.75
Industrial (Urban)	0.75
Industrial (Rural)	0.9
Commercial	0.9
Heavily Developed Areas	0.9
Paved Areas	0.9
Future Residential Undeveloped Upstream Areas	0.55
Future Industrial Undeveloped Upstream Areas	0.75
Gravel	0.6
Permeable Pavements	0.2

Site specific runoff coefficients for greenfield developments can be used subject to approval from the City.

The runoff coefficients listed in Table 1, above, are applicable for storms up to and including the 10-year event. For storms greater than this return period, an adjustment factor shall be applied to account for expected soil saturation. Runoff coefficients shall be multiplied by factors of 1.1, 1.2, and 1.25 for the 25, 50, and 100-year return periods respectively to a maximum runoff coefficient of 1.0.

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5.2.5 Drainage Area

Drainage systems must be designed to accommodate all upstream drainage areas considering interim and ultimate development conditions. The drainage area(s) shall be determined using available topographic data, or LiDAR, if available. Drainage area plans shall:

- Display all areas and coefficients for each drainage and sub-drainage area. When several surface types are encountered, the coefficient should reflect the weighted average.
- Be completed according to design requirements.

5.2.6 Hydraulic Grade Line Analysis

The maximum hydraulic grade line elevation for the minor system is 0.3 m below the underside of footings for the 100-year event where historical gravity foundation drains are connected. Storm sewers shall be designed to limit surcharging during the 100-year storm event to 0.3 m below the rim elevation where gravity drains are not connected to the storm sewer system and should not otherwise be above the rim elevation of the storm sewer maintenance holes. New sewers may be required to incorporate inlet control measures to prevent surcharge and thereby prevent basement floodings for events up to a 1:100-year return frequency; this is subject to review by the City in conjunction with demonstration of available major system capacity.

Backwater valves will provide additional basement protection from storm sewer back-ups during these rare events.

To assess the impact of local surcharged conditions the Darcy-Weisbach equation can be used.

$$H = f \left(\frac{L}{D} \right) \left(\frac{v^2}{2g} \right) + (K_1 + K_2 + \dots) \left(\frac{v^2}{2g} \right)$$

where:

H	=	Head Loss (m)
f	=	$8(g/((R/6)/n)^2)$
K	=	Loss coefficient for maintenance holes and bends
L	=	Length of Pipe (m)
D	=	Diameter of Pipe (m)
V	=	Velocity of flow (m/s)
R	=	Hydraulic Radius (m)
n	=	Manning's roughness coefficient
g	=	Gravitational Constant (9.81 m/s ²)

If surcharge of an existing system has been calculated based on the Darcy-Weisbach method, the City may require a dynamic model such as PCSWMM to simulate the system to provide more realistic results and demonstrate the impacts to the drainage system.

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5.3 Pipe Sizing

5.3.1 Pipe Capacity

Pipe size shall be determined based on free-flowing conditions using Manning's equation. The capacity of the storm sewer shall be determined on the basis of the pipe at or below 80% full flow.

Manning's Formula:

$$Q = \frac{1}{n} AR^{2/3} S^{1/2}$$

where:

- Q = Design flow (m³/s)
- n = Manning's roughness coefficient
- A = Cross sectional area of flow (m²)
- R = Hydraulic radius (m), (area of flow / wetted perimeter)
- s = Slope of pipe (m/m)

Manning's roughness coefficient shall be as defined in Table 2 below.

Table 2: Manning's Roughness Coefficients

Pipe Material	Roughness Coefficient (n)
Concrete	0.013
PVC	0.013
HDPE	0.013
Corrugated Metal 68 x 13 mm corrugations	0.024
Corrugated Metal - 25% paved invert	0.021
Corrugate Metal – 50 mm corrugations	0.035

5.3.2 Flow Velocity (Flowing Full)

Flow velocities shall be determined using:

$$V = \frac{Q}{A}$$

Where:

- V = velocity (m/s)
- Q = flow (m³/s)
- A = cross sectional flow area (m²)

Flow velocities within storm sewer systems shall be in accordance with MECP Guidelines, which include but are not limited to:

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- The minimum flow velocity based on the pipe flowing full shall be 0.75 m/s.
- The maximum flow velocity based on the pipe flowing full shall be 6 m/s.
- Additional erosion, scouring, and pipe displacement protection measures shall be provided by a Licensed Engineering Practitioner where flow velocities exceed 4.5 m/s.
- Velocities less than 0.75 m/s may be considered during select circumstances. Refer to MECP guidelines for additional information. The City Engineer shall be consulted during these instances.

5.3.3 Minimum Sizes

The City standard shall apply:

- The minimum size for an on-street storm sewer shall be 300 mm in diameter.
- For storm sewer laterals, the minimum service connection size shall be 250 mm in diameter. Storm sewer laterals shall be colour coded white.

5.3.4 Minimum Grades

The minimum pipe grade shall be 1% on the first leg of the sewer. The remaining system shall be sloped as required to achieve the minimum velocity as stated above. The minimum grades for storm sewers, flowing fully, based on (n) = 0.013 are specified in **Error! Reference source not found.** below.

Table 3: Minimum Pipe Grades

Pipe Diameter (mm)	Minimum Slope (%)
up to 375 mm	0.4
450 to 525 mm	0.3
600 to 1200 mm	0.2
1350 mm and greater	0.15

5.3.5 Pipe Material

All pipe materials and fittings must comply with CSA and OPSS standards. Both rigid and flexible pipes are allowed in the construction of storm sewer systems.

Storm sewer sizes 450 mm diameter or greater shall be constructed of reinforced concrete.

Before selecting pipe material, soils must be evaluated for contamination and the presence of compounds that could affect the suitability of the proposed materials. For soils contaminated with hydrocarbons, nitrile gaskets or equivalent should be specified.

When material selection is based on specific site conditions, proper documentation should be provided in support of the selected material and its location must be documented in the record/as-built drawings.

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The chosen storm sewer pipe material must be capable of withstanding all potential loading conditions, including an appropriate safety factor.

5.4 System Layout

5.4.1 Minimum Pipe Cover

Storm sewers must be installed at a depth greater than the frost penetration level to prevent freezing. If this depth cannot be achieved, the storm sewer must be insulated. The insulation design must be verified by a Licensed Engineering Practitioner.

The minimum cover to the top outside pipe barrel of a storm sewer system shall not be less than 1.5 metres from the centreline of the roadway unless alternate measures are implemented as approved by the City.

For storm sewers exposed to traffic loading, the pipe classification and depth of pipe cover must consider a loading factor in accordance with relevant regulations, codes, and by-laws. This includes, but is not limited to, the Highway Bridge Design Code (for vehicular traffic), the Railway Safety Act, and the Transport Canada Act. Appropriate structural support must be provided as required. The maximum pipe cover should follow the manufacturer's recommendations.

All supporting calculations pertaining to design shall be provided to the City.

5.5 Storm Sewer Location

The storm sewers shall generally be located as shown on the standard City road cross-section drawings, unless approved by the city. This standard location shall be generally 1.5 metres north or east of the centreline of the road allowance.

In the case of crescents, looped and curvilinear streets, this standard location may be varied to the extent that the storm sewer remains on the same side of the centreline of the street (i.e., left or right) to minimize shadowing and avoid crossing the sanitary sewer trenches at the changes in direction of the street.

The placement of replacement storm sewers should be specifically determined based on the location of existing utilities and other site conditions. Every effort should be made to design in accordance with the City's design criteria and standard cross-sections.

5.5.1 Horizontal and Vertical Separation

Watermains should cross above sewers with sufficient vertical separation to allow for proper bedding and structural support of the watermain and the sewer main wherever possible.

A minimum clearance of 0.30 m shall be provided at the point of crossing between the outside of the pipe barrels of storm and sanitary sewers.

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A minimum vertical clearance of 0.50 m shall be provided at the point of crossing between the outside of the pipe barrels of the sanitary sewers and watermain.

A minimum horizontal separation of 2.5 m shall be provided between the outside of the pipe barrels of the sewers and watermain. Refer to the MECP's F-6-1 Procedure for additional information if the minimum horizontal and/or vertical separations cannot be met.

When it is not possible for the watermain to cross above the sewer main, the watermain passing under a sewer shall be protected as follows:

- A vertical separation of at least 0.50 m shall be provided between the outside face of the sewer and the top of the watermain.
- The sewer shall be adequately supported to prevent excessive deflection of joints and settling.
- The length of watermain pipe under the sewer shall be centred at the point of crossing so the joints will be equidistant and as far as possible from the sewer. Watermain pipe joints shall be located 1.5 metres (minimum) from the centreline of the sewer (both sides).

Sewer and watermain crossings over or under other utilities shall be designed to meet the minimum clearances required by the respective utility owner. Minimum pipe cover for both sewer and watermain infrastructure shall conform to applicable City standards at all crossing locations.

5.5.2 Limits of Construction

Sewers shall be terminated with a maintenance hole at the upstream subdivision limits when external drainage areas are considered in the design. The design of the terminal maintenance holes 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 to allow for proper service lateral connection.

5.5.3 Sewer Alignment

Storm sewers shall be laid in a straight line between maintenance holes unless radius pipe has been designed.

The change in direction of flow in any maintenance hole shall not be permitted at acute interior angles. The maximum change in direction of flow in a maintenance hole, for sewer sizes 900 mm diameter and smaller shall be 90°, and shall be 45° for pipes over 900 mm.

Radius pipe shall be allowed for storm sewers 975 mm in diameter and larger provided a maintenance hole 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 pipe manufacturer.

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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 consultant.

5.5.4 Changes in Pipe Size

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

5.6 Maintenance Holes

5.6.1 General Requirements

Maintenance holes must be precast concrete and shall be designed and constructed in accordance with the most recent OPSS and OPSD. Where the OPSS and OPSD are not applicable, the maintenance holes shall be individually designed and detailed.

5.6.2 Locations and Spacing

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

Maintenance holes in boulevards shall be located, wherever possible, a minimum of 1.5 m from the face of curb or other service.

Manhole spacing is to be calculated or be set based on Table 4: Maintenance Hole Spacing below.

Table 4: Maintenance Hole Spacing

Sewer Diameter (mm)	Maximum Spacing (m)
600 mm or less	120
675 mm and greater	150

5.6.3 Drops and Losses

Suitable drops shall be provided across all maintenance holes 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 0.6 m/sec.

Hydraulic calculations shall be submitted for all junction and transition maintenance holes on sewers where the outlet is 1,050 mm. or greater. In addition, hydraulic calculations may be required for maintenance holes where the outlet pipe is less than 1,050 mm dia. if, in the opinion of the city, there is insufficient invert drop provided across the maintenance hole.

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The obvert of the inlet pipe(s) shall not be lower than the obvert of the downstream (outlet) pipe to maximize hydraulic efficiency. The minimum drop across manholes shall be set based on Table 5: Minimum Vertical Drop Across Manholes below.

Table 5: Minimum Vertical Drop Across Manholes

Change in Direction (Degrees)	Minimum Vertical Drop (mm)
0	20
1-45	50
46-90	80

Where the difference in elevation between the obvert of the inlet and outlet pipes exceeds 0.9 m, a drop structure shall be placed on the inlet pipe.

5.6.4 Maintenance Hole Details, Sumps and Benching

Maintenance holes shall be minimum 1200 mm in diameter or be sized based on the sewer diameter plus 600 mm, whichever is greater. If this does not correspond to a standard size, the next largest standard size shall be used.

Storm sewer maintenance holes serving local sewers less than 900 mm shall be constructed with a 300 mm sump to promote sediment capture along the sewer system. This is irrespective of whether the sewers are in an area where sumps previously were not provided or where the pipes discharge into a stormwater management pond.

Manholes connecting sewers having nominal diameters of 900 mm and greater, benching is to be provided rather than sumps to improve the hydraulics of the system.

All storm sewer maintenance hole benching shall be to the obvert of the outlet pipe on a vertical projection from the spring line of the sewer, all in accordance with the standard detail drawing. The minimum width of benching shall be 230 mm.

Maintenance holes and catch basins shall be precast concrete structures. Under special circumstances, designs using cast-in-place concrete can be considered by the City. Maintenance holes and catch basins shall be provided with monolithic bases and watertight joints.

The provision of safety landing (safety grating) is required at the mid-point depth of manhole, when the depth ranges between 5.0 and 10.0 m in accordance with OPSD 404.020. Additional safety landings are required at third-point depths, when the manhole is equal to or greater than 10.0 m to 15.0 m deep. All incoming pipes are to be below safety landings, where possible.

5.6.5 Opening, Frame and Cover Requirements

All maintenance holes, located within the travelled portion of a roadway, shall be adjusted to the final grades with cast-in-place concrete and have the rim elevation set flush with the surface of the base course asphalt. The concreting and setting of the frame and cover shall be completed in accordance with the details provided in the standard drawing.

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A maximum of 300 mm of modular rings shall be permitted on maintenance holes in new subdivisions. No concrete shall extend over the edge of the maintenance hole. Prior to the placement of the final lift of asphalt, maintenance hole frames shall be reset to final elevations. All maintenance hole frames shall be adjustable as per the City's approved Material Specifications For Watermain, Sewer & Appurtenances document with OPSD 401.010 Type A closed cover labeled "Storm".

All 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.

5.7 Catch Basins

5.7.1 Location and Spacing

Catch basins shall be selected, located and spaced in accordance with the conditions of design and be sufficient in number to capture the targeted design storm. The design of the catch basin location and type shall take into consideration the lot areas, the lot grades, pavement widths, road grades and intersection locations. To ensure the capture or inlet capacity matches that of the storm sewer, the spacing of catch basins on streets may be varied.

Catch basins shall be generally located upstream of sidewalk crossings at intersections and upstream of all pedestrian crossings. Catch basins shall not be located in driveway curb depressions or sidewalks, or located within 1 m of barrier free parking spaces on roads or parking lots.

Maximum Catch Basin spacing for storm sewers designed to convey the 5-year design storm event shall be per Table 6: Maximum Catch Basin Spacing below.

Table 6: Maximum Catch Basin Spacing

Road Pavement Width	Road Gradient	Maximum Spacing
< 10 m	≤ 3.0 %	100
	> 3.0 %	70
≥ 10 m	≤ 3.0 %	70
	> 3.0 %	60

5.7.2 Catch Basin Types

Catch basins must be pre-cast concrete and shall be designed and constructed in accordance with the most recent OPSS and OPSD. All catch basins shall be of the single, double or ditch inlet type.

Double catch basins shall be required when the catch basin intercepts flow from more than one direction. Double catch basins are to be installed at the low point of any road.

Ditch inlet catch basins shall be implemented to capture surface drainage within ditches for conveyance to the storm sewer system. Ditch inlets shall be provided within roadways having

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semi-urban and rural cross-sections, located at the downstream end of the ditch. Ditch inlets shall correspond with OPSD 705.030 and 705.040. Ditch inlet frames and grates shall correspond with OPSD 403.010 while Ditch inlet adjustment units shall correspond with OPSD 704.010.

Special catch basins and inlet structures shall be fully designed and detailed by the Engineering Consultant.

Rear Yard Catch Basins

Due to maintenance concerns rear yard catch basins (RYCB) shall be limited to the extent possible. Positive drainage should be provided from rear yard areas toward the City's right-of-way to mitigate RYCB implementation. Where positive rear yard drainage cannot be provided, RYCB shall not service more than four (4) lots, or a maximum swale length of 50 m.

The RYCB and lead connections shall be located entirely on one lot, offset by 1.0 m from the property line. The RYCB lead shall be 300 mm diameter, offset from the building edge by 1.0 m, and adjacent to the property line.

A hydraulic gradeline (HGL) analysis may be required for Proposed RYCB for the 100-year storm event to demonstrate that rear yard areas will not be impacted during surcharge conditions; the HGL analysis is subject to the request, review, and approval of the City.

5.7.3 Inlet Control Devices

Urban drainage systems are designed while considering both minor and major systems, often referred to as dual-drainage systems. As per Section 6.2.1, subdivisions greater than 5 ha must be designed while adhering to the dual drainage principle using a hydrologic platform that evaluates peak design flows for the purpose of storm sewer sizing and evaluating the hydraulic grade line (HGL) elevations. Subdivisions greater than 5 ha, must incorporate inlet control devices (ICDs) sized to limit the captured flow to the design basis of the sewer system to prevent surcharging during extreme events.

The City of Orillia Engineering Design Criteria identifies commercially distributed ICDs as the preferred servicing solution over custom-made devices, as they are factory-calibrated and supplied with published head–discharge relationships which in turn, has a predictable performance under surcharge conditions and can be integrated in a dual-drainage modelling exercise.

It is recommended that commercially distributed ICDs be used under low to medium peak flows (i.e., 10 L/s to 30 L/s) as they are designed to minimize the risk of clogging. If the design flow is less than 10 L/s along the right-of-way, catch basins shall be interconnected with the downstream catch basin equipped with an ICD, to increase the design flow of the device. When peak flows are less than 10 L/s for interconnected catch basins, and pre-approved by the City, the ICDs shall restrict stormwater inflow to the storm sewer by inducing a controlled vortex inside the device (promoting swirling motion and reducing the risk of clogging), instead of relying only on a small orifice opening.

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Under peak flows greater than 30 L/s, custom-made ICDs (i.e., site-fabricated orifice plates or plug-type) are permitted, to the discretion of the City, provided that the orifice is greater than 125 mm (supporting calculations to be provided).

5.7.4 Catch Basin Leads

Minimum catch basin lead size and slope shall be in accordance with Table 7: Catch Basin Leads below.

Table 7: Catch Basin Leads

Catch Basin Type	Minimum Connection Size (mm)	Minimum Grade (%)
Single	300	2.0
Double	375	2.0
Rear Lot	300	2.0
Ditch Inlet	375	2.0

In general, catch basins located in close proximity to a maintenance hole shall have their leads connected to the maintenance hole. Long catch basin connections (in excess of 20 m) shall be connected to a maintenance hole or, alternatively, the lead can be connected to the sewer and a 1,200 mm diameter maintenance hole catch basin used in lieu of the normal 600 mm square catch basin.

5.7.5 Frame and Cover Requirements

All catch basins located within the travelled portion of a roadway, shall have the frame elevation set flush with the surface of the base course asphalt. The adjusting and setting of the frames and grates shall be completed in accordance with the details provided in OPSD 704.010 upon placement of surface course asphalt.

Temporary asphalt curbing shall be placed behind all catch basins within the travelled portion of the roadway at the stage of base course asphalt. Asphalt curbing shall be placed in accordance with OPSD 601.010 - Type "D", between the two adjacent expansion joints.

Prior to placing surface course asphalt, temporary asphalt curbs shall be removed and replaced by concrete curb.

Catch basins shall be precast with sump and correspond with OPSD 705.010 (single) and 705.020 (double). Catch basin adjustment units shall correspond with OPSD 704.010. Catch basin frames and grates shall correspond with OPSD 400.090 (herring bone style). For landscaped areas, a "beehive" type frame and cover shall be used as per OPSD 400.120.

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5.8 Service Connections

5.8.1 General Requirements

Storm service connection pipes shall be colour coded white to avoid cross connections. Colour coding method includes pipe color, wrapping, demarcation tape, or stenciling.

Tracer wire is recommended for service connections where feasible as determined by the design engineer. Tracer wires shall be attached to the top of the service connections. Refer to the City's approved material specifications list for tracer wire gauge and approved manufacturers.

The minimum diameter for a service connection shall be 150 mm in diameter

Storm laterals shall never be connected to any sanitary mainline. Under no circumstances will flow from private drain connections enter the main against the flow in the main

5.8.2 Connection Types

Connections to storm sewers shall be made using pre-manufactured tee fittings or strap-on saddles in accordance with OPSS. Wye fittings shall be considered on a case-by-case basis where tee fittings cannot be achieved. Storm sewer lateral connections to maintenance holes are permitted. Connections shall be made using long sweep elbows and tees or wyes (if approved). Connections shall not be made by breaking through the pipe wall on site. One storm sewer lateral is permitted per lot.

5.8.3 Inspection Maintenance Hole

For institutional, commercial, industrial and multi-residential properties an inspection maintenance hole shall be located on the private side of the property line for access to the service lateral. A corresponding maintenance hole shall not be required along the mainline storm sewer at each property, unless it is required to meet OPSD. An oil grit separator is not permitted as an inspection manhole.

5.8.4 Marking and Plugging Requirements

Plugged or capped service laterals shall be marked by a white painted 2x4 Stake at the end cap with adhesive tape labelled "CAUTION STORM SEWER". The service lateral shall be capped 0.3 m inside of property line.

5.8.5 Service Material

PVC pipe shall be used for residential lateral connections. The pipe shall be white in colour and DR 28 shall be used. Laterals larger than 150 mm shall be PVC DR 35.

5.8.6 Service Depth

Storm sewer laterals shall have a minimum cover of 1.5 m at the property line from finished grade to the top of the pipe.

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5.8.7 Service Grade

The grade of the storm sewer lateral shall range between a minimum and maximum of 2% and 8%, respectively. Connections to mainline storm sewers consisting of rigid or flexible pipe shall be made at 10 and 2 o'clock (along the top of the pipe) using long sweep elbows.

5.8.8 Rainwater Leaders

Rainwater leaders shall be discharged onto a concrete splash pad prior to grassed or garden areas, a minimum of 0.6 m away from the building edge, and away from wells or tile bed areas. Rainwater leaders shall not encroach over property lines to adjacent private lands and shall be directed away from adjacent buildings.

The City will not permit rainwater leaders to directly discharge onto impervious surfaces or to be directly connected to the City's storm sewer system without an intermediate stormwater management system to restrict flow rates.

5.8.9 Foundation Drains

The City requires a sump pump system be installed in every building. In any case, the underside of footing shall be set above the seasonal high ground water level.

Where sump pumps are installed in residential developments with open ditches, discharge pipelines shall not be placed within the City's ditch lines of the road allowances. Sump pump discharge pipelines shall be directed to rear or side yard drainage swales. In such cases the sump pump shall discharge via a concrete splash pad to a grassed area a minimum of 0.6 m away from the house avoiding driveways, walkways and adjacent properties.

5.9 Third Pipe Collection System

Third Pipe Collection System, where implemented, shall be designed to collect water only from the foundation drains and is subject to review and approval by the City. Foundation drain discharge collection system shall not receive water from any sites that are contaminated or suspected to be contaminated unless:

- Environmental site assessment is completed to confirm that site is free from contamination.
- Remediation work is undertaken prior to acceptance by the system.
- Pretreatment is in place to achieve acceptable results.

Foundation drain collection pipes shall be installed at sufficient depth (greater than frost penetration) to prevent freezing. If this is not achievable due to site specific condition, the pipes shall be insulated to provide the required protection.

The minimum size of the pipe in the foundation drain collection system shall be 150 mm in diameter (nominal pipe size).

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The minimum slope for the gravity pipes within the foundation drain collection system shall be 1% where feasible.

Maintenance holes shall be provided for foundation drain collection system as required, maintenance hole spacing shall not be more than 150 m.

All material used in the foundation drain Sewers including pipes, fittings, valves, devices, shall meet all applicable quality standards adopted by the Ontario Provincial Standards for Roads and Public Works and/or local municipal standards. Where applicable standards conflict, the more stringent standard shall apply.

5.10 Bedding and Backfill Requirements

5.10.1 Bedding, Embedment and Cover

The class of pipe and the type of bedding shall be designed to suit loading and proposed construction conditions. Pipe bedding and cover shall be granular material in accordance with OPSD requirements for rigid and/or flexible pipe.

Embedment for flexible pipe shall be Granular A material in accordance with OPSS requirements. Bedding, embedment and cover materials shall be placed for the full width of the trench and compacted to a minimum of 95 percent of Standard Proctor Maximum Dry Density (SPMDD), as specified by ASTM D698 or higher, if recommended by the geotechnical consultant.

Alternate granular materials for pipe bedding may be specified, subject to the approval of the City, however clear stone bedding or high-performance bedding are generally not permitted. In areas where it is difficult to control the infiltration of ground water into the sewer trenches clear stone bedding may be considered provided it is completely wrapped in a suitable geotextile, selected and installed in accordance with the manufacturer's requirement and at the direction of the geotechnical consultant.

Where poor soil conditions and high ground water levels are present, the Consultant shall prepare special designs for the City's approval including recommendations from the geotechnical engineer.

5.10.2 Backfill

Trench backfill shall be considered as starting at 300 mm above the obvert of the storm sewer. Backfill shall be in accordance with OSPS and OPSD requirements including recommendations provided in the geotechnical report for the site.

5.11 Lot Grading

5.11.1 General Requirements

The grading of all lots and blocks in new developments must be carefully monitored by the Consulting Engineer in order to prepare sites for the erection of buildings and to provide

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satisfactory drainage from all lands within the development. In this regard, the design of the grading for all developments will be of primary concern to the municipality and the following criteria shall be used in the preparation of all lot grading plans for new development in the City.

All lot drainage shall be designed to conform to the Stormwater Management Report, overall Lot Grading Plan for the subdivision and City standards. The Developer shall be responsible for performing the grading of lots in accordance with the approved Grading Plan and to the satisfaction of the City.

5.11.2 Drawing Requirements – Residential

Prior to application for a building permit, individual lot grading plans for each lot shall be approved by the Developer's Consultant prior to submission to the City. Lot grading plans shall be provided to the City and display the following information:

- Lot description including Registered Plan Number.
- Geodetic site benchmark as shown on approved Engineering Drawings.
- Dimensioned property limits and house outline location with all setbacks shown.
- House type; normal, side split, back split, etc.
- Finished first floor elevation.
- Finished garage floor elevation.
- Finished and original grades over septic tile beds.
- Finished basement floor elevation (all locations).
- Elevation of underside of footings.
- Top of foundation wall (all locations).
- Existing and proposed lot grades for each of the corners of the lot and intermediate points of grade change.
- Existing trees to be maintained.
- Driveway locations, widths and proposed grades.
- Parking Areas
- Finished road grades adjacent to lot.
- Location of dwelling entrances.
- Location of rainwater downspouts.
- Location of walkways.
- Arrows indicating the direction of all surface drainage and swales.
- Location and elevation of swales.
- Patios, decks and/or porches.
- Swimming pools, in ground and above.
- Terraces, retaining walls and tree wells.
- Location and dimensions of all easements.
- All yard catch basins with rim and invert elevations.
- Curb cut locations.
- Hydrants, streetlights, Bell and cable TV pedestals, hydro transformers.
- Location and type of any private sewage disposal system and reserve areas and private wells.

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- Location of all road features along frontage and flankage of lots (curb lines, catch basins, sidewalks, etc.).
- Lot grading certificate by Developer's Engineer in accordance with the Subdivision Agreement requirements.
- Proposed driveway culverts with size, type, invert and slope information.
- Number of front and rear entry step risers.
- Engineered fill level is to be shown where applicable. Light-weight fill, if required, to be clearly identified on the Grading Plan and shall be in accordance with the Geotechnical Engineer's recommendations.

Prior to a building's superstructure proceeding, the Developer's Engineer or OLS must certify the final footing and foundation elevations conform to the site grading plans and the Building Code.

5.11.3 Certification

Prior to pouring building footings, an Ontario Land Surveyor must install survey pins in order to accurately locate the foundation.

Prior to the release of any lot from the conditions of the Subdivision Agreement, the Developer's Consulting Engineer shall provide certification to the City the grading and drainage of each lot is in accordance with the approved lot grading and drainage plans.

This certification is to include that:

- The lot grading plan conforms to the storm drainage plan and neighboring properties will not be negatively impacted. Plan and certificate are to be submitted with the building permit application.
- The final footing and top of foundation are in conformance with the certified grading plan (Tolerance 100 mm).
- The final grading for each lot conforms to the individual lot grading plan.

If the final grading differs from the approved lot grading plan, the Licensed Engineering Practitioner (Consulting Engineer) shall provide details of the variance from the approved plans and shall include his recommendations for certification of the area if required.

A site inspection shall be arranged by the Licensed Engineering Practitioner, Consultant, with the City Engineer, to review the grading of lots after completion of sodding.

5.11.4 Lot Grading Design – Residential

The front yards of all lots shall be graded to drain away from the building envelope and towards the street. Front yard catch basins will not be permitted by the City.

Rear to front lot grading is preferred and a maximum of three rear lots shall outlet between any two lots.

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All boulevard areas shall be graded with a constant slope from the curb to the street limit (minimum slope to be 2%, maximum slope to be 5%) and all water boxes, maintenance hole covers, valve boxes, etc., shall be set flush with the finished sod surface.

Driveways shall not be used as outlets for any swales.

Reverse driveways are not encouraged and where placed shall require a trough drain at the street gutter; all reverse slope driveways are subject to review and approval by the City.

All rear yard drainage shall be directed away from the houses in defined swales which outlet at the curb, sidewalk or a rear yard catch basin. Overland flow routes must be provided for all rear yard catch basins which will protect all structures in the event of catch basin blockage or a major storm event.

The drainage from all the lands within the subdivision limit is to be provided for internally with drainage over abutting lands being permitted only in exceptional cases at the discretion of the City Engineer.

The maximum depth of ponding at a catch basin (static) until it overflows to another outlet is 0.3 m. The spill at the street low point shall be below any building footprint elevations. The spill in rear yards shall be below any building footprint elevations.

The grading along the limit of the subdivision shall be carefully controlled to avoid disturbance to the adjoining areas. In general, lot drainage should be directed away from top of banks or valley slopes.

The lot grading design shall provide for drainage problems on adjacent property that can be best resolved by permitting drainage through the subdivision.

All lot surfaces shall be constructed to a preferred minimum grade of 2.0%, and absolute minimum of 1%.

All lot surfaces shall be constructed to a maximum average lot grade of 12% (calculated from the difference in lot elevations between the rear wall of the dwelling and property line – embankments included). A minimum of 6 metres adjacent to the rear of the house shall be graded at 2% - 5% slope.

Maximum slope between all terraces and embankments shall be 3:1 when the vertical difference does not exceed 1 metre and 4:1 when the vertical differences exceed 1 metre. Between successive terraces, an intermediate level area of at least 1.50 metres in width must be provided.

The lot grading design shall provide for the temporary drainage of all blocks of land within the subdivision intended for future development under site plan agreements or park development plans.

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The grade around dwellings shall be a minimum of 2% away from dwellings from a point 150 mm below top of foundation wall or as required by OBC.

Generally, rear yard catch basins shall be eliminated wherever possible; rear yard catch basins are subject to City approval. When required, rear yard catch basins and outlet pipes shall be located entirely on the same lot. In general, rear yard catch basins shall be located 2.0 metres from the lot line.

Driveway grades shall be designed and constructed at a minimum of 2% and maximum of 6% grade. Driveway locations shall not extend beyond lot line projections within the right-of-way.

5.11.5 Area Grading

5.11.5.1 General Requirements

Where earth cuts and fills in excess of 400 mm are required within the lots and blocks of the new development, rough grading of the area must first be performed prior to road construction.

In general, blocks intended for future development, such as institutional and commercial uses, shall be graded to preliminary grades and drain appropriately, compatible with adjacent roadways and abutting properties and complete with appropriate re-stabilization and erosion and sediment control measures as described in this document.

5.11.5.2 Construction Requirements

Prior to commencing rough grading, the Developer must implement the approved erosion and sediment control plans as outlined in this document. Where the proposed grading plan identifies fill over registered lots, 'Engineered Fill' shall be placed and supervised by the Consulting Engineer in accordance with the Geotechnical Engineer's recommendations.

All block grading shall conform to the storm water management report. The Developer shall be responsible for the grading of blocks until assumption of the subdivision.

The Developer and his Consultant shall be responsible for approval and certification of the following:

- Certification that the block grading plan conforms to the storm drainage plan. The block grading plan and certification shall be submitted with the building permit application.
- Certification of the final grading for each block conforms to the storm drainage plan and the block grading plan.

5.11.6 Infill

All infill development or re-development (i.e., development within existing built-up subdivisions or area) must comply with the drainage requirements of the subdivision or area as outlined in a previous master servicing study. If no such study exists or if there is an increase in the site's overall runoff coefficient, the designer must ensure that there will be no adverse impact to the

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existing storm system. On-site stormwater management measures may be required if the existing system is at or near capacity.

5.12 Joints, Fittings, Couplings and Restraint Devices

All joints, fittings, couplings and restraint devices for storm sewer systems shall be in accordance with MECP Design Criteria, OPSS and OPSD and shall be compatible with the pipe material and class with which they will be used.

5.13 Cleaning, Inspection and Testing

5.13.1 General Requirements

All newly constructed storm sewers maintenance holes, and access structures shall be visually inspected upon satisfactory completion of all other testing, prior to the City's recommendation for issuance of "Substantial Completion".

All storm works shall be thoroughly flushed and/or cleaned of debris. A CCTV inspection as per OPSS 409 PROV shall be required prior to "Final Acceptance" and shall include a clear, stationary, CCTV shot and reporting on all laterals or inspected by methods deemed suitable under MECP Guidelines. All CCTV records shall have the project manhole designation and the appropriate City manhole designation.

Defects in each pipeline length shall be coded according to the NASSCO Canadian Edition of the Pipeline and Assessment Certification Program (PACP). A report identifying any unusual or sub-standard conditions shall also be submitted.

5.13.2 Deflection Testing

A deflection test, by methods identified as suitable under MECP Guidelines, shall be completed for all new flexible Storm Sewers at least 30 calendar days after backfilling but prior to paving.

5.13.3 Asset Information Collection

The City will provide the most current templates ahead of the completion of all works. The Developer will be required to complete all templates and submit in that form, to the City, prior to any assets being brought into service. These templates may include, but are not limited to, asset unique number, description, manufacturer, model, serial number, length, material, dimensions, in-service date, replacement cost, useful life, GPS location, address, location, or other details. Some of the attribute information may be provided by the City, such as asset unique number and useful life.

Additional information such as maintenance schedules, consumable parts list, and operations manuals may be required.

All templates are to be completed in the format as required by the City.

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5.14 Inverted Siphons

Inverted siphons may be permitted by the City in lieu of other acceptable solutions on a case-by-case basis. If approved, inverted siphons shall be designed in accordance with MECP Guidelines. Design criteria include, but are not limited to:

- Inverted siphons must be designed to account for potential siltation, grease and debris accumulation, air locking, maintenance, and odor issues.
- They should have water-tight joints and be able to withstand hydrostatic pressure.
- Gravity drains or other dewatering methods must be included to facilitate inspection and maintenance.
- The minimum pipe size for inverted siphons should be 250 mm in diameter.
- Appropriate cover must be provided above the inverted siphon based on the type of crossing structure.
- Pipes should be sized to achieve a self-cleansing velocity between 1.1 m/s and 1.3 m/s during a 25 mm storm event (First Flush). If these velocities cannot be achieved, alternative flushing methods must be incorporated into the design.
- Inverted siphons should have at least two parallel barrels of the same size, each capable of handling the design flow rate. Single barrel siphons are acceptable if additional arrangements for inspection and maintenance are included in the design.
- Inverted siphons must have inlet and outlet chambers sized for inspection and maintenance.
- Control valves or sluice gates should be installed in inlet and outlet chambers, especially on multi-barrel siphons, to isolate or divert flows to each pipe.
- Inverted siphons should not have sharp vertical or horizontal bends, and the slope for the upward vertical leg should be limited to 2:1 (H:V).

5.15 Stormwater Pumping Station Design

The following criteria is applicable for all new and retrofit stormwater pumping station projects. All storm pumping stations must conform to MECP design guidelines where applicable. In general, unless otherwise directed by the City:

- Minor Stormwater Pumping Stations are below 50 L/s capacity and consist of a submersible wetwell pumping station with an above-grade electrical panel.
- Major Stormwater Pumping Stations are at or above 50 L/s capacity and consist of a wetwell/drywell and an above-grade building structure.

Stormwater pumping stations shall be designed to convey peak stormwater flows without flooding of the roadway or nearby properties. As these facilities operate primarily in response to wet weather events, they may remain inactive for extended periods. The design of stormwater pumping stations shall account for the prolonged non-operational intervals that are common to these facilities.

Forcemains are to be designed in accordance with the City's Wastewater Engineering Design Criteria.

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5.15.1 All Stormwater Pumping Stations

For all stormwater pumping station projects, the following design elements must be considered:

- OIT's on all stations for station control
- Variable Frequency Drives
- Hydrostatic back up control for pumps
- Reverse functionality for pumps
- Forcemain bypass with camlock fitting
- Lifting equipment accommodation for major equipment and confined space entry
- Lockable junction boxes that are mounted for exterior access where feasible
- Safety grating in wetwell to allow for safe access to all instrumentation and junction boxes mounted internally
- Safety ladder with single handle T-bar style safety handle
- Snow storage and clearing considerations
- Security Fencing
- Adequate exterior lighting
- Intrusion alarms on all access points
- Security cameras and connection to City alarm system
- Xeriscaping for landscaping

5.15.2 Minor Stormwater Pumping Stations

For Minor Stormwater Pumping Stations, the following design elements must be considered:

- Intrusion alarms
- Floatation control
- Insulated panel
- Double 1500 watt heaters in electrical panel,
- Connection for portable backup generator,
- Separate 115v 15amp outlet for tools or emergency space heater
- Roof drip edge for cabinet doors to mitigate snow/rain dripping into open cabinet
- Paved area (or increase to paved area) to allow temporary off-road parking for operations vehicles and supporting contract snow clearing
- Bollards
- No Parking and No Dumping signs

5.15.3 Major Stormwater Pumping Stations

For Major Stormwater Pumping Stations, the following design elements must be considered:

- Epoxy slip resistant coating for floors
- Washroom
- Elimination or reduction of confined spaces
- Air filters on VFD's intakes
- Areas for a desk/workspace

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- Touchless taps
- Automatic lighting inside
- Wetwell vector truck connection with camlock fitting
- 50mm water service with pressure indicating transmitter
- Hydro meter and main disconnect mounted internally
- Steel roof with ice breaks and gable rooves over entrances.
- Backup generator

6.0 STORMWATER MANAGEMENT

This section outlines the stormwater management (SWM) guidelines for the City of Orillia. Developers must contact the Environment and Infrastructure Services Department for clarification and guidance on the requirements and standards that may affect new SWM facilities.

6.1 General Requirements

The stormwater management requirements must reflect distinct solutions and vary depending upon the watershed, and in some cases the storm sewer shed, where the site is located.

Site-specific requirements can be obtained from the City. A stormwater management report will be required for all development applications.

Site specific storm water management reports will be required for all development applications and shall be consistent with existing Watershed Planning Studies and Master Drainage Plans prepared in support of the Official Plan and / or Secondary Plan areas including the latest Stormwater Management Master Plan.

In general, Licensed Engineering Practitioners shall prepare storm water management reports that addresses the requirements of the City's Official Plan, Appendix A of the CLI-ECA, including a hierarchical approach to runoff volume control.

6.2 Dual Drainage Modelling

6.2.1 General

The City implements a major and minor system approach to storm water conveyance and control, comprised as follows:

- Minor System – conveyance of the frequent design storm event via surface swales, roadside ditches, curb and gutters, catch basins and storm sewers.
- Major System – overland conveyance of the significant storm events up to the 1:100-year return period via streams, valleys, man-made channels, roadways, roadside ditches and ponds.

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Subdivisions greater than 5 ha must be designed to adhere to the dual-drainage principle. To support this design, a dual drainage model must be developed that considers both minor and major systems and confirm that it adheres to the storm design criteria. The City's preferred modelling platform is PCSWMM.

A Stormwater Management Report must be prepared to support the design of the Subdivision's minor and major systems, including the design of end of pipe facilities, and Low Impact Development (LID) measures, if applicable. The Report must document the analyses undertaken and demonstrate that both storm sewers and major overland system comply with the design criteria identified in this Section.

Rural Catchments – shall be modelled with an approved hydrological software platform using the SCS 24-hour design storm to generate peak flows.

Urban Catchments – shall be modelled with an approved hydrological software platform using the Chicago 4-hour design storm.

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 the more stringent is used for each individual element of the drainage system (pipe flow, street flow, channel flow, detention storage).

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. The maximum rainfall intensity should be compatible with that of real storms on record. All parameter assumptions used in the approved software platform input shall be clearly identified in the storm water management report.

6.2.2 Storm Sewer System

Storm sewers servicing areas greater than 5 ha must be evaluated using a dual drainage model. Software platform must be capable of analyzing the hydraulics along the minor system (storm sewers) and well suited to analyze the major overland system. The preferred dual drainage software platform is PCSWMM.

The dual-drainage model must be developed to evaluate design storm events of various magnitudes, durations and types, in accordance with the recommendations identified in the city's Stormwater Master Plan (SWMP).

The selected design storms must reflect the rainfall statistics derived as part of the city's SWMP. The Model should also consider historical storms and/or climate change events in accordance with the recommendations of the SWMP.

The dual-drainage analyses to include and/or adhere to the following:

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- Storm sewers to capture, without any surface ponding, the 1:5-year design storm.
- Catch basin spacing and ICD selection to be developed in accordance with Section 5.7 and meet the objective of no surface ponding during the design event.
- Inlet Control Devices (ICDs) may be integrated into the subdivision design, subject to the review and approval by the City on a case by case basis, and when there is available capacity on the surface for overland flow conveyance or storage, and the design has been validated by a dual-drainage model.
- In areas with no basements, the storm sewer system is to be designed to ensure that ICDs must operate under free-flowing conditions up to the 1:100-year.
- Grading within subdivisions is to be developed, ideally, using a saw-tooth profile along ROW and rear yards.
- A minimum vertical grade difference of 150 mm is to be provided between the spill elevation (along the ROW) and ground elevation at the building envelope.
- Static roadway sags must not exceed 350 mm in depth, and preferably not exceed 300 mm to allow for dynamic routing.
- The depth of flow during the 1:100-year shall be contained within the ROW.
- During storms of greater magnitude than 1:100-year such as historical or climate change events, the depth of flow may extend beyond the ROW provided that it does not reach any part of the building envelope. This criterion also applies in rear yard and side yard areas. In all instances, flow depth must remain below the lowest building opening.
- A minimum freeboard of 300 mm should be provided between the 1:100-year Hydraulic Grade Line (HGL) elevation and the unit's underside of footing (USF).
- During storms of greater magnitude than 1:100-year such as historical or climate change events, the HGL during these instances can reach the underside of footing but cannot be higher than the bottom elevation of the footing.

6.3 Water Balance

The City applies a hierarchical approach to stormwater management and each step must be applied to the maximum extent possible before proceeding to the next, consistent with the requirements of the City's CLI-ECA provided within Appendix A:

- On-site Retention through infiltration, reuse or evapotranspiration.
- LID Filtration.
- Conventional Stormwater Management.

Where there is no water balance assessment completed in previous studies, development must either:

- Control the recharge to meet Pre-development conditions on property, or
- Control the runoff from the 90th percentile storm event.

For the City of Orillia, the 90th percentile storm event is the 28 mm event as identified within the Runoff Volume Control Targets for Ontario Final Report (MECP, October 27, 2016).

The maximum extent possible is constrained by the following:

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- Natural heritage system – local linkages, core features, and 300 m buffers around core features
- Karst topography – areas with known or potential karst
- Natural hazards – flood hazards, erosion hazards, and steep slopes
- Soil quality – low, low/medium, and high permeability
- Bedrock depth – areas with shallow bedrock (less than 1 m depth)
- High groundwater levels or areas where increased infiltration will result in elevated groundwater levels or groundwater mounding
- Source protection areas – intake protection zones, wellhead protection areas, significant groundwater recharge areas
- Brownfield sites where sites contain contaminated soils or groundwater

A site-specific geotechnical assessment for the existence of karst on the site must be completed.

At the City's discretion, it may consider a reduced infiltration and water budget requirement if the proponent is able to clearly demonstrate that meeting the preceding is not feasible on the site, due to physical constraints such as an elevated groundwater condition, bedrock or other system constraints.

6.3.1 Water Balance Calculations

If post to pre water balance is being proposed by means of infiltration, the water balance assessment must be completed in accordance with LSRCA Technical Guidelines for Stormwater Management Submissions. Pre-development water balance conditions are for a greenfield condition.

The Ontario Ministry of the Environment Stormwater Planning and Design Manual (2003) provides representative values for evapotranspiration in Ontario and provides guidance for factors to be used (based on MOEE, 1995 guidance) in determining recharge and runoff. It should be noted that the MOE Stormwater Manual (2003) provides examples only and where possible, local estimates of evapotranspiration and water surplus are to be provided using the Thornthwaite and Mather approach and data obtained from a local climatic station.

It is recommended that a water balance and, if necessary, additional infiltration tests and water quality samples be completed to verify feasibility.

Groundwater

When a Hydrogeological Report is required to support a development application, groundwater monitoring wells shall be installed and equipped with data loggers, which should be installed for a minimum of one (1) year to document the seasonal fluctuations and identify the seasonally high groundwater level.

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6.3.2 Low Impact Development Practice

Low Impact Development (LID) is a stormwater management practice aimed at mitigating increased runoff and improving water quality by managing runoff close to its source.

LID uses site design strategies to minimize runoff and mimic natural hydrology through infiltration, evapotranspiration, harvesting, filtration, and detention. These practices contribute to the reduction of stormwater runoff volume and peak flow rate intensity, and remove contaminants like nutrients, pathogens, and metals. They have been widely implemented in Ontario as part of the treatment train approach.

Key LID practices include:

- Bioretention
- Perforated Pipe Systems
- Permeable Pavements
- Soakaways
- Green Roofs
- Enhanced Grass Swales
- Dry Swales

The City supports the use of these innovative stormwater solutions and encourages the development of new designs and technologies. Solutions should follow best practices from Ontario's design guides, the MECP Stormwater Management Planning and Design Manuals, while green infrastructure and LID practices shall be designed according to the Low Impact Development Stormwater Management Planning and Design Guide (TRCA/CVC, 2010) or the Sustainable Technologies Evaluation Program (STEP) Wiki Guide.

Construction of low impact development practices shall be undertaken as per the CVC/TRCA's Low Impact Development Stormwater Management Planning and Design Guide.

An Operations and Maintenance manual shall be provided for all Low Impact Development Practices and it shall be consistent with the STEP Low Impact Development Stormwater Management Practice Inspection and Maintenance Guide.

6.4 Stormwater Quantity Control

The degree of control on the quantity of run-off from a proposed development shall not be greater than the corresponding predevelopment peak flow for the 1:2-year, 1:5-year, 1:10-year, 1:25-year, 1:50-year, and 1:100-year design storm events. In catchments within the Severn Sound or Mill Creek watersheds peak flow control shall include up to the Timmins Storm regulatory event.

In general, quantity control measures are to be designed in accordance with the MOE Stormwater Management Planning and Design Manual – March 2003 or latest version, LSRCA criteria, and the City's CLI-ECA within Appendix A.

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In addition to introducing pond storage into a storm water management system, increased flows resulting from increased impervious areas may be mitigated by utilizing measures such as:

- Discharging rainwater leaders onto grassed areas.
- Providing temporary rooftop storage.
- Parking lot storage or using grassed swales rather than piped flow.

Other factors, such as snowmelt run-off with large volume and longer duration and potential adverse downstream effects due to uncoordinated timing of peak flows must be considered when designing storm water management facilities.

Underground storage tanks are not approved stormwater management measures as part of the municipal CLI-ECA system and will only be considered in exceptional cases. Superpipe systems will only be considered in exceptional cases.

Joint use facilities i.e., detention ponds over recreational playing fields and passive parks, will be considered on an individual basis subject to suitably designed control measures and the intended park use.

6.4.1 Stormwater Management Pond Requirements

The design of stormwater management ponds shall be completed with consideration of the following aesthetic and landscape design criteria:

- Dry Ponds:
 - Ponds shall be designed to limit the maximum depth of water to 1.8 m above the lowest point of the stormwater basin. An additional 0.3 m freeboard is required above the maximum computed water surface elevation. The maximum depth of the extended detention zone shall not exceed 1.0 m above the lowest point of the pond.
 - Maximum side slope will be 5:1 from the bottom of the dry pond to the limit of maximum extended detention, with a minimum horizontal length of 3.0 m. The minimum allowable gradient on the bottom of the basin shall be 1.0% and the maximum gradient shall be 5%.
- Wetlands
 - Wetlands shall be designed to limit the maximum depth of water to 2.1 m above the lowest point of the stormwater basin excluding micro pools. An additional 0.3 m freeboard is required above the maximum flood level. The maximum depth of the extended detention zone shall not exceed 1.0 m above the permanent pool elevation.
 - Maximum peak flow attenuation zone shall not exceed 1.8 m above the permanent pool elevation.
 - A maximum 5:1 slope below the permanent pool level shall be permitted around the entire stormwater management wetland. A maximum 5:1 slope above the permanent pool level shall be permitted around the entire stormwater management wetland. The slope shall extend from the permanent pool level to

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the limit of maximum extended detention. The horizontal distance of this slope must be a minimum of 3.0 m.

- Wet Ponds
 - Wet ponds shall be designed to limit the maximum depth of water to 3.3 m above the lowest point of the stormwater basin. An additional 0.3 m freeboard is required above the maximum flood level. The maximum depth of the extended detention zone shall not exceed 1.0 m above the permanent pool elevation. The permanent pool depth shall range between a minimum depth of 1.0 m to a maximum depth of 1.5 m, unless for a localized area such as a plunge pool.
 - A maximum 5:1 slope below the permanent pool level shall be permitted around the entire stormwater management wet pond. The horizontal distance of this slope must be a minimum of 3.0 m. A slope commencing from this point to the lowest point of the stormwater basin shall be a maximum of 3:1. A maximum 5:1 slope above the permanent pool level shall be permitted around the entire stormwater management wet pond. The slope shall extend from the permanent pool level to the limit of maximum extended detention. The horizontal discharge of this slope shall be a minimum of 3.0 m.
- General
 - Fencing of stormwater management facilities shall be minimized. Where stormwater management facilities are to be owned by the City and abut private property, fencing may be required at the discretion of the City. At a minimum, demarcation of property boundaries is required. Fencing and/or property demarcation shall be to City standards.
 - Facility signage to be compliant with the City's CLI-ECA and subject to the review by the City; the signs shall identify the name of the facility, the asset ID (set by the City for City-owned facilities), the address, the CLI-ECA number, a note that access is prohibited at all times, a note stating the function of storm ponds (settling of solids) and standard safety tips. A sign shall be required at each public access point to the stormwater facility.
 - In situations where existing natural areas are proposed to be used for stormwater management, exemptions to the depth and slope criteria may be provided to minimize disturbance to the natural feature, at the discretion of the City.
 - Designed pedestrian access areas shall not exceed a maximum slope of 12:1.
 - Notwithstanding the above slope and depth criteria, in the case of headwall design, the depth of water related to adjoining side slopes may vary and fencing is required for safety purposes.
 - Maintenance access requirements are to be determined on a site-by-site basis; however, the following general criteria are recommended:
 - Controlled maintenance access routes shall be provided to both inlet and outlet structures and forebays.
 - A minimum 3.0 m wide surface to accommodate maintenance vehicles within a minimum 10 m turning radius (inside radius) and a flat 10 m loading areas is required. Maintenance access routes shall not exceed a maximum slope of 10:1.
 - The design of maintenance routes and loading areas shall be to the approval of the Development Services and Engineering Department at the City.

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- Sediment drying area may be required to the discretion of the city, adjacent to the forebay area to facilitate dewatering of sediment prior to removal to an approved disposal location.
- Maintenance by-pass shall be provided via a maintenance hole upstream of the entry to the pond to divert all flow from the pond during maintenance and sediment removal procedures.

6.4.2 Operation and Maintenance Manual

All stormwater management quantity control measures, including LID measures, shall have an Operations and Maintenance Manual which shall include, at a minimum:

- Procedures for the routine operation of the Sewage Works;
- Inspection programs, including the frequency of inspection, and the methods or tests employed to detect when maintenance is necessary, including:
 - The presence of algae and/or invasive species; and
 - Measurements of sediment depth, manual water levels, visual observations, as appropriate to the facility.
- Maintenance and repair programs, including:
 - Frequency of maintenance and repair; and
 - Pond cleanout, dewatering and management.
- Operational and maintenance requirements to protect sources of drinking water
- Emergency Response, Spill Reporting and Contingency Plans and Procedures for dealing with Equipment breakdowns, potential Spills, and any other abnormal situations, including notification to the SAC, the Medical Officer of Health, and the District Manager, as applicable;
- Procedures for receiving, responding, and recording public complaints, including recording any follow-up actions taken; and
- As-built drawings or record drawings of the infrastructure.

6.5 Stormwater Quality Control

Water quality treatment will be required for all new development within the City.

Water quality treatment shall conform to MECP requirements and shall use the treatment train approach to stormwater management with source, conveyance and end-of-pipe measures. All stormwater management (SWM) measures shall provide as a minimum an "Enhanced" level of protection (i.e., 80% TSS Removal).

Quality measures shall be reviewed with the City at project commencement. It is required to provide calculations for Stormwater quality control facilities and plans of the quality management measure(s) with cross sections of the facilities, details of inlets, outlets, maintenance access, and berm construction and landscaping.

Water quality catch basin inserts, such as CB Shields and goss traps, can be part of a treatment train approach but do not achieve any specific water quality TSS reduction.

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6.5.1 Phosphorus Removal

The developer shall evaluate anticipated changes in phosphorus loadings between pre-development and post-development through a Stormwater management plan at the request of the City. The assessment should include sufficient detail to be used at a local site level. Phosphorus reduction on site shall be calculated by either using the MECP Lake Simcoe Phosphorus Budget Tool or the STEP LID Treatment Train Tool. Applicable phosphorus removal rates are identified within the Phosphorus Budget Tool in Support of Sustainable Development for the Lake Simcoe Watershed (Hutchinson, March 2012) while updated phosphorus removal rates are identified within the LSRCA Technical Guidelines for Stormwater Management Submissions (April 2022) or as amended.

The phosphorus assessment shall address the CLI-ECA requirements identified within Appendix A.

6.5.2 Manufactured Treatment Devices

The term Manufactured Treatment Device (MTD) is used within the City's CLI-ECA Agreement with the MECP, and refers to two distinct technologies:

- Sedimentation MTD: Commonly referred to as an Oil Grit Separator (OGS) that primarily functions to remove coarse sediments, debris, and light oils from stormwater.
- Filtration MTD: Similar in function to a sedimentation MTD, however incorporates a filtration process that removes a greater portion of fine sediments from stormwater in addition to the capability of a sedimentation MTD.

Areas subject to the collection of contaminants or spills shall be fitted with adequate Manufactured Treatment Devices (MTDs).

All MTDs shall be verified by the Canadian Environmental Technology Verification (ETV) program and sized in accordance with the LSRCA Technical Guidelines for Stormwater Management Submissions (April 2022) or as amended.

When two or more sedimentation MTD are installed in series, no additional sediment removal credit shall be applied beyond the sediment removal credit of the largest device in the series.

6.6 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 LSRCA, MNR, DFO and/or MECP.

6.6.1 Culverts and Bridges

Only arterials and collectors should, if feasible, be permitted to cross the major system watercourses. It is also recommended designers consider the need to design culverts and bridges on such arterials and collectors for at least the 1:100-year storm flow, if not for the Regional Storm flow. If smaller culverts or bridges are provided, the backwater effects for the

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1:100 year and Regional Storm flows must be determined. Open bottom concrete culverts shall be designed and placed for all watercourse crossings subject to the approval of the City. In accordance with applicable legislation and policies, consultation and/or approvals should be undertaken with relevant review agencies (e.g., DFO, LSRCA) to confirm their regulatory requirements for watercourse/valley crossings.

All culverts and bridge designs shall be sized to accommodate the bankfull channel. Structure designs shall incorporate existing or proposed hydraulically sized substrate and demonstrate maintenance of fluvial processes (i.e., flow regime and sediment transport) to mitigate risk of increased erosion or sedimentation.

Table 8: Design Flow Frequency below outlines design flood frequency for select road classifications.

Table 8: Design Flow Frequency

Road Classification	Design Flood Frequency
Arterial	1:100 Year to Regional
Collector	1:50 Year
Urban Local	1:25 Year
Rural Local	1:25 Year
Temporary Detour	1:10 Year
Driveway	1:5 Year

All culverts must be of sufficient length to provide for a preferred 5:1 (minimum 3:1) slope off the driving surface to the ditch invert. All driveway culverts require entrance approval.

Ministry of Natural Resources, DFO and/or LSRCA approval under their regulations may be required for watercourse/valley crossings. As such, culverts shall be designed in accordance with applicable regulations, including but not limited to:

- MTO's Highway Drainage Design Standards
- OPSS
- OPSD

Bridges and other major drainage structures shall require special designs as determined by the City. Design submissions should include the following, at a minimum:

- Hydraulic calculations, which should include demonstration that the frequency and magnitude of flooding or erosion shall not be increased on upstream or downstream properties.
- Geomorphic assessment to characterize existing watercourse conditions and evaluate risk related to erosion and channel migration.

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6.6.2 Open Channels

The proposed criteria for an open channel design must be submitted to the City for approval before the actual design process begins. Open channels are defined as major system overland flow channels, minor system outfall channels, or natural channels. Major system overland flow channel designs may need to accommodate the Regional Storm or the 100-year storm for new developments.

Design criteria for natural channels shall include the following:

- Geomorphic analysis to determine a design discharge (i.e., bankfull flow) and channel morphology (planform, profile and cross-sectional dimensions) referencing field investigations and relevant design constraints.
- Stability analysis demonstrating performance of channel lining (incl. bed and bank) materials under frequent flow conditions (25 mm through 5-year events), with consideration for flows up to both the 1:100-year return interval and Regional storms.

The Consultant shall also be responsible for obtaining the approval of relevant review agencies (e.g., DFO, LSRCA) to address their regulatory requirements for channel designs, if the channel design concept is favourably considered.

6.6.3 Watercourse Erosion and Bank Instability

Watercourse erosion and instability pose a risk to human safety and public and private property. When an area is to be developed or redeveloped, the City requires that watercourse erosion hazard limits relevant to the development area be delineated in accordance with the MNR (2002) Rivers & Streams Systems Technical Guides: Erosion Hazard Limit. The Developer shall also undertake a geomorphic evaluation to document existing watercourse conditions, including evidence of erosion and instability.

6.6.4 Definitions

Design Discharge (Bankfull flow): The flow rate that is most effective in the transport of sediment, which is typically associated with the elevation at which the width/depth ratio of the channel cross-section is at a minimum. Some common physical indicators of bankfull elevation include inflection points in bank slopes; elevations of depositional (bar) features; and changes in riparian vegetation (lowest point of woody vegetation).

Bioengineering: A technique for stabilization that incorporates the use of vegetation and engineering structures to increase slope or bank stability.

Erosion threshold: The estimated hydraulic force necessary to initiate sediment entrainment (erosion). Threshold forces (commonly velocity and shear stress) are estimated based on empirical relationships for the bed and bank material composition as determined through a geomorphic field investigation.

Sediment Transport: In the context of municipal stormwater engineering, sediment transport primarily refers to the movement of soil, sand, gravel, and other substrate within natural

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watercourses and stormwater systems. This movement is driven by the flow of water and can occur in various forms, including:

- Suspension: Finer particles like silt and clay are carried within the water column.
- Saltation: Larger particles like sand bounce along the channel bed.
- Traction: The largest particles, such as gravel and cobbles, roll or slide along the bottom.

Understanding sediment transport is important for managing stormwater systems effectively because excessive sediment can reduce conveyance capacity (due to deposition), degrade water quality and damage infrastructure.

6.6.5 Stormwater Erosion Control

Erosion and deposition are natural processes that are necessary for the maintenance of the form and function of a watercourse. Changes in land use can result in changes in the frequency, magnitude and duration of surface runoff produced by precipitation events, which can result in increased rates of erosion. Developers must take preventive and mitigative actions to ensure that new development or redevelopment does not exacerbate existing issues of erosion and watercourse instability.

When a development or redevelopment requires an end-of-pipe facility for erosion control, the Developer shall undertake a geomorphic assessment that includes, at a minimum:

- Reconnaissance-level audit to characterize existing watercourse conditions, including observations of erosion to provide an assessment of the channel's geomorphic stability and corresponding processes.
- Detailed geomorphic survey of the channel's longitudinal profile, bedforms (e.g., riffles and pools), representative cross-sections, and substrate sampling of the channel bed and banks at an appropriate number of locations.
- For each detailed geomorphic survey location, establish an erosion threshold for the existing bed and bank materials using sediment entrainment models.
- Analysis of frequent synthetic storm events (e.g., 25 mm, 2-year and 5-year events) under existing (predevelopment/redevelopment) and proposed (uncontrolled and controlled) conditions, including:
 - Visual comparison of existing and proposed condition hydrographs to evaluate changes in magnitude, and duration.
 - Review and, if appropriate, refinement of the erosion threshold.
 - Quantitative comparison of threshold exceedance using several criteria, including cumulative time of exceedance, cumulative effective work, and cumulative effective shear stress (erosion index).

It is anticipated that post-development exceedance will match (relative difference within 5%) existing condition exceedance unless over-control is required. On a site-by-site basis, the City may require the Developer to undertake a continuous erosion exceedance analysis using a minimum five years of rainfall data.

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In such instances where the implementation of erosion hazard limits and end-of-pipe stormwater management practices are not sufficient to mitigate potential for downstream erosion and watercourse instability, the City may require the Developer to implement additional remedial and preventative measures to reduce the risk of increased erosion downstream caused by surface drainage contributions from the development.

Additional guidance regarding geomorphic erosion analysis methodologies can be found in the Toronto and Region Conservation Authority (2012) Stormwater Management Guidelines and Credit Valley Conservation (2015) Fluvial Geomorphic Guidelines.

6.6.5.1 Remedial and Preventative Measures

The implementation of bank stabilization works represents one category of remedial and preventative measure. Should this type of site-specific erosion control measure be favourably considered, the Developer shall prioritize the preservation of watercourse dynamics and aim to preserve the natural aesthetic of the valley or stream corridor. Bio-engineering techniques are the preferred approach to bank stabilization.

The design of bank stabilization measures shall be based on a fluvial geomorphic review of the watercourse, which includes a stability analysis to demonstrate performance of the proposed stabilization measure under frequent flow conditions, with consideration for flows up to both the 1:100-year return interval and regional storms. Protection to this level will be adequate provided care is taken to prevent any damage by higher floods.

In cases where the watercourse is coincident with a valley slope (valley contact point), bank stabilization designs are subject to erosion hazard limit considerations for confined valley systems, including the stable slope allowance and toe erosion allowance, as determined using accepted geotechnical and engineering principles, per the MNR (2002) Technical Guide. In this 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.

Where watercourse remediation (channel bed and banks) may be favourably considered, designs shall be subject to the City's Design criteria for natural channels (refer to Section 6.6.2). The proposed criteria for an erosion or bank stability design shall be submitted to the City for approval prior to the actual design being undertaken.

Additional guidance regarding bio-engineering stabilization measures and natural channel design can be found in the MNR (2001) Adaptive Management of Stream Corridors in Ontario. The MNR (2002) Technical Guide River & Stream Systems: Erosion Hazard Limit provides additional guidance regarding the determination of watercourse erosion hazard limits.

At a minimum the runoff volume generated from a 28 mm storm shall be detained for 24 to 48 hours to provide erosion control of the downstream receiving watercourse as per the Runoff Volume Control Targets for Ontario Final Report (MECP, 2016). If detention and discharge of a 28 mm storm between 24 to 48 hours cannot be achieved, the criteria specified within the most recent version of the LSRCA Technical Guidelines for Stormwater Management Submissions shall be applied.

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6.6.6 Major Systems and 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.

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 depth of water at the gutter shall not exceed 0.3 m.

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 safe overland flow."

Storm drainage shall be provided on a major system and minor system basis, with stormwater management controls, as required by the appropriate agencies, in accordance with the MECP's "Stormwater Management Planning and Design Manual, 2003." The maximum depth of ponding for major flow routes shall be 300 mm deep. No ponding shall occur in the roadway for the minor storm events. The major storm drainage system shall permit continuous overland flow along roads and easements without flooding onto lots during a 100-year storm. The route of the flood flows resulting from this storm through to a major watercourse shall be shown on a plan and any potential areas of flooding shall be identified.

6.6.7 Swales

All drainage swales shall be located on lot lines unless the adjacent property is not undergoing development. In such cases drainage swales shall be located entirely within the lot being developed.

The maximum flow allowable to any side yard swale shall be from the equivalent of three lots or 0.5 hectares, whichever is less.

The maximum area contributing to a rear yard swale discharging directly onto a road allowance shall be the equivalent of three rear yards or 0.50 hectares, whichever is less.

Swales providing internal drainage from each lot shall have a minimum slope of 2.0%.

Minimum depth of any swale to be 150 mm.

Maximum depth for a rear yard swale to be 750 mm.

Maximum depth for a side yard swale to be 450 mm.

Maximum side slope on any swale shall be 3:1.

Desirable swale depth to be 225 mm. Minimum swale depth to be 150 mm. Maximum swale depth to be variable, but dependent on location and safety considerations.

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The maximum side slope on swales should be three horizontal to one vertical (3H:1V). The maximum slope of embankments between properties should also be 3H:1V. Failing this, a retaining wall should be designed.

6.7 Inlets, Outlets and Special 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 work necessary to protect against erosion.

6.7.1 Inlet Structures

Inlet structures shall:

- Be fully designed by the Consultant when OPSD structures are not deemed suitable.
- Include inlet grates that generally consist of inclined parallel bars or rods set in a plane at approximately 180 degrees with the top away from the direction of flow.
- Include Gabions, riprap or concrete at all inlets to protect against erosion and to channel the flow to the inlet structure.
- Follow guidelines established by the Ministry of Transportation Drainage Manual.
- For any culvert on a new or reconstructed watercourse, where an inlet grating is required, include in the design, measures of safety and minimize the risk of entanglement or entrapment of a person.

6.7.2 Outlet Structures

Outlet Structures shall:

- Use the OPSD headwall standards for all storm sewers up to 2,400 mm diameter. For sewers over 2,400 mm. the headwalls shall be individually designed.
- Have all headwalls equipped with a grating over the outlet end of the pipe and a railing across the top of the headwall for the protection of the public.
- Private headwall outlet structures should only be located on private property and should be accessible for operations and maintenance.
- Align with the watercourse flow, with the directional changes accommodated within the sewer.
- Not be connected to existing or proposed road crossing culverts. Storm sewer outfalls must be terminated at separate headwall structures, adjacent to the outlet side of road crossing culverts.
- Use gabions, riprap, or concrete at all outlets to prevent erosion. The extent of this protection depends on flow velocity, soil conditions, and site specifics.
- Where proposed within a natural valley or stream corridor, have designs that incorporate bio-engineering techniques to integrate required erosion protection design elements with the surrounding landscape and enhance ecological functional attributes of the outlet structure is preferred.

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- In cases where an outlet structure is offset from the watercourse, have designs that incorporate an outlet channel that provides a functional hydrologic connection to the watercourse (refer to Section 6.6.2).

7.0 EROSION AND SEDIMENT CONTROL

7.1 General Requirements

Urban developments can increase sediment loading to nearby water bodies, especially during construction. To mitigate sediment laden, erosion and sediment control measures must be implemented according to Provincial Guidelines, unless modeling shows no adverse effects on stream stability.

The ESCP must address specific requirements for each stage of construction as follows:

- Tree removal
- Clearing and grubbing
- Topsoil stripping and rough grading
- Construction of services
- Street and building construction

Additional requirements may be necessary where creek or stream crossings for underground services, bridge or culvert construction across active streams, channel diversions and outfalls to active streams are encountered. Plans shall outline measures to reduce impact on the streams including the timing of construction activities to minimize disruption as required by LSRCA, MNR and DFO, where applicable.

The erosion and sediment control (ESC) measures as indicated on the drawing set shall be installed and implemented prior to any construction taking place. Erosion and sediment control measures and notes are to be identified on all lot grading drawings, storm water management facility drawings, channels, outlet structure drawings and plan and profile drawings where applicable. If erosion and sediment control measures are extensive, a separate drawing may be required.

The ESC measures shall have regard to at least one of the following:

- CSA W202 Erosion and Sediment Control Inspection and Monitoring Standard, as amended from time to time; or
- Erosion and Sediment Control Guideline for Urban Construction (2019), as amended from time to time, prepared by the Toronto Region Conservation Authority.

The phasing of individual developments must be taken into account during the design of the control measures including locations for topsoil stockpiles. A primary consideration will be to expose the least possible area of land for the shortest possible timeframe.

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ESC measures shall be prepared by a Qualified Person for sites with drainage areas greater than 5 ha.

Installation and maintenance of the ESC measures specified in the ESC plan shall have regard to CSA W208 Erosion and Sediment Control Installation and Maintenance, as amended from time to time.

For any construction project, both private or City-led, records of ESC inspections need to take place on a regular basis, especially after a rainfall event or after a snow melt, to ensure ESC measures are working and in place. The records shall have the following:

- Include the name of the inspector, date of inspection, visual observations, and the remedial measures, if any, undertaken to maintain the temporary ESC measures.
- Be retained with records relating to the construction activity. If this construction activity is related to a subdivision development, the Developer and their Engineer shall provide these records to the City upon Substantial Completion as per the Development Agreement.
- Be retrievable and made available to the MECF upon request.
- Any regulated works other than those identified on the engineering drawings shall require additional approvals from all applicable authorities.

The engineer shall monitor all erosion and sediment control measures during construction and make any modifications to the measures as required to ensure that no silt or sediment enters onto private property, existing roadways, existing sewer systems, rivers or watercourses and Environmentally Sensitive Areas .

ESC measures shall be inspected by a Qualified Person for sites with drainage areas greater than 5 ha.

7.2 Erosion and Sediment Control Measures

7.2.1 General Measures

All disturbed ground left inactive shall be stabilized by seeding, sodding, mulching or covering or by their equivalent measure. The period of time shall not exceed 30 days unless otherwise authorized by the City.

7.2.2 Silt Fence

Silt fencing shall be installed wherever surface runoff drains onto adjacent properties, completely around the base of topsoil stockpiles and along the perimeter of all other areas sensitive to sediment accumulation (e.g., watercourses, valleys, woodlots, areas to remain undisturbed etc.). Installations shall be specified as "Light Duty" or "Heavy Duty" according to the application.

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7.2.3 Topsoil Stockpile Protection

Stockpiles shall be located so the toe of the slope is a minimum of 10 m away from a roadway, drainage channel or residential lot. The maximum sideslopes shall be 1.5 horizontal to 1.0 vertical.

Runoff shall be controlled by light duty sediment control fence or other approved measures. If remaining for more than 30 days, stockpiles shall be stabilized by vegetative cover or other means.

The maximum stockpile height shall be approved by the City in consideration of the surrounding land uses and duration the stockpile is to be in place.

7.2.4 Sediment Basins, Interceptor Swales

Temporary sediment basins shall be constructed on sites having a disturbed drainage area of greater than 4 hectares. Basins may also be required for smaller areas of disturbance which are sensitive in nature as required by the City.

The basin shall be designed to settle out particles 0.04 mm in diameter or larger from surface water runoff and storm sewer flows and shall be sized to meet LSRCA criteria of minimum 125 m³/ha, 24hr detention and 125 m³/ha permanent pool storage volume or the ultimate pond criteria.

Ponds are to have filter fabric / clear stone wrapped perforated riser outfalls with anti-seepage collars and rip rap overflow weirs.

7.2.5 Rock Check Dams

To be installed in swales and ditches in accordance with OPSD 219.210 and 219.211 where runoff drains to adjacent properties.

7.2.6 Catch basin Controls

Sediment controls for catch basins are to be provided in accordance with the inlet protection practices identified within the Sustainable Technologies Evaluation Program (STEP) Erosion and Sediment Control Guide for Urban Construction (2019).

Catch basins shall be cleaned when the sump is full and before sediment accumulates to within 300 mm of the outlet lead.

7.2.7 Stone Pad Construction Access (Mud Mat)

In order to reduce the tracking of mud onto paved streets, a pad of crushed stone shall be constructed at the site entrance and exit leading onto any existing road. The stone pad shall be a minimum of 450 mm thick, 30 m long and 5 m wide. The first 15 m from the entrance/exit shall be constructed with 50 mm clear stone. The remaining 15 m shall be constructed with 150 mm riprap.

Revision Record

Engineering Design Criteria: Stormwater

7.2.8 Rip Rap

Rip rap shall be placed in conjunction with an approved geotextile within inlet/outlet structures, overflow protection, channel banks, gabions and rockfill structures. Gradation shall be in sizes ranging from 100 mm to 200 mm, as per Ontario Provincial Standard Specifications.

7.2.9 Rock Protection

Gradation shall be in sizes ranging from 100 mm to 500 mm, as per Ontario Provincial Standard Specifications.

7.2.9.1 Turfstone

Constructed in conjunction with an approved geotextile, for use as overflow protection, channel lining, and/or surface access roads using City approved products. Turfstone voids are to be filled with topsoil and seeded.

7.2.9.2 Geotextile

Geotextiles shall be constructed within inlet/outlet structures, sub-drains, blanket drains, gabion lining, retaining walls, ditch lining, channel linings, access roads, rockfill structures, dykes and energy dissipaters. Type and sizing of geotextile is to be approved by the City.

7.3 Drawing and Report Requirements

ESCP Drawings shall comprise:

- Location of buildings, existing and proposed, within and adjacent to the property
- All natural features within and adjacent to the property (woodlots, watercourses, valley lands etc.).
- Trees to be preserved.
- Existing contours at 0.5 m intervals.
- Proposed interim and final elevations.
- Areas to be disturbed.
- Direction of overland flow.
- Staging of construction and implementation of control measures.
- Proposed erosion and sediment control measures (silt fence, check dams, sediment basins, interceptor swales, stone mud mats, etc.).
- Topsoil stockpile locations with estimated quantities, maximum height and side slopes.
- Detail drawings.

The ESCP shall be accompanied by a report which, at a minimum, outlines staging of construction and implementation of the proposed erosion and sediment control measures, a description of measures to be undertaken, silt basin calculations, features to be protected and an inspection and maintenance program.

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The report shall also recommend measures to control dust such as road cleaning, watering, work restrictions on windy days, minimizing disturbed areas and other measures.