

1.3 Stormwater Management System

Urban development has the potential to impact the quantity and quality of stormwater runoff. Accordingly, the stormwater management system is to be designed to limit flooding and minimize hazards under the major storm events. The stormwater management system should also provide a reasonable level of convenience and safety for pedestrians and traffic use by removal of lot and street surface runoff under more frequent storm events. This typically leads to the installation of a storm sewer system designed to minimize the impact of development on water quality and aquatic life in receiving waters.

The stormwater management system is also designed to protect the environment by returning water into the ground where feasible and removal of pollutants prior to it entering receiving waters.

1.3.1 General Design Considerations

1.3.1.1 [Stormwater Management Plan](#)

The stormwater management plan shall include the Stormwater Management Report (see 1.3.1.9) along with other related information. It provides an integrated means of dealing with the many impacts of urban development on water quality and quantity, erosion, sedimentation and the hydrologic cycle (preservation of groundwater resources). The preparation of a stormwater management plan shall be based on an approved Master Drainage Plan, Master Environmental Servicing Plan (MESP), the City-Wide Storm Drainage and Stormwater Management Master Plan, TRCA initiatives or the criteria established by the City and the TRCA and any other relevant jurisdictions. The plan shall outline all tributary areas, the minor and major system design and the stormwater management facility design including the impacts of riparian rights and is to be accompanied by a Stormwater Management Operations and Maintenance Manual. In addition, the plan shall identify and assess the potential environmental impact the proposed development will have on the receiving watershed. All Stormwater Management Reports and designs shall bear the seal, date and signature of the licensed Professional Engineer under whose direction they were prepared.

The stormwater management plan shall be developed in accordance with the City's Design Criteria and Standard Drawings, the TRCA's Stormwater Management Criteria (April 2012 or most recent edition) and the MECP's Stormwater Management Planning and Design Manual (2003 or most recent edition).

1.3.1.2 [Level of Service](#)

The system is to be designed to provide conveyance drainage for a variety of storm frequencies through the minor and major system and provide flood protection for all storms up to the greater of the 100-year return frequency or regional storms where mandated by TRCA.

1.3.1.3 [Minor System](#)

Storm sewers shall be designed to convey at least a 5-year return frequency storm and shall not surcharge during any storm return frequency event up to and including the 100-year return frequency level. The combined design of storm sewer and overland flow system must be capable of handling a 100 year return storm without surcharging the minor system.

For new industrial subdivision development, storm sewers are to be designed to convey the 5-year return frequency storm from the road allowance and 180 L/s/ha from lots/blocks, or as otherwise specified in the relevant Master Drainage Plan or equivalent document, if available.

1.3.1.4 [Major System](#)

Runoff flows in excess of the design capacity of the minor system shall be conveyed via streets, open channels, storm sewers and walkways to a safe outlet. The combination of the overland flow system and the minor system

shall be designed for a 100-year return frequency to prevent flooding of private property with maximum level of road flooding and surface detention as defined in Table 1-6.

1.3.1.5 [Open Channels](#)

Open channels shall be designed:

- To convey the peak flow from the 100-year return frequency or regional storm event, whichever is greater, in accordance with City and TRCA policy.
- To prevent erosion damage for all frequency storms.
- With a maximum velocity of 1.5 m/s.
- To maintain the characteristics and aesthetics of a natural watercourse to the satisfaction of the City, TRCA and MNRF.

1.3.1.6 [Approvals](#)

The system shall be designed to meet the requirements of the City of Vaughan, the Regional Municipality of York, the Ministry of the Environment, Conservation and Parks (MECP), Ministry of Natural Resources and Forestry (MNRF), the Toronto and Region Conservation Authority (TRCA), the Ministry of Transportation (MTO), Fisheries and Oceans Canada (DFO), downstream municipalities and other governing authorities having jurisdiction.

1.3.1.7 [Tributary Area Inflows](#)

Allowances shall be made for inflows from geographically tributary adjacent subdivisions or lands in their current and ultimate conditions in accordance with the Official Plan.

1.3.1.8 [Outlet Locations](#)

The outlet location for sewers or channels shall be approved by the City.

1.3.1.9 [Stormwater Management Report](#)

The Stormwater Management Report shall demonstrate:

- The manner in which stormwater will be conveyed from the site.
- Context plan that shows how the proposed drainage system will tie into the existing drainage system of the surrounding area.
- How it conforms with the approved Master Drainage Plan, Master Environmental Servicing Plan (MESP), the City-Wide Storm Drainage and Stormwater Management Master Plan, TRCA initiatives or other approved criteria.
- How external flows will be accommodated.
- The design capacity of the receiving system(s).
- The appropriate Stormwater Management Measures to be used to ensure there will be no negative impacts on the quality and quantity of ground and surface water resources.
- The proposed methods of controlling or minimizing erosion and siltation on-site and downstream areas during and after construction.
- The stormwater management techniques which may be required to control minor and major flows.
- The proposed implementation of any Low Impact Development (LID) measures.
- Any other relevant matters pertaining to the strategy and as may be required by the City or external authorities.

The Stormwater Management Report shall also include overall grading plans for the subject lands.

In the absence of explicitly stated criteria from other studies or sources, the proponent shall consult with the City and any other relevant authorities having jurisdiction in order to establish criteria to be applied and the scope of analysis required to support a project's approvals.

1.3.1.10 [Roof Drains](#)

Roof Drains are to be discharged to the ground surface onto splash pads and flows to be directed away from the building and towards the road where possible and in such a way as to prevent ponding or seepage into the weeping tile.

Generally, roof drains are to be located at the front of the house and discharge at least 1 m past any high point on a split-draining lot such that the drainage from the entire roof is directed to the municipal road allowance rather than the rear yard.

Roof drains may be located at the rear of a building provided that the elevation and the design of a portion of the roof are such that the eaves cannot direct the rainwater to the front of the building or where subdivision design allows.

1.3.1.11 [Foundation Drainage](#)

Where a separate foundation drain collector is required, it shall be designed on the basis of a continuous flow rate of 0.075 litres per second per residential lot plus infiltration (to be calculated in accordance with 1.4.2.2). The minimum foundation drain collector diameter shall be 200 mm. Material and bedding standards applicable to storm sewers shall also be applicable to foundation drain collectors. The designer is responsible to locate the foundation drain collection system at a suitable location within the right-of-way, to the satisfaction of the City.

1.3.1.12 [Infiltration](#)

Where soils reports have identified that techniques such as lot level controls, infiltration trenches and perforated pipe systems are suitable, the implementation of such techniques shall be encouraged.

1.3.1.13 [Roads](#)

Road grading must direct flows from the right-of-way to a safe outlet at specified low points. Outlets can be walkways or open sections of roads leading to open spaces or river valleys. The overland flow route through walkways shall be captured and directed by the pipe system (100-year) to the stormwater management pond outlet. In the event that the proposed overland flow route is adjacent to the stormwater management pond and has low risk of flooding private properties, the City may consider allowing 1:25 year storm event and above be conveyed to the stormwater management pond via overland flow directly. Roads may be used for major system overland flow conveyance during the greater of the 100-year return frequency or regional storm subject to the flow depth constraints provided in Table 1-6.

Hydraulic analyses are to be conducted where traffic calming measures have the potential to impact the hydraulic capacity of the roadway in order to justify and support the stormwater management scheme.

Table 1-6 Overland Flow Depth Constraints

Location	Constraints
Open Spaces	As required for overland flow outlets
Local Roads	Maximum depth of ponding is 0.20 m above the crown of road and the water level up to the right-of-way
Collector Roads	Maximum depth of ponding is 0.10 m above the crown of road and the water level up to the right-of-way
Arterial Roads	Maximum depth of ponding/flow is to the crown of the road and the water level up to the right-of-way

To address the climate change controls, the maximum depth of ponding/flow for August 19, 2005 storm event is 0.3m above the gutter line and the water level should be retained within the right-of-way.

1.3.1.14 [Minimum Flood Protection](#)

Table 1-7 Minimum Flood Protection

Location	Constraints under 100-Year Storm Event
Private Property, Schools & Parkland	No structural damage No basement flooding Positive overland flow to outlets
Public Property	No structural damage No erosion

1.3.1.15 [Peak Flow Calculation](#)

Pre-development peak flows shall be computed by the Rational Method or by a unit hydrograph method as described in the MECP (formerly MOE) Guidelines and MTO Drainage Manual.

Post-development design flows shall be determined using the Rational Method only where the design area is less than 40 hectares and runoff control facilities are not considered. Computer models, as outlined in the Provincial Urban Drainage Design Guidelines shall be required in calculating major and minor systems flows for design areas greater than 5 hectares. The engineer is responsible for selecting the most appropriate model to suit the drainage study area.

When the Rational Method is used, the general format of the City's Standard Storm Sewer and Overland Design Sheets are to be used. When computer modelling is used, the report shall indicate model parameters, assumptions used, outflow hydrographs and hydraulic grade line levels where applicable, flow depths and spreads and any other pertinent information.

Where drainage from external areas is captured by a sewer system, the more critical case based on either the time of concentration including the external area or the time of concentration excluding the external area shall be used. Actual velocities of computed peak flows shall be used to estimate the time of concentration.

A design evaluation of inlet times must be submitted for prior approval if the design includes inlet times different from those specified above.

Where the Rational Method is used, the peak rate of runoff, Q , is calculated according to the equation $Q = RAIN$

Where $Q =$ flow in litres per second (L/s)

$R =$ runoff coefficient, dimensionless

- A = area in hectares (ha)
 I = average intensity in millimetres per hour (mm/h)
 N = conversion factor (where A is in hectares and I is in mm/h, then $N = 2.778$)

1.3.1.16 a) Rainfall Intensity

Rainfall intensity-duration-frequency (IDF) curves are provided Table 1-8. Unless otherwise required, design storm hyetographs shall be based on a 3-hour duration.

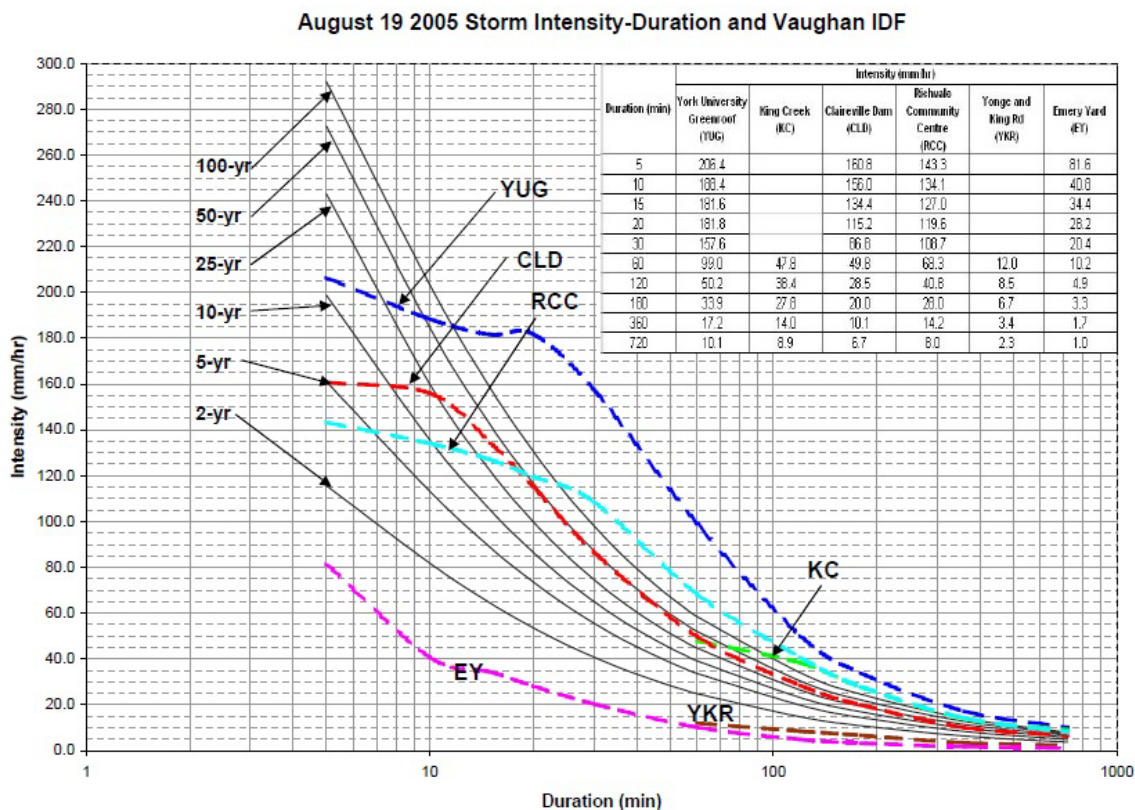
Table 1-8 Rainfall Intensity

Return Frequency	Intensity (T is time of concentration in minutes)
2 years	$I = 647.7 \times (T + 4.0)^{-0.784}$ mm/h
5 years	$I = 929.6 \times (T + 4.0)^{-0.798}$ mm/h
10 years	$I = 1021 \times (T + 3.0)^{-0.787}$ mm/h
25 years	$I = 1100 \times (T + 2.0)^{-0.776}$ mm/h
50 years	$I = 1488 \times (T + 3.0)^{-0.803}$ mm/h
100 years	$I = 1770 \times (T + 4.0)^{-0.820}$ mm/h

Where the first leg of a residential storm sewer system is sized using the Rational Method, the initial inlet time shall be 7 minutes for the 5-year return period storm. The above shall apply where the upstream drainage area does not include large open space or other areas for which overland flow times can be determined in accordance with the Airport Method or Bransby-Williams Method as discussed in the MTO Drainage Management Manual, or other suitable method to the satisfaction of the City.

b) Climate Change Adaptation

The Consultant shall use the IDF curve below prepared for August 19, 2005 storm event from the York University (YUG) rain gauge to model the ponding limit requirements.



1.3.1.17 [Runoff Coefficients](#)

The estimation of runoff coefficients is the responsibility of the engineer and is dependent upon land use and surface treatment for which Table 1-9 provides some guidance.

Table 1-9 Runoff Coefficients

Land Use	Runoff Coefficient for 5-Year Return Period Storm (R_5)
Residential <ul style="list-style-type: none"> Single family, semi-detached, duplex, triplex, quad 	Designer to calculate actual composite runoff coefficient Minimum = 0.50
Block Residential Development <ul style="list-style-type: none"> Block townhousing, stack townhousing, apartments 	Designer to calculate actual composite runoff coefficient Minimum = 0.65
Neighbourhood Commercial, Commercial Centre, Institutional	Designer to calculate actual composite runoff coefficient Minimum = 0.75
Infill Development	Site specific Designer to calculate actual composite runoff coefficient
Unimproved Open Space <7% Slope	0.25
Unimproved Open Space ≥7% Slope	0.30

Neighbourhood Park, Cemetery	0.45
District/Regional Park	0.75
Sodded Area	0.25
Paved and Gravel Areas	0.90
Roof Area	0.90

For estimating flows using the Rational Method from storms larger than the 5 year return storm the runoff coefficients should be increased to account for the increase in runoff due to saturation of the catchment surface. Coefficients for the larger storms can be derived as follows:

$$R_{10} = 0.8 \times R_5 + 0.2 \qquad R_{50} = 0.6 \times R_5 + 0.4$$

$$R_{25} = 0.7 \times R_5 + 0.3 \qquad R_{100} = 0.5 \times R_5 + 0.5$$

1.3.1.18 [Dual Drainage System Analysis](#)

A computerized hydrologic and hydraulic model is to be developed and used to conduct a dual drainage system analysis for developments greater than 5 ha in size, although smaller developments may require such analysis depending on receiving drainage systems (at the discretion of the City). In cases where drainage from the development is to discharge to existing systems, detailed modelling of such downstream systems may be required, at the discretion of the City. The analysis is to be fully documented, prepared and signed by a Professional Engineer.

1.3.2 Storm Sewer System Design

1.3.2.1 [Sewer Capacities](#)

Manning's Formulae shall be used to determine the capacity of the sewers:

$$Q = \frac{1}{n} A \times R^{\frac{2}{3}} \times S^{\frac{1}{2}} \quad \text{and} \quad V = \frac{1}{n} R^{\frac{2}{3}} \times S^{\frac{1}{2}}$$

where Q is the full flow capacity of the pipe (m³/s)

V is the full flow velocity in the pipe (m/s)

n is Manning's roughness coefficient (dimensionless)

A is the cross-sectional area of the pipe (m²)

R is the hydraulic radius of the pipe (i.e., cross-sectional area ÷ wetted perimeter; m)

S is the slope of the pipe (i.e., slope of hydraulic grade line when flowing full; m/m)

For concrete or polyvinyl Chloride (PVC) sewer pipe a roughness coefficient (n) of 0.013 shall be used. For corrugated pipe a roughness coefficient (n) of 0.024 shall be used.

1.3.2.2 [Velocity Constraints, 5-Year Return Period Design Storm Condition](#)

- For storm sewers, the minimum velocity shall be 0.75 m/s based on actual flow depth and the maximum velocity shall be 5.0 m/s under full flow conditions.

- Energy dissipators at outlets shall be designed to reduce velocities to 1.0 m/s or lower.
- Sewers must be self-cleansing.

1.3.2.3 Hydraulic Losses at Maintenance Holes

A sufficient drop shall be provided across each maintenance hole to offset any hydraulic losses, the obverts of inlet pipes shall not be lower than obverts of outlet pipes, and drop structures shall be used only when drops of more than 0.6 metres are necessary. Calculations for hydraulic losses shall be included with storm design information.

1.3.2.4 Layout Details

1.3.2.4 (a) Trunk and Local Sewers

1.3.2.4 (a) (i) MINIMUM SIZE - The minimum diameter of storm sewers shall be 300 mm.

1.3.2.4 (a) (ii) LOCATION - Storm sewers shall generally be located 1.5 metres west or south of the road center line in separate trench or in a common trench. The minimum horizontal clearance between the outside wall of the adjacent sewer pipes shall be 800 mm. On crescent roads or roads with numerous bends, the sewer position may generally follow the same relative side of the road allowance.

1.3.2.4 (a) (iii) DEPTH - A minimum depth of 1.2 metres to the top of pipe from the finished road or ground surface elevation, or a sufficient depth for any foundation drains or other connections shall be provided.

1.3.2.4 (a) (iv) CLEARANCES - Minimum clearances between services shall be provided in accordance with MECP guidelines.

1.3.2.4 (a) (v) ALIGNMENT - Storm sewers shall generally be straight aligned between maintenance holes, however, curvilinear alignment through deflected sewer pipes or deflection at joints within the manufacturers specifications are permitted for sewer pipes (675mm dia. And above) with the approval of the City.

1.3.2.4 (b) Maintenance holes

1.3.2.4 (b) (i) LOCATION - Maintenance holes shall be placed at the top end or dead end of a sewer line or where changes in size, material, alignment, or grade occur.

1.3.2.4 (b) (ii) SPACING - The maximum spacing between maintenance holes shall generally be according to the following:

Table 1-10 Storm Sewer Maintenance Hole Spacing

Sewer Diameter	Distance (m)
200 to 900 mm	110
≥ 975 mm	180

1.3.2.4 (b) (iii) DROP MAINTENANCE HOLES - Drop maintenance holes shall be sized in accordance with OPSD 1003.010 or OPSD 1003.020 and provided for all sewer junctions having an elevation difference in excess of 0.6 metres that cannot be eliminated by changing sewer grades.

- 1.3.2.4 (b) (iv) MAINTENANCE HOLE COVERS - Where a maintenance hole is located in stormwater detention or flood plain areas the maintenance hole frame & cover shall be of the sealed variety. Where a maintenance hole is located where the surcharged sewer design hydraulic grade line is higher than the rim elevation, maintenance hole covers shall be the perforated type and shall be anchored as per Section 1.4.4.4. In all other areas standard maintenance hole covers shall be used. Covers should state "STM" or "FDC", as applicable.
- 1.3.2.4 (b) (v) TYPE – Maintenance holes shall be cast in place or precast concrete in accordance with all applicable OPSD and OPSS requirements.

Integrated / telescopic frame and cover maintenance hole systems shall be used for the following applications:

- sewer system and/or maintenance hole rehabilitation programs
- asphalt resurfacing and/or roadway reconstruction/renewal programs
- new developments

For sewer system/maintenance hole rehabilitation programs, asphalt resurfacing programs, and roadway reconstruction/renewal programs, necessary adjustment units for maintenance hole frame and covers shall be fabricated from a single precast concrete riser section (minimum height of 150mm). Stirrups are to be doweled to the existing concrete maintenance hole, around the single precast concrete riser section. A temporary (circular) form shall be placed around the single precast concrete riser section and pre-mixed non-shrink grout shall be applied between the riser section and the form. A telescopic frame and cover system that can be integrated within the final asphalt surface shall be used with a minimum material guarantee of 25 years to be extended by the manufacturer.

For new developments, a single precast concrete riser section (minimum height of 300mm) shall be used within a precast concrete maintenance hole tapered top that can accommodate the riser section. A pre-mixed non-shrink grout shall be used between the single precast riser section and the tapered top section. A telescopic frame and cover system that can be integrated within the final asphalt surface shall be used with a minimum material guarantee of 25 years to be extended by the manufacturer.

Precast Concrete Modular Adjustment Units for Maintenance Holes

The use of precast concrete modular adjustment units is generally not permitted. However, exceptions (generally up to two adjustment units) may be allowed on a case-by-case basis subject to the approval of the City to facilitate adjustments for placement of surface course asphalt only. Precast concrete modular adjustment units shall be mortared and parged using pre-packaged non-shrink grout (per ASTM C1107).

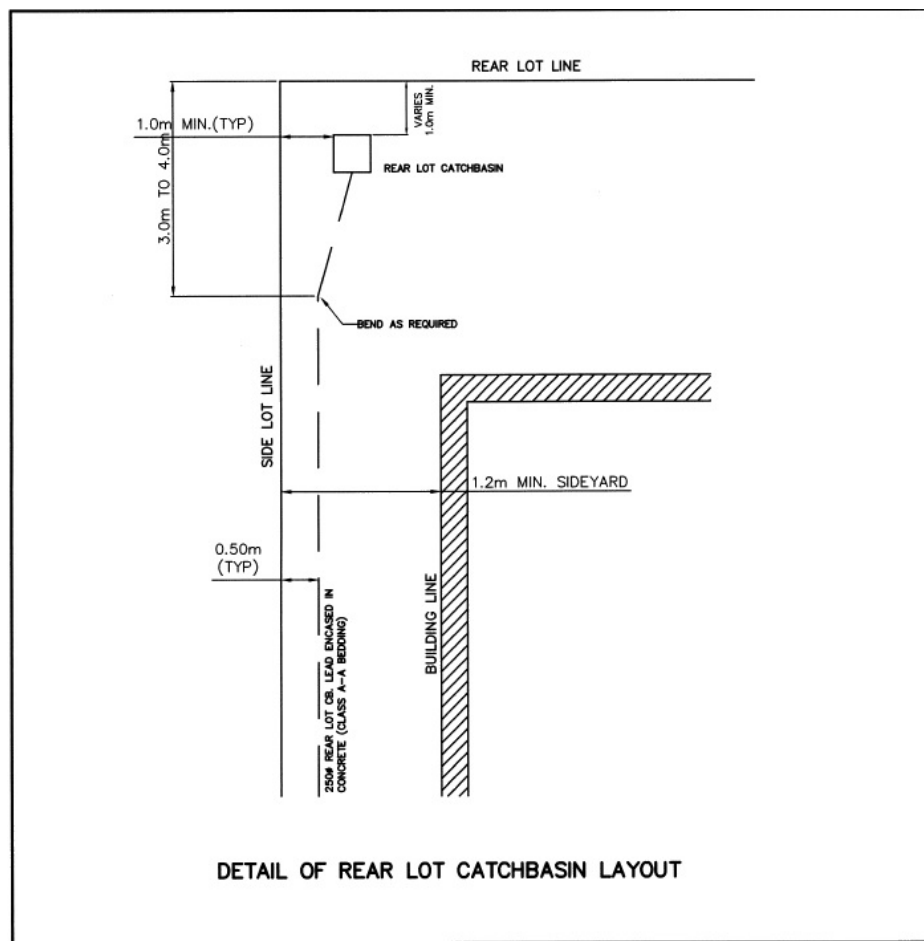
- 1.3.2.4 (b) (vi) BENCHING – Benching of maintenance holes shall extend to obvert (top) of pipe.
- 1.3.2.4 (c) Catchbasins
- 1.3.2.4 (c) (i) LOCATION - Upstream of pedestrian crossings and not within 1.0 m of curb depressions and residential driveways. Double catchbasins required at all low points and at any other locations where determined by Consulting Engineer when applying the principles of dual drainage system design.

- 1.3.2.4 (c) (ii) TYPE – Catchbasins shall be in accordance with Standard Drawing S-104, with OPSD 400.010, OPSD 400.010, OPSD 400.020 or OPSD 400.110 frame and grate (to be selected in consultation with the City). Side inlet catchbasin is permitted for collector road with the approval of the City. Side inlet catchbasin shall be designed and constructed in accordance with Standard Drawing S-108 and the associated OPSD & OPSS details.
- 1.3.2.4 (c) (iii) SPACING – Catchbasins should be provided at adequate intervals to ensure that the road drainage can be intercepted up to the capacity of the storm sewer. The spacing will vary with the road width, grade and crossfall and with the design storm frequency. The spacing will also be affected by the location of pedestrian crossing points, intersections, low points, driveway depressions, etc. In general, for pavement width up to 9.8 m with two per cent crossfall, the maximum spacing should be as indicated in Table 1-11 Catchbasin Spacing. Stormwater management systems using inlet control catchbasins may use less frequent spacing than those listed and, in such cases, the designers must justify whatever spacing is used

Table 1-11 Catchbasin Spacing

Road Gradient	Maximum Spacing
0.5% to 3%	107 m
3.1% to 4.5%	90 m
over 4.5%	75 m

- 1.3.2.4 (c) (iv) LEADS - Minimum 250 mm at 0.7% grade for single catchbasins and 300 mm at 0.7% grade for double catchbasins. Leads shall connect to maintenance holes where possible. Where catchbasins are designed for inlet controls, lead sizes down to 150 mm for singles or doubles can be used where such sizes will limit flows to the gravity capacity of the sewer system and surface flow does not exceed the maximum ponding depth on roads. Orifice plates are not permitted to be used as control devices. The City will only allow low head inlet control devices that will be easy to maintain.
- 1.3.2.4 (c) (v) REAR YARD CATCHBASINS – Shall be sumpless. The rear yard catchbasin lead shall be a minimum 250 mm diameter, with concrete encasement bedding to a minimum of 150 mm above the pipe and extending from the catchbasin to the curb line (not streetline) and normal bedding elsewhere, all as per applicable OPSD details. To be located so that the catchbasin is entirely on one lot and the outlet pipe is on the same lot. The rear lot catchbasin shall only be placed on a residential lot provided that the stormwater runoff from that rear lot is tributary to the rear lot catchbasin. The catchbasins shall be located 1.0 m clear from property lines. A minimum horizontal separation between rear yard catchbasin leads and street furniture (hydrants, streetlights, etc.) of 1.0 m (centre-to-centre) and a minimum 1.0 m clearance from the property line shall be maintained at all times. Refer to Standard Drawings S-103 and S-105.



- 1.3.2.4 (c) (vi) PARK CATCHBASINS – Storm drainage inlets (e.g., catchbasins, interim ditch inlets, etc.) shall be located a minimum of 5 metres away from all property lines.
- 1.3.2.4 (d) Sewer Materials
- 1.3.2.4 (d) (i) Polyvinyl chloride (PVC) pipe and pipe joints shall conform to the following standards:
1. 100 mm – 150 mm diameter: CSA B182.1, ASTM D3034, Min. DR 28
 2. 200 mm to 375 mm diameter: CSA 182.2, ASTM D3034, Min. DR 35
 3. > 375 mm (Max. 450 mm) diameter: CSA 182.2, ASTM F679 (T-1), Min. DR 35
- 1.3.2.4 (d) (ii) Concrete pipe and pipe joints shall conform to the latest revisions of OPSS 1820, CSA A257.3 and the following standards:
1. Non-reinforced concrete pipe: CSA A257.1, ASTM C14
 2. Reinforced concrete pipe: CSA A257.2, ASTM C76, ASTM C655
- 1.3.2.4 (d) (iii) PVC Profile Pipe (e.g., Ultra-Rib) – Not permitted.
- 1.3.2.4 (e) Bedding Materials.
- 1.3.2.4 (e) (i) Bedding type selection shall be based on depth of sewer, sewer material, trench width and configuration and soil conditions in accordance with OPSS and OPSD.
1. PVC pipe: bedding and cover material conform to OPSS 1010 Granular A and recycled materials are not permitted.

2. Concrete pipe: bedding material shall conform to OPSS 1010 Granular A and recycled materials are not permitted. Cover material shall be mortar sand conforming to OPSS 1010 Granular D.
- 1.3.2.4 (e) (ii) High Performance Bedding (HPB) is not an acceptable bedding material except in constrained installations where proper placement and compaction of granular bedding is not possible and as specifically directed by the City. Any requests for HPB are to be supported with a geotechnical engineer's justification.
 - 1.3.2.4 (e) (iii) Pipe loading calculations shall accompany the design submission. Selected native backfill may be used with the approval of the City.
 - 1.3.2.4 (f) Service Connections
 - 1.3.2.4 (f) (i) Service connections are to be in accordance with City Standard Drawings C-101, C-102, C-104 and all applicable OPSD details. For greater clarity where applicable, sewer service connections for flexible main pipe sewer shall be installed in accordance with OPSD 1006.020 with a maximum 45° angle of connection at the main and the pipe colour shall only be white for storm service connections. In addition, temporary end caps shall state "STM" or "FDC" for foundation drain collector or "CWC" for clean water collector. Sewer service connections to rigid main pipe sewer shall be installed in accordance with OPSD 1006.010.

For connections to existing sewers, circular coring and adapted fittings per manufacturer specifications are to be employed and as approved by the City.
 - 1.3.2.4 (f) (ii) Adjacent lots with greater than 0.2 m basement elevation differences shall not be serviced by double lot storm sewer service connections.
 - 1.3.2.4 (f) (iii) Service connections shall be installed to the centre of the primary frontage of the park block or as otherwise specified by the City, in accordance with City Standard Drawings and all applicable OPSD details.
 - 1.3.2.4 (f) (iv) Service connections are to be installed on the main sewer lines, wherever possible.
 - 1.3.2.4 (f) (v) In re-development applications, existing service connections can be reused subject to a condition assessment including, but not necessarily limited to, CCTV inspection to the satisfaction of the City. Any obvious occurrences of root intrusion, displaced joints or other physical defects will require replacement with a new connection, at the discretion of the City. Any re-development applications servicing more than one (1) unit on a single property must have a control maintenance hole in accordance with Standard Drawing C-102.
 - 1.3.2.4 (f) (vi) For low-rise residential re-development, existing service connections may only be reused on a 1-for-1 basis with respect to the number of units serviced (i.e., number of units draining to service connection under re-development scenario cannot exceed the number of units previously draining thereto), subject to satisfactory condition assessment.

1.3.3 Testing & Inspection

1.3.3.1 General

- 1.3.3.1 (a) CCTV inspections are to be carried out by City forces at the cost of the Owner prior to acceptance of the storm sewer system by the City. Additional inspections may be required as determined by the City, prior to placing top course asphalt and assumption of the service.
- 1.3.3.1 (b) Deflection testing of thermo-plastic sewer pipes is required and shall be conducted in accordance with OPSS 410.07.16.05.

- 1.3.3.1 (c) Exfiltration tests, where required by the City, shall be conducted in accordance with OPSS 410.07.16.04.
- 1.3.3.1 (d) A representative of the City is required to be present during any testing of services.

1.3.3.2 Cracked Sewer Service Connection Tee Fittings

- 1.3.3.2 (a) Any cracked service connection tee fittings discovered during CCTV inspections shall be repaired to the satisfaction of the City.
- 1.3.3.2 (b) In cases where top asphalt is not in place, the cracked sewer service connection tee fitting shall be excavated, removed and replaced.
- 1.3.3.2 (c) In cases where top asphalt has been placed, and subject to the approval of the City:
 - 1.3.3.2 (c) (i) The cracked sewer service connection tee fitting may be repaired by means of a tee liner or other suitable trenchless technology approved by the City in accordance with City policy.
 - 1.3.3.2 (d) In cases where top asphalt has been placed and it has been determined by the City that the sewer service connection tee fitting cannot be adequately repaired by installing a tee liner or other acceptable trenchless technology, then it shall be excavated, removed and replaced.

1.3.4 Decommissioning

1.3.4.1 Service Connections

Service connections shall be decommissioned by cutting and capping/plugging the connection at the main line and filling in any abandoned sections with a grout, lean concrete mix or other suitable material which must be approved by the City.

1.3.4.2 Maintenance Holes

Any sewer openings to the maintenance holes (MHs) are to be plugged from within the MH, the cone section of the MH is to be removed and the MH is to be filled with sand prior to backfilling and restoration of the surface.

1.3.4.3 Sewer Lines

Any abandoned sewer lines are to be plugged at the ends and filled with a grout, lean concrete mix or other suitable material which must be approved by the City's Environmental Services Department.

1.3.5 Stormwater Management Facilities

Stormwater management facilities shall be designed to provide an effective and efficient method of pollutant removal, peak flow control, augment the effectiveness of source and conveyance controls for both the major and minor systems. Stormwater quality controls shall be implemented to mitigate the impact of increased sediment and pollutant loadings, temperature changes, base flow reductions, habitat changes and ground water effects on the receiving watercourse.

End-of-pipe quality control facilities should only be considered for developments greater than five hectares where source controls are impractical. Financial contributions in lieu of implementing additional quality treatment will be considered for areas where the City has identified future storm water management enhancement projects. End-of-pipe quality control facilities are typically considered for developments greater than five (5) hectares where source

controls are impractical. For developments less than five (5) hectares, quality control measures such as, but not limited to low impact development (LID) measures and oil-grit separator (OGS) must be considered.

Where a stormwater management facility is required, it shall be located on lands conveyed to the City by the landowner free of charge and encumbrances. Lands designated for a stormwater management facility should not be considered part of the full parkland dedication.

These guidelines for the design of stormwater management facilities in the City shall be considered supplementary to the latest versions of the MECP Stormwater Management Practices Planning and Design Manual and the TRCA Stormwater Management Criteria.

1.3.5.1 [General Urban Design Guidelines](#)

Stormwater management ponds shall be designed to encourage safe public access and shall be integrated as positive and safe amenities within the community, natural open space and/or trail systems. This can be achieved by consolidating the ponds into larger facilities, thereby creating a larger attraction for the community while also minimizing on-going maintenance costs. The objective of creating few, well-designed community ponds will assist in greater concentration of use as well as provide a public focus and opportunities for passive use by surrounding community.

Stormwater ponds should include as much public exposure as possible. The street pattern should also contain significant frontage of the pond facility onto the adjacent streets and promote views and reinforce their focal nature within the community.

A stormwater management pond area fronting onto an arterial road should be designed as a community entrance or gateway. A formal urban landscape architectural style should be used along the streetscape edge. An attractive, inviting gateway feature at the intersection of two roads should be used to enhance the profile and visibility of the gateway. Where a stormwater management facility abuts a road, it is necessary for the first 6 to 8 metres of the pond block to have a maximum 7:1 slope with a more urbanized/manicured landscape treatment to better blend into the community streetscape character.

In order to reinforce their role as important community features, engineered structures associated with the design of stormwater management ponds should be attractive as well as functional. This may involve using highly textured, irregularly-shaped natural landscape materials such as armour stone and ledgerock (instead of concrete), in the design/construction of headwalls and energy dissipators. It may also involve ornamental fencing around headwalls and/or lockable ornamental grates to cover the opening of outfall pipes. Fencing around headwalls should be heavily screened with plant materials to reduce negative visual impacts.

Stormwater management ponds should be designed as passive recreation/open space areas and as visual amenities for the community at large. They should also be designed as natural features in an urban context. This involves using landscape design and construction techniques that enhances natural structures and processes including overland flows, infiltration, floral and faunal habitat/migration, and a strong vertical structure and deep edge for vegetative rehabilitation. Safety considerations in these areas include gradients, slope stability and restricting public access to high flow areas.

Stormwater management ponds should be designed to provide a reasonable level of safety. This involves engineering, grading and landscaping issues associated with the storm pond system.

The success of stormwater management ponds as important community features depends in large part on their visibility from local and arterial roads. This involves creating long-distance vistas to the pond from local, arterial and scenic roads. It also involves creating short-distance views, to enhance the experience of pedestrians and bicyclists in the open space area.

Permanent pools should be designed with the intent of enhancing visual interest and reducing stagnant water. This may involve creating interesting views, vistas and perspectives from public roads abutting the stormwater

management pond area and from different locations within the site. It may involve varying the edge of ponds with different hard/soft landscape materials. It may also involve different geometric shapes for the pond edge. Soft curves in a serpentine shape are recommended because they lend themselves well to the creation of retention ponds, sediment forebay inlets and overflows.

Consideration should be given to reducing maintenance and restricting public access to the pond edge, while simultaneously enhancing visual diversity, interest and safety. Logs, stone, emergent plant species, and a variety of other hard and soft landscape materials may be employed to achieve this.

The following sub-sections discuss the features for ponds for two hierarchical levels: Community Gateway Focus; and Open Space.

1.3.5.1 (a) Community Gateway Focus Ponds

- Architectural and/or landscape features should be used to enhance stormwater management ponds as important components of community gateways. These special features may include but are not limited to arbors, gazebos, footbridges, lookouts, upgraded signage, seating areas and community mailbox kiosks. The palette of colours, design forms and materials of these elements shall be co-ordinated with the community streetscape character.
- As a general objective, 50% of the total linear pond perimeter should be bounded by a public road right-of-way, public park, or combination of publicly owned and accessible lands however, not directly adjacent to school sites. Safe access to the perimeter of ponds should be examined on a site-by-site basis. Stormwater management ponds should have a significant amount of public exposure through a combination of pond edge treatments.
- The type of feature selected should depend on pond size, pond location, and other site-specific conditions including proximity and visibility from the public streets.

1.3.5.1 (b) Open Space Ponds

- Stormwater ponds that are located within or adjacent to designated open space lands should be designed to support and encourage public use of natural features for a variety of low-intensity activities while minimizing any negative environmental effects.
- All open space storm ponds shall be designed to respect existing grades and contours by providing gradual slopes and natural transitions.
- Natural materials and methods should be used in the design of open space stormwater management ponds. This may include elements such as limestone or granite rock, plant materials with fibrous root systems to stabilize slopes, plant species that can trap toxic and particulate matter and other appropriate bio-engineering techniques.
- Stormwater management ponds should be designed as focal features in naturalized open space areas. Landscape features should be incorporated to provide an aesthetically pleasing environment as well as restricted access to ponds. This may include terraces, gazebos and seating along the perimeter of storm ponds. It may also include raised viewing platforms along the edge of ponds or incorporated in the design of community mailbox areas.

1.3.5.2 Temporary Stormwater Management Facilities

In situations where the ultimate downstream infrastructure or a stormwater management facility is not available, the City will consider the use of a temporary facility. All temporary facilities shall be designed to meet the same guidelines that are applied to permanent facilities. Temporary facilities will not be assumed as municipal services by the City. The Developer shall be responsible for the operation and maintenance until the ultimate facility is constructed.

1.3.5.3 [Emergency Overflow Spillway](#)

Each facility shall be designed with an emergency overflow spillway to allow storm drainage to safely exit the facility in the event that the outlet fails to function or the storm event is greater than the facility's designed capacity. The spillway shall be designed to convey the highest design inflow rate of the facility, while maintaining a minimum 0.3 metre freeboard around the perimeter of the facility.

1.3.5.4 [Facility Storage Requirements](#)

Storage volume requirements for permanent pool, quality control and extended detention shall be based on criteria established in the Stormwater Management Planning and Design Manual, the TRCA's Stormwater Management Criteria, or site specific requirements as established in an approved Master Environmental Servicing Plan, Master Drainage Plan, City-Wide Storm Drainage & Stormwater Management Master Plan or as otherwise established by the City, TRCA or other relevant authorities with jurisdiction.

1.3.5.5 [Outfalls](#)

Outfall structures to proposed stormwater management facilities or existing channels or watercourses shall be designed to prevent erosion or damage in the vicinity of the outfall from maximum design flows. All outfall structures shall be accessible by maintenance equipment. The structures must be designed to stop unauthorized entrance and have appropriate handrails. Insofar as possible, outfall structures shall be designed and constructed to blend in with the surroundings so as not to dominate the landscape.

A geodetic monument shall be established on the top of the concrete headwall or other appropriate location on the structure to assist in future water level monitoring. The monument shall have horizontal and vertical control.

1.3.5.6 [Facility By-Pass](#)

A by-pass pipe or channel shall be provided to redirect flows around the facility during maintenance. The by-pass shall be designed to convey the peak flow from a 2-year return period storm event and in accordance with the Stormwater Management Planning and Design Manual ("Maintenance By-pass" in Section 4.7 of 2003 edition).

1.3.5.7 [Maintenance Access Routes & Pedestrian Trails](#)

Dual-purpose roads should be designed where maintenance roads coincide with pedestrian trails/pathways. Dual-purpose roads should be constructed of limestone screening with a stabilizing/binder agent, to accommodate vehicles and pedestrians (Urban Design Division Standard Drawing ULA 305).

Controlled maintenance access roads are required to the sediment forebay and all inlet/outlet and emergency overflow spillway structures of the stormwater management facilities. The maintenance access road shall be of turfstone or granular dust free surface (or City approved alternate) to provide for all-weather ingress and egress with a minimum width of 4.0 metres and a maximum grade of 12%. Access roads as wide as 6.0 metres may be required to provide for large trucks, as determined by the City's Environmental Services department at the detailed review stage. Curves on an access road shall have a minimum centreline radius of 12.0 metres.

Where these access roads are in high profile locations or within the mow strip zone, a specialized surface treatment is to be used which results in a turf appearance.

A minimum of two removable bollards (Urban Design Division Standard Drawing ULA 407) shall be designed and placed at all locations where the maintenance access road outlets to a municipal right of way to the satisfaction of the City's Environmental Services Department.

In the event that a pedestrian trail is located within a storm pond block, the trail should be constructed above the maximum extended detention elevation or 100-year return frequency ponding elevation, whichever is greater.

Trails shall be 3.0 metres wide and constructed of a granular dust-free stonedust surface or other suitable material. However, in locations where a pond abuts a community street or arterial road, the City may require another surface material such as stabilized stonedust, asphalt or concrete.

A 3.0 metre safety zone shall be provided on either side of the trail. A safety zone shall be interpreted as a space where sightlines are preserved and does not have entrapment zones. The maximum slopes of the safety zone shall be 3:1 above the trail and 6:1 below the trail. This zone shall be planted with low ground covers to the satisfaction of the City.

See 1.3.5.18 for planting guidelines for Pedestrian Trails.

1.3.5.8 [Configuration and Grading](#)

The grading and landscaping near the pond edges is to be designed to ensure public safety and to maximize the functionality of the pond. Terraced grading (e.g., a section graded sequence of 7:1, 3:1 and finally, 7:1) shall be implemented along the pond edges, specifically adjacent to the permanent pool, to minimize the potential for the public to fall into the pond.

Stormwater management facilities shall be designed to have a curvilinear and natural configuration with a minimum length-to-width ratio of 3:1 and varying side slopes between 3:1 and 7:1 with an average slope of 5:1, subject to the provisions of Table 1-12 Stormwater Management Facility Design. Natural materials such as ledgerrock and armour stone may be used to create naturalized facilities.

Retaining walls are not permitted in stormwater management facilities for purposes of making up grade differentials, however, they are permitted if used for aesthetic purposes and, in which case, the exposed bottom of the retaining walls must be situated at least 0.3 m above the 100-year high water level in the facility.

Table 1-12 Stormwater Management Facility Design

Design Element	Wet facility	Wetland facility
Permanent Pool	Generally 1.0 to 2.0 metres, although additional depth may be required (e.g., up to 3.0 m) for thermal mitigation.	0.15 to 0.3 metres
Maximum Extended Detention Storage above the permanent pool water level	1.0 metre	1.0 metre
Maximum Quantity Control Storage above the permanent pool water level	2.0 metres	2.0 metres
Maximum Depth of Water	4.0 metres (or 5.0 m if permanent pool depth is 3.0 m)	3.0 metres
Minimum Freeboard above maximum water level	0.3 metres	0.3 metres
Side Slopes	5:1 slope from the bottom of the facility for a minimum distance of 3.0 metres past the extended detention upper water limit; 5:1 average slope elsewhere.	5:1 slope from the bottom of the facility for a minimum distance of 3.0 metres past the extended detention upper water limit; 5:1 average slope elsewhere.

The main cell of the facilities shall have a minimum 150 mm depth stone layer composed of 50 mm crusher-run limestone to mark for pond bottom for future maintenance.

1.3.5.9 [Sediment Forebays](#)

Forebays are required for all storm water management facilities. The permanent pool depth shall range between a minimum depth of 1.0 m to a maximum depth of 1.5 m in which a maximum depth of 0.5 m shall be used for sediment accumulation. Forebays shall not exceed 33% of the total Wet Pond surface area. All access to forebays should be discouraged through dense landscape plantings, excluding maintenance access routes. The configuration of the facility forebay shall also provide a minimum length to width ratio of 2:1. The base of the sediment forebay shall be treated with a hard surface (e.g., 150 mm depth stone layer composed of 50 mm crusher-run limestone or other alternative approved or otherwise required by the City) to facilitate future maintenance and the removal of sediments.

1.3.5.10 [Reverse-Sloped Pipes](#)

The invert of any reverse-sloped pipes must be a minimum 0.5 m above the pond bottom.

1.3.5.11 [Berming](#)

Berming within facilities shall be designed with a minimum top width of 2.0 metres with 3:1 maximum side slopes.

1.3.5.12 [Transition between SWM Facilities and Urban Land Uses](#)

A minimum setback of either 15 metres from the 5-year stormwater elevation in the facility or 3 metres from the 100-year stormwater elevation, whichever is the greater, shall be provided to the nearest pond block boundary.

1.3.5.13 [Mow Strip](#)

A three metre wide sodded mow strip with a maximum crossfall grade not exceeding 5% is required along the perimeter of the stormwater management facility blocks where they abut residential, commercial or industrial development.

1.3.5.14 [Fencing & Safety Barriers](#)

Safety barriers around stormwater management ponds may be required particularly on sites with steep slopes. They may consist of fencing, bollards, stone and/or other materials/structures deemed appropriate in terms of visual impacts, existing site conditions and functional requirements. If required, safety barriers should be located on the crest of slopes, to ensure they are seen and recognized as restraint structures. When a stormwater management pond abuts a park, with or without steep slopes additional fencing/ barrier shall be required.

Safety barriers along single loaded roads shall be in accordance with the Geometric Design Guide for Canadian Roads and should be incorporated in screen plantings to reduce their negative visual impact on the community streetscape. Safety barriers should not obstruct sight lines along the main view corridors into a storm pond.

Hard fencing (e.g., chain link, wood, decorative metal, etc.) defeats the functional purpose of natural stormwater management pond systems because it impedes wildlife migration. It also defeats their aesthetic purpose because it conflicts with the informal character many users associate with naturalized areas. Alternative boundary-defining and access-controlling features, including “green” fencing and massed plantings, should therefore be used in the design of natural stormwater management areas.

Notwithstanding the foregoing, fencing of rear and/or flanking private property lines and school sites is required. A 1.5m high black vinyl fence abutting stormwater management pond areas is required in such cases and shall be designed in an informal style/character to ensure visual “fit” with adjacent naturalized areas. Where walkways, commercial and institutional blocks abut stormwater management facilities, the City may require that a 1.8 metre high privacy wood fence be installed in lieu of the 1.5 m chain link fence, determined on a site specific basis.

A no-gate and no-encroachment policy for fences along adjacent property lines (regardless of land use) shall be strictly enforced.

Fences shall be installed in accordance with Standard Drawing FRW-106.

1.3.5.15 Safety (Life Saving) Stations

Safety stations (Standard Drawing S-107) shall be implemented in stormwater management facilities in accordance with the following:

- A minimum of two (2) safety stations per every 200m throughout the facility and spaced 200 m apart;
- A minimum of one (1) safety station is required for each road frontage to a facility; and
- A minimum of one (1) safety station is required for each entry/access for pedestrian trails.
- Safety stations are preferred to be located above the 100-year return frequency water level.

1.3.5.16 Signage

1.3.5.16 (a) Pond Naming and Warning Signage

Pond name signs (Standard Drawing S-106) are required in accordance with the City's naming procedure. All stormwater management ponds shall include a minimum of 2 warning signs in accordance with Standard Drawing S-106, located generally at all public access points into a pond. However, additional signs may be necessary in some pond facilities as required by the City.

1.3.5.16 (b) Pedestrian Access Routes

Pedestrian access routes shall include signage that identifies that no trail maintenance will occur during the winter.

1.3.5.16 (c) Pedestrian Scale Signage

1.3.5.16 (c) (i) Stormwater management ponds that include pedestrian/bicycle trails shall incorporate signage that identifies the designated routes, significant features and promotes the community image.

1.3.5.16 (c) (ii) Large Community Identity Sign Boards (Urban Design Division Standard Drawings ULA 410 and ULA 411) shall be located at all pedestrian entrances into a pond facility, they should include the following design requirements:

1. The signage material shall be a porcelain coated steel product set on a powder coated steel frame and 3.5" diameter posts with stainless steel carriage bolt hardware;
2. The identification format shall provide an overall map of the storm pond, that includes an overall trail route of the community open space system;
3. The sign shall identify user types and regulations in addition to information about the facility; and
4. The City of Vaughan logo shall be identified along the bottom of the sign with the appropriate colour scheme.

1.3.5.16 (c) (iii) Small directional post markers shall be used primarily for directional information at strategic locations along the storm pond trails including intersections, they should include the following design requirements:

1. The post marker shall be constructed of 150mm × 150mm western red cedar with a maximum of 3 prefabricated metal flashings per post;
2. The post marker should have an overall height of 1.2 metres with a 0.5 to 1.0 metre setback off the trail edge; and

3. The post marker shall include flashings that identify directional arrows, trail identification and City logo.

1.3.5.16 (d) Engineering Specifications

1.3.5.16 (d) (i) Lateral Bearing Pressure

Geotechnical engineer to certify sign installation depth based on lateral bearing pressure of soil, differentiating between native and fill conditions, accounting for the topsoil thickness (see 1.3.5.17) which shall be considered devoid of structural strength, accounting for the geometry of the sign and a wind pressure of 30 psf.

1.3.5.16 (d) (ii) Other Issues

In cases where the stormwater management facility is designed with a concrete base, sufficient distance is to be maintained between the concrete structure of the facility and the concrete foundation of the sign such that there is no interaction of forces between these structures.

In cases where the stormwater management facility is designed with natural soil conditions, sufficient distance is to be maintained between the facility and the concrete foundation of the sign such that water saturation in the soil surrounding the sign base is avoided.

In all cases, a minimum 6 m (20 ft) clearance is required between the sign and the facility.

- 1.3.5.16 (e) In cases of Trail interruptions as a result of new construction, the Developer shall provide appropriate signage or barricades at point of interruption. The signage or barrier should be to the City's satisfaction and should inform and prevent the use of the trail from that point.

1.3.5.17 Topsoil

Topsoil within the entire stormwater management block (with the exception of the maintenance access road), outside the permanent pool, is to be a minimum of 300 mm in depth. Testing of the topsoil will be required to the satisfaction of the City.

1.3.5.18 Landscape Plantings & Groundcovers

All slopes from the permanent pond elevation to the property line (not including walkways, trails or maintenance access routes) shall be planted. Incorporating a wide range of slopes and ponding depths into a stormwater management facility is encouraged in order to facilitate a wide range of flora and fauna habitat conditions.

Plant material shall be provided to reinforce the edge between the maintained and low maintenance zones. Plantings shall also be provided to buffer or screen views to significant engineering structures such as outfall weirs, headwalls, siltation forebays, service access roads, adjacent industrial lands and for safety purposes. The use of large clusters of coniferous trees immediately adjacent to street frontages are not recommended due to pedestrian safety concerns related to visibility from the street. Aquatic plants are to be planted throughout the pond while allowing for infill over a reasonable period of time.

The density of shrub planting, for safety purposes, shall vary depending on the degree of slope. Shrub planting shall prevent public access on all 3:1 slopes.

Deciduous trees should be planted at a minimum distance of 1.5 m from the edge of pedestrian trails. Maintenance is required to ensure that canopies are raised to a minimum of 2.2 m and shrubs must be regularly prevented from naturalizing this zone. The planting of coniferous trees within this zone is not permitted.

- 1.3.5.18 (a) Native species should be used in all stormwater management pond areas to enhance their visual and functional integrity. The planting strategy for these areas can be divided into six zones based on average water depth and soil moisture content, noting that the first five zones correspond with

the guidelines provided in the TRCA Stormwater Management Criteria and the MECP Stormwater Management Planning and Design Manual, while the sixth zone is distinct and customized for any urban edges to such facilities.

1.3.5.18 (a) (i) Deep water areas (submergent vegetation)

Wet ponds are comprised of mostly deep-water areas.

1.3.5.18 (a) (ii) Shallow water areas (submergent vegetation)

Shallow water areas involve permanent pools which are less than or equal to 0.5 metres deep. They are usually located around the perimeter of wet ponds. Shallow water vegetation should be selected on the basis of several objectives including nutrient uptake, stormwater filtration, user safety and the enhancement of pond aesthetics. It should also be selected on the basis of providing ancillary benefits such as preventing the re-suspension of bottom sediments and reducing flow velocities which promote sedimentation.

1.3.5.18 (a) (iii) Extended detention or shoreline fringe areas (hardy grasses and shrubs)

Shoreline fringe areas are delineated by the land between the permanent pool and high water mark (extended detention storage) for erosion/water quality control, therefore, these areas are subject to frequent wetting. They are also subject to higher soil moisture conditions caused by water level fluctuations during peak storm events and the continued influence of the permanent pool during dry weather conditions.

The planting design objectives for shoreline fringe areas are similar to those for shallow marsh areas. The growing conditions in fringe areas are, however, harsher due to frequent wet/dry cycles. For this reason, special attention should be paid to the selection of appropriate hardy, grasses and shrubs and to soil wetness during implementation to ensure that plant materials become properly established.

1.3.5.18 (a) (iv) Flood fringe areas (grasses, trees and shrubs)

If the wet pond is to control peak flow rates during infrequent storm events, a flood fringe area characterized by periodic inundation will be created. The influence of the permanent pool and frequent storm events is less pronounced in flood fringe areas than it is in shoreline fringe areas.

Recommended plant materials in this zone include a range of native grasses, wildflowers, shrubs and trees. There should be a graduated change in plantings at the junction of flood fringe areas and upland areas to ensure a smooth, naturalized transition.

1.3.5.18 (a) (v) Upland areas (naturalized grasses/wildflowers, trees and shrubs)

Upland areas have the highest vertical elevation and generally incorporate a wide variation in side slopes and landscape elements. Upland areas should be designed to restrict access to steep slopes and pond inlets/outlets. Plant materials should be selected on the basis of safety considerations, their aesthetics, and their ability to provide shade and protection from the wind. They should also be selected with due consideration for topography and surface drainage, soil conditions, adjacent plant communities, their potential for on-site transplantation and the availability of nursery stocks.

A sustainable, naturalized landscape approach requiring little or no maintenance should be adopted in the planning/design of upland areas. This should involve designated regeneration areas to enhance natural communities and habitat, as well as massed tree and shrub plantings to give upland areas a distinctly urban character. Upland groundcover shall be comprised of a naturalized seed / wildflower mix to the satisfaction of the City.

1.3.5.18 (a) (vi) Urban edge areas (low mow grasses, trees and shrubs)

The first 6 to 8 metres of pond perimeter edge shall be planted with large caliper (60mm) deciduous trees, coniferous trees (minimum 1800mm height), shrub planting (minimum 600mm height) and a low mow (Pickseed 'Greenscape' or City approved alternate) seed mixture.

1.3.5.18 (b) Plant Material Quantities

1.3.5.18 (b) (i) Aquatic Planting

The total number of aquatic plants shall be installed at the rate of one plant per 0.5 linear metres of total shoreline length one metre below the permanent water elevation. The composition of aquatic plant species shall correspond to the following percentages:

1. 20% shoreline
2. 20% narrow leafed emergent
3. 20% broad leafed emergent
4. 20% floating species (eg. *Nymphaea odorata*, *Nuphar* sp., *Potamogeton*)
5. 20% submergent species (eg. *Elodea Canadensis*, *Potamogeton* sp.)

1.3.5.18 (b) (ii) Shrub Planting

The total number of shrubs shall be based on one shrub per 6 square metres of dry area of the facility (i.e., lands above the permanent or normal water elevation). Six to eight species of shrubs native to Ontario shall be specified. Species that provide opportunities for wildlife enhancement (food, shelter, etc.) are preferred. The purpose of this planting ratio is not to encourage repetitive landscape design, but to act as a relative guide to associate shrub plant densities.

1.3.5.18 (b) (iii) Tree Planting

The total number of trees shall be based on one tree per 30 square metres of dry area of the facility (i.e., lands above the permanent or normal water level). Six to eight species of trees native to Ontario shall be specified. Caliper stock (60mm) shall be placed in the upland and urban edge areas of the pond. Whip stock may also be used in certain areas of a pond facility as determined by the City to achieve the required planting densities.

1.3.5.18 (b) (iv) Terraseeding of Storm Pond Areas

All disturbed areas within the urban edge area, upland area and fringe area of stormwater management ponds shall be planted with a naturalized seed mix using the 'Terraseed' method. This seed mix should be planted in the spring or fall at a rate of 200 kg/ha, combined with 400 kg/ha of fertilizer (8-32-16) and 3300 kg/ha shredded compost to meet or exceed US Composting Council's Seal of Testing Assurance or equal, applied using Express Blower Supplemental Seed Injection System.

1.3.5.18 (b) (v) Upland Edge and Fringe Area

All disturbed areas outside 5-year return period flood line shall be naturalized using the 'Terraseed' method with a wildflower add-mixture. The composition is as follows (or approved equal):

1. 25% Canada Wild Rye (*Elymus Canadensis*)
2. 25% Big Bluestem (*Andropogon Gerardii*)
3. 25% Little Bluestem (*Schizachyrum Scoparius*)
4. 15% Fox Sedge (*Carex Vulpinoidea*)
5. 10% Poverty Oat Grass (*Danthonia Spicata*)

Wildflower Add-Mixture: Add 3.4 kg/ha 'Pickseed 14 Species Wildflower Blend' (or City approved alternate), to the above naturalized native seed mixture to introduce wildflower species into the facility sward.

1.3.5.18 (b) (vi) Urban Edge and Mow Strip Area

All disturbed areas of stormwater ponds that are subject to routine maintenance shall be 'Terraseeded' with 'Pickseed Envirogreen' (or City approved alternate), with a composition as follows:

1. Jasper Creeping Red Fescue
2. Spartan Hard Fescue
3. Banff Kentucky Bluegrass
4. Lowgrow Perennial Ryegrass

1.3.5.18 (c) Planting Notes

- 1.3.5.18 (c) (i) Plantings should be designed to permit ongoing access to the pond, forebay, inlets and outlets for maintenance purposes. Placement of plant materials shall not obstruct or impede future sediment removal works.
- 1.3.5.18 (c) (ii) Density calculations of required plant material shall be shown on landscape drawings. Calculations shown shall include the surface areas (in square metres) of the forebays and ponds ("wet areas") and the "dry" areas which surround the normal water level within the pond block. The pond perimeter length and the total area of the pond block shall also be shown.
- 1.3.5.18 (c) (iii) Landscape drawings shall show planting area locations, numbers and species of all plants.
- 1.3.5.18 (c) (iv) Plantings shall be placed in nodal or banding arrangements of vegetation, which also consider the species-specific moisture regime in the case of terrestrial species and water depth in the case of the aquatic plants.
- 1.3.5.18 (c) (v) Trees shall be planted at 6.0 metre on centre, shrubs at 1.0 to 1.5 metres on centre.
- 1.3.5.18 (c) (vi) Aquatic plant groupings shall be distributed in the forebay and pond area. *Typha latifolia* may be especially useful in providing temporary sediment capture in the forebay treatment areas prior to the installation of the final aquatic plantings. *Typha* sp. used for temporary sediment capture should be addressed as a separate item in the cost breakdown.
- 1.3.5.18 (c) (vii) Aquatic plant plugs shall be placed 0.5 m to 1.0 m on centre and shall be planted in groups consisting of a minimum of 10 plants per group.
- 1.3.5.18 (c) (viii) A minimum of 450 mm of topsoil shall be placed in all terrestrial planting areas and 300 mm in aquatic planting areas or spread evenly throughout the facility in a continuous layer. This specification shall be shown on both landscaping and engineering drawings. Subsoil and topsoil to be compacted to the satisfaction of the geotechnical engineer to ensure the structural and functional integrity of the pond shall also be inspected by a Landscape Architect to ensure its suitability for planting purposes. All terrestrial planting beds shall be mulched to a minimum depth of 75mm with a bark mulch approved by the Landscape Architect.
- 1.3.5.18 (c) (ix) Topsoil to be friable natural loam, range pH 6.0-pH 7.5 containing a minimum of 4% organic matter and shall be free of debris, sod, stones, roots, lumps and other solid materials over 25mm diameter. Stockpiled topsoil shall be tested for N, P, K, Mg, soluble salt content, organic matter and pH value etc. and shall be suitable for the proposed use. Topsoil shall be tested, and approved by the Landscape Architect prior to submission to the City for final acceptance.

- 1.3.5.18 (c) (x) Due to the risk of erosion and subsequent sedimentation within a storm water management facility, topsoil shall be stabilized prior to the planting of trees and shrubs and shall be done within the construction year's growing season by seeding or engineered methods. If topsoil stabilization cannot be achieved within this period, topsoil application must wait until the following spring.
- 1.3.5.18 (c) (xi) No trees shall be planted within 6.0 metres of any storm sewers.
- 1.3.5.18 (c) (xii) Following the one (1) year stabilization period, final completion of the stormwater management pond is to include the planting of aquatic vegetation to the satisfaction of the City and in accordance with the approved drawings. Planting of aquatic vegetation should be scheduled to occur in spring or early summer and is to be carried out after the completion of the final sediment clean-out of the pond. Special care should be taken to ensure that planting locations do not dry out in the first year.
- 1.3.5.18 (c) (xiii) No herbicides or pesticides shall be applied within or adjacent to areas subject to planting or within the limits of disturbance. Where supplements or amendments to the soil are required, composted organic material that is satisfactory to both the Landscape Architect and the City may be used.
- 1.3.5.18 (c) (xiv) A Landscape Architect shall inspect and certify the quantities, species, conditions and the locations of all aquatic and terrestrial plantings at the time such plantings take place.
- 1.3.5.18 (c) (xv) Stormwater management facilities are subject to periodic inundation, no plant material other than aquatic and wetland seed mix species shall be planted less than one metre above the normal permanent water level. For solar insulation, particularly on the south and west shores, tree and shrub plantings should be placed within three metres of the normal permanent water level.
- 1.3.5.18 (c) (xvi) Prior to planting, the pond permanent water elevation shall be observed for a period of not less than one (1) year by both the design engineer and the landscape architect. The Consultant shall provide certification that the construction of the pond conforms to the approved plans and that the pond functions in accordance with the Stormwater Management Report. Following this stabilization period and discussions with the Conservation Authority and the City, revisions to the planting plan may be necessary.
- 1.3.5.18 (c) (xvii) Tree stakes shall be removed one (1) year after the trees are planted and all dead plant material replaced to the satisfaction of the City and TRCA.
- 1.3.5.18 (d) Landscape Maintenance
- Ponds on tablelands and adjacent lots/roads should receive more routine maintenance than ponds located in valleylands.
- Stormwater management pond areas should be designed to include three zones, representing different levels of maintenance, clearly delineated with a bold line on the appropriate stormwater management facility drawings.
- 1.3.5.18 (d) (i) Zone 1
1. The line demarcating Zone 1 should include the inside slope of upland plant groups and where necessary, pedestrian pathways and other prominent features.
 2. Regular maintenance every two to three weeks (highly visible upland zone, in close proximity to users and public street).

3. Turf, shrub/flower beds and trees in upland areas should receive regular maintenance because of their high visibility from adjacent public streets and residential developments.
4. The line of grass cutting should be selected with a view to enhancing visual interest. It is intended that this area be maintained at a grass height of 100mm to 150mm.

1.3.5.18 (d) (ii) Zone 2

1. Zone 2 is a transition zone between upland and lowland areas. This area should be defined as lands not included in either Zone 1 or 3. For this reason, the limits of Zone 2 should be defined by the edges of Zone 1 and Zone 3.
2. Two to three cuts per year (visible from a distance, mid slope, flood fringe zone, further from public streets and users).
3. Grass height in Zone 2 should be maintained at a maximum height of 300 mm to 450 mm.

1.3.5.18 (d) (iii) Zone 3

1. Zone 3 is a critical edge of planting. It not only defines the water line, but it also provides for a safety zone and environmental buffer.
2. It is intended that this area be naturalized and allowed to change in response to varying water levels.
3. No regular maintenance other than sediment clear out (shoreline edge zone, visible from a distance, low maintenance, contact with users discouraged).
4. There should be virtually no routine cutting or maintenance in Zone 3.
5. Occasional cutting of invasive and/or foreign plant materials may however be required.

1.3.5.19 Building Permit Requirements

Applications for building permits shall only be submitted for any lot or block in a plan, where a stormwater facility (or storm water management solution) has been constructed and has been certified by a Professional Engineer with respect to its conformance with the approved design volumes and elevations. This certification is to include a topographic survey of the pond immediately following its construction and before discharging water into the pond which confirms that the approved design elevations and available storage volumes meet the design requirements without over-excavation of the pond, to the satisfaction of the City.

1.3.5.20 Performance Monitoring and Assumption Requirements

In order to ensure that SWM facilities are performing as intended in their design and in accordance with their Environmental Compliance Approvals (ECAs; formerly Certificates of Approval) from the Ministry of Environment Conservation and Parks, the performance monitoring requirements outlined in this section must be met.

After grading of the facility is completed, a topographic survey prepared by an Ontario Land Surveyor shall be completed, of the facility to determine the elevations prior to the facility being operational. The survey work is to be conducted in a dry condition and the Engineer is to confirm the capacity, by way of comparing the constructed elevations to the design elevations and calculating volumetric capacity, of the facility prior to acceptance and the issuance of building permits. Over-excavation of SWM ponds for purposes of collecting sediment during construction or otherwise is not permitted.

The forebay and main cell sediment levels shall be monitored on an annual basis until assumption. Accumulated sediments in the forebay and main cell shall be removed on an annual basis unless it is demonstrated that the accumulated sediment volume is less than 25% of each of the forebay and main cell permanent pool volumes. The volume of sediments shall be estimated using at least five uniformly distributed measurements of sediment depth in the forebay and at least five measurements of sediment depth along the mid-section along the length of the main cell. A secchi disk shall be used to estimate levels in a wet condition if the water level is too deep for a sediment rod to reach. Prior to removal and disposal of accumulated sediment, quality samples of the sediment from both the forebay and main cell shall be taken and submitted to an accredited laboratory to determine the disposal method.

On a yearly basis between April 1 to November 30 from the time of substantial completion to assumption, at least five (5) water samples shall be taken at the outfall from the facility to assess the TSS concentrations in mg/L. The samples shall be taken within 24 hours after a significant rainfall event and are to be submitted to an accredited laboratory for analysis and results submitted to the City. Depending on the water quality control performance, remedial works may be required to the satisfaction of the City.

A metric staff gauge shall be installed adjacent to the storm sewer inlet headwall so that the “zero” reading is set at the permanent pool elevation. The outlet structure shall be inspected on a monthly basis to ensure that hydraulic features (e.g., perforated riser inlets, etc.) are not blocked due to sediments or debris. The monthly inspection shall be undertaken in dry weather conditions after the extended detention storage is expected to be completely drawn down in accordance with the design. The monthly reports shall include a date- and time-stamped photograph of the staff gauge and a reading to determine any fluctuations in the permanent pool elevation.

Prior to substantial completion, flow measurement equipment shall be installed at all inlets and outlets in addition to the measurement of water levels using a pressure transducer and data logger with measurements recorded at 5 minute intervals. The water level sensor shall be referenced to nearby geodetic benchmark(s) and, as discussed in 1.3.5.5, a geodetic benchmark should be installed on the top of the concrete headwall or other appropriate location of the facility’s outlet structure. After each season (i.e., April 1 to November 30), the data shall be reviewed in conjunction with rainfall data from the nearest TRCA or other appropriate rain gauge for the 8 largest rainfall events and compared to the approved engineering design of the facility and MECP Environmental Compliance Approval (ECA; formerly Certificate of Approval). The analysis shall include, but not necessarily be limited to, the following for each of the events:

- Verification of permanent pool or normal water level.
- Verification of the stage-discharge curve.
- Fluctuation of water levels in response to rainfall events.
- Facility drain down time.

The results of this analysis shall include graphical plots of water level fluctuations for each of the events with the expected design water levels for the permanent pool, erosion control extended detention zone, 2-year, 5-year, 10-year, 25-year, 50-year and 100-year indicated on the plots.

Depending on the performance of the facility, remedial works may be required to the satisfaction of the City. At least one complete season following any remedial works shall be monitored prior to consideration for assumption. The City reserves the right to require additional monitoring until the facility is performing to its satisfaction.

Prior to assumption, accumulated sediment within stormwater management facilities is to be removed such that the required storage volumes are available. The following are the general requirements for assumption of stormwater management facilities:

- 1.3.5.20 (a) A preconstruction meeting is to be organized prior to any work. The purpose of the meeting is to discuss the public notification process, the proposed works and any other matters as determined by the City.

- 1.3.5.20 (b) Submission of a set of the approved SWM drawings (hard copy) showing the plans, cross-sections, inlets, outlets and all other relevant features of the facility.
- 1.3.5.20 (c) Prior to dredging the stormwater management facility, the following information is to be submitted to the City:
1. Copies of the required permits from all regulatory agencies
 2. Wildlife Impact Assessment for dredging operations
 3. Name of contractor and contact number for site foreman
 4. Written procedure for sediment removal
 5. Timeline for completion
 6. Sediment testing results
 7. Information on the proposed haul route and disposal location
 8. Restoration plan in conformance with approved landscape plan for the facility
- 1.3.5.20 (d) A certification letter from a Professional Engineer confirming that the SWM facility has been cleaned out at the completion approval stage, and that the water quality (e.g., permanent pool), erosion and water quantity control requirements have been met based on the as-built conditions and that the as-built conditions conform to the approved design elevations.
- 1.3.5.20 (e) Bathymetric surveys of the permanent pool bottom elevation before and after the sediment removal process, confirming the permanent pool volumes in both instances.
- 1.3.5.20 (f) All SWM facility signage and other related requirements should be met according to the City's criteria and as required by the Subdivision Agreement.

1.3.5.21 Information Submission Requirements

- 1.3.5.21 (a) A digital copy of the final or as-constructed subdivision submission shall be provided to the City prior to the start of the Guaranteed Maintenance Period. Submissions shall contain all material indicated in this document and shall be submitted in well-organized digital folders, named and numbered according to this document. Submissions that do not comply with these requirements will be considered incomplete. Only complete submissions that comply with these requirements will be accepted and reviewed.
- 1.3.5.21 (a) (i) Complete the SWM Facility Information Survey (Table 1-14) and include a scanned copy in the electronic submission.
- 1.3.5.21 (a) (ii) Provide a complete digital set of both the approved and the as-constructed technical drawings. The drawings should be signed and sealed by a qualified Professional Engineer. The drawings shall include, but not necessarily be limited to, the following:
1. Storm sewer drainage area plans (internal & external)
 2. Overland flow drawings
 3. All drawings related to proposed SWM facilities including plan view, cross-sections and details of facility, inlet and outlet structures, etc.
 4. All major and minor system design sheets
 5. An original topographic survey of the as-constructed SWM pond conditions sealed by a qualified Ontario Land Surveyor

Drawings shall be scanned or saved as "Tagged Image File Format" – TIFF Group 4 (*.TIF) with the following characteristics:

1. Quality of scans must be such that all line types can be easily differentiated with a minimum scan resolution of 400 dots per inch (dpi).

2. Image size must be at 1:1 scale with original record and printed items must maintain original drawing scale.
3. Orientation of the title block and/or descriptive text must be horizontal.
4. Drawing text of 5 point or higher must be legible and all characters easily differentiated on scanned image.
5. Full size scanners must be used.
6. Scanners must contain adaptive area thresholding ability.
7. Image must not be skewed, where an acceptable skew is limited to 0.5 degrees.
8. Minimum of 25.4 mm (1 inch) white space border is to be provided around image, where image is defined as the area within the drawing neat-line.

1.3.5.21 (a) (iii) SWM Design & Facility Operation/Maintenance Reports

Provide final versions of the Stormwater Management Report and the Stormwater Management Operations & Maintenance Manual, signed and sealed by a qualified Professional Engineer. Include all attachments and appendices. The complete report is to be submitted in "Portable Document Format" (*.PDF).

1.3.5.21 (a) (iv) Digital Photos of SWM Facility

Photographs of constructed SWM facility immediately prior to assumption shall be provided. These photos should include all significant components such as inlets, outlets, weirs, etc. Refer to Table 1-13 for common element types. Photographs shall be submitted in "Joint Photographic Experts Group" image file format (*.JPG) with a high resolution. The following naming convention is to be followed for each image file:

1. Brief description of photograph's subject
2. Date photo was taken (YYYY-MM-DD)

Example filename: Access_Road_2008-Jul-21.jpg

1.3.5.21 (a) (v) AutoCAD Drawing

Provide an AutoCAD drawing tracing the outline of the 100-year return period water level and the permanent pool (normal water) level of the pond properly geo-referenced. All property lines associated with the pond block in question should be included. Significant features of the pond should be indicated in accordance with Table 1-13.

The AutoCAD file shall be compatible with AutoDesk AutoCAD 2000 (*.DWG) with the following characteristics:

1. CADD layers to be neatly organized and named logically with one layer representing one real world class of object.
2. All data to be geo-referenced to real world coordinates using a Projection/Coordinate System Universal Transverse Mercator, North American Datum (NAD83) Zone 17N and also to be referenced to legal property/parcel fabric.
3. All linework and text to be located in drawing "Model Space".

1.3.5.21 (a) (vi) GIS Shapefile

Provide GIS shapefiles tracing the outline of the 100-year return period water level and the permanent pool (normal water) level of the pond properly geo-referenced. All property lines associated with the pond block in question should be included. Significant features of the pond should be indicated in accordance with Table 1-13.

The format shall be ESRI shapefile or feature class compatible with ArcMap 9.1 with the following characteristics:

1. All data to be geo-referenced to real world coordinates using a Projection/Coordinate System Universal Transverse Mercator, North American Datum (NAD83) Zone 17N and also to be referenced to legal property/parcel fabric.
2. Deliver Feature Class data neatly organized in an ESRI Personal Geodatabase.
3. Attribute values within any Feature Class to be standardized and coded whenever possible using Coded Value Domains and must conform to M.I.D.S. Standard 1.95 whenever possible.
4. Full Metadata, conforming to City requirements, for each object is to be created.
5. All alpha characters to be upper case.

Table 1-13 SWMSoft Facility Component Symbol Legend

AR Access Road	Ga Gate	? Other
BB Baffle Blocks	Gr Grate	O Outlet
BM Bench Mark	Hw Headwall	Pi Pipe
Be Berm	I Inlet	Ra Railing
Bw Boardwalk	Lk Lock	RW Retaining Wall
Ch Channel	Lo Lookout	RP Riser Pipe
DI DICB	Ls Life Saving Station	Sw Spillway
Fa Facility	MH Manhole	Va Valve
Fe Fence	MG Manicured Grass	Ve Vegetation
		Ww Walkway
		Wr Weir

Table 1-14 SWM Facility Information Survey

1	Facility Name	
2	Type	<input type="checkbox"/> Wet Pond <input type="checkbox"/> Dry Pond <input type="checkbox"/> Wetland <input type="checkbox"/> Hybrid <input type="checkbox"/> Oil/Grit Separator <input type="checkbox"/> Infiltration Basin <input type="checkbox"/> Infiltration Trench <input type="checkbox"/> Porous Pavement
3	Function	<input type="checkbox"/> Quality Control <input type="checkbox"/> Quantity/Flood Control <input type="checkbox"/> Erosion Control
4	Pond Type	<input type="checkbox"/> Offline <input type="checkbox"/> Online
5	General Description	
6	Location Description	
7	Nearest Major Intersection	
8	Municipal Address	
9	Easting	
10	Northing	
11	Access	
12	Driveway	<input type="checkbox"/> Yes <input type="checkbox"/> No
13	Driveway Material	
14	Vehicle Turnaround	<input type="checkbox"/> Yes <input type="checkbox"/> No
15	Gate Present	<input type="checkbox"/> Yes <input type="checkbox"/> No
16	Lock Present	<input type="checkbox"/> Yes <input type="checkbox"/> No
17	Adjacent Land Use	<input type="checkbox"/> Residential <input type="checkbox"/> Commercial <input type="checkbox"/> Industrial <input type="checkbox"/> Rural
18	Block Number	
19	Comments	

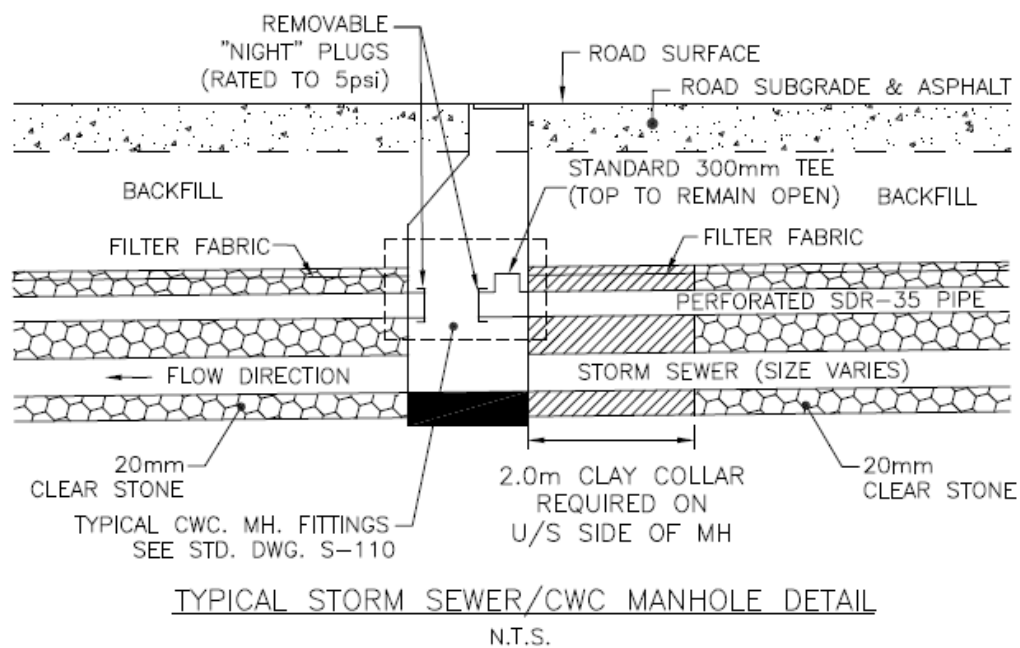
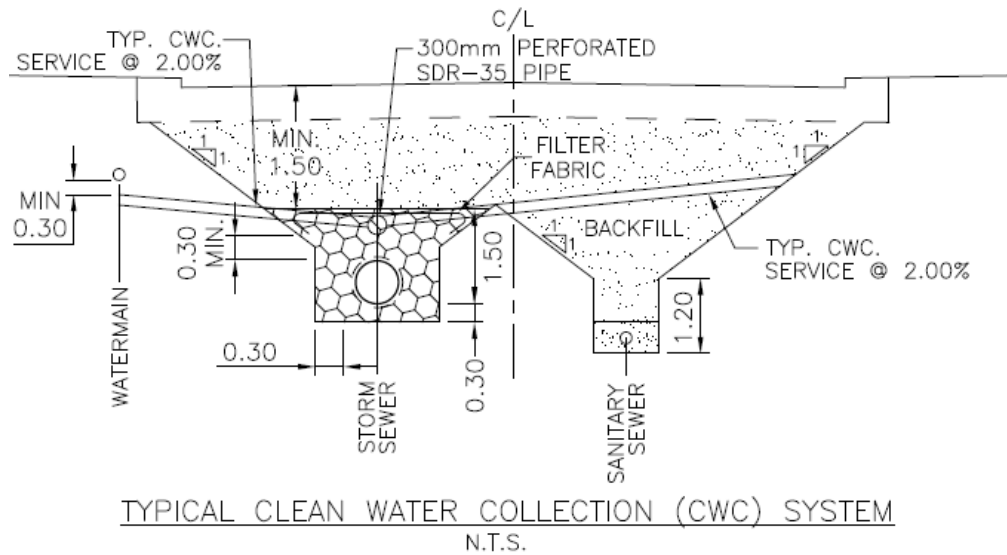
1.3.6 Low Impact Development (LID) Practices

LID measures shall be considered wherever practical to implement on a site- or development-specific basis, at the City's discretion, and shall be designed in accordance with the latest version of the relevant City LID Guides, Low Impact Development Stormwater Management Planning and Design Guide (CVC, TRCA).

LID measures with low maintenance requirements may be used to reduce infrastructure requirements (e.g., SWM pond volumes, other), however, their implementation shall:

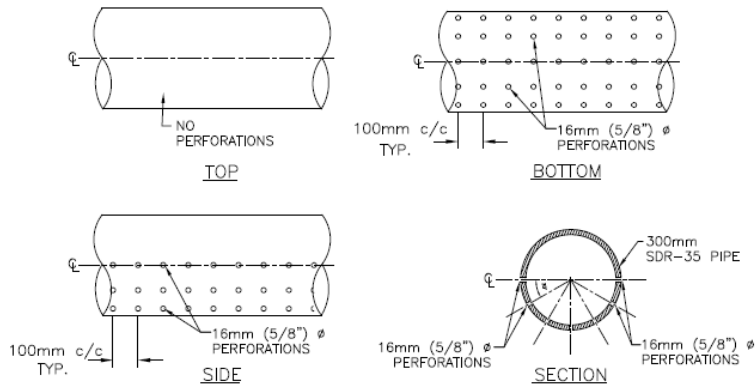
- Demonstrate a net benefit to the City with respect to performance and life-cycle costs, subject to the consideration and approval of the City.
- Only be implemented where the LID measures are under the City's ownership or, in cases where under private ownership, appropriate maintenance agreements and enforcement controls can be established.
- Avoid the use of high maintenance measures.

Although all appropriate LID measures may be considered based on site conditions, the City has identified clean water collectors (CWC) and infiltration type LID's as preferred technologies where the native soils and groundwater table are conducive to infiltration type LID's. CWC systems shall be designed in general accordance with Figures I-2 and I-3.

**NOTES:**

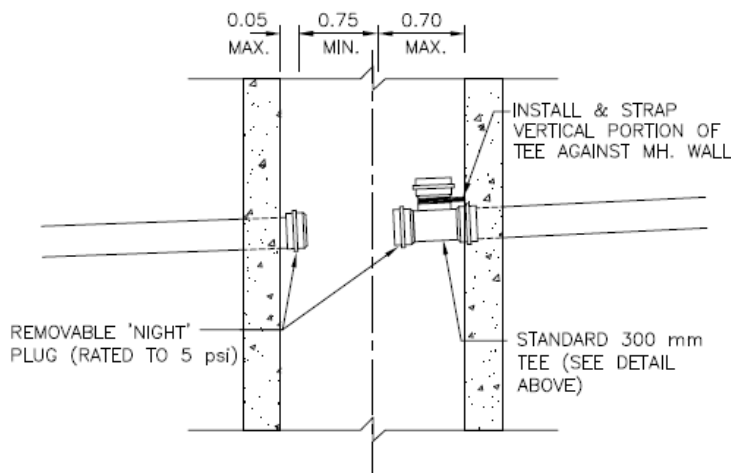
1. STORM SEWER TO BE INSTALLED IN A 50mm CRUSHER-RUN LIMESTONE BEDDING.
2. A CWC PERFORATED PIPE IS TO BE INSTALLED 300mm ABOVE THE OBVERT OF THE STORM SEWER.
3. FOR TRENCHING DETAILS AND PROCEDURE PLEASE REFER TO OPSS 401.
4. WRAP TOP AND SIDES OF TRENCH TO CWC INVERT ELEV. WITH FILTER FABRIC (ARMTEC 160, TERRAFIX 270R OR APPROVED EQUIVALENT)

Figure 1-2 Clean Water Collector (CWC) – Sections



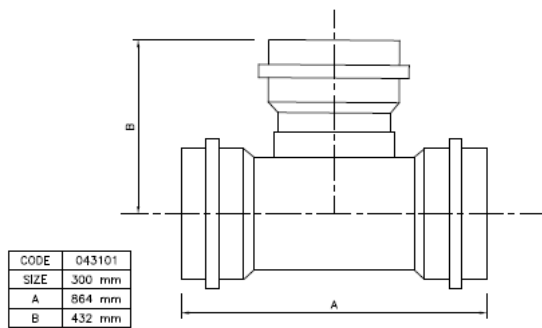
CWC PIPE PERFORATION DETAIL

N.T.S.



TYPICAL CWC. MH. FITTINGS

SCALE: N.T.S.



CODE	043101
SIZE	300 mm
A	864 mm
B	432 mm

ALL DIMENSIONS ±25 mm

STANDARD 300mm TEE

N.T.S.

NOTES:

1. REFER TO CITY'S STD. DWG. C-101 FOR NOTE IN SANITARY AND STORM SERVICES CONNECTIONS.
2. HOUSE ROOF LEADERS TO DISCHARGE TO CWC SERVICE PIPE AT A MINIMUM SLOPE OF 2.00%.
3. MINIMUM DEPTH TO INVERT FOR CWC AT STREET LINE IS 1.50m
4. MARKERS SHALL BE PLACED AT ENDS OF SANITARY, STORM & CWC CONNECTIONS.
5. CWC SERVICE WITHIN LOT NOT TO BE INSTALLED UNTIL ROOF LEADERS ARE INSTALLED.

Figure 1-3 Clean Water Collector (CWC) – Details

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