Design Criteria for Sanitary Sewers, Storm Sewers and Forcemains for Alterations Authorized under Environmental Compliance Approval

Ministry of Environment, Conservation and Parks

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Preface

The *Design Criteria* establish the minimum design requirements for *alteration* to an existing sewage collection system and stormwater system by adding, modifying, replacing or extending sanitary sewers, forcemains or storm sewers to satisfy one of the conditions imposed by the Director in sewage collection system ECA and stormwater ECA authorizing future *alterations*. Compliance with this Criteria and other conditions of the ECA negates the need for the owner of the municipal sewage collection and stormwater system to apply for an amendment to the ECA for the *alteration* of sanitary sewers, forcemains or storm sewers within the collection system.

The existence of these Criteria does not preclude *alteration* of sanitary sewers, forcemains or storm sewers that are not designed in accordance with these *Design Criteria*. However, any *alterations* to collection systems that are either not designed in accordance with this *Design Criteria* or does not satisfy the conditions of the ECA are subject to the requirement to obtain an amendment to the ECA prior to proceeding with the undertaking.

Other approving authorities, such as municipalities in which the works are constructed or regional governments, may have servicing standards or criteria that are more stringent than the requirements outlined in the Sanitary Sewer, Storm Sewer & Forcemain *Design Criteria* and they shall be considered acceptable for the purposes of complying with the requirements of the Sanitary Sewer, Storm Sewer & Forcemain *Design Criteria*.

The *Design Criteria* document reflect program decisions that would be routinely made by the approving Director that issues ECAs under the authority of the Ontario Water Resources Act and the Environmental Protection Act. The *Design Criteria* may be updated from time to time by the Director or in order to conform to any future changes to the provincial policy, regulation or legislation that apply to sanitary sewers, forcemains or storm sewers.

Definitions

“Alteration” has the same meaning as in SDWA 2002.

“Appurtenance” includes a valve, valve chamber, flow meter, maintenance access point, maintenance hole, manhole, grate, catch basin, catch basin lead, ditch inlet chamber or other minor accessory part of a sewer;

“Combined Sewer”; means pipes that collect and convey both wastewater from residential, commercial, institutional and industrial buildings and facilities and stormwater runoff through a single-pipe system, but do not include Nominally Separate Sewers;

“Compound of Concern” means a contaminant that, based on generally available information, may be emitted from a component of the drinking water system to the atmosphere in a quantity that is significant either in comparison to the relevant point of impingement limit or if a point of impingement limit is not available for the compound, then based on generally available toxicological information, the compound has the potential to cause an adverse effect as defined by the EPA at a point of impingement;

"CWA" means the Clean Water Act, R.S.O. 2006, c.22, as amended;

“Design Criteria” means MECP’s Design Criteria for Sanitary Sewers, Storm Sewers and Forcemains for Alterations Authorized under Environmental Compliance Approval;

"Director" means a person appointed by the Minister pursuant to section 5 of the EPA for the purposes of Part II.1 of the EPA;

"EAA" means the Environmental Assessment Act, R.S.O. 1990, c. E.18, as amended;

"Emergency Situation" means a structural, mechanical or electrical failure that causes a temporary reduction in the capacity, function or performance of any part of the Sewage Collection System or an unforeseen flow condition that may result in:

a) danger to the health or safety of any person;

b) injury or damage to any property, or serious risk of injury or damage to any property; or,

c) deleterious adverse impact to the natural environment;

"EPA" means the Environmental Protection Act, R.S.O. 1990, c.E.19, as amended;

"Equivalent Equipment" means a substituted equipment or like-for-like equipment that meets the required quality and performance standards of a named equipment;

"Event" means an action or occurrence, at a given location within the Works that causes a Bypass or an Overflow or natural environment. An Event ends when there is no recurrence of the incident at the same location in the 12-hour period following the last incident;

“Hauled Sewage” means the same as defined under O.Reg. 347

"Ministry" means the ministry of the government of Ontario responsible for the EPA, CWA and OWRA and includes all officials, employees or other persons acting on its behalf;

“municipal sewage system” means a sewage system or part of a sewage system;

a) that is owned by a municipality or by a municipal service board established under the Municipal Act, 2001 or a city board established under the City of Toronto Act, 2006,

b) that is owned by a corporation established under sections 9, 10 and 11 of the Municipal Act, 2001 in accordance with section 203 of that Act or under sections 7 and 8 of the City of Toronto Act, 2006 in accordance with sections 148 and 154 of that Act;

“natural environment” means the air, land and water, or any combination or part thereof, of the Province of Ontario;

“operating authority” means, in respect of a municipal sewage system, the person or entity that is given responsibility by the owner for the operation, management, maintenance or alteration of the system;

"Owner" means the [Municipality or Municipal Services Board], and includes its successors and assignees;

"OWRA" means the Ontario Water Resources Act, R.S.O. 1990, c. O.40, as amended;

"Part II Order" means an order issued by the Minister that makes a Class Environmental Assessment Project an Undertaking that is subject to Part II of the EAA;

"Professional Engineer” means a person who holds a full licence to practice in the Province of Ontario;

"Prescribed Persons” means persons prescribed as per O. Reg. 208/19;

"Rated Capacity" means the Average Daily Flow which the Works are approved to handle;

“Sanitary Sewer” means pipes that collect and convey wastewater from residential, commercial, institutional and industrial buildings;

“Sanitary Sewer Overflow Event” means release of sanitary sewage to the environment from a sanitary sewer or appurtenance;

“service connection” means the pipe portion of a sewage works that extends from a sewer to the property line of a property serviced by the sewer;

“Sewage Collection System” means a system of sewage works, excluding plumbing, that is established for the purpose of collecting sewage from users of the system and includes:

a) Anything used for the collection, storage, pumping, or transmission of sewage;

b) Anything used for the management of residue from collections system or the management of the discharge of a substance into the natural environment from the collection system

c) That for greater certainty does not include anything within the property line of the sewage treatment plant.

“sewer” means any system of pipes, drains and appurtenances used for the collection or transmission of sewage, but does not include plumbing to which the Building Code Act, 1992 applies or a pumping facility;

"Significant Drinking Water Threat" has the same meaning as in the CWA;

"Significant Threat Policy(ies)" has the same meaning as in the CWA;

"Source Protection Plan" means a drinking water source protection plan prepared under the CWA;

“Spill” means the same as defined under Reg. 675;

"District Manager" means the District Manager or a designated representative of the appropriate local office of the Ministry, where the Works are geographically located;

“Uncommitted Reserve Hydraulic Capacity” means uncommitted reserve capacity as described in MECP’s Procedure D-5-1; and

"Works" means the sewage works described in the Owner’s application, this Approval, Proposed Works and the modifications made under Limited Operational Flexibility.

1.0. Introduction

The *Design Criteria* establish the minimum design requirements for *alteration* to an existing sewage collection system and stormwater system to satisfy one of the conditions imposed by the Director in sewage collection system Environmental Compliance Approval (ECA) and stormwater ECA authorizing future *alterations*. The designers and proponents of such works are responsible to ensure that all the applicable federal and provincial requirements are incorporated in the design and construction of sanitary sewers, storm sewers and forcemains. where regulations and standards are referenced in this document, most up to date version shall be used.

1.1. General Requirements

1.1.1. *Alteration* to an existing *sewage collection system* by adding, modifying, replacing or extending existing sanitary or forcemains, and/or *appurtenances*, is not permitted when such works;

1. results in exceedance of *uncommitted reserve hydraulic capacity* of the downstream;
    a. *sewage collection system* including sewage pumping stations;
    b. receiving sewage treatment facilities; or
2. causes an adverse discharge to the natural environment within the *sewage collection system* or at the downstream sewage treatment facilities; or
3. adversely impacts the approved effluent quality of sewage treatment facilities.

1.1.2. *Alteration* to an existing stormwater system by adding, modifying, replacing or extending existing storm sewers, and/or *appurtenances*, is not permitted when such works;

1. results in exceedance of *uncommitted reserve hydraulic capacity* of the downstream;
    a. conveyance system;
    b. the receiving stormwater management/treatment facilities; or
2. causes an adverse discharge to the natural environment; or
3. adversely impacts the approved effluent quality of stormwater works.

1.1.3. The existing *sewage collection system* may be altered by adding, modifying, replacing or extending existing sanitary or forcemains, *appurtenances*, and other components of these systems that are pre-authorized in the ECA, subject to the following conditions;

1. The design for addition, modification, replacement or extension of sanitary sewers, forcemains or storm sewers, and/or *appurtenances*;
    a. has been prepared by a *Professional Engineer*;
    b. has been designed to transmit but not to treat wastewater; and
    c. satisfies these *Design Criteria*.

2. *Uncommitted reserve capacity* calculations for the downstream *sewege collection system* and treatment facilities has been prepared and submitted by the proponent to the Owner with the supporting documentation.
3. Municipality shall have a plan and process, as the owner of the system, to forecast and track *uncommitted reserve capacity* and verify the proposed *alteration* of the system can be accommodated.
4. All required documentation detailed in this *Design Criteria* and/or in the ECA has been completed.

1.1.4. The existing stormwater system may be altered by adding, modifying, replacing or extending existing storm sewers, *appurtenances*, and other components of these systems that are pre-authorized in the ECA, subject to the following conditions;

1. The design for addition, modification, replacement or extension of storm sewers, and/or *appurtenances*;
    a. has been prepared by a *Professional Engineer*;
    b. satisfies these *Design Criteria*; and
    c. has been planned, designed and built to be consistent with the Provincial Water Management: Policies, Guidelines, and Water Quality Objectives.
2. All documentation detailed in this *Design Criteria* and/or in the ECA has been completed.

1.2. Design Considerations

1.2.1. All sanitary sewers, storm sewers, forcemains, maintenance holes, and chambers, shall be designed considering all relevant soil and hydrogeological conditions as identified by the geotechnical professional.

1.2.2. The design of all maintenance holes, chambers and structures shall conform to all applicable requirements including, but not limited to: Occupational Health and Safety Act, Ministry of Labour Confined Space Guidelines and Fire Protection and Prevention Act.

1.2.3. All new maintenance holes and chambers shall be designed with explicit and documented consideration for future inspection, operation, maintenance, and rehabilitation.

1.2.4. All precast structures shall include necessary hardware to prohibit heave due to frost action.

1.2.5. Sewers, maintenance holes and chambers containing valves, monitoring devices, or other such *appurtenances* shall be avoided in areas subject to flooding or in areas of high groundwater (regular and seasonal).

1.2.6. If *appurtenances* are located in areas subject to flooding/high groundwater, Inflow and Infiltration reduction and flotation prevention measures shall be included in the design.

1.2.7. The design shall include in the project specifications requirements for;

1. mandatory inspection and testing as per Appendix A of this document; and

2. adequate control of siltation and erosion during construction.

1.2.8. An assessment of the proposed works shall be completed to determine if the works pose a Significant Drinking Water Threat and if they are, the design shall incorporate features that mitigate the threat to sources of drinking water, such as those included in:

1. Ministry's Standard Operating Policy for Sewage Works published on the Environmental Registry (Posting #012-2968), as amended from time to time; and
2. Source Protection Plan policies pertaining to the works.

1.3. Protection of Water Supplies

1.3.1. Sanitary sewers, storm sewers, forcemains, and all associated *appurtenances* and structures shall be designed with provisions to provide the required protection for drinking water supply systems in accordance with the MECP's F-6-1 Procedures to Govern Separation of Sewers and Watermains.

1.3.2. Refer to Section 15 (Separation Distances from Contamination Sources) of MECP's Watermain *Design Criteria*, for the required separation distances between the drinking water supply system components and sanitary sewers, storms sewers, forcemains and associated, *appurtenances* and structures.

2.0. Design of Sanitary Sewers

2.1. Design Flows

2.1.1. Residential Flows

1. The average daily residential flows of 225 to 450 L/cap/day shall be used in the design for sizing the pipe.
2. Peaking factor can be calculated using either the Harmon Formula or Babbitt Formula. At minimum, a peaking factor of 2.0 shall be used in the design.

2.1.2. Commercial Flows

1. The minimum allowance for commercial flows shall be 28 m^3/ha/day. Actual flow monitoring data at the subject site or a similar site observed locally can be used.
2. The Sewage flows listed on Table 1 may be used in the design for individual commercial facilities.

2.1.3. Institutional Flows

1. Historical water use data at the subject site or a similar site (covering at least 2 years) of the facility or other similar facilities can be used to calculate average institutional flows. Where historical water use data is not available, the unit values for institutional flows listed in Table 1 can be used. The designer shall use professional judgement to select appropriate flow rate within the range.

2.1.4. Industrial Flows

1. Where available, actual flow monitoring data at the subject site or a similar site (covering at least 2 years) shall be used for accurate prediction of industry specific wastewater flows. Where actual flow data is not available, an average flow from 0.3 to 0.5 L/s/ha can be used.

2.1.5. Extraneous Flow (I&I)

A long-term inflow and infiltration rate between 0.1 L/s/ha and 0.25 L/s/ha shall be used in pipe sizing.

Table 1 - Common Sewage Flowrates for Commercial and Institutional Uses

Description	**Unit Sewage Flow (L/d)**	**Flow Unit Per**
Shopping Centre (floor area in m^2)	2.5 – 5.0	Based on total floor area in m^2
Hospitals	900 – 1,800	Bed
Schools	70 - 140	student
Travel Trailer Parks	340 800	Space (without water hook-ups) Space (with indiv. water hook-ups)
Campgrounds	225 - 570	Campsite
Mobile Home Park	1,000	Parking space
Motels	150 - 200	Bed space

Hotels	225	Bed space

2.2. Pipe Diameters

2.2.1. The minimum size of the Gravity Sewer conveying sewage in municipal sanitary sewer system shall be 200 mm in diameter (nominal pipe size). Sewer pipe 150 mm in diameter can be used if it is demonstrated that there is no risk of clogging and the design is accepted by the local municipality.

2.3. Friction Factors

2.3.1. Sanitary and storm sewers: Sanitary and storm sewers shall be designed using either the Chézy- Kutter, Darcy Weisbach or Chézy-Manning's formula. Appropriate roughness coefficient shall be used according the type of pipe used. The friction loss coefficient must be appropriate to the installed pipe, but not less than the equivalent of a Manning's equation "n" of 0.013 for all new smooth-wall sewer pipes.

2.4. Flow Velocity

2.4.1. Gravity sewers shall be designed with uniform slopes between the maintenance holes.

2.4.2. All gravity sanitary sewers shall be designed and constructed with slopes to provide at least 0.6 m/s of flow velocity at design flows to maintain solids in suspension.

2.4.3. In certain circumstances, such as rehabilitation/replacement of an existing sewer where deepening of individual sewer section will not be possible, design flow velocities of less than 0.6 m/s may be considered provided that appropriate measures are taken to facilitate frequent flushing and maintenance needs and the Municipality accepts the increased maintained requirements.

2.4.4. The maximum velocity in all sanitary sewers shall be less than or equal to 3.0 m/s at design flows.

2.5. Anchors/Restraints

2.5.1. Sanitary sewers on 20 percent slope or greater shall be anchored securely with concrete anchors or equal.

2.5.2. Anchors and anchorage spacing shall be designed by a *Professional Engineer* based on sewer material, anchor type and site conditions. Recommended maximum anchorage spacing is 11 m on grades between 20 percent and up to 35 percent, 7.3 m on grades between 35 percent and up to 50 percent, and 4.9 m on grades that exceed 50 percent.

2.5.3. Where velocity in the sanitary sewers approaching or exceeding 3 m/s due to steep grades and providing a drop maintenance hole is not possible, sewers shall be designed for protection against maximum scouring velocity and erosion control measures shall be taken.

2.6. Pipe Material

2.6.1. All material used in the addition, modification, replacement, or extension of sanitary sewers including pipes, fittings, valves, devices, and materials used for the rehabilitation shall meet all applicable quality adopted by the Ontario Provincial Standards for Roads and Public Works and/or local municipal standards. Where applicable standards conflict, the more stringent standard shall apply. Prior to specifying pipe material, soils shall be assessed for contamination. Nitrile gaskets or equivalent shall be specified for soils contaminated with hydrocarbons, unless soil remediation prior to construction provides satisfactory results.

2.6.2. If the material is used based on specific site conditions, the reasons for material selection should be stated and location shall be identified in the record drawings.

2.7. Pipe Strength

2.7.1. The sanitary sewer pipe material selected for a particular application shall be able to withstand all of the combinations of loading conditions to which the pipe is likely to be exposed along with an appropriate safety factor.

2.8. Pipe Cover and Frost Protection

2.8.1. Sanitary sewers shall be installed at sufficient depth (greater than frost penetration) to prevent freezing. If this is not achievable, the sewer shall be insulated to provide the required protection. Insulation must be designed or verified by a *Professional Engineer*.

2.8.2. For sanitary sewers subject to traffic load, a loading factor in accordance with the regulations, codes and by-laws of authorities having jurisdiction shall be considered for selecting depth of pipe cover. This includes but not limited to: Highway Bridge Design Code (for vehicular traffic), Railway Safety Act, and Transport Canada Act. Appropriate structural support shall be provided to the pipes as required.

2.8.3. Maximum pipe cover should be per the manufacturer recommendations.

2.9. Sewers Installed below Seasonally High Groundwater Table

2.9.1. Sanitary sewer systems which are installed lower than 0.5m the seasonally high groundwater elevation (SHGWT) shall be designed to minimize inflow and infiltration.

2.9.2. The pipe shall be designed to forcemain standards. The use of HDPE pipe or equivalent may be appropriate. Maintenance hole spacing shall be maximized where appropriate.

2.9.3. The maintenance hole shall be externally wrapped.

2.9.4. The maintenance hole covers shall be designed to be watertight, air vents shall be provided at appropriate locations.

2.10. Maintenance holes

2.10.1. Maintenance holes shall be provided at the end of each sewer line; at all changes in grade, size, or alignment; at all intersections and/or at a distance not greater

than 120 m for sewers up to 375 mm in diameter, and 150 m for sewers between 450 mm to 750 mm in diameter.

2.10.2. In circumstances where maintenance holes cannot be provided, an upstream maintenance hole at a distance of 30 m (max) is required to facilitate maintenance.

2.10.3. An additional straight through maintenance hole with similar upstream and downstream sloped sewers shall be provided between new subdivisions and the municipal system for the purposes of flow monitoring.

2.10.4. The minimum drop across maintenance holes shall be 25 mm for straight runs and 50 mm for 90-degree bends. Alternately, sewer grade may be maintained across maintenance holes provided minimum required flow velocity is maintained.

2.10.5. Where a smaller diameter sewer line joins a larger one, the invert of the larger sewer shall be lowered to maintain the same energy gradient, or the pipe obverts are matched.

2.10.6. A drop structure shall be provided for sewers entering a maintenance hole at an elevation of 610 mm or more above the maintenance hole invert.

2.10.7. An external drop structure is recommended for all new maintenance holes. Where the difference in elevation between the incoming sewer and the maintenance hole invert is less than 610 mm, the invert shall be benched to prevent solids deposition.

2.10.8. If an external drop structure is not feasible, an internal drop structure can be used if the structure is provided with restraint straps or equivalent.

2.10.9. Maintenance holes shall be located away from any overland flow route or ponding area. Grading around maintenance holes shall be benched so as to direct water away from the maintenance hole.

2.10.10. If it is necessary to locate a maintenance hole where overland flow is a risk, watertight frame & grate and covers shall be specified.

2.10.11. Frost straps (internal or external) shall be provided to hold maintenance hole sections together (at least three (3) between each section). External straps to extend vertically from top to bottom.

2.10.12. Joints between maintenance hole sections, and between maintenance hole sections and inlet and outlet pipes, shall be sealed with gasketed flexible watertight connections. Where works are cast-in-place, sealing is required only at the point of connection between individual components of the maintenance hole structures shall be sealed.

2.10.13. Maintenance holes that are subject to high ground water or flooding conditions, shall have a water tight membrane outside to reduce infiltration.

2.10.14. Maintenance holes shall be designed based on the pipe size, alignment and inspection and maintenance needs. The minimum diameter of maintenance holes shall be 1200 mm (48 in). A minimum access diameter of 610 mm (24 in) shall be provided.

2.10.15. Safety platform spacing shall be designed for deep maintenance holes per Occupational Health and Safety Act requirements and inspection, operation and maintenance needs. Multiple platforms may be required based on the depth of the maintenance holes.

2.11. Inverted Siphons

2.11.1. Inverted siphons shall be designed with consideration of potential siltation, air locking, maintenance, and odor issues

2.11.2. The minimum pipe size for inverted siphons shall be nominally 200 mm in diameter.

2.11.3. Pipes shall be sized such that a Self-Cleansing velocity between 1.1 m/s to 1.3 m/s is achieved at least once per day. Where the required velocities cannot be achieved alternate means of flushing shall be incorporated in the design.

2.11.4. Gravity drains or any other means of draining or dewatering the inverted siphon shall be incorporated to facilitate inspection and maintenance.

2.11.5. Air jumpers shall be sized to carry the required air flow between the inlet and outlet chambers.

2.11.6. Inverted siphons shall be designed with at least two parallel barrels to accommodate flow variations.

2.11.7. If a double barrel siphon is not feasible, a single barrel inverted siphon is acceptable provided that additional arrangements are incorporated in the design to facilitate inspection, operation and maintenance.

2.11.8. Inverted siphons shall be equipped with inlet and outlet chambers sized to facilitate inspection, operation and maintenance.

2.11.9. Control valves/sluice gates shall be installed in inlet and outlet chambers especially on multi-barrel siphons to isolate or divert flows to each pipe.

2.11.10. Inverted siphons shall not be designed with sharp vertical or horizontal bends. The slope for the upward vertical leg shall be limited to 1:2 (V:H).

2.11.11. Ventilation is required at the Inlet and outlet chambers.

2.12. Service Connections (Service Laterals)

2.12.1. All *service connections* shall be constructed to be water tight.

2.12.2. The minimum diameter for a *service connection* to main sewer for gravity flow shall be 100 mm in diameter. Sanitary sewer pipes on both private and public side shall be colour coded green to avoid cross connections.

2.12.3. Sanitary laterals and sanitary *service connections* shall be specified with a minimum 1% slope (2% slope is recommended).

2.12.4. Where required, the riser pipe on the sanitary service pipe shall be installed at a maximum 1:1 slope, before transitioning to a nominally horizontal installation. The transition from the nominally horizontal section to the steep section shall be completed with a long radius bend.

2.12.5. Cleanouts should be installed at or near the property line to facilitate inspection and cleaning.

3.0. Design of Forcemains

3.1. Pipe Diameters

3.1.1. The minimum size for a sewage forcemain shall be 100 mm in diameter.

3.1.2. A smaller diameter forcemain may be acceptable if it is used to maintain the minimum velocity in the forcemain (as outlined in this document). A grinder pump or equivalent shall be provided for such applications and Design Brief including detailed hydraulic calculations shall be submitted by a *Professional Engineer*.

3.2. Friction Factors

3.2.1. Forcemains shall be designed using Hazen-Willams formula or Darcy -Weisbach equation. Hazen-Willims formula is recommended for design of forcemains. Where data are not available, the forcemains shall be designed using the equivalent to Hazen-Williams C-factors listed in Table 2 for pipes made of traditional materials or their equivalent.

Table 2 - Hazen-Williams C-Factors

Material	C-Factor
Steel pipe	100
PVC, HDPE, lined ductile iron	120

3.3. Flow Velocity

3.3.1. Forcemains shall be designed for a cleansing velocity of at least 0.6 m/s.

3.3.2. The maximum velocity in the forcemains shall not exceed 3.0 m/s.

3.4. Anchors/Restraints

3.4.1. Restrained joints shall be installed at all tees, bends, end of forcemains and connections for all forcemains. Calculations will be required from the *Professional Engineer* to determine the number of joints to be restrained beyond the bend, fitting, tee etc.

3.4.2. In the case of non-restraining mechanical and/or slip-on joints, restraint shall be provided by adequately sized thrust blocks positioned at all plugs, caps, tees, line valves, reducers, wyes, and bends deflecting 22 ½ degrees or more.

3.4.3. In designing thrust blocks or other restraint systems, transient pressures shall be added to the normal operating pressures when calculating the thrust forces.

3.4.4. Act requirements and inspection, operation and maintenance needs.

3.5. Pipe Material

3.5.1. Forcemain material used in the addition, modification, replacement, extension or rehabilitation including pipes, fittings, valves, devices, and other materials used shall meet the more stringent of quality standards adopted by Ontario Provincial Standards for Roads and Public Works or local Municipal standards

3.5.2. Prior to specifying pipe material, soils shall be assessed for contamination. Nitrile gaskets or equivalent shall be specified for soils contaminated with hydrocarbons.

3.5.3. If the material is used based on specific site conditions, the reasons for material selection should be stated and location shall be identified in the record drawings.

3.6. Pipe Strength

3.6.1. The forcemain pipe material selected for a particular application shall be able to withstand, with a margin of safety, all the combinations of loading conditions to which the forcemain it is likely to be exposed.

3.7. Pipe Cover and Frost Protection

3.7.1. Forcemains shall be installed at sufficient depth (greater than frost penetration) to prevent freezing., If this is not achievable, forcemains shall be insulated/or heat traced. Insulation/heat tracing shall be designed/verified by a *Professional Engineer*.

3.7.2. For forcemains subject to traffic loading, a loading factor in accordance with the regulations, codes and by-laws of authorities having jurisdiction shall be considered for selecting depth of pipe cover. This includes but not limited to: Highway Bridge Design Code (for vehicular traffic), Railway Safety Act, and Transport Canada Act. Appropriate structural support shall be provided to the pipes as required.

3.7.3. If a protective sleeve is used appropriate sleeve material shall be selected based on the site conditions.

3.7.4. Maximum pipe cover should be as per the manufacturer recommendations.

3.8. Termination

3.8.1. For flows greater than 30 L/s, transition maintenance holes shall be provided at forcemain discharge points to provide smooth flow transition into the receiving gravity sewers.

3.8.2. The transition maintenance hole shall be designed based on the pipe size, alignment and inspection and maintenance needs. The minimum diameter of maintenance holes shall be 1200 mm (48 in). A minimum access diameter of 610 mm (24 in) shall be provided.

3.8.3. The forcemains shall enter the transition maintenance hole at a point not more than 0.3 m above the flow line. No other gravity sewers shall enter the transition maintenance hole.

3.8.4. Protective coatings or approved concrete additive shall be provided in the transition maintenance hole to prevent deterioration due to presence of hydrogen sulfide or other corrosive chemicals.

3.8.5. The sewer connecting the transition maintenance hole to downstream maintenance hole shall be sized to flow at half depth to ensure a smooth flow.

3.8.6. Safety platforms shall be designed for deep maintenance holes per Occupational Health and Safety Act.

3.9. Identification

3.9.1. A Tracer Wire shall be installed for all non-metallic forcemains regardless of the size, identifier codes or markings can be added to identify the use of pipe in conformance with local municipal standards.

3.10. Maintenance

3.10.1. All new forcemains longer than 150 m shall be provided with swab launching ports and/or flushing ports. Swab catching ports may be required.

3.10.2. Isolation valves shall be provided as required to facilitate maintenance. Non-return valves may be required when forcemains are connecting into a common forcemain.

3.10.3. Cleanouts/drain chambers shall be provided at low points of a forcemain.

3.11. Transient Pressures

3.11.1. A hydraulic transient analysis shall be undertaken as part of the design process considering the worst-case failure scenario involving the most critical pump and forcemain-in-service combination. The analysis shall be completed using hydraulic models based on the final sizes and layout of pumps and forcemains including locations of air/vacuum release valves. Based on the hydraulic transient analysis, provide devices, if necessary, to protect the forcemain such as, but not limited to, surge valves, surge tanks, etc.

3.11.2. The forcemains shall be designed so that pipes and joints are able to withstand the maximum operating pressure plus the surge pressure that would be created by stopping a water column moving at 0.6 m/s.

3.11.3. The forcemains shall be designed such that pipes, joints, fittings and valves are able to withstand full vacuum pressure.

3.12. Air and Vacuum Relief Valves

3.12.1. A combination of sewage air and vacuum relief valves shall be placed at all high points in the forcemain to relieve air locking and to relieve negative pressures on forcemains.

3.12.2. At minimum, the Air/vacuum relief valves shall conform to AWWA standard C512-15 Air Release, Air/Vacuum and Combination Air Valves for Water and Wastewater Service, as amended from time to time.

3.13. Drain Valves

3.13.1. Drain valves shall be placed at all low points in the forcemain to facilitate cleaning.

3.13.2. Drain valves on the forcemain are to be flanged connections in valve chambers. Where possible, the valve chamber may be drained to the closest gravity sanitary sewer or maintenance hole or drained back into the wet well.

3.13.3. A drain pipe shall be connected from the chamber to the nearest wastewater pipe.

3.14. Service Connections

3.14.1. Minimum diameter of a forcemain for a *service connection* is 100 mm in diameter. Grinder pumps or equivalent must be provided in the case the size of the forcemain is less than 100mm in diameter but not less than 75mm.

4.0. Combined Sewers

4.1. Rehabilitation of Existing Combined Sewers

4.1.1. Sewers shall be planned, designed, installed and operated to minimize or eliminate *combined sewer* overflows.

4.1.2. New *combined sewer* system is not permitted.

4.1.3. Addition or extension of an existing *combined sewer* is not permitted.

4.1.4. Rehabilitation, repair and replacement of an existing *combined sewer* is permitted only if:

1. It is demonstrated in a design brief by a *Professional Engineer* that such works will not result in an increase in CSO volume, frequency, duration or deterioration of CSO discharge quality.

4.1.5. Rehabilitation of existing *combined sewer* overflow structures is permitted including instrumentation and controls that are installed for the purpose of monitoring and reporting only.

4.1.6. Rehabilitation of existing CSO control structures is permitted including modifications that are intended only to improve the performance or optimize utilization of the existing control structures.

4.1.7. Storm sewer connection to a *combined sewer* is not permitted except for *combined sewer* separation project where the municipality proposes a temporary storm connection to a combined system. This approach requires a detailed plan to disconnect and separate the storm sewer to a separated storm outlet according to an established schedule. Specifically, if it is demonstrated that such works will not result in an increase in CSO volume, frequency, duration or by-pass of treatment during the schedule period.

4.2. CSO Detention Facilities

4.2.1. Construction of new CSO detention facility for an existing CSO control structure for the purpose of reducing volume, frequency or duration of a CSO discharge and to improve quality of combined CSO discharges is permitted provided that;

1. Is not designed to replace an existing outfall to a watercourse;
2. does not have a direct environmental discharge such as to watercourse, groundwater or the ground from the detention structure;
3. is controlled by an existing CSO control structure; and
4. it is demonstrated in a design brief by a *Professional Engineer* that such works has structural integrity to function as intended/designed.

5.0. Storm Sewers

5.1. Design Consideration

5.1.1. Only stormwater shall be accepted or collected by storm sewers.

5.1.2. Sanitary sewage or combined sewage shall not be accepted or collected by storm sewers or conveyed or directed to a stormwater works.

5.1.3. Stormwater Management shall be designed using an integrated treatment train approach used to minimize stormwater management flows and reliance on end of pipe controls through measures including source controls, lot level controls and conveyance techniques.

5.1.4. Storm sewers shall be designed, using most recent rainfall intensity, duration and frequency (IDF) curves available from the respective municipality for which the sewers are to be constructed. If the municipality does not have access to current IDF curves (including recent events), adjacent jurisdictions shall be consulted for IDF curves, and worst-case values shall be used in design.

5.1.5. In the design of conveyance drainage system, local weather data to be used to establish design storm frequency criteria, at a 2-year return design storm or greater storm event can be used for minor system design.

5.1.6. Inlet times shall be calculated based upon the overland flow route under fully developed system conditions.

5.2. Runoff Calculations

5.2.1. The peak rate of runoff from an area may be calculated using the using the following formula:

$$Q = 2.78\ C \cdot I \cdot A$$

Where Q is the Peak flow in liters per second, A is the area in hectares, C is run-off coefficient (dimensionless) and I is average rainfall in mm per hour for a duration equal to the time of concentration for a particular storm frequency.

5.2.2. The range of runoff coefficients shown in Table 3 may be used for design purposes. A *professional engineer* shall select the appropriate “C” value within the range.

Table 3 - Runoff Coefficients

Source	**Runoff Coefficient (C)**
Asphalt, concrete, roof areas	0.90-1.00
Grassed areas, parkland	0.15-0.35
Brick Roads	0.7-0.85
Sandy Soil	0.05-0.25
Playgrounds	0.2-0.35
Gravel	0.6-0.7

5.2.3. For calculating runoff for less frequent, high intensity storms for particular type of area in Table 2, upper values of the range shall be used. The lower value of the range may be used for shorter recurrence interval storms under conditions of moderate to flat slopes.

5.3. Pipe Size

5.3.1. Storm sewers shall be designed to flow at *Full Design Capacity* of the pipe. Storm sewer capacities shall be calculated using the Manning's equation with roughness coefficient (n) or equivalent as listed in Table 4 for all new pipes.

Table 4 Manning's Roughness Coefficient (n) for New Pipes

Pipe Material	Roughness Coefficient (n)
Smooth-walled pipe materials (HDPE, PVC, Concrete)	0.013
Corrugated metal pipe	
Plain Pipe	0.024
Paved Invert	0.020

5.3.2. The minimum size of the storm sewer shall be 250 mm in diameter. For storm sewer laterals, the minimum service connections shall be 100 mm diameter white pipe.

5.4. Flow Velocity

5.4.1. The minimum flow velocity in the storm sewer shall be 0.75 m/s. Velocities in storm sewers shall not exceed 6 m/s.

5.4.2. Additional protection against erosion, scouring and pipe displacement must be provided by a *professional engineer* where flow velocities exceed 3.0 m/s.

5.4.3. The storm sewers shall be placed at a minimum slope of 1% on first leg of the system.

5.5. Pipe Material

5.5.1. Rigid and flexible pipes including but not limited to concrete, polyvinyl chloride (PVC) and high-density polyethylene (HDPE) pipes may be used in construction of storm sewers.

5.5.2. Prior to specifying pipe material, soils shall be assessed for contamination. Nitrile gaskets or equivalent shall be specified for soils contaminated with hydrocarbons.

5.5.3. If the material is used based on specific site conditions, the reasons for material selection should be stated and location shall be identified in the record drawings.

5.6. Pipe Cover and Frost Protection

5.6.1. Storm sewers shall be installed at sufficient depth (greater than frost penetration) to prevent freezing, if this is not achievable, sewers shall be insulated. Insulation must be designed/verified by a *professional engineer*.

5.6.2. Storm sewers that are subject to traffic loading, a loading factor in accordance with the regulations, codes and by-laws of authorities having jurisdiction shall be considered for selecting depth of pipe cover. This includes but not limited to: Highway Bridge Design Code (for vehicular traffic), Railway Safety Act, and Transport Canada Act. Appropriate structural support must be provided to the

pipes as required. If a protective sleeve is used appropriate sleeve material shall be selected based on the site conditions.

5.6.3. Maximum pipe cover should be per the manufacturer recommendations.

5.7. Maintenance Holes

5.7.1. Maintenance holes shall be provided at each change in alignment, pipe size, grade, material and at all pipe junctions. For blind connections, an upstream maintenance hole at a distance of 30 m (max) is required to facilitate maintenance.

5.7.2. Maintenance hole spacing depends on pipe size; spacing shall be in conformance to local municipal design guidelines. Where municipal design guidelines do not exist, the maximum spacing as listed in Table 5 can be used.

Table 5 - Maintenance Hole Spacing

Sewer Diameter (mm)	**Spacing (m)**
250 to 975	110
1050 to 1350	130
1500 to 1650	160
1800 and Above	305

5.8. Catch Basins

5.8.1. Catch basins shall be provided at adequate intervals to ensure that the drainage is intercepted up to the capacity of the storm sewer.

5.8.2. Street catch basin spacing will vary with the street width, grade and cross fall, the location of pedestrian crossing points, intersections, low points and driveway depressions. Maximum Catch basin spacing shall be per Table 5.

Table 6 - Catch Basin Spacing

Road Gradient (%)	**Maximum Spacing (m)**
0 to 3	110
3.1 to 4.5	90
Over 4.5	75

5.8.3. The minimum diameter of the catch basin lead is 250 mm and the minimum of 1% slope shall be provided for a catch basin lead.

5.9. Inverted Siphons

5.9.1. Inverted siphons shall be designed with consideration of potential siltation and air locking.

5.9.2. Inverted siphons shall be designed with water tight joints, and to withstand hydrostatic pressure.

5.9.3. Gravity drain or any other means of draining or dewatering the inverted siphon shall be incorporated to facilitate inspection and maintenance.

5.9.4. The minimum pipe size for inverted siphons shall be nominally 250 mm in diameter.

5.9.5. Appropriate cover shall be provided above the inverted siphon based the type of crossing structure.

5.9.6. Pipes shall be sized such that a Self-Cleansing velocity between 1.1 m/s to 1.3 m/s is achieved in 25 mm storm event (First Flush). Where the required velocities cannot be achieved alternate means of flushing shall be incorporated in the design.

5.9.7. Inverted siphon shall be designed with at least two parallel barrels of same size, each capable of conveying the design flowrate. Single barrel inverted siphons are acceptable provided that additional arrangements are incorporated in the design to facilitate inspection, and maintenance.

5.9.8. Inverted siphons shall be equipped with inlet and outlet chambers sized to facilitate inspection and maintenance.

5.9.9. Control valves/sluice gates shall be installed in inlet and outlet chambers especially on multi-barrel siphons to isolate or divert flows to each pipe.

5.9.10. Inverted siphons shall not be design with sharp vertical or horizontal bends, the slope for the upward vertical leg shall be limited to 1:2 (V:H).

6.0. Foundation Drain Discharge Collection System (Third Pipe System)

6.1.1. Foundation drain discharge collection system shall be designed to collected water only from the foundation drains.

6.1.2. Foundation drain discharge collection system shall not receive water from any sites that are contaminated or suspected to be contaminated unless;

1. Environmental site assessment is completed to confirm that site is free from contamination; or
2. Acceptable results are obtained after remediation work; or
3. Pretreatment is in place to achieve acceptable results.

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

6.1.4. The minimum size of the pipe in the foundation drain collection system shall be 200 mm in diameter (nominal pipe size).

6.1.5. The minim slope for the gravity pipes within the foundation drain collection system shall be 1%.

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

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

6.1.8. Foundation drain collection system may be discharged to storm sewers subject to the following conditions:

1. Will not result in an exceedance of the *uncommitted reserve capacity* of the downstream municipal stormwater management system;
2. Does not adversely impacts the approved effluent quality of stormwater works; and
3. Meet the conditions listed in the Environmental Compliance Approval.

7.0. Documentation

7.1.1. All documentation required here in this document and in the ECA shall be completed.

7.1.2. The forms referenced in the Environmental Compliance Approvals (ECAs) for sewage and stormwater are available in the Central Forms Repository

Appendix A: Inspection and Testing

1.0. Inspection and Testing Requirements for Sanitary Sewers and Forcemains

1.1. General Requirements

1.1.1. All new sanitary sewers, forcemains, maintenance holes and chambers shall be inspected and tested to ensure integrity of the installed material for water tightness prior to placing into service.

1.1.2. All inspections and testing shall be performed as specified here in this document.

1.1.3. Inspection and testing plans including; procedure, equipment, schedule, safety requirements and emergency response plan shall be submitted to the owner/operating authority at least two (2) weeks prior to the inspection or testing. Plans must be accepted by the owner prior to proceeding with the inspection or testing

1.1.4. The operating authority shall be notified and a confirmation of receipt to be acquired at least five (5) business days prior to inspection or testing.

1.1.5. All inspection reports and test results shall be provided to the owner in a format specified by the owner or the operating authority including printed copies, PDF copies and digital files.

1.1.6. A single testing plan can be used for similar tests; however, each test shall be recoded separately.

2.0. Sanitary Sewers

2.1. Inspections

2.1.1. All new sewers and associated appurtenances shall be inspected to confirm alignment and to ensure that the sewer pipe is free from obstructions, debris and defects.

2.1.2. All maintenance holes/access structures shall be inspected for any defects, leaks, debris and to ensure proper benching.

2.1.3. Acceptable inspection methods for sanitary sewers and maintenance holes include;

1. Visual Inspections as per OPSS.MUNI 433
2. Closed-Circuit Television (CCTV) Inspection as per OPSS.MUNI 409
3. Zoom Camera Inspections as per OPSS.MUNI 432
4. Sonar Inspections as per OPSS.MUNI 435
5. Laser Inspections as per OPSS.MUNI 434

2.1.4. All new and rehabilitated sanitary sewers, maintenance holes shall be video inspected to evaluate the physical condition of a sewer pipe and to identify any obstructions in the sewer pipes. Any defects identified in the inspections shall be corrected and the respective pipe segments shall be re-inspected.

2.1.5. Sonar inspections can be used for sanitary sewers under submerged and partially submerged conditions.

2.1.6. Laser inspections are recommended for more accurate measurement of defects and deflection in the sanitary sewers.

2.2. Testing

2.2.1. In special circumstances specific testing requirements may apply, refer to MECP's *Watermain Design Criteria for future alterations* for additional inspection and testing requirements for sanitary sewers, forcemains and associated appurtenances when;

1. Installed within areas the works would pose a significant drinking water threat; and
2. if the required separation distance from watermains and associated appurtenances cannot be achieved.

2.3. Leakage Testing

2.3.1. Leakage Test shall be performed on all sewers and maintenance holes to ensure integrity of the conveyance system.

2.3.2. Prior to performing a leakage test, both active and inactive service connections and stubs shall be identified using dye testing or other equivalent methods.

2.3.3. All active connections and service laterals shall be plugged using plugs designed to withstand test pressures, plugs shall be suitably braced for additional safety. All inactive service connections shall be sealed.

2.3.4. Pipe sections and associated components that are subject to pressure testing shall be fully restrained against movements in the event of failure. Component that are not intended to be pressurized shall be isolated.

2.3.5. Prior to leakage testing potential risks and hazards shall be identified and appropriate safety measure shall be taken. The procedure shall conform to all applicable health and safety requirements, including, but not limited to; Occupational Health and Safety Act, Ministry of Labour Confined Space Guidelines and Fire Protection and Prevention Act.

2.3.6. The following are acceptable leakage tests for sanitary sewers and maintenance holes;

1. Low Pressure Air Testing
2. Water (Hydrostatic) Test

2.3.7. Groundwater elevations shall be considered for selection of the appropriate testing method.

2.3.8. Hydrostatic testing is preferred, low pressure air test for sanitary sewers is acceptable in lieu of water testing where water is not readily available, or the differential head is the test section is great than 8 m or freezing temperature exist.

2.3.9. Low pressure air test is not recommended when groundwater elevation is 600 mm or greater above the crown of the pipe being tested. Where groundwater

elevation is less than or equal to 600 mm test pressure shall be adjusted to compensate for ground water pressure.

2.3.10. Low pressure air testing equipment shall include a pressure relief valve set to 9 psi (max) to avoid over pressurizing.

2.3.11. Low pressure air testing procedure shall confirm to;

1. OPSS.MUNI 410 for pipe sewers
2. ASTM C 1244 for maintenance holes

2.3.12. Water test procedure shall conform to OPSS.MUNI 410.

2.3.13. Clean water shall be used for hydrostatic testing.

2.3.14. If a segment of the system fails during leak testing, source of leakage shall be identified, and all defective material shall be repaired or replaced to the satisfaction of the owner. The repaired or replaced sections shall be retested until results acceptable to the municipality are obtained. During retesting, maintenance holes shall be tested separately to pipe sewers.

2.4. Deflection Testing

2.4.1. A deflection test shall be completed for all new flexible pipes at least 30 calendar day after backfilling but prior to paving.

2.4.2. Mandrel testing and laser profiling are acceptable tests for pipe deflection testing.

2.4.3. Equipment used to perform Mandrel tests shall be specifically designed for the pipe material being tested.

2.4.4. Mandrel test shall be performed in accordance with OPSS.MUNI 438.

2.4.5. Laser profiling shall conform to OPSS. MUNI 434

2.4.6. Pipe segments failing the Mandrel test shall be removed and replaced.

3.0. Forcemains

3.1. Hydrostatic Testing

3.1.1. Hydrostatic testing shall be performed to all new and rehabilitated/repaired forcemains in accordance with OPSS.MUNI 412 (Ontario Provincial Standards Specification, published by Ontario Ministry of Transportation) at a pressure of 1.5 times the maximum operating pressure.

3.1.2. Water used in the hydrostatic testing shall be disposed to sanitary sewers.

3.1.3. The maximum pressure shall be recorded at the lowest point along the length of the pipe subject to testing.

Appendix B: Understanding Risk to Sources of Drinking Water

- Components of sewage systems may present a risk to sources of drinking water, and therefore be subject to source protection plans made under the Clean Water Act.
- Whether you are designing a new sewage collection system, expanding an existing system, or conducting normal operations and maintenance, it is important to be able to identify which components of your system (sanitary sewers, pumping stations, holding tanks, etc.) and the location where they may be pose a significant risk, in order to plan and implement risk management measures as well as comply with any requirements for drinking water source protection within the ECA.
- Under the Clean Water Act, sources of water that are accessed by municipal drinking water systems are protected from threats to drinking water quality and quantity.
- A total of 22 specific activities are prescribed as **Drinking Water Threats** in Ontario Regulation 287/07, section 1.1. This includes "*the establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage*."
- The risk level of a prescribed drinking water threat is determined in accordance with:
    i. the **Directors Technical Rules** established under the Clean Water Act which set out the methods for delineating the shape and size of vulnerable areas (including wellhead protection areas (WHPA) and intake protection zones (IPZ) around municipal systems), determining the intrinsic vulnerability within those areas, and assessing the risk posed by drinking water threats.
    ii. the **Tables of Drinking Water Threats** (chemical and pathogen tables for water quality) identify the specific circumstances under which a drinking water threat poses a low, moderate or significant threat to drinking water sources. The Tables of Drinking Water Threats are organized by subcategories of activities for the prescribed threats in O. Reg. 287/07, including different types of sewage works, and are available at Ontario.ca as well as through an interactive threats look-up tool.
- Activities may also be a significant drinking water threat if they are associated with a chemical or pathogen identified as a drinking water issue within an **issue contributing area** (ICA) in the Assessment Report.
- Activities may also be a significant drinking water threat if they occur within an **event-based area** (EBA) that represents an area modelled for spills that would reach a surface water intake during extreme storm events (e.g. sanitary sewer trunk breaks, or wastewater treatment plant disinfection failure).
- The vulnerable areas and vulnerability scores for each source protection area are listed and mapped in local assessment reports and source protection plans and available through the provincial Source Protection Information Atlas.
- If the sewage works are located in an area where they may pose a significant threat to drinking water sources (WHPAs, IPZs, ICAs or EBAs), source protection plan policy may apply.

- For additional information on source protection plans and resources that can support the identification of threats to sources or drinking water, you may also refer to guidance from MECP and your local conservation authority.