



City of Orillia

Engineering Design Criteria: Wastewater



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Engineering Design Criteria: Wastewater

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1.0 INTRODUCTION

The City of Orillia Engineering Design Criteria: Wastewater manual is intended to provide all stakeholders, including City staff, engineering consultants, developers, and the public with common design reference standards to facilitate consistent application of sanitary sewer design practices within the City of Orillia (City).

These standards are to be read in conjunction with the latest editions of the Ontario Provincial Standard Specifications (OPSS), the Ontario Provincial Standard Drawings (OPSD), the Ministry of Environment, Conservation and Parks Design Criteria for Sewage Works, the applicable Environmental Compliance Approval, the City of Orillia Material Specifications for Watermain, Sewer, & Appurtenances, and the City of Orillia Standard Drawings and Specifications. In the case of a discrepancy, the City Standards shall prevail unless otherwise directed by the City.

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

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

2.0 DEFINITIONS AND ABBREVIATIONS

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

Definitions

City	City of Orillia.
City Representative / City Engineer	Any person, company, or organization, assigned to a project by the City to carry out work on their behalf. The name of the Representative shall be specified prior to the start of construction on any project.
Contractor	An independent company or individual acting as the Contractor and having entered into a legal contract to supply labour, material, equipment, management to construct, repair or install services.
Developer(s)/Owner(s)	The person(s) entering into the subdivision agreement / site plan agreement with the Corporation of the City of Orillia.
Engineering Consultant	A competent Professional Engineer or Geoscientist or firm of engineers or Geoscientists employed by the Developer or City which is registered with Professional Engineers Ontario and/or Professional Geoscientists Ontario, possessing a

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current Certificate of Authorization to practice professional engineering or geoscience.

Professional Engineer A person licensed by Professional Engineers Ontario (PEO) under the Professional Engineers Act and legally authorized to practice professional engineering, use the protected title "Professional Engineer" or the designation "P.Eng.", and take public responsibility for engineering works.

Standard Drawings Formal technical documents that use universally accepted conventions to communicate the specifications of a design.

Abbreviations

ASTM	American Society for Testing and Materials
CSA	Canadian Standards Association.
MECP	Ontario Ministry of the Environment, Conservation and Parks.
OBC	Ontario Building Code.
OPSD	Ontario Provincial Standard Drawings.
OPSS	Ontario Provincial Standard Specification.

3.0 REFERENCE DOCUMENTS

The design and construction of all new sanitary sewers and associated appurtenances shall be completed in accordance with the latest version of this manual, industry standards and best practices. The criteria outlined in this manual is intended as a supplemental specification that overrides other specifications. Where not overtly defined or overridden by the criteria outlined in this manual, design criteria to follow industry standards and best practices, including but not limited to the latest versions of the following:

- Ontario Provincial Standard Specifications (OPSS) and Ontario Provincial Standard Drawings (OPSD)
- The City of Orillia Official Plan
- Ministry of Environmental, Conservation and Parks (MECP) Design Criteria for Sanitary Sewers, Storm Sewers and Forcemains for alterations authorized under Environmental Compliance Approval
- Municipal Consolidated Linear Infrastructure Environmental Compliance Approval (CLI ECA)
- Environmental Compliance Approval (ECA) for the Wastewater Treatment Centre (WWTC)
- Ministry of Environmental, Conservation and Parks (MECP) Design Guidelines for Sewage Works

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- According to manufacturer's specifications
- The Canadian Standards Association (CSA)
- The American Society for Testing and Materials (ASTM)
- Applicable City of Orillia By-laws including but not limited to Municipal Code Chapter 1047 Sewage Discharge

3.1 Applicable Acts

The design and construction requirements for linear sanitary sewer systems outlined in this manual do not override or substitute any applicable legislative requirements. The design of new linear sanitary sewer systems must be completed in accordance with the most current versions of applicable legislative requirements, including but not limited to the following:

- Municipal Act
- Planning Act
- Ontario Water Resources Act
- Environmental Assessment Act
- Environmental Protection Act
- Accessibility for Ontarians with Disabilities Act (AODA).

4.0 USE OF MANUAL

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

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

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

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

5.0 DESIGN

5.1 General Requirements

Section 5.0 outlines the minimum requirements for the design of sanitary sewers, forcemains, and related infrastructure within the City.

The City is responsible for collection and treatment of local sanitary wastewater. Prior to the commencement of any design for sanitary sewage works in support of a development project, the applicant shall obtain confirmation from the City there is adequate treatment plant capacity and conveyance infrastructure capacity is available for the development proposed. Where adequate conveyance or treatment capacity cannot be confirmed, additional investigations

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and/or engineering solutions must be completed by the Proponent and submitted to the City for review.

Sanitary sewers designed and constructed in accordance with the most recent requirements and specifications of the City are required to carry domestic, commercial and industrial sewage from each area of the development under consideration. Flow is to be by gravity to the greatest extent feasible. Pumped systems will be considered or required with the approval of the City where depth and/or water table issues are deemed to create undue operational burden.

Exceptions to these guidelines may be allowed on a case-by-case basis but will require approval from the City.

5.2 Design Flows and Sanitary Sewer Design Sheets

The design flow in each length of sewer shall be computed on sanitary sewer design sheets with sufficient detail to be acceptable to the City. Analysis of downstream sanitary sewer capacity up to the nearest larger-diameter sewer or pumping station is to be included. For each area entered on the design sheet, the City maintenance hole numbers, the size and grade of the sewers, and the number of the detailed plan and profile for each section of the sanitary sewer shall also be shown.

Sanitary sewers shall be sized to adequately convey peak domestic sewage flow with a d/D (depth over diameter) of less than 0.80. Peak domestic sewage flows will be calculated as the sum of residential, commercial, industrial, and institutional sewage flows and will include for “peak” flow (i.e., a peaking factor will be applied) as well as extraneous flows as discussed in the following section.

5.2.1 Residential Sewage Flows

The following formula shall be used to calculate the sewage flow for residential areas:

$$Q_{(d)} = \frac{PqM}{86,400} + IA$$

Where:

$Q_{(d)}$	=	Peak domestic flow plus extraneous flows (L/s)
P	=	Design population (individuals)
q	=	Average daily per capita flow (L/cap/day)
M	=	Harmon Peaking factor
I	=	Unit of peak extraneous flow (L/s/ha)
A	=	Gross drainage area (ha)

The design population shall be derived from the drainage area and expected maximum population over a design period of 20 years.

Future land use and population shall be based on the approved City of Orillia Official Plan and/or direction from the City’s Planning Division. Household population shall be based on a minimum of 2.32 persons per unit unless advised otherwise in writing by the City.

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The average daily residential flows of 230 L/cap/day shall be used in the design for sizing the pipe.

A peak extraneous design flow of 0.28 L/s/ha shall be used, unless an area specific extraneous flow factor is provided by the City.

The residential peaking factor shall be calculated based on the Harmon formula:

$$M = 1 + \frac{14}{(4 + P^{0.5})}$$

Where:

M = Ratio of peak flow to average flow
P = Population in thousands

At minimum, a peaking factor of 2.0 shall be used in the pipe design. A maximum peaking factor of 4.0 shall be used in the pipe design.

5.2.2 Non-Residential Sewage Flows

Non-Residential sewage flows shall be calculated or estimated by the proponent based on expected Non-Residential activities.

Where available, actual water consumption data or sanitary flow monitoring data at the subject site or a similar site (covering at least two years) shall be used for accurate prediction of Non-Residential specific wastewater flows and peaking factors.

In the absence of any flow data, proponents may consult the current version of the Ontario Building Code (OBC) or other industry standard resources as approved by the City, to estimate appropriate flows for the Non-Residential activity.

If the activity for the property is unknown, an average design flow of 28 m³/gross ha/day or as provided in Table 1 of the MECP Design Criteria shall be used for Institutional and Commercial properties, and 36 m³/gross ha/day for Industrial properties, using the property area being developed and not the floor area of the building. The peaking factor for sewage flows can be determined using peak water usage rates for these facilities. At minimum, a peaking factor of 1.5 shall be used in the design of commercial and institutional properties and 2.0 for industrial properties. The proponent must provide a rationale for the peaking factor used to determine peak flows.

A peak extraneous design flow of 0.28 L/s/ha shall be used for all Non-Residential properties, unless an area specific extraneous flow factor is provided by the City.

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5.2.3 Flow Monitoring and Investigations for Existing Capacity

5.2.3.1 Sewer Capacity

In circumstances where the development contributes wastewater to an existing sewer section that exceeds 0.80 d/D (depth over diameter) or 80% of pumping station capacity in either the sewer design sheets or the City wastewater model, the City will require flow monitoring to confirm the actual flows and/or capacity. This applies whether the sewer or sewage pumping station is in this condition prior to development.

The proponent is to provide a flow monitoring plan to the City for review and approval in order to determine flows in subject sewer(s) that would capture at least two (2) separate rain events of 25 mm or greater precipitation (or equivalent snowmelt events) over 24-hour periods. The proponent is to provide the flow monitoring results for review and acceptance by the City. The proponent is also to provide analysis of the results (sealed by a P. Eng), including:

- Average dry-weather and wet-weather flows over the monitoring period,
- Inflow and infiltration rates in the catchment area based on the flow monitoring, and
- Engineering opinion on whether the sewer contains sufficient capacity to accommodate the development.

If the City determines there is insufficient sanitary sewer capacity in the sewer after reviewing the results of the flow monitoring and analysis, then physical engineering solutions to correct the issue must be proposed by the proponent, accepted by the City, and implemented prior to development.

5.2.3.2 Sewage Pumping Station Capacity

In circumstances where the development contributes wastewater in excess of 80% of pumping station capacity in either the sewer design sheets or the City wastewater model, the City will require flow monitoring and/or investigation to confirm the actual flows and/or capacity of the sewage pumping station and forcemain. This applies whether the sewage pumping station is in this condition prior to development.

The proponent is to provide an investigation plan to the City for review and approval to determine influent flows and sewage pumping station and forcemain capacity for wet day conditions.

The proponent is also to provide analysis of the results (sealed by a P. Eng), including:

- average dry-weather and wet-weather flows over the monitoring period,
- inflow and infiltration rates in the catchment area based on the flow monitoring, and
- engineering opinion on whether the sewage pumping station contains sufficient capacity to accommodate the development within 85% of rated capacity.

If the City determines there is insufficient capacity in the sewage pumping station after reviewing the results of the investigation and analysis, then physical engineering solutions to correct the issue must be proposed by the proponent, accepted by the City, and implemented prior to development.

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5.3 Gravity Sewer Design

5.3.1 Pipe Capacity

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

Manning's Formula:

$$Q = \frac{1}{n} \times A \times R^{2/3} \times S^{1/2}$$

Where:

- Q = Design Flow (m³/s)
- n = Manning's roughness coefficient
- A = Cross Sectional Area of Flow (m²)
- R = Hydraulic Radius (area of flow / wetted perimeter)
- S = Slope of the Hydraulic Grade Line (m/m)

For all types of pipes, a roughness coefficient of n = 0.013 shall be used.

5.3.2 Flow Velocity

Flow velocities shall be determined using the following formula:

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

Where:

- V = Velocity (m/s)
- Q = Flow (m³/s)
- A = Cross Sectional Area of Flow (m²)

The minimum full flowing velocity within gravity sanitary sewers shall be 0.6 m/s, and the maximum velocity shall be less than or equal to 3.0 m/s.

In accordance with MECP Design Criteria, design flows of less than 0.6 m/s may be considered in circumstances where deepening of individual sewer sections is not possible, such as rehabilitation or replacement projects. In these circumstances the designer is required to demonstrate why minimum flow velocity can not be achieved and propose appropriate measures to facilitate or offset the increased maintenance requirements. Exceptions to the City's Standard are subject to review and approval by the City.

The velocity change in a maintenance hole from one pipe to another shall not exceed 0.6 m/s.

5.3.3 Gravity Pipe Grade

The maximum and minimum grades for pipes shall be the grade necessary to meet the maximum and minimum velocity requirements except the required grade for the minimum

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velocity requirement shall not exceed 2% or the road grade where the road grade exceeds 2%. The minimum desirable design grades shall be 1% for the first upstream leg.

5.3.4 Gravity Pipe Size

Pipe size shall be determined using Manning's Formula. Minimum size of gravity sewer pipe shall be 200 mm in diameter. No decrease of pipe size from a larger size upstream to a smaller size downstream will be allowed regardless of the increase in grade.

When a sewer is installed at invert depths greater than 5.0m, or where the invert is below the seasonal water table, the pipe shall be oversized as directed by the City on a case-by-case basis to accommodate potential future re-lining.

5.3.5 Gravity Pipe Material

Sanitary sewers shall be constructed of reinforced concrete pipe, Polyvinyl Chloride (PVC) pipe or polyethylene. All pipes and fittings shall conform to CSA, ASTM and the following standards:

- Reinforced Concrete Pipe shall be steel reinforced and conform to OPSS.MUNI 1820.
- Polyvinyl Chloride Pipe (PVC) shall conform to OPSS.MUNI 1841.
- Polyethylene shall conform to OPSS MUNI 1840.
- Dimension ratio (DR) of PVC sewer pipe shall not exceed 35.

Reinforced concrete pipe shall be used for sewers greater than 450 mm diameter. PVC pipe may only be used for sanitary sewers up to and including 450 mm in diameter.

For single family and semi-detached units, multiple family, and other residential blocks, the service connections shall be PVC.

All bends on sanitary service connections shall be long radius, sweep bends.

The type and classification of all sanitary sewer pipes shall be clearly indicated on all profile drawings for each sewer length.

Sanitary sewer with inverts located lower than 0.6 m below the Seasonally High Groundwater Table shall be designed to minimum infiltration as per the MECP Design Criteria.

Pipe materials selection shall be supported by site conditions including the geotechnical, hydrogeological and hydraulic investigations and City approval.

5.4 System Layout

5.4.1 Minimum Pipe Cover

In all instances, the proposed sanitary sewer shall be installed at a depth sufficient to also service lands external to the site as determined by the City.

The minimum depth of cover shall be 2.75 m measured from the centreline elevation of the road to the obvert of the sewer.

Sanitary sewers shall be located with inverts a minimum of 1.0 m below basement floor elevations to allow for the installation of sewer laterals.

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Where sanitary sewers cannot be installed at a depth greater than the frost penetration level to prevent freezing, the sewers must be insulated. Insulation must be designed or verified by a Licensed Engineering Practitioner.

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

Maximum pipe cover shall be as per manufacturer's recommendations.

5.4.2 Sanitary Sewer Location

All sanitary sewers shall be located as shown on the typical City roadway cross sections. In general, this location is 1.5 m south or west of the centreline of the roadway.

Easements should be avoided where feasible. Where permitted, sewer easements must be at least 6.0 metres wide, and the minimum may be wider depending on the depth of the sanitary sewer. Any exceptions must be approved by the City. The final approved width will vary based on the size and depth of the pipe and whether other utilities are included in the easement.

5.4.3 Horizontal and Vertical Separation

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

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

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

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

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

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

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

5.4.4 Limits of Construction

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

5.4.5 Sewer Alignment

Sanitary sewers shall be laid in a straight line between maintenance holes unless approved by the City and radius pipe has been designed. Additional information may be required when deviating from a straight line between maintenance holes. Joint burial (common trenching) with storm sewers will be considered when supported by the recommendations of a soils report prepared by a qualified geotechnical engineering consultant.

5.4.6 Tracer Wire

All forcemains and gravity sewers shall have tracer wire installed, unless otherwise directed by the City. Refer to the City's standard specifications for tracer wire gauge and approved manufacturers.

5.5 Maintenance Holes

5.5.1 General Requirements

Maintenance holes to 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.

5.5.2 Locations and Spacing

Maintenance holes shall be located at each change in alignment, gradient or pipe material, at all pipe junctions and at intervals along the pipe to permit entry for maintenance of the sewer.

Maximum spacing of maintenance holes shall be 120 m for sewers 400 mm or less in diameter and 150 m for sewers between 450 mm and 750 mm in diameter.

Sanitary sewer maintenance holes shall not be located in the path of surface runoff such as gutters nor road sags to reduce infiltration. Where alternative placement is not possible, the design is to incorporate measures to prevent infiltration in accordance with MECP Design Criteria and is subject to City approval.

5.5.3 Sampling Maintenance Hole Requirements

All Non-Residential properties must include a sampling maintenance hole preferred at the property line to allow for sampling and monitoring of the wastewater stream leaving the site, unless otherwise permitted by the City. The sampling maintenance hole must meet the requirements as set in City Municipal Code Chapter 1047.

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5.5.4 Maintenance Hole Details

- No changes in flow direction are allowed without using a maintenance hole.
- All maintenance hole chamber openings shall be located on the side of the maintenance hole parallel to the flow for straight run maintenance hole, or on the upstream side of the maintenance hole at all junctions.
- The maintenance hole shall be centred on the sanitary sewer main.
- Flexible sanitary sewers shall be connected to maintenance holes using adaptors in accordance with the most recent version of ASTM C923. Connectors for rigid pipe shall be grouted in place.
- The maximum change in the direction of flow in any sanitary sewer maintenance hole shall be 90°. For pipes 1050 mm and larger, the maximum change in direction should not exceed 45°. A change of flow direction at acute interior angles shall not be permitted.
- When pipe size does not change through a maintenance hole, the minimum invert drops across the maintenance hole shall be made to compensate for hydraulic losses as shown in Table 4 below. If required, sewer grade can be maintained across the maintenance hole provided the minimum required flow velocity is maintained. Refer to the MECP Design Criteria Section 5.7.5.1 – Allowances for Hydraulic Losses at Sewer Manholes for additional information.

Table 1: Minimum Invert Drops Across Maintenance Holes

Alignment Change	Drop Required
Straight run	Grade of Sewer, Min 0.025 m
15 - 45 degrees	0.03 m
45 - 90 degrees	0.06 m

- 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.
- All maintenance holes shall be benched as per Section 5.5.6 – Benching Requirements below.
- Safety platforms or alternate safety measures shall be employed for deep maintenance holes as per Occupational Health and Safety Act, R.S.O. 1990, c. O.1 requirements and inspection, operation, and maintenance needs.
- When any dimension of a maintenance hole exceeds those on the relevant OPSDs, the maintenance hole must be individually designed and detailed.
 - Safety gratings shall be required in all maintenance holes greater than 5.0 m in depth. Safety gratings shall not be more than 5.0 m apart and shall be constructed in accordance with the relevant OPSDs.
 - Whenever practical, a safety grating shall be located 0.5 m above the drop structure inlet pipe.
- For pre-fabricated maintenance holes, steps will be solid circular steps as per OPSD 405.020. For cast-in-place maintenance holes, steps will be solid rectangular steps as per OPSD 405.020.
- Maintenance holes extending lower than 0.6 m below the Seasonally High Groundwater Table shall be externally wrapped with a waterproof membrane as per the MECP Design Criteria.
- Buoyancy of sewers and maintenance holes shall be considered in the design, and where required, adequate provision shall be made to prevent flotation.

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- Lockable maintenance holes shall be considered in areas where public access is a concern, such as park blocks, open spaces, pumping stations, and Wastewater Treatment Plants.

5.5.5 Frame and Cover Requirements

All maintenance holes located within the travelled portion of a roadway shall have the rim elevation initially 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 relevant OPSDs and OPSSs. A minimum of two modular rings and a maximum of 300 mm of modular rings shall be permitted on maintenance holes in new subdivisions. No concrete shall extend over the edge of the maintenance hole.

Prior to the placement of the final lift of asphalt, maintenance hole frames shall be reset to final elevation.

Watertight maintenance holes and sealed maintenance hole covers are required where structures extend below the expected groundwater table, and in areas prone to ponding and/or flooding. Where multiple consecutive maintenance holes meet these requirements, ventilation must be implemented.

All other maintenance hole frames shall be adjustable as per the City's approved Material Specifications For Watermain, Sewer and Appurtenances document.

All other covers shall be OPSD 401.010 Type A closed cover labelled "Sanitary".

5.5.6 Benching Requirements

Full height benching is required in maintenance holes for pipes 300 mm or less in diameter. Three-quarter height benching can be used for pipes greater than 300 mm. Maintenance holes shall be pre-benched. All benching and pipe opening alternatives must comply with OPSD standards, including OPSD 701.021 – Maintenance Hole Benching and Pipe Opening Alternatives.

5.5.7 Drop Structures

Drop maintenance holes are to be used where the invert levels of the inlet and outlet sewers differ by greater than 0.61 m. Drop structures must be external unless the maintenance hole is of a large size (i.e. 1500 mm or larger in diameter). Where a drop structure is not feasible, alternative methods of energy dissipation from falling flow and minimizing air entrapment and odor problems shall be specified. Drop maintenance holes shall be in accordance with OPSD standards. Drop structure connections must not interfere with access, ladders or safety grates in any way.

Where possible, a deeper sanitary sewer shall be considered prior to designing excessive invert drops, drop maintenance holes or excessively steep benching.

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5.6 Service Connections

5.6.1 Service Connection General Requirements

All sanitary sewer service connections for single and semi-detached dwellings and townhouse units shall be individual services. Storm service connections, roof leader connections, and sump pump connections to the sanitary sewer shall not be permitted.

5.6.2 Service Location

The proposed locations for the sanitary sewer service connections shall be shown on the plan and profile drawings and shall be in accordance with the locations specified on the Standard Drawings. Sanitary connections shall be in accordance with OPSD 1006.010 Sewer Service Connections for Main Pipe Sewer.

Sewer service connections shall be installed to the mid-point of the frontage of all single-family lots as shown on the Standard Drawings. The service pipe must be installed at right angles to the main and in a straight line from the main to the lot.

For new development, residential connections shall terminate at the center of the property line with a test fitting, 125 mm x 100 mm reducer, plug suitably braced to withstand test pressures and 89 mm x 38 mm marker placed from the invert of the connection to 600 mm above grade painted green.

5.6.3 Service Connection to Main

The service connections to the newly installed mainline sewer shall be made with an approved manufactured tee. Approved saddles shall only be used for connecting to existing sewer mains. A minimum separation of 1.0 m along the main sewer, between the service connection and maintenance holes shall be provided.

No service connection of a size greater than half the diameter of the main sewer shall be cut into the main sewer. A maintenance hole shall be installed on the main sewer at the intersection of a service connection that has a size greater than half the diameter of the main sewer except for a 150 mm service connection to a 200 mm or 250 mm main sewer provided an approved manufactured tee is installed and provided the invert of the service connection is above the springline of the main sewer.

For new service laterals being installed with new mainline sewers, the same contractor shall construct sanitary sewer laterals on both the public and private sides.

5.6.4 Service Size

Sanitary connections for single family residential properties shall be minimum 125 mm in diameter from the mainline sanitary sewer to the property line.

Sanitary connections for multiple family residential block, institutional, commercial and industrial block developments shall be minimum 200 mm in diameter, and an inspection maintenance hole shall be required on private property 1.50 m from property line to centre of rim.

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5.6.5 Service Material

Lateral connections shall be green in colour. Laterals 150 mm or smaller in diameter shall be PVC pipe DR-28. Laterals larger than 150 mm shall be PVC DR35. In accordance with MECP Design Criteria, all service connections are to be watertight.

Any service lateral (public or private) made using “No Corrode” or “Orangeburg” material must be replaced at the proponent’s cost and may not be re-used in whole or in part.

5.6.6 Service Depth

The depth of the service connections for single-family units and semi-detached units at the property line, measured from the final centreline road elevation shall be minimum 2.50 m.

Risers shall be used when the depth to obvert of the sewer main exceeds 4.50 m. The riser connection shall not exceed 3.0 m in depth. The use of risers shall be in accordance with MECP Design Criteria.

5.6.7 Service Grade

The minimum and maximum grades for sanitary sewer service connections shall be in accordance with Table 5 below.

Table 2: Service Connection Grade

Size of Connection (mm)	Minimum Grade (%)	Maximum Grade (%)
125	2.0	8.0
150	1.0 (2.0 is recommended)	6.0
200	1.0 (2.0 is recommended)	6.0

5.7 Bedding, Cover and Backfill Requirements

5.7.1 Bedding, Embedment and Cover

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

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

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

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Where poor soil conditions and/or high ground water levels are present, custom trenching and bedding designs shall be prepared for the City's approval including recommendations from the geotechnical engineer.

5.7.2 Trench Backfill

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

5.8 Joints, Fittings, Couplings and Restraint Devices

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

When installing gaskets, all pipe ends shall be thoroughly cleaned. For gaskets requiring field lubrication, a lubricant recommended by the pipe manufacturer shall be used. The pipe shall be properly positioned by means of an appropriate mechanism. Sufficient pressure shall be applied in making the joint to ensure that the joint is in position. Sufficient restraint shall be applied to the line to ensure that joints are held in this position. Once the pipe has been jointed, a test shall be made with a feeler gauge at intervals around the joint to ensure that the gasket has not been displaced from the spigot groove. If the gasket is found out of position, the joint shall be opened and the gasket placed in its proper position. If necessary, a new gasket shall be installed.

5.9 Inverted Siphons

Inverted siphons shall be avoided in general but may be permitted by the City in lieu of other acceptable solution on a case-by-case basis. If approved, inverted siphons shall be designed in accordance with MECP Design Criteria.

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

5.10 Low Pressure Systems

Low pressure sewage collection systems in conjunction with septic tank effluent pumping (STEP) shall be avoided in general but may be permitted by the City in lieu of other acceptable solution on a case-by-case basis. If approved, low pressure systems and service connections shall be designed in accordance with MECP Design Criteria.

No sleeve or liner protrusions, sealer, grout, or other foreign material is permitted into connections. All cuts shall be smooth and without residual material left around the opening.

5.11 Sewage Pumping Station Design

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

- Minor Sewage Pumping Stations are below 50 L/s capacity and typically consist of a submersible wetwell pumping station with an above-grade electrical panel.

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- Major Sewage Pumping Stations are at or above 50 L/s capacity and typically consist of a wetwell/drywell and an above-grade building structure, though a submersible wetwell pumping station with an above-grade electrical panel may be considered at the City discretion.

5.11.1 All Sewage Pumping Stations

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

- Operator Interface Terminals on all stations for station control
- Variable Frequency Drives
- Hydrostatic back up control for pumps
- Reverse functionality for pumps
- SCADA in accordance with the City SCADA Master Plan
- Forcemain bypass with camlock fitting
- Lifting equipment accommodations for major equipment and confined space entry
- Lockable junction boxes that are mounted for exterior access where feasible
- Safety grating in wetwell to allow for safe access to all instrumentation and junction boxes mounted internally
- Safety ladder with single handle T-bar style safety handle
- Snow storage and clearing considerations
- Security Fencing
- Adequate exterior lighting
- Intrusion alarms on all access points
- Security cameras and connection to City alarm system
- Xeriscaping for landscaping

5.11.2 Minor Sewage Pumping Stations

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

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

5.11.3 Major Sewage Pumping Stations

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

- Washroom

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- Touchless faucet
- Epoxy slip resistant coating for floors
- Elimination or reduction of confined spaces
- Air filters on VFD's intakes
- Dedicated area for a desk/workspace
- Automatic interior lighting
- Wetwell vactor truck connection with camlock fitting
- 50mm water service with pressure indicating transmitter
- Hydro meter and main disconnect mounted internally
- Steel roof with ice breaks and gable rooves over entrances
- On-site permanent generator (natural gas preferred for permanent)

5.12 Design of Forcemains

5.12.1 Pipe Forcemain Diameter

Forcemains shall be designed using the Hazen-Williams formula:

$$Q = 0.275 \times C \times D^{2.63} \times S^{0.54}$$

Where:

- Q = Design Flow (m³/s)
- C = Hazen Williams Friction Coefficient
- D = Diameter (m)
- S = Slope of the Hydraulic Grade Line (m/m)

The flow velocity of a forcemain shall be at least 0.6 m/s for cleansing, and shall not exceed 3.0 m/s.

If a small diameter forcemain is required, the design shall meet the requirements outlined in the MECP Design Criteria.

5.12.2 Forcemain Friction Factors

The Hazen Williams Friction Coefficient used in the design of forcemains shall be in accordance with the MECP Design Criteria.

5.12.3 Forcemain Anchors/Restraints

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

All joints shall be mechanically restrained as required, which are to be designed to withstand testing pressures. Thrust blocks shall be used at all tees, bends and valve caps.

The size of pipe, manufacturer and soil conditions shall be considered when determining the required restraint distances.

All restraints and thrust blocks shall be designed to consider worst case scenario soil conditions.

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5.12.4 Forcemain Material

The pipe material selection is to take into account the design and transient pressures, soil conditions and constructability. The pipe material selected shall be in accordance with the MECP Design Criteria. Under no circumstances shall the material be coloured blue. Where practicable, the preferred material for forcemain installation shall be HDPE.

Corrosion protection for forcemains shall be in accordance with OPSS and shall be a complete petrolatum coating system or cathodic protection in the form of zinc anodes as shown in Table 6 below.

Table 3: Corrosion Protection

Component	Petrolatum System	Cathodic Protection
Buried Metallic Fittings – on flanged surfaces, nuts, bolts, tie rods, clamps, valves, sleeves and couplings.	Required	Required
Mechanical Restraints	Required	Not Required
Valve Chambers – surface of pipes, valves and appurtenances	Required	Not Required
Metallic Forcemain – at each metallic component	Not Required	Required
PVC SDR 18 Forcemain 1.0 m horizontally from each metallic component	Not Required	Required
HDPE Forcemain 1.0 m horizontally from each metallic component	Not Required	Required

The pipe strength selected shall be in accordance with the MECP Design Criteria.

5.12.5 Forcemain Minimum Pipe Cover

The minimum forcemain depth shall be 2.0 m from the finished grade to the top of the pipe. Where other underground conflicts with the minimum depth required for the forcemain, the forcemain depth may be increased in these areas.

Where the minimum 2.0 m of cover over the forcemain cannot be achieved, the forcemain shall be insulated or heat traced in accordance with the MECP Design Criteria. In addition, where minimum forcemain depth is not achieved, supporting calculations shall be provided to demonstrate pipe deflection will not exceed specified limits due to live loading.

5.12.6 Forcemain Cleanout Chamber

Forcemain cleanout ports and drain chambers should be evaluated at all low points, final location of all cleanout ports and drain chambers are subject to City approval.

5.12.7 Forcemain Termination

The design of forcemains shall include a maintenance hole for discharging of the forcemain. The forcemain termination shall be in accordance with the MECP Design Criteria.

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5.12.8 Forcemain Transient Pressure

The design of a forcemain shall include a hydraulic transient analysis in accordance with the MECP Design Criteria. The hydraulic transient analysis shall be completed using a hydraulic model.

5.12.9 Forcemain Valves

Forcemain design shall include swab launching ports and/or flushing ports, isolation valves, non-return valves, cleanouts/drain chambers at low points of the forcemain, sewage air and vacuum relief valves at all high points of the forcemain as required by the MECP Design Criteria.

5.13 Cleaning, Inspection and Testing for New Wastewater Infrastructure

The following inspections and tests shall be completed by a third party on all new and replaced sanitary sewers, forcemains, maintenance holes, connections and chambers:

- Visual Inspections (All sanitary sewers including connections and associated Appurtenances)
- Leakage Testing
- Deflection Testing
- Hydrostatic Testing (for forcemains only)

All testing and inspections noted above shall be performed in accordance with MECP Design Criteria.

Dewatering shall be discontinued at least three (3) days prior to testing.

Piezometers shall be placed in the excavation alongside the sewer at approved locations to monitor the groundwater level. Prior, during and after testing of the sewer and maintenance holes, the static water level shall be recorded.

In accordance with MECP Design Criteria, an inspection and testing plan shall be submitted at least two weeks prior to the testing and inspection works. The plan shall include, but is not limited to, procedure, schedule, safety requirements, and emergency response plan.

A permanent record on a USB or portable hard drive of all CCTV inspection forms and videos shall be supplied as part of the substantial performance and final acceptance inspections, illustrating a continuous record of the sewer installations, service connections, maintenance hole, etc. Two hard copies of the CCTV inspection forms are to be supplied. Defects in each pipeline length shall be coded according to the NASSCO Canadian Edition of the Pipeline and Assessment Certification Program (PACP). A report identifying any unusual or sub-standard conditions shall also be submitted.

Flushing, cleaning, and a CCTV inspection as per OPSS.MUNI 409 shall be required prior to "Final Acceptance" and shall include CCTV and reporting on all laterals. All CCTV records shall have the project maintenance hole designation and the appropriate City maintenance hole designation.

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5.13.1 Infiltration / Exfiltration Tests

Infiltration and exfiltration tests shall be conducted by a third party on new and replaced sanitary sewers as per the requirements in OPSS 410.07.16.03 and 410.07.16.04.

A written inspection report shall be submitted within five (5) business days of the completion of the fieldwork. The inspection report shall document the results of the tests and identify locations of leaks in the sewer and the associated pipe condition codes.

5.13.2 Deflection Tests

Mandrel deflection inspections shall be conducted by a third party on new and replaced sanitary sewers as per the requirements in OPSS.MUNI 438. Pipe sections that do not allow the mandrel to pass freely shall be replaced.

A written deflection inspection report shall be submitted within five (5) business days of the completion of the fieldwork. The inspection report shall identify locations of deflections in the sewer and the associated pipe condition codes.

5.13.3 Negative Air Pressure (Vacuum) Tests

Negative air pressure (vacuum) test shall be conducted by a third party on new concrete maintenance holes prior to backfill as per the requirements in ASTM C1244 standard Test Method for concrete Sewer Manholes by the Negative air Pressure (Vacuum) Test Prior to Backfill.

5.13.4 Flow Monitoring for Acceptable Flows

Downstream flow monitoring is required for any development serviced by private or new sewers or where inverts of new sewers are located below groundwater level. A suitable downstream maintenance hole with straight through connections and influent pipe grade supporting laminar flow must be included prior to connection to the existing sanitary sewer system. Flow monitoring must be conducted by an acceptable third-party engineering consultant and be maintained until leak acceptable flows are observed for one continuous year. The requirements of the flow monitoring are outlined below:

- The proponent is to provide a flow monitoring plan to the City for review and approval in order to determine flows in the sewer that would capture at least 12 consecutive months, including one complete Spring (February 15 – May 14) and Summer (May 15 to October 31). A minimum of sixteen (16) storm events that generate a rainfall volume of 12.5 mm or greater shall be captured during the 12-month period. The proponent is to provide the flow monitoring results and analysis for review and acceptance by the City.
- Rainfall-Derived Inflow and Infiltration (RDII) compliance shall be determined on a volumetric basis; the maximum allowable RDII values shall not exceed a capture coefficient (Cv) of 1% in summer and 2% in winter (winter being November 1 – May 14).
- RDII volume (Q) versus rainfall depth (i) plots shall be generated for each storm event. Should the flow monitoring results not be acceptable, the security for the installation of the sewers, or another security for the purposes of ensuring acceptable sewer construction, will be held by the City until the causes of RDII have been identified and repaired.

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- The proponent shall install, calibrate, and remove (upon study completion) the flow monitoring devices, and shall be able to provide units capable of measuring flow at all times and that do not cause operating concerns, such as (but not limited to) flow interference, obstruction, and reduced hydraulic capacity. The use of primary devices such as weir plates or devices that result in substantial reductions in flow capacity in the system is not acceptable. The proponent shall also provide site-servicing and maintenance on an as required basis.

5.14 Decommissioning of Sewers and Laterals

In general, abandoned sewers and laterals must be removed. If removal is not feasible, then abandoned sewers and laterals shall be grouted and abandoned or cut and capped at the City discretion.

5.15 Asset Information Collection

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

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