Township of
SEVERN

ENGINEERING STANDARDS

Stormwater Management & Storm Sewers

Table of Contents

Table of Tables

Table of Equations

1 Introduction

The purpose of this section is to outline the minimum requirements for the design and construction of municipal servicing within the Township. These requirements are intended to provide guidance and minimum expectations, but this shall not relieve the practitioner of the responsibility of ensuring a completed product demonstrating competent engineering and full compliance with all applicable legislation.

2 Other Applicable Acts, Codes, Standards, Legislation, Design Guidelines

Practitioners must be fully familiar and ensure compliance with other applicable acts, codes, standards, legislation, and design guidelines when carrying out municipal servicing design.

The Township of Severn is subject to all Federal, Provincial, and local legislation related to stormwater management, runoff control, and flood control, including but not limited to that from the following:

- Department of Fisheries and Oceans (DFO)
- Ministry of the Environment, Conservation and Parks (MECP)
- Ministry of Natural Resources and Forestry (MNRF)
- Severn Sound Environmental Association (SSEA)
- Transportation Association of Canada (TAC)
- Ministry of Transportation (MTO)

Practitioners are responsible for ensuring all designs meet the requirements of the Township's Consolidated Linear Infrastructure Environmental Compliance Approval (CLIECA) or obtaining direct Ministry approval as noted below.

Practitioners are fully responsible for obtaining all approvals and permits necessary for the project from the relevant approval authorities.

3 Deviation from Standards

If the practitioner deems that a deviation from these standards is required, they must make a formal request to Town, complete with a memorandum identifying the proposed deviation along with an explanation of the rationale behind the requirement and how it will be of benefit. The Township may approve or reject any/all requests and the practitioner must comply with that decision. If a deviation is approved, a copy of the written approval must be included with any submissions to the Township.

4 General Requirements

A significant shift has occurred in recent decades around the planning and design of stormwater management infrastructure. Rather than reliance upon end of pipe controls, additional focus has been placed on utilizing source control as well as conveyance control to reduce the requirements for end of pipe controls, providing a more effective means of achieving water balance, erosion, water quality, and water quantity control targets.

Additional challenges have also been introduced due to changing climate conditions.

Where applicable, the planning for stormwater management practices should begin as early as possible and should be integrated at a watershed/subwatershed and/or Master Plan level with other practices and from a multi-disciplinary perspective.

Stormwater management practices for a particular project must meet the requirements of any available background studies, including those aforementioned watershed/subwatershed and/or Master Plans.

With this in mind, the Township has set the following objectives for stormwater management within its municipal boundaries:

- Protect against climate change related impacts to the extent possible;
- Provide peak flow control, water quality protection, habitat enhancement, water balance, and erosion control;
- Prevent loss of life and minimize impact to adjacent properties;
- Prevent inconveniences from surface ponding and flooding;
- Maintain groundwater recharge and prevent adverse impacts on the local groundwater systems and base flows in receiving watercourses;
- Prevent downstream flooding and erosion;
- Prevent pollution discharges to watercourses;
- Prevent soil losses and sediments to sewer systems and waterbodies from construction activity; and
- Prevent impairment and enhance, where possible, terrestrial and aquatic life and habitat.

In order to support these objectives, the design of stormwater management controls should focus on:

- Provision of source control, where possible. Implementing measures to control runoff at the source or at lot level to capture, infiltrate and/or treat stormwater runoff can limit the runoff contributing to the ultimate outlet point and improve the quality of the runoff to the ultimate outlet.

- Provision of conveyance control. Implementing measures to control runoff between the source and outlet point to capture, infiltrate, and/or treat runoff in decentralized locations throughout the catchment area prior to the ultimate outlet point, such as in ditches, swales, or other infiltration facilities can also help to reduce runoff volumes and peak flows as well as maintain water balance.
- Provision of end of pipe control. Controls that are implemented at the ultimate outlet point of the catchment area should be implemented after source and conveyance controls have been considered to achieve the necessary level of stormwater quality and quantity targets.

In general, stormwater management design for any project shall address the following:

- stormwater quantity control;
- stormwater quality control;
- erosion and sediment control; and
- water balance.

The Township requires that all stormwater be directed to a sufficient outlet. A sufficient outlet typically constitutes a lake or permanently flowing watercourse. A sufficient outlet may also include the road allowance provided that written permission is obtained from the Township. In the case where the discharge is directed over private land, a legal right of discharge registered on title must be obtained and copies of all written documentation must be provided.

Calculations for the conveyance capacity of the downstream conveyance routes must be provided to demonstrate that upstream, downstream and adjacent landowners do not incur adverse impacts, including increased runoff volumes, and that the flow is conveyed in a safe manner.

Stormwater management designs must consider and accommodate all upstream and external drainage areas in both interim and ultimate conditions.

4.1 Stormwater Quantity Control

The Township implements a Major and Minor system approach to stormwater conveyance and control, comprised as follows:

Minor (conveyance) System - 5-year return period – storm sewers, catch basins, driveway culverts, surface swales, etc.

Major (overland) System - 100-year return period (or Regional) – streams, valleys, man-made channels, roadways, roadside ditches, etc.

The Township requires stormwater quantity control to reduce peak flow runoff from a proposed project. Control of peak flows to allowable levels is required for the 2 through 100-year design storms and is to be based on specific watershed/subwatershed flood

control criteria, if applicable. Where flood control criteria does not exist, peak flows must not exceed pre-development levels.

It is noted that the Township may also require other design storms to be analyzed (i.e. regional storm).

In addition to peak flow control, post-development flows must not adversely impact downstream infrastructure or properties.

There are some situations where the Township may permit exceptions to the quantity control requirements, including:

- For new construction and reconstruction of linear works such as roads, trails, and sidewalks that are not part of a plan of development and that result in the creation of new impervious surface, controls should be implemented for the runoff generated from the 25mm storm event from the new impervious surfaces or net increase in impervious area.
- For roadway, trail, and sidewalk resurfacing where the impervious area is not increasing, the Township encourages the incorporation of controls to the maximum extent possible.
- For minor linear works retrofit projects, such as shoulder paving or addition of a turning lane, the control requirements will be at the Township's discretion.
- For stormwater management specific retrofits (i.e. construction of new and/or reconstruction of existing municipal stormwater management infrastructure for an area that is already serviced and is not part of a plan of development), the Township encourages achieving volume control to the maximum extent possible.

4.2 Stormwater Quality Control

In general, stormwater quality controls are to be designed in accordance with MECP Stormwater Management Planning and Design Manual. The Township requires that Level 1 (80% TSS Removal) or Enhanced treatment of stormwater runoff is achieved for a proposed project.

Additional stormwater quality requirements may exist, such as for phosphorous removal; therefore, it is recommended that the Township be contacted to confirm the requirements prior to commencement of design.

Employing stormwater management practices that minimize stormwater contaminant loads and maintain or increase the extent of vegetative and pervious surfaces are preferred.

4.3 Erosion and Sediment Control (ESC)

The Township requires that the design of a proposed project include measures to reduce and/or eliminate erosion and control sediment transport. Priority must first be placed on

erosion control in order to minimize volume of sediment; thereby, reducing reliance upon measures to control that sediment. As a primary measure, phasing of the proposed work shall be incorporated, where possible, to reduce erosion potential. The phasing and measures to be incorporated for each phase must be clearly identified on the ESC plans.

ESC measures shall be adequate to mitigate any impacts to Township infrastructure, watercourses, wetlands, other environmentally sensitive areas or features, and downstream properties.

ESC measures must be in accordance with any available background studies, including but not limited to watershed/subwatershed plans, Master Plans, geomorphic studies, or erosion analyses. Where such studies do not exist, the ESC design must be in accordance with the MECP Stormwater Management Planning and Design Manual.

It is expected that the ESC design will incorporate common elements, including but not limited to:

- Tree removal/clearing/grubbing.
- Phased/minimized topsoil stripping and limited areas of exposed soil. In cases where soils will remain exposed for extended periods (i.e. greater than 30 days), it shall be protected with vegetative cover.
- Protection of topsoil stockpiles. Stockpiles shall be located so the toe of the slope is a minimum of 10 m away from any roadway, drainage channel, or adjacent residential lot. They shall not be located in low areas or areas where water may accumulate. The maximum side slopes shall be 1.5:1 or as required by the geotechnical engineer. The maximum height shall be approved by the Township. If remaining in place for more than 30 days, stockpiles shall be stabilized by vegetative cover or other means.
- Installation of siltation control fence wherever surface runoff drains onto adjacent properties, completely around the base of any topsoil stockpiles, and along the perimeter of all other areas sensitive to sediment accumulation (e.g. watercourses, valleys, woodlots, areas to remain undisturbed etc.). Heavy duty, wire backed silt fence, as per OPSD 219.131, modified to 900 mm height above ground, is preferred.
- Installation of construction access mats at all exits from the site to reduce tracking of mud and debris onto adjacent roads. The access mats shall be a minimum of 450 mm thick, 20 m long and 5 m wide. The first 15 m from the exit shall be constructed with 50 - 100 mm stone placed on geotextile fabric (Terrafix 270R or approved equivalent). The remaining 5 m shall be constructed with 150 mm riprap.
- Installation of rock check dams as per OPSD 219.210 and 219.211.
- Construction of temporary interceptor swales, vegetative buffers, and sediment control ponds designed as per the MECP Stormwater Management Planning and Design Manual.

- Protection of existing infrastructure, including catchbasins, using filter cloth or catchbasin inserts.
- Measures to control dust such as road cleaning, watering, work restrictions on windy days, etc.
- Cut/fill analysis, including calculations and drawings, to demonstrate how it will be balanced in floodplain areas.
- Details for ongoing performance monitoring, maintenance, and spill control/response plan.

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 MNR and DFO, where applicable.

4.4 Water Balance

The Township requires projects to replicate the predevelopment hydrologic cycle and maintenance of natural water balance to protect groundwater recharge and support area environments.

If a water balance assessment or study has been completed for the area in which a project falls (i.e. through a watershed/subwatershed plan, source protection plan, Master Stormwater Management Plan, Class EA, etc) and the assessment includes sufficient detail to be used at a project level, the recommendations contained within the respective assessment or study shall be followed.

If a water balance assessment or study has not been completed, the Township requires that the design provides recharge to meet pre-development conditions for the project area or the equivalent of the runoff volumes generated from the 25 mm storm event.

There are some situations, such as retrofit projects, where the Township may permit exceptions to the water balance requirements and other situations, such as in environmentally sensitive areas, where additional water balance requirements may be required. Therefore, it is recommended that the Township be contacted to confirm the requirements prior to commencement of design.

5 Hydrologic Analysis

5.1 Catchment Area Delineation

The Township requires that practitioners utilize topographic survey data to delineate catchment areas for the project site. Supplemental data, including contour information confirmed by field visits may be used in delineating external contributing catchment areas.

5.2 Rainfall Intensity Duration Frequency Data

The intensity of rainfall is to be determined by inputting the project's specific location into the Ministry of Transportation Ontario's online IDF Curve Lookup Tool and obtaining the coefficient data to be utilized in the following formula.

Equation 5-1: Rainfall Intensity Duration Frequency Formula

$$Intensity\ (mm/hr)\ =\ A\ x\ TB$$

where T is the time of concentration and A and B are coefficient parameters.

In order to account for the effects of climate change, practitioners are to increase the 'A' coefficient parameter by 15% prior to completing their calculations.

Detailed assumptions and calculations shall be submitted to support the results.

5.3 Time of Concentration

The minimum initial time of concentration is to be 10 minutes.

To calculate the initial time of concentration for upstream, undeveloped lands, the Bransby-Williams or Airport Method may be used. The most appropriate method will be determined at the discretion of the Township.

5.4 Design Storm Selection

In general, rural catchments shall be modelled using the SCS 24 hr design storm to generate peak flow values, whereas urban catchments shall be modelled using the Chicago 4 hr design storm.

In most cases, the consultant will be required to run both sets of design storms to make sure that the more stringent is used for each individual element of the drainage system (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.

5.5 Run-off Coefficients

A general guideline for run-off coefficients based on land use are presented in the table below.

Table 5-1: General Runoff Coefficients

Land Use	Runoff Coefficient
Parks and Playgrounds	0.20 – 0.35
Single Family Residential (Urban)	0.45 – 0.50

Land Use	Runoff Coefficient
Single Family Residential (Suburban/Estate)	0.30 – 0.40
Semi-Detached Residential	0.55 – 0.65
Multi-Family Residential (Townhouses)	0.65 – 0.75
Apartments/Condos	0.75 – 0.80
Institutional (Schools, Churches)	0.75 – 0.80
Industrial (Urban)	0.80 – 0.90
Industrial (Rural/Semi-Rural)	0.75 – 0.80
Commercial	0.90 – 0.95
Asphalt/Concrete Areas	0.95

A minimum run-off coefficient of 0.55 is to be used for undeveloped upstream external areas where future residential development may be expected and 0.75 where future industrial, high-density residential or commercial development may be expected.

Practitioners are responsible for assessing each specific project, considering additional factors such as the Hydrologic Soil Type, and developing suitable composite or weighted coefficients to be used for design purposes. Detailed assumptions and calculations shall be submitted to support the identified run-off coefficients.

5.6 Rational Method

The analysis and calculation of runoff flows for drainage areas that are less than 5 ha in size shall be based upon the Rational Method. The Rational Method is computed as follows:

Equation 5-2: Rational Method Equation

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

Where:

Q = Flow (m^3/s)

A = Area (ha)

C = Run-off coefficient

I = Intensity (mm/hr)

The Rational Method calculations must be checked using a model approved by the Township where the drainage area is greater than 5 hectares. The larger of the flows is to be used in the design of the stormwater system unless approved otherwise.

5.7 Modelling Tools

The Township accepts the use of the following modelling software to establish existing and proposed runoff peak flows and volumes:

- HYMO-based models (i.e. OTTHYMO, SWMHYMO).
- SWMM-based models (i.e. EPA SWMM, PCSWMM).

Practitioners must be fully trained and qualified in the use of the selected software and must be able to recognize and understand all methods, approaches, basic data, rationale, and calculations used by the programs. Practitioners assume full responsibility for the proper application of the modelling tools used.

All model input and output files must be provided in PDF format and digital versions provided when requested.

6 Storm Sewer Design

Storm sewers shall be designed and constructed in accordance with the most recent requirements and specifications of the Township.

In general, storm sewers shall generally be designed to accommodate the 1:5-year storm and such that individual pipes only reach a maximum of 85% of their total capacity. The Township may require a system to convey additional flows at their discretion.

All storm sewers shall be of adequate size and depth to accommodate the potential development of upstream lands within the watershed and/or the drainage of any areas designated by the Township.

The use of clean water collection or “third pipe” systems, must be approved by the Township on a project specific basis. If approved, these systems shall be designed using the same criteria contained within this section, with the exception of horizontal alignment. The practitioner is to provide options for the horizontal alignment and rationale for the preferred option for the Township’s consideration.

7 Pipe Sizing and Specifications

7.1 Pipe Capacities

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

Equation 7-1: Mannings Equation for Storm Sewer Capacity

$$Q = \left(\frac{1}{n}\right) * R^{\frac{2}{3}} * S^{\frac{1}{2}} * A_{CS}$$

Where:

Q = Flow (m^3/s)
A_{CS} = Cross-sectional area (m^2)
R = Hydraulic radius (m)
S = Slope (m/m)
n = Roughness coefficient as noted below

The value of the roughness coefficient used shall be as follows.

Table 7-1: Manning's Roughness Coefficient (Storm Sewer)

Pipe Material	Roughness Coefficient
Concrete	0.013
Corrugated Metal	0.024
Corrugated Metal (smooth wall)	0.021
PVC	0.013
HDPE	0.013

7.2 Flow Velocities (Full Flow Condition)

The minimum acceptable velocity in a storm sewer is 0.8 m/s and the maximum acceptable velocity is 4.0 m/s during the 5-year storm event.

Where velocities in excess of 3.0 m/s are proposed, additional design factors shall be considered to protect against scour, erosion, and hydraulic jumps. Supercritical flow should not occur.

7.3 Pipe Size

The minimum size for a storm sewer shall be 300 mm diameter.

7.4 Pipe Slopes

Regardless of flow velocities obtained, the minimum design slope for storm sewers shall be as follows.

Table 7-2: Minimum Pipe Slopes

Pipe Diameter	Minimum Slope
≤ 375 mm	0.40%
450 – 525 mm	0.30%
600 – 1200 mm	0.25%
> 1200 mm	0.20%

7.5 Depth of Cover

The minimum depth of cover to the top of the outside pipe barrel shall not be less than 1.5 metres from the final centreline of road elevation or 1.2 m from the finished ground surface. The practitioner must ensure the depth of the storm sewer is sufficient to provide a suitable outlet for any existing and planned development within the overall catchment area. Further the practitioner must consider conflicts with other underground infrastructure and utilities as well as basement elevations and hydraulic grade lines where foundation drain collectors are proposed.

The maximum depth of cover shall not exceed the applicable OPSD maximum height of fill table requirements.

7.6 Location

Storm sewers shall be located as shown on the standard road cross-section drawings. This standard location is generally 1.5 metres north or east of the centreline of the road allowance on the opposite side of any sanitary sewer. In the case of crescents and curvilinear streets, this standard location may be varied to the extent that the storm sewer remains on the same side of the centreline to avoid crossing the sanitary sewer at the changes in direction of the street.

All storm sewers will be laid in a straight line between maintenance holes, except where radius pipe is permitted.

Radius pipe will be permitted for pipe sizes of 1050 mm and greater, provided a maintenance hole is located within 30 m of the beginning or the end of the radial section. The minimum centreline radius allowable shall be as per the manufacturer's recommendation or as directed by the Township.

7.7 Pipe Clearance

Sufficient vertical separation between any pipe crossings must be provided to allow for proper bedding and structural support.

Generally, a minimum clearance of 0.3 metres shall be provided between the outside of all pipe barrels at all points of crossing.

For clearances between storm sewers and watermain, practitioners shall follow the Ministry publication entitled F-6-1 Procedures to Govern Separation of Sewers and Watermains.

In cases where the storm sewer crosses a recent utility trench at an elevation higher than the elevation of the utility, a support system shall be designed to prevent settlement of the storm sewer, or alternatively the original trench will be re-excavated to the top of the utility and shall be backfilled with non-shrinkable fill (low strength concrete) to adequately support the storm sewer. When the storm sewer passes under an existing utility, adequate

support shall be provided for the utility during and after construction to prevent damage to that utility.

7.8 Changes in Pipe Size

No decrease of pipe size from a larger size upstream to a smaller size downstream will be permitted, regardless of any increase in grade.

7.9 Pipe Bedding

The type of bedding shall be selected based on loading and anticipated construction conditions. For rigid pipe, Class B bedding (compacted Granular A bedding and cover over the sewer) in accordance with OPSD shall be used.

Embedment for flexible pipe shall be homogeneous Granular A in accordance with OPSD.

Alternate granular materials for pipe bedding may be specified, subject to the approval of the Township; however, clear stone bedding is generally not permitted. In areas where it is difficult to control the infiltration of ground water into the sewer trench, clear stone bedding may be considered provided it is supported by a geotechnical recommendation and it is completely wrapped in a suitable geotextile, selected and installed in accordance with the manufacturer's specifications.

The width of trench at the top of the pipe must be carefully controlled to ensure that the maximum trench width is not exceeded unless additional bedding or higher strength pipe is used. Where poor soil conditions and high ground water levels are present, the practitioner shall prepare special designs for the Township's approval.

7.10 Materials

All storm sewers larger than 450 mm in diameter shall generally be constructed of reinforced concrete with a suitable strength class recommended by the practitioner. With Township approval, smooth wall HDPE pipe with a minimum pipe stiffness of 320 kPa may be used for mains up to 900 mm diameter.

Storm sewer leads from catch basins shall be constructed with HDPE or PVC pipe. Ultra-Rib storm sewer is not permitted within the Township.

The class of reinforced concrete pipe shall conform to the requirements of OPSS MUNI 1820.

Polyvinyl chloride (PVC) pipe products shall conform to the requirements of OPSS MUNI 1841. The pipe must be manufactured with factory assembled spigot gasket and integral bell joints.

Polyethylene pipe products (HDPE) shall conform to the requirements of OPSS MUNI 1840.

8 Maintenance Hole Requirements

8.1 Size, Location, and Spacing

Maintenance holes shall be sized based on incoming and outgoing pipe sizes. All maintenance holes shall be minimum 1200 mm diameter.

The minimum size of any maintenance hole access shall be 685 mm.

All maintenance holes shall be centered on the storm sewer main.

Maintenance holes 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.

Where maintenance holes are located within a boulevard, they shall be a minimum of 1.5 m from the face of curb and any other service, utility, or appurtenance.

Sewers shall be terminated with a maintenance hole at the project limits. The design of the terminal maintenance holes must allow for the future extension of the sewer.

For land development projects, where 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.

The maximum spacing between storm maintenance holes shall be as follows.

Table 8-1: Maximum Maintenance Hole Spacing

Pipe Diameter	Max. Maintenance Hole Spacing (m)
≤ 600 mm	100
675 – 1200 mm	120
> 1200 mm	150

8.2 Frame and Grate

All maintenance hole frames shall be as per OPSD 401.010 with Type A closed cover labeled “Storm”.

All maintenance holes, located within the travelled portion of a roadway, shall 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. No concrete shall extend over the edge of the maintenance hole.

Prior to the placement of the surface course asphalt, maintenance hole frames shall be reset to final elevations.

Precast concrete adjustment units shall be used for any maintenance hole adjustments. A maximum of three adjustment units or a total of 300 mm is permitted at the top of the

structure. Any adjustment in excess of 300 mm must be completed with a precast concrete riser section.

8.3 Drops Across Maintenance Holes

A sufficient drop shall be provided across the maintenance hole to compensate for energy losses due to changes in flow direction and velocity.

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

Hydraulic calculations shall be submitted for all junction and transition maintenance holes on sewers where the outlet is 1050 mm or greater. In addition, hydraulic calculations may be required for maintenance holes where the outlet pipe is less than 1050 mm diameter if, in the opinion of the Township, there is insufficient invert drop provided across the maintenance hole.

Regardless of the invert drop across a maintenance hole as required by calculations, the obvert of the outlet pipe shall not be higher than the obvert of the inlet pipe in any maintenance hole.

The minimum drops across maintenance holes shall be as follows.

Table 8-2: Minimum Drop Across Maintenance Holes

Change in Direction	Minimum Drop (mm)
Straight run	30
≤ 45°	50
> 45° ≤ 90°	80

Where the difference in elevation between the maintenance hole inlet and outlet pipes is greater than 0.6 m and pipe slopes cannot be adjusted to reduce the difference, an external drop structure must be provided in accordance with OPSD.

8.4 Additional Requirements

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

b) All maintenance hole chamber openings shall be located on the side of the maintenance hole parallel to the flow for a straight run maintenance hole, or on the upstream side of the maintenance hole at all junctions.

c) Change in the direction of flow in any storm maintenance hole shall not be permitted at acute interior angles. The maximum change in direction of flow in a maintenance hole, for sewer sizes 1050 mm diameter and over, shall be 45°.

d) The obvert(s) on the upstream side of a maintenance hole shall in no case be lower than the obvert(s) on the downstream side of the maintenance hole.

e) All storm sewer maintenance holes shall be benched to the obvert of the outlet pipe for pipe sizes 600 mm or less and to the spring line of the outlet pipe for pipe sizes 675 mm and greater.

f) The minimum width of benching in all maintenance holes shall be 230 mm.

g) Safety platforms shall be provided in all maintenance holes greater than 5.0 m in depth. Safety platforms shall not be more than 5.0 m apart and shall be constructed in accordance with OPSD.

h) Frost depth shall be assumed to be 1.5 m. All maintenance holes shall have frost straps in accordance with OPSD 701.100. Frost tapers shall be provided as per OPSD 803.030 and 803.031, as applicable.

i) The practitioner is required to individually analyze each maintenance hole with respect to the application of OPSD standards with consideration of soil conditions, groundwater, buoyancy, loading and other pertinent factors to determine structure suitability. In all cases where the standards are not applicable, maintenance holes must be individually designed and detailed.

9 Catch Basin Requirements

9.1 Size, Location, and Spacing

Catch basins shall be selected, located, and spaced in accordance with the specific conditions of each project.

All catch basins at street intersections shall be located on the tangent section of the curb at a minimum of distance of 0.6 m from the beginning or the end of the radial portion of the curb.

Catch basins shall generally be located a sufficient distance upstream of pedestrian crossings and not within any curb depressions.

Double catch basins are required when the catch basin intercepts flow from more than one direction, such as at low points of any road.

Rear yard catch basins shall be eliminated whenever possible.

The maximum spacing for catch basins, including cul-de-sacs, shall be as per the following table.

Table 9-1: Maximum Catch Basin Spacing

Pavement Width	Maximum Spacing (m)	
	≤ 4% Road Grade	> 4% Road Grade
≤ 8.5	90	60

Pavement Width	Maximum Spacing (m)	
	≤ 4% Road Grade	> 4% Road Grade
> 8.5 ≤ 9.8	80	55
> 9.8 ≤ 12.2	75	50
> 12.2	60	40

The above spacing is provided as a guideline only. The practitioner is responsible for assessing the project and determining the catch basin capacity, location, and spacing requirements as part of the overall stormwater management strategy and design. At a minimum, the catch basin design shall provide sufficient capacity to capture runoff from the design storm event, which is typically 5-year, but may be greater. The spacing of catch basins may also be altered where Low Impact Development features are proposed and/or where inlet controls are to be implemented.

All catch basin structures shall have frost straps in accordance with OPSD 701.100.

9.2 Frame and Grate

In general, "bicycle proof" catch basin grates shall be required for all catch basins located in roadway or walkway areas. Pyramidal type shall be used for catch basins located within ditches or any rear lot catch basins specifically approved by the Township.

The frame and cover for catch basins in roadway or walkway areas shall be as detailed in OPSD 400.100. Catch basins located in grassed areas shall have a Birdcage Grate per OPSD 400.120.

All catch basins located within the travelled portion of a roadway, shall have the frame elevation set flush with 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 "B", between the two adjacent expansion joints.

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

9.3 Catch Basin Leads

For single catch basins, the minimum size of connection shall be 300 mm diameter and the minimum grade shall be 1.0%.

For double catch basins, the minimum size of connection shall be 375 mm diameter and the minimum grade shall be 1.0%.

For rear lot catch basins specifically approved by the Township, the minimum size of the connection shall be 300 mm diameter and the minimum grade shall be 1.0%. All rear lot catch basin leads shall be concrete encased where adjacent to a building envelope.

Catch basin leads shall have a minimum depth of cover of 1.2 m from the finished surface elevation to the obvert of the pipe.

In general, catch basins located in close proximity to a maintenance hole shall have their leads connected to the maintenance hole. Catch basin leads may not exceed 30.0 m when connected to the maintenance hole or sewer. Alternatively, a longer lead can be connected to the sewer and a 1200 mm diameter maintenance hole catch basin used in lieu of the normal 600 mm. square catch basin.

9.4 Additional Requirements

a) Catch basins must be pre-cast concrete and shall be designed and constructed in accordance with the most recent OPSS and OPSD.
b) Prefabricated tees shall be used for connection of catch basins to storm sewers.
c) Special catch basins and inlet structures shall be fully designed and detailed by the practitioner.

10 Rainwater Leaders, Foundation Drains and Storm Connections

10.1 Rainwater Leaders

Location of rainwater leaders must be considered in the overall stormwater management strategy and design.

Rainwater leaders for all types of low to medium density residential buildings shall be discharged onto grassed or garden areas and away from wells or tile bed areas.

Rainwater leaders for high-density residential, commercial, and industrial buildings shall be discharged onto grassed or garden areas, where possible, or as otherwise approved by the Township.

Rainwater leaders shall not encroach over other adjacent private lands.

Discharging of rainwater leaders to soakaway pits may be considered, but must be approved by the Township.

Pre-cast concrete splash pads shall be placed at each rainwater leader downspout or other approved discharge location.

10.2 Foundation Drains

Where gravity drainage is not practical, the Township requires that a covered sump with an automatic pump be installed to discharge the water to an approved discharge location.

In every case, the underside of footing shall be set a minimum of 0.5 m above the seasonal high ground water level, or as recommended in the geotechnical report.

Where sump pumps are installed in residential developments with open ditches, discharge pipes shall not be placed within the Township's road allowance. Sump pump discharge pipes shall be directed to rear or side yard drainage swales.

In no case will sump pump discharge pipes be connected to a storm sewer system unless engineered and approved by the Township.

10.3 Storm Connections

Storm service connections shall be considered on a project specific basis.

Where approved by the Township:

a) The connection to the main line sewer will be made with an approved manufacturer's tee for main sewer sizes up to and including 450 mm.

b) The type and size of pipe shall be a minimum 150 mm white PVC DR-28 conforming to OPSS for single family residential. Multiple family, commercial, industrial and institutional connections will be sized individually by the practitioner.

c) A 150 mm x 100 mm cast iron or PVC test fitting with a test plate marked "Storm" shall be installed at the property line. A maintenance hole will be required for all connections to multiple family, industrial, commercial, institutional and parks. The maintenance hole will be located at the street line. The connection obverts shall be matched with the main sewer obvert wherever possible.

d) Parking lots, driveways and/or other hard surfaced areas servicing multiple family, commercial, industrial, institutional and other blocks, will be serviced by an internal drainage system (including catch basins, maintenance holes and pipe) which will connect to the storm sewer system or other suitable outlet as determined by the Township.

e) Service connections shall not be constructed within driveways unless otherwise approved by the Township.

f) Service connections shall not be connected to a catch basin.

11 Subdrain

For urban roadways, 150 mm diameter perforated subdrains shall be installed, continuous from catch basin to catch basin, wrapped in suitable filter fabric. Subdrain shall be located in accordance with the typical road cross-section drawings and as per OPSD.

Subdrain may also be permitted for other types of installations, such as in low impact development features. These installations must be detailed and specifications provided on a case-by-case basis for Township approval.

12 Channels and Overland Flow

A continuous overland flow route, capable of conveying flows in excess of what is being captured by the minor system, must be established to direct flows to a sufficient and approved outlet. Flows must be contained within either the road right-of-way or within municipal easements. To meet the criteria for major storm run-off, low points in roads must have adequate provision for safe overland flow.

The combination of the minor and major system shall be capable of preventing flooding onto private property and conveying flows in a manner that limits road flooding as follows:

Table 12-1: Maximum Roadway Ponding Depth

Location	Maximum Ponding Depth (m)	
	25-Year Storm	100 Year/Regional Storm
Local Road	0.05 m above crown	0.15 m above crown
Collector and Industrial Road	Up to crown	0.10 m above crown
Arterial Road	Single lane to remain open	Up to crown

There shall be no flooding or ponding on roads during the minor storm event (i.e. 5-year).

Overland flow may be conveyed through walkways, parks, open spaces, ditches, and channels, subject to Township approval.

The proposed criteria for any open channel design shall be submitted to the Township for approval prior to the actual design being undertaken. Major system overland flow channel designs may be required to accommodate the Regional Storm or the 100-year storm for new development.

Manning's equation shall be used to compute the capacity of surface stormwater conveyance features such as channels, swales, and ditches. The value of the roughness coefficient used shall be as follows.

Table 12-2: Manning's Roughness Coefficient (Overland Flow)

Type of Cover	Roughness Coefficient
Natural (depending on cover type, density, etc.)	0.030 – 0.080
Concrete/Asphalt	0.015
Armour Stone/Gabion	0.025

Where possible, channels and ditches shall have minimum and maximum profiles of 0.5% and 6% respectively.

The maximum permitted velocities shall be as follows.

Table 12-3: Maximum Overland Flow Velocities

Type of Channel	Maximum Velocity (m/s)
Natural/Grass	1.5
Concrete/Asphalt	4.0
Armour Stone/Gabion	2.5

Where adjacent to a roadway, the channel or ditch invert is to be a minimum of 0.15 m below the adjacent road sub-grade.

Where permitted by the Township, open ditches shall be designed in accordance with the TAC Geometric Design Guide, MTO Design Supplement and Design Manuals.

In rural or semi-urban areas, where conditions require ditch depths greater than 1.5 m and/or steep ditch grades, the practitioner is to eliminate and/or protect against roadside hazards (i.e., conversion of ditch to a pipe network, provision of barrier system, etc.) while also considering feasibility of maintenance.

13 Culverts and Bridges

Only arterials and collectors, where feasible, will be permitted to cross the major system watercourses. It is also recommended that practitioners consider the need to design culverts and bridges on such arterials and collectors for at least the 1:100-year storm event, if not for the Regional Storm event. If smaller culverts or bridges are provided, the backwater effects for the 1:100 year and Regional Storm flows must be determined. Concrete box culverts shall be designed and placed for all watercourse crossings subject to the approval of the Township. MNR and/or DFO approval may be required for watercourse/valley crossings under their regulations.

Table 13-1: Design Storm Event for Bridges & Culverts

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 slope off the driving surface to the ditch invert.

Bridges and other major drainage structures shall require special designs as determined by the Township. Hydraulic calculations will be required.

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

Requirements for flow and hydraulic calculations regarding fish passage for culverts and bridges shall be completed in accordance with the MTO Drainage Management Manual and may be subject to review by MNRF and DFO.

All structural culverts and bridges shall be deigned in accordance with the Canadian Highway Bridge Design Code.

14 Inlet, Outlet, and Special Structures

OPSD structures shall be used where possible. Where OPSD structures are not suitable, all inlet, outlet, and special structures shall be individually designed and fully detailed by the practitioner.

Hydraulic design calculations for inlet and outlet structures must be performed in accordance with the MTO Drainage Management Manual.

Suitable materials and channelling techniques must be used at all inlets and outlets to protect against scour and erosion as well as to provide embankment stabilization. Gabions are generally not preferred, but may be considered in special cases, upon approval by the Township.

Outfalls shall not discharge to a steep slope or be connected to existing or proposed road crossing culverts.

Outfall channels shall be extended from the outlet structure to the natural watercourse and shall be designed such that flow in the outfall channel is tangential to the flow in the natural watercourse at the confluence.

Grates shall be provided on all inlet and outlet structures in accordance with OPSD.

A suitable barrier, preferably a 1.5 m high chain link fence, shall be provided along all structures for public safety.

15 Hydraulic Modelling Tools

The Township accepts the use of the following modelling software options for completing hydraulic analysis, where required:

- FlowMaster, CulvertMaster, spreadsheet calculations for culvert/ditch capacity
- HEC-RAS, PCSWMM for culvert/bridge analysis and floodplain mapping

New and/or replacement culverts and bridges must not increase floodline water surface elevations from existing conditions.

Where free flowing conditions are not present, backwater analysis may be required.

Practitioners must be fully trained and qualified in the use of the selected software and must be able to recognize and understand all methods, approaches, basic data, rationale, and calculations used by the programs. Practitioners assume full responsibility for the proper application of the modelling tools used.

All model input and output files must be provided in PDF format and digital versions provided when requested.

16 Embankment Stabilization

Where erosion or bank instability is already evident in an area or is anticipated to be of concern, the Township requires that the design incorporates appropriate remedial and/or preventative measures.

Where designing erosion or bank stabilization works, preservation of the watercourse dynamics and natural valley aesthetics must be secondary only to achieving a sound technical solution.

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

17 SWM Controls and Requirements

The following provides a summary of the source, conveyance, and end of pipe controls that are approved by the Township.

Table 17-1: Acceptable Types of SWM Control

Type of Control	Description
At Source	▪ Rainwater Harvesting ▪ Roof Leader Disconnection ▪ Soakaway Pits/Infiltration Trenches ▪ Vegetative Filter Strips ▪ Green Roofs (project specific approval required) ▪ Permeable Pavement (project specific approval required) ▪ Rooftop/Parking Lot Storage (project specific approval required)
Conveyance	▪ Open Ditches (project specific approval required) ▪ Enhanced Grassed Swales ▪ Bioretention/Bioswales ▪ Perforated Pipes
End of Pipe	▪ Oil/Grit Separators ▪ Superpipes/Storage Chambers ▪ Wet/Dry Ponds

Type of Control	Description
	▪ Wetlands

The proposed strategy and control selection must be approved by the Township during pre-consultation and prior to commencement of design.

The design for the selected controls must be completed in accordance with MECP Stormwater Management Planning and Design Manual. Additional specific design requirements, which are particular to the Township, are included in the following subsections.

17.1 Soakaway Pits/Infiltration Trenches

Subject to geotechnical and hydrogeological investigations and recommendations, soakaway pits and infiltration trenches may be used to store and promote infiltration of runoff.

The maximum draw-down time should be less than 48 hours, soils permitting. Longer drawdown times may be permitted where soils exhibit lower percolation rates.

Soakaway pits and infiltration trenches shall be located a minimum of 5.0 m from buildings with basements to avoid infiltration to drainage tiles and sump pumps.

Operation and maintenance requirements shall be provided and where the soakaway pits and/or infiltration trenches are installed on private property, the property owner shall be responsible for implementing the required operation and maintenance program, including the completion of all necessary monitoring and repairs to ensure the continued performance of the unit.

17.2 Oil/Grit Separators

Oil/Grit separators can be a useful tool for smaller drainage areas and when combined in a treatment train approach with other stormwater management controls.

Oil/Grit separators must be sized to treat a minimum of 90% of the runoff volume and achieve total suspended solids (TSS) removal efficiency equivalent to the Enhanced level of treatment (i.e. minimum 80% TSS removal) based on an appropriate site-specific particle size distribution.

Supporting documentation and calculations are to be provided by a qualified professional demonstrating compliance with the above noted criteria.

Operation and maintenance requirements must be provided for all oil/grit separators.

Where oil/grit separators are installed on private property, the property owner shall be responsible for implementing the required operation and maintenance program, including the completion of all necessary monitoring and repairs to ensure the continued performance of the unit.

18 Superpipes/Storage Chambers

Superpipes and storage chambers may be permitted where geotechnical and hydrogeological investigations support this approach and where no practical alternatives exist and surface space for other facilities is limited.

Superpipe systems shall be designed like storm sewers, while functioning as both the detention and conveyance system. They may be installed in an online or offline configuration.

Due to the complex nature of superpipe design, hydraulic modelling using appropriate software must be completed to determine a number of factors including peak flow analysis, required storage volumes, and Hydraulic Grade Line (HGL) analysis.

The following additional design criteria must be considered:

- Completion of additional geotechnical/hydrogeological, and buoyancy analysis may be required to inform the system design.
- Location and placement shall be considered and a minimum of 1.5 m of separation from other infrastructure obtained to permit future maintenance, operation, and/or replacement. Increased separation shall be provided where necessary.
- Where orifice plates are proposed as part of the outlet design, detailed drawings and calculations must be provided to demonstrate the proposed plate connections and their ability to withstand anticipated forces.
- A minimum pipe diameter or box culvert height of 1.0 m is required to allow for accessibility within the pipe for maintenance and cleanout.
- A minimum slope of 0.5% is required to completely drain the system. Slopes should be kept to the minimum as steep slopes will reduce the amount of storage available. Further, when superpipes are being used in an online configuration, minor system flows within the superpipe segment must still meet the minimum pipe velocity criteria.
- Systems shall preferably be made of reinforced concrete. Other options may be considered by the Township in specific site conditions provided that the integrity of the system is guaranteed and demonstrated in the design documentation provided.
- All joints shall be made watertight to minimize infiltration or seepage of groundwater into the system.
- Maintenance access points via risers shall be included at the upstream and downstream ends of the superpipe and at a maximum of 50 m intervals in between.
- Emergency surface overflow paths must be provided in the event the superpipe or its outlet becomes plugged.

18.1 Pond (Wet/Dry/Hybrid/Wetland) Requirements

The design of stormwater management ponds shall be completed in accordance with the MECP Stormwater Management Planning and Design Manual, as supplemented herein.

The table below summarizes several key design requirements pertaining to the geometry and function of all new ponds within the Township. It is noted that these design requirements may not explicitly apply to pond retrofits, but shall be used as a guide and best efforts made.

Table 18-1: SWM Pond Design Requirements

Design Requirement	Description
Length to Width Ratio	▪ Minimum flow path length to width ratio of 3:1. Internal berming within the facility may be used to increase flow path to meet this criterion, but will only be considered where physical constraints impact the configuration.
Slopes	▪ Maximum side slope will be 5:1 from the bottom of the pond to the limit of maximum extended detention, with a minimum horizontal length of 3.0 m. ▪ Where a planting shelf is incorporated, the maximum side slope will be 7:1 for that area. ▪ The minimum allowable gradient on the bottom of a dry pond shall be 1.0% and the maximum gradient shall be 5%.
Depths	▪ A minimum freeboard of 0.3 m is required.
	▪ Permanent pool depth for wet ponds shall range from 1.0 m–1.5 m and 0.15 m – 0.45 m for wetlands. ▪ Deeper permanent pool areas at outlet structures may be considered in situations where site specific conditions warrant or to facilitate the use of a reverse pipe outlet.
	▪ Maximum extended detention depth of 1.0 m above permanent pool for both wet ponds and wetlands.
	▪ Maximum water depth shall be 1.8 m for dry ponds; 2.1 m for wetlands, and 3.3 m for wet ponds.
	▪ Depths may vary to meet specific aquatic or terrestrial species requirements, where identified.
Facility Boundary	▪ The Township's preference is to integrate the pond with the surrounding area, using naturalized measures rather than fencing. However, where the pond abuts private property, a 1.5 m chain link fence may be required.

Design Requirement	Description
	▪ Berming around the facility may be required with a minimum top width of 2.0 m (where no trail or access road is located on the berm) or 4.0 m where a trail or access road is proposed.
Sediment Drying Area	▪ A sediment drying area may be required adjacent to the maintenance access and located close to the forebay. The area is to be sloped at 2.0 – 5.0% toward the pond and shall consist of the same surface treatment as the maintenance access.
Signage and Markings	▪ Cautionary and advisory signage shall be erected adjacent to the pond where it can be clearly viewed by the public. ▪ A geodetic marker/monument providing vertical and horizontal control shall be installed on a permanent structure location (such as a concrete headwall) to assist in future monitoring.
Planting	▪ Plantings must be provided in accordance with the MECP Stormwater Management Planning and Design Manual. ▪ Plantings shall be included for submergent; aquatic, shoreline, and flood fringe; as well as upland areas and shall consist of native species only.
Maintenance	▪ A maintenance by-pass shall be provided via a maintenance hole upstream of the inlet to divert flow from the pond during maintenance operations. ▪ A maintenance access route with a minimum width of 3.0 m, is required to all inlet and outlet structures, spillways, as well as the forebay. Two access points shall be provided or the access road shall be looped to all access points. Sufficient turnaround areas shall be provided, where required. The maximum inside turning radius shall be 10.0 m. The maximum slope on the maintenance access route shall be 10:1. ▪ The maintenance access route base shall consist of a minimum of 300 mm compacted granular 'A' material or 50 mm crusher run limestone (or as specified by a geotechnical engineer). Depending upon the use (i.e. if also used as a walkway or trail), the surface treatment may consist of HL8 asphalt, 19mm crusher run, turfstone, or geogrid.
Other	▪ Where ponds are located in areas that are subject to the collection of contaminants or spills, an upstream oil/grit separator will be required. ▪ A minimum of one borehole shall be located near the centre of the stormwater block to assess the nature of existing soils and

Design Requirement	Description
	the ground water elevation. The local ground water elevation shall be compared to the proposed pond elevations to further inform the design. Additional measures such as impermeable liners may be required. ▪ Operations and maintenance requirements must be provided in the form of a manual for all ponds.

19 Testing and Acceptance

All sewers are to be cleaned and flushed prior to testing.

All maintenance holes, catch basins, and other structures shall be visually inspected by the practitioner and the Township for any deficiencies.

All storm sewer main testing shall be carried out from maintenance hole to maintenance hole, including any connections.

A deflection test, as per OPSS MUNI 410, shall be performed on all storm sewers constructed of flexible pipe material, not sooner than 30 days after the completion of backfilling.

A CCTV inspection as per OPSS MUNI 409 shall be conducted upon satisfactory completion of all other testing; prior to the Township's recommendation for issuance of "Substantial Completion"; and prior to the placement of any surface course asphalt. For land development projects, additional CCTV inspection may be required prior to final assumption.

A digital recording shall be supplied, illustrating a continuous record of the sewer installations, service connections, maintenance holes, etc. A report identifying any unusual or sub-standard conditions shall also be submitted.