Region of Peel
working with you

LINEAR WASTEWATER STANDARDS

VERSION	DATE	DESCRIPTION OF REVISION
R 1.0	2023/03/29	New Linear Wastewater Standard

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1. Instructions to Designers

The Linear Wastewater Standards document provides requirements for the design of linear wastewater infrastructure for the Region of Peel (the Region), with the overarching goal of ensuring and facilitating consistency in approach, quality, and output. Notwithstanding this goal of uniformity, this document is not intended to restrict creativity, innovation, and ingenuity; hence the Designer shall review these requirements and adopt them as applicable. Ultimately, however, the responsibility for design rests solely with the Designer, and this responsibility is in no way diluted or absolved by these guidelines. The Designer must provide supporting calculations for their design bearing the stamp and signature of a qualifies professional engineer registered or licensed to practice in Ontario. Any exceptions to these guidelines herein will be considered by the Region at its sole discretion on a case-by-case basis and as required to meet project specific design requirements.

The Designer is responsible to follow or align with all overarching provincial or federal standards, specifications, guidelines, regulations and any applicable Regional and Municipal Bylaws, the more stringent shall apply.

All standards, specifications, guidelines, regulations, acts, bylaws, or documents referenced within this Linear Wastewater Standards document shall refer to the latest version unless otherwise stated. The Designer is to be familiar with all relevant Region documents required for the design of linear wastewater infrastructure for the Region of Peel. Region documents are available from the Region's website (https://www.peelregion.ca/), or directly from the Region's project manager or each responsible Region Department for the document. The following is a list of relevant Region documents, including but not limited to those referenced in this design criteria.

Region Documents

- Region of Peel Project Implementation Procedures Manual (PIPM)
- Region of Peel Project Design and Specifications Manual
- Region of Peel Sewage Pumping Station (SPS) Design Standards
- Region of Peel Capital Works Specification - Volume 2
- Region of Peel Sewage Pumping Station and Forcemain Shutdown and Bypass Requirements
- Region of Peel Sewage Shutdown and Bypass Requirements
- Region of Peel Standard Drawings

- Region of Peel Sanitary Sewer Rehabilitation Standard Specifications (in development)
- Linear Infrastructure Testing and Acceptance Manual for Water and Wastewater Assets

2. Design Flow

2.1. Equivalent Population

Equivalent populations shall be calculated based on land use information as specified in the following sections. Max Sewer Flow/ level of service shall align with the requirements of this Standard and Region of Peel Water/ Wastewater Peel Master Plan (Vol 4.), unless otherwise superseded by MECP or other regulatory requirements. In cases of noted conflict(s), the more stringent requirements shall apply, unless otherwise required by specialty design and verified via hydraulic modeling.

2.1.1. Residential

Unless site specific information is available, population equivalent densities are to be calculated based upon the following criteria in Table 2-1.

Table 2-1 Population Density - Persons per Hectare

HOUSING TYPE	DENSITY (PERSONS/HECTARE)
Single family (greater than 10 m frontage)	50 persons/hectare
Single family (less than 10 m frontage)	70 persons/hectare
Semi-detached	70 persons/hectare
Townhouses	175 persons/hectare
Apartment Buildings	475 persons/hectare

When the number of units and type of housing are available, calculation of the equivalent population to be based on the following criteria in Table 2-2.

Table 2-2 Population Density - Person per Unit (as per Region’s latest DC Background Study)

HOUSING TYPE	DENSITY (PERSON/UNIT)
Single detached	4.2 person/unit
Semi-detached	4.2 person/unit
Townhouse	3.4 person/unit
Large Apartment (greater than 1 bedroom)	3.1 person/unit

HOUSING TYPE	DENSITY (PERSON/UNIT)
Small Apartment (less than or equal to 1 bedroom)	1.7 person/unit

If the proposed population equivalent for apartments is greater than 475 persons/hectare, then the population equivalent used for design shall be calculated based on a density of 2.7 persons per unit (ppu) using the equation below.

$$\frac{2.7ppu \times No.Units}{Area} = persons/hectare$$

2.1.2. Industrial, Commercial, and Institutional (ICI)

For light industrial areas, the Designer is to use an equivalent population of 70 persons per hectare. Individual studies will be required for special industries and major industrial areas.

For commercial areas, the equivalent population of 50 persons per hectare shall be used in the absence of known information.

Individual studies are to be undertaken for infill commercial development, redevelopment, land use intensification and areas where the equivalent population will be greater than 50 persons per hectare.

For institutional land uses, the equivalent populations shall be calculated as follows:

- Junior Public Schools: 1/3 × number of students (600 students minimum)
- Senior Public Schools: 1/2 × number of students (900 students minimum)
- Secondary Schools: 2/3 × number of students (1500 students minimum)
- Hospitals: Apply a population equivalent of 3 persons per bed

2.2. Daily Per Capita Sanitary Flow

The daily per capita sanitary flow shall be 285 liters per capita per day (L/cap/day). Where land use type is known, the flows shall be based on the following:

- Residential – 290 L/cap/day
- Non-Residential – 270 L/emp/day

2.3. Average Dry Weather Flow

Equivalent population shall be used to calculate the Average Dry Weather Flow (ADWF). The ADWF for each sanitary sewer reach (maintenance hole to maintenance hole) shall be determined by multiplying the total accumulated equivalent population contributing to that reach by the Daily per Capita Sanitary Flow as shown below:

Average Dry Weather Flow (ADWF) = Daily per Capita Flow × Equivalent Population.

2.4. Peaking Factor

The Peaking Factor (PF) is the ratio of peak dry weather flow to average dry weather flow. The Harmon Formula shall be used to determine peaking factors as shown below:

$$PF = 1 + \frac{14}{4 + \left(\frac{\mathrm{P}}{1000}\right)^{0.5}}$$

Where: PF = Peaking Factor, ratio of peak dry weather flow to average dry weather flow
P = Tributary equivalent population

The peaking factor shall be limited to a minimum of 2.0 and a maximum of 4.0.

2.5. Extraneous Flow (Infiltration and Inflow)

The extraneous flow (infiltration and inflow), $Q_{I\&I}$, is used as an allowance to account for any infiltration and inflow that makes its way into the wastewater system over the lifespan of the infrastructure. The following sections and formulae are to be used to determine the infiltration and inflow flow:

$$Q_{I\&I} = R_{I\&I} \times A$$

Where: $Q_{I\&I}$ = Extraneous Flow, includes both Inflow and Infiltration (L/s)
$R_{I\&I}$ = Inflow and Infiltration Rate (L/s/ha) – see Sections 2.5.1 and 2.5.2
A = Tributary Gross Area (ha)

2.5.1. Greenfield Growth Areas

The infiltration and infiltration portion of sewage flow shall be 0.26 L/s/ha for all types of land use. This factor applies to the gross area of all lands. If and where necessary, the Region shall provide additional guidance based on hydraulic modelling results, other known information and will govern if a discrepancy exists.

For maintenance holes located in low-lying areas and/or subject to flooding, the Region may at its discretion require an additional inflow allowance of 0.28 L/s per maintenance hole.

2.5.2. Existing Areas

The Designer is to reference available flow monitoring results or the best, most recent information to establish inflow/infiltration flows in an existing service area. Failing that, the inflow and infiltration portion of sewage flow shall be 0.26 L/s/ha for all types of land use. This factor applies to the gross area of all lands.

When designing sanitary sewers in existing areas, the Region reserves the right to have existing flows validated using its all-pipe hydraulic model to confirm sizing of new sanitary sewers.

For maintenance holes located in low-lying areas and/or subject to flooding, the Region may at its discretion require an additional inflow allowance of 0.28 L/s per maintenance hole.

2.6. Design Flow Determination

The design flow is the sum of the average dry weather flow, ADWF, which has been adjusted with the peaking factor, PF, and the extraneous flow (inflow and infiltration) allowance, $Q_{I\&I}$, as outlined in the following equation:

$$Q_{des} = PWWF = PDWF + Q_{I\&I} = (ADWF \ x \ PF) + Q_{I\&I}$$

Where: Q_{des} = Design Flow (L/s)

PWWF = Peak Wet Weather Flow (L/s) =PDWF + $Q_{I\&I}$

PDWF = Peak Dry Weather Flow (L/s) = ADWF × PF

ADWF = Average Dry Weather Flow (L/s)

PF = Peaking Factor (Ratio of Peak Dry Weather Flow to Average Dry Weather Flow)

$Q_{I\&I}$ = Extraneous Flow; Inflow and Infiltration (L/s)

2.7. Sanitary Sewer Hydraulic Modelling

The Designer is responsible to ensure that based on existing flow data and through the performance of hydraulic modeling, that the design shall not cause the exceedance of capacity or level of service of the incoming our outgoing existing sanitary system or will not cause system surcharge, basement flooding or risk of a spill to the environment. The Region reserves the right to validate existing flows in the system using the Region's all-pipe hydraulic model.

2.8. Bypass Pumping Design Flows

The Designer is to refer to the most up to date version of the Region's "Sewer Shutdown and Bypass Requirements" guideline documents for Consultants, Contractors, and the Region.

For forcemain bypassing requirements, the most up to date version of the 'Sewage Pump Station and Forcemain Shutdown and Bypass Requirements' guideline documents for Consultants, Contractors, and the Region are to be referenced.

2.9. Specialized Hydraulics

2.9.1. Froude Number

To validate the design flows calculated using Manning's Formula, the following Froude number equation shall be used:

$$F = \frac{V}{(gD)^{0.5}}$$

Where: F = Froude number

F= 1, critical flow

F > 1, supercritical flow (fast, rapid flow)

F < 1, subcritical flow (slow, calm flow)

D = Hydraulic depth (m), $\frac{A}{T}$

A = Cross-sectional area of flow (m^2)

T = Top width of free flow surface (m)

V = Flow velocity (m/s)

g = Gravitational Acceleration Constant,9.81 (m/s^2)

The Designer is to ensure that subcritical flows (F<1) are used to the greatest extent possible in design to minimize potential for turbulent flow or hydraulic jump.

2.9.2. Specialized Structures

In the event supercritical flow or deep drops (> 5 m) are anticipated, specialized structures will be required. Refer to Section 7.

3. Mainline Gravity Sanitary Sewer

3.1. Flow Velocities

The Designer must provide supporting calculations to demonstrate that, minimum velocity, maximum velocity and minimum grade are maintained to ensure correct operation of the sanitary sewer.

The flow velocities shall be determined by Manning's Formula:

$$V = \frac{Q_{des}}{A}$$

Where: V = Flow velocity (m/s)

Q_{des} = Design Flow (m^3/s); 1 m^3/s = 1,000 L/s

A = Cross sectional area of flow (m^2)

3.1.1. Minimum Velocity

The minimum velocity shall not be less than 0.75 m/s at design flow.

3.1.2. Maximum Velocity

The maximum flow velocity shall not be greater than 3.0 m/s with the pipe flowing full.

3.1.3. Minimum Grade

All sanitary sewers shall be designed and sloped to achieve self scour / cleansing and the minimum velocity as outlined in Section 3.1.1. The last leg of sewer shall have a minimum grade of 1.00%

Designs shall also avoid steep sewer grades that may cause additional issues such as development of supercritical flows that will off gas when flow drops back to subcritical.

3.1.4. Flow Ratio

In general, mainline sanitary sewers shall be sized to convey the projected peak wet weather flow. The flow ratio of peak wet weather flow to full flow capacity (Q_{des}/Q_f) is not to exceed 0.7 as shown in the formula below.

$$Q_r = \frac{Q_{des}}{Q_f} \leq 0.7$$

Where: Q_r = Flow Ratio - ratio of peak wet weather flow to full flow capacity

Q_{des} = Design Flow, under projected peak wet weather flow

Q_f = Pipe full flow capacity

3.2. Pipe Size and Material

3.2.1. Pipe Sizing

Pipes shall be designed to a size which is sufficient to handle the sanitary peak wet weather flow. To determine pipe size and capacity, Manning's Formula shall be used as shown in the equation presented below.

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

Where: Q = Design Flow (m^3/s)

n = Coefficient of Roughness

R = Hydraulic Radius $\left(\frac{A_F}{P_W}\right)$

A_F = Area of pipe Flowing Full

P_W = Wetted Perimeter

S = Slope (m/m)

A = Cross-Section Area of Pipe (m^2)

The coefficient of roughness (n) for all pipes shall be 0.013. The minimum pipe size shall be 200 mm diameter and must meet and maintain minimum velocities as outlined in Section 3.1.1.

3.2.2. Pipe Classification

3.2.2.1. Pressure Classification

Pipes shall be classified by pressure, based on Table 3-1 below.

Table 3-1 Gravity Sanitary Sewer – Pipe Size and Classification

PIPE SIZE	CLASSIFICATION
200 mm to 525 mm[1]	Non-Pressure Designed
600 mm and above	Pressure Designed[2]

[1] On a case-by-case basis, design constraints may require pipes to be pressure designed at the discretion of the Region.

[2] For pipes 600 mm and above, hydrostatic field testing to 345 kPa (50 psi) will be required see Section **Error! Reference source not found.**.

3.2.2.2. Major Trunk (Primary Collection) System

Major trunk sanitary sewers equal to or larger than 750 mm diameter dedicated to the conveyance of wastewater between local trunk sanitary sewers and wastewater treatment plants.

3.2.2.3. Sub-Trunk (Local Trunk Collection) System

Pipes 375 mm to 675 mm in diameter used to convey wastewater from local sanitary sewers to major trunk sanitary sewers.

3.2.2.4. Local Collection System

200 mm to 300 mm in diameter used to collect wastewater from individual service laterals to either sub-trunk and/or major trunk sanitary sewers.

3.2.3. Pipe Material

The Designer shall select appropriate pipe materials for gravity sanitary sewer applications, based on the matrix presented in Table 3-2 and Table 3-3. The Designer shall consider alternative pipe materials and gasket materials in areas with high hydrocarbons.

Table 3-2 Gravity Main Sanitary Sewer – Pipe Materials and Size Matrix (up to 525 mm)

MATERIAL	MAIN SIZE DIAMETER[1]	PIPE TYPE	JOINT TYPE	STANDARDS / SPECIFICATIONS	ADDITIONAL REQUIREMENTS
Non – Pressure Tested Pipe – Gravity Applications					
Polyvinyl Chloride (PVC)	200 mm to 525 mm	Flexible	Rubber gasket bell and spigot	CSA B182.2; ASTM D3034	
High Density Polyethylene (HDPE)	200 mm to 525 mm	Flexible	Welded (butt fused)	CSA B182.6; ASTM F714	Shall only be used for trenchless applications (new construction and/or rehabilitation)
Reinforced Concrete Pipe (RCP)[2, 3]	300 mm to 525 mm	Rigid	Rubber gasket bell and spigot	CSA A257 Series	

[1] All pipe sizes are internal pipe diameter.

[2] Reinforced concrete pipes without protective lining shall not be used in ICI area and/or areas prone to H_2S generation.

[3] Refer to Section 3.2.4 for Region approved concrete protective liners.

Table 3-3 Gravity Main Sanitary Sewer – Pipe Materials and Size Matrix (600 mm and above)

MATERIAL	MAIN SIZE DIAMETER[1]	PIPE TYPE	JOINT TYPE	STANDARDS / SPECIFICATIONS	ADDITIONAL REQUIREMENTS
Pressure Tested Pipe – Gravity Applications					
Concrete Pressure Pipe (AWWA C30*X*)[2,3,4]	600 mm and above	Rigid	Rubber gasket, steel bell and spigot	AWWA C301; AWWA C303	Min. pressure 50psi (345kPa). Complete with approved protective lining[2]
	900 mm and above	Rigid	Rubber gasket, steel bell and spigot	AWWA C300; AWWA C302[3]	
Fibreglass Reinforced Pipe (GRP) – -**Pressure Pipe System**	600 mm and above	Flexible	Rubber gaskets and coupling / sleeve	AWWA C950; ASTM D3754	Min. pressure 50psi (345kPa); Min. pipe stiffness 46psi (317kPa) Pipe joint and pipe to chamber connection shall be designed to be watertight and meet the sanitary pressure design requirements

[1] All pipe sizes are internal pipe diameter.

[2] Refer to Section 3.2.4 for Region approved concrete protective liners.

[3] The Designer is to consider all testing requirements with special attention to pipe component pressure restrictions before specifying AWWA C302 pipes.

[4] All joints shall be internally grouted/pointed per manufacture's recommendation for all AWWA 30*X* series pipes prior to completing in field protective lining requirements at joint assemblies.

For pipes 600 mm and greater in diameter, alternative materials will be considered by the Region at its sole discretion on a case-by-case basis and as required to meet project specific design requirements. Consideration of alternative pipe materials will only be given if existing approved pipe materials do not meet project specific design requirements. Alternative pipe material may also be considered if it can be adequately proven that an alternative material meets or exceeds all specific design requirements and provides the Region a net benefit/improvement over and above the current approved materials regarding asset performance, price, improved constructability, or any other project attributes that the Region deems appropriate.

When proposing alternative materials, the Designer shall provide all the necessary documentation, Comparison Matrix, and calculations required for the Region to fully assess the proposed alternative pipe material. The Comparison Matrix shall include the typical material and the proposed material utilizing the same criteria for both. The criteria shall include but not limited to the following:

- Product Specifications and/or Data Sheets including maximum field test and/or operating pressures, dead and live load thresholds, pipe dimensions (including tolerances), H2S corrosion resistance, yield strength, compressive strength, tensile strength, etc.
- Joint watertightness (including orientation)
- Installation procedures
- Testing methodology in accordance with Region's testing requirements
- Notation of the CSA, AWWA, and/or ASTM Standards that the products are designed, produced, and tested to
- Physical characteristics (yield strength, compressive strength
- Unit Cost ($/metre length)
- Procurement/turnaround time
- Repair methods and procedures
- Type of maintenance hole and connection methods
- Any other data requested by the Region

On pipe connections 600mm and greater, designers shall be responsible for designing any new connection to any new and/or existing structures. Designers shall note that use of the 2-5 series STD DWG's, (non-pressure design), or 2-7 series STD DWG's (pressure design/ ridged) are not applicable to flexible pipe materials not listed above. The designer shall implement the intent of the 2-7 series STD DWG's inclusive of differential settlement.

Final written approval for the use of these alternative materials must be provided by the Region's Director of Engineering. The decision to approve the request for alternative pipe materials shall be at the sole discretion of the Region.

3.2.4. Protective Liners

Protective liners shall be installed on the interior of concrete pipes (reinforced concrete and AWWA C30*X*) and structures as either physically (embedded) bonded or chemically bonded. The Designer shall choose a liner that provides internal corrosion protection, long-term adhesion to the host pipe, and is watertight. The pipe with the installed protective lining shall not have an increase coefficient of roughness than the host pipe and the Designer shall consider the lining's effect on system hydraulic and operational requirements.

The Designer shall determine the appropriateness of the chosen protective liner based on installation requirements, pipe size, hydrostatic pressures and warranty requirements of the pipe and liner system. All liners shall be applied in the manufacturer's facility within a controlled environment.

The protective liner is not intended to improve the structural performance of the host pipe. It is to protect the host pipe from internal corrosion related to H_2S formation for the design life of the pipeline. The liner design shall rely on the host pipe to provide all internal and external load resistance.

The chosen protective liner shall have demonstrated chemical resistance to a hydrogen sulfide environment or to the fluid being conveyed within an ICI area. The protective liners must be supported by verifiable, independent third-party testing and demonstrate conformance with the physical and corrosion resistant performance requirements. The design life of the protective liner shall be at least the same as the host pipe. All liners shall be installed as per the liner manufacturers recommendation and in alignment with the pipe or structure manufacturers requirements.

3.2.4.1. Physically (Embedded) Bonded

Physically (embedded) bonded or physical barriers are protective liners that have a mechanical bond/interlocking with the concrete pipe or structure. For new installation/construction of concrete infrastructure, these liners may be cast or embedded into the inner concrete wall surface during the manufacturing process.

The Designer must consider the installation of the physical barrier at pipe joints and concrete structure corners. For concrete pipes installed using single pass tunnelling, physically bonded protective liners shall be held back a minimum 35 mm for both pipe ends (bell end and spigot end). These areas including joint gap shall be field cap stripped after the tunnel operation is completed (after internal joint grouting/pointing). Physically bonded protective liners shall not be used on AWWA C302 pipes for single pass tunnelling.

Examples of physically bonded protective liners, include but not limited to, flexible HDPE or PVC sheet liner with continuous locking extensions.

3.2.4.2. Chemically Bonded

Chemically bonded protective liners are liners that provide a chemical bond to the cured concrete structure. Installation of these protective liners require significant surface preparation of the concrete surface prior to installation to ensure the specified bond strength.

Chemically bonded protective liners are usually in the form of a coating system. Product materials include polyurea, epoxy, polyurethane or other polymeric compound that meets the required performance criteria. These liners are usually spray applied or trowelled onto the prepared concrete surface. Chemically bonded protective liners shall be 100% solids and volatile organic compounds (VOC) free.

3.3. Pipe Selection and Design

3.3.1. Rigid Pipe Design

The Designer shall use the Marston's formula for dead and live loads as outlined below and as described in the current version of the American Concrete Pipe Association's (ACPA) Concrete Pipe Design Manual, Appendix B or the revised design methodology as outlined in ACPA's manual, Chapter 4. The ACPA manual is available at concretepipe.org.

3.3.1.1. Open Cut Installation

Live Loads

For calculating transmitted live loads on sanitary sewer pipes, use Marston's Formula:

$$W_t = \frac{1.0}{L} I_c C_t T$$

Where: W_t = Average load per unit length of pipe (kg/linear metre)
L = Length of pipe (metres) on which the load is computed
I_c = Impact factor for a moving load
C_t = Load Coefficient
T = A concentrated surface load (kg)

For vehicular traffic, use loading in accordance with the Ontario Highway Bridge Design Code (OHBDC). For railroad traffic, use E-80 loading (1.75) or additional requirements per the respective railroad company.

Dead Load

For calculating backfill loading on sanitary sewer pipes, use Marston's Formula:

For trench conditions (refer to ACPA Manual, Appendix B)

$$W_d = C_d W {B_d}^2$$

For embankment conditions (refer to ACPA Manual, Appendix B)

$$W_c = C_c W B_c^2$$

Where: W_d = The soil backfill load in kg/linear metre
W_c = The soil backfill load in kg/linear metre
C_d = The load coefficient for trench condition
C_c = Coefficient (dimensionless) for positive projecting embankment condition

W = Unit weight of the backfill material in kg per metre^3

B_d = Width of trench in metres, measured in a horizontal plane at the extreme top of the pipe

Min. O.D. of the pipe + 0.45 m

Max. O.D. of the pipe + 0.75 m

B_c = The O.D. of the pipe in metres

O.D. = Outside Diameter

The minimum ASTM 0.01 crack, three edge bearing strength requirements for reinforced concrete pipe is to be used in determining pipe strength.

Refer to Region's Standard Drawings (STD DWG) 2-3-1 for standard pipe beddings and resultant load factors to determine field supporting strength. For installation in a common trench, a minimum 2.0 m horizontal separation (O.D. to O.D.) is required.

3.3.1.2. Trenchless Installation

Trenchless installation methods shall be used to facilitate, but not limited to, crossing of watercourses, utilities, obstructions, excessive depth, etc. There are two main types of trenchless methodologies, single pass and two pass. Single pass trenchless methods involve installation of a pipeline which is utilized to resist/transfer tunneling forces and when complete becomes the carrier pipe. Two pass involves installation of a primary liner (or casing) in a single pass then followed by the installation of the new pipeline as a secondary liner (or carrier pipe) within the primary liner. Typical trenchless installation methods and techniques are presented in the tables below.

Single Pass

Table 3-4 Allowable Rigid Pipe Materials and Trenchless Techniques – Single Pass

METHOD	MATERIAL	
	Reinforced Concrete Pipe (RCP)[1]	**Concrete Pressure Pipe (AWWA C30*X*)[2]**
Jack & Bore	N	Y
Microtunnelling	N	Y
Pipe Ramming	N	Y
Pipe Bursting	*Additional details provided in Rehabilitation Section	

[1] Reinforced concrete pipe material is limited to non-pressure design and only acceptable up to 525 mm diameter per Section 3.2.3. These tunnelling methods typically have larger diameter requirements.

[2] Not all CPP AWWA C30*X* products are available for all applications. The Designer is to ensure the appropriate product is selected for the required application.

Two Pass

Table 3-5 Allowable Rigid Pipe Materials and Trenchless Techniques – Two Pass

METHOD	TYPE OF LINER	MATERIAL		
		RCP[1]	AWWA C30*X*[2]	Other[3]
Jack & Bore / Auger Boring	Primary	Y	Y	Steel
	Secondary	Y	Y	
Microtunnelling	Primary	Y	Y	Fibreglass Reinforced Pipe (FRP)
	Secondary	Y	Y	
Pipe Ramming	Primary	Y	Y	Steel
	Secondary	Y	Y	
Tunnel Boring Machine (TBM)	Primary	N	N	Steel, Rib and Lagging, Rock Bolt
	Secondary	Y	Y	
Earth Pressure Balance Machine (EPBM)	Primary	N	N	Precast Segments
	Secondary	Y	Y	

[1] Reinforced concrete pipe is only used up to 525 mm as per Section 3.2.3 for secondary pipe (carrier pipe). As a primary liner, RCP is available and acceptable in large diameter pipes.

[2] Not all CPP AWWA C30*X* products are available for all primary lining applications. The Designer is to ensure that the appropriate product is selected for the required application.

[3] Not all other product types are available for the primary liner application. The Designer is to ensure that the appropriate product type is selected for the required application.

3.3.2. Flexible Pipe Design

3.3.2.1. Open Cut Installation

Live Load

For calculating transmitted live loads on sanitary sewer pipes, use Marston's Formula:

$$W_t = \frac{1.0}{L} I_c C_t T$$

Where: W_t = Average load per unit length of pipe (kg/linear metre)

L = Length of pipe (metres) on which the load is computed

I_c = Impact factor for a moving load

C_t = Load Coefficient

T = A concentrated surface load (kg)

For vehicular traffic, use loading in accordance with the Ontario Highways Bridge Design Code (OHBDC). For railroad traffic, use E-80 loading (1.75) or additional requirements per the respective railroad company.

Dead Load

The vertical soil pressure due to the prism load may be calculated using the following formula:

$$P = WH\frac{1}{10{,}000\ cm^2}$$

Where: P = Prism Load (kg/cm^2)

W = Unit weight of the backfill soil (kg/m^3)

H = Depth of cover (m)

Deflection

The maximum allowable deflection of flexible pipes under loadings shall be 50% of the manufacturer's specifications. Percent deflection may be calculated using the following formulae:

Percent Deflection:

$$\frac{\%\Delta Y}{D} = \frac{(D_L\ x\ K\ x\ P\ x\ 100)}{(0.149F/\Delta Y) + (0.061E')}$$

Where: E$'$ = Modulus of soil reaction (kPa)

For main sanitary sewer line = 6900 kPa

For sanitary connections = 1379 kPa

D_L = Deflection lag factor (1.50)

K = Bedding constant (0.11)

P = Prism Load $\left(WH\ x\frac{1}{10000\ cm^2}\right)$

H = Depth of cover (m)

W = Unit weight of backfill material (minimum 2080 kg/m^3)

F/ΔY = Minimum 1.83 kg/cm/cm

3.3.2.2. Trenchless Installation

For a description of the trenchless installation methodologies refer to Section 3.3.1.2 above.

Single Pass

Table 3-6 Allowable Flexible Pipe Materials and Trenchless Techniques – Single Pass

METHOD	MATERIAL	
	Polyvinyl Chloride (PVC)[1]	High Density Polyethylene (HDPE)[3]
Horizonal Directional Drilling (HDD)	Y[2]	Y
Pipe Bursting	*Additional details provided in Rehabilitation Section	

[1] Butt welded/fused joints will not be permitted for PVC. Installation only for straight runs with limited deflections.
[2] HDPE maximum size is 525 mm (inside diameter) as per Section 3.2.3.

Two Pass

Table 3-7 Allowable Flexible Pipe Materials and Trenchless Techniques – Two Pass

METHOD	TYPE OF LINER	MATERIAL		
		PVC[1]	HDPE[2]	Other[3]
Jack & Bore	Primary	N	N	Steel, Concrete
	Secondary	Y	Y	
Microtunnelling	Primary	N	N	Concrete, Fibreglass Reinforced Pipe
	Secondary	Y	Y	
Pipe Ramming	Primary	N	N	Steel, Concrete
	Secondary	Y	Y	
Tunnel Boring Machine (TBM)	Primary	N	N	Steel, Rib and Lagging, Rock Bolt
	Secondary	Y	Y	
Earth Pressure Balance Machine (EPBM)	Primary	N	N	Precast Segments
	Secondary	Y	Y	

3.3.3. High Water Table Conditions

The Designer shall determine groundwater conditions as part of Preliminary Design Engineering and Report, and meet all requirements of PIPM section 10.4.6 regarding Geotechnical and Hydrogeological Investigations, I

Buoyancy and flotation checks are to be carried out and presented with all design calculation submissions to the Region.

3.3.3.1. Jointing Requirements

The Designer shall verify that jointing measures selected are watertight and will be able to sustain the groundwater pressures in accordance with the geotechnical and hydrogeological reports.

3.3.3.2. Trench Plugs

Trench plugs are to be installed at the proper height for mains, as per Region's STD DWG 2-3-2, for all areas with high water table conditions. Trench plugs to be spaced at minimum 100 m intervals unless otherwise specified, or as per geotechnical and hydrogeological reports.

3.3.3.3. Design Against Flotation

The Designer will take all steps necessary to ensure that the pipe is designed in a manner that prevents uplift/flotation due to high groundwater levels. These calculations must be submitted as part of the preliminary design report, per the Region's Project Implementation Procedures Manual (PIPM).

3.3.4. Thrust Restraint

3.3.4.1. Thrust Blocks

The use of thrust blocks is not permitted.

3.3.4.2. Restrained Joints

Mechanical restraints must be designed at all fittings and adjacent pipe sections to prevent pipe movement and joint failure. The Designer shall design the joints and any modifications to the pipe design to allow the proper operation of the pipe during field pressure testing.

3.4. Pipe Depth, Location, and Bedding

3.4.1. Pipe Depth

3.4.1.1. Minimum and Maximum Depth of Cover

In residential areas, the obvert of the sanitary sewer shall be a minimum of 2.5 m below the centre line of the road allowance. Where this is not possible, minimum basement elevations of 1.0 m above the sanitary sewer obvert are to be maintained. These elevations are to be included in the Servicing Agreement.

In industrial and commercial areas, the sanitary sewer obvert shall be a minimum of 3.5 m below the centre line of the road allowance where possible.

At watercourse crossings, refer to Section 3.4.2.2 for requirements.

In all cases the proposed sanitary sewer shall be installed at sufficient depth to service lands external to the site as determined by the Region.

Generally, maximum depth of cover should be such that the trench depth will not exceed 8.0 m. Sanitary sewers installed with depths of cover greater than 8.0 m or within trenches at any depth in poor conditions are required to be specially designed by a Professional Engineer. Construction methodology shall be determined contingent on geotechnical, hydrogeological, and technical requirements.

New pipes shall be designed so that its depth and location remain outside of the Zone of Influence of existing or future structures or foundations.

3.4.1.2. Insulation

In any circumstance where the depth of bury or location of the sanitary sewer will cause potential issues with freezing conditions, insulation and/or any other mitigation methodologies must be applied to the satisfaction of the Region. Insulation to prevent freezing shall be provided as specified in Table 3-8 based on depth of cover. The insulation shall be included, at minimum, on both sides of the trench and top (full trench width).

Table 3-8 Insulation for Specific Cover Depths

DEPTH OF COVER (m)	THICKNESS OF INSULATION (mm)
< 1.7 to > 1.4	50
< 1.4 to > 1.2	75

Heat Sinks

Insulation shall be included completely around the sanitary sewer pipe envelope (full trench width) whenever within 2.0 m crossing, above, below, or adjacent to such as a large culvert, large chambers, or ventilated underground structures regardless of depth.

3.4.2. Pipe Location

3.4.2.1. Minimum Clearances

Minimum clearances are required to mitigate conflicts with existing utilities, and for ease of operation and maintenance. The sanitary sewer shall be located 1.50 m north or east of the centerline of the road allowance or at the discretion of the local municipality unless conflicts with other utilities require a revised location. Curvilinear pipeline alignments may be permitted for large diameter sanitary sewers only, provided it is parallel to the road centerline and compensation is provided for head losses due to curvature.

A 0.5 m vertical clearance (O.D. to O.D.) shall be maintained.

A 2.0 m horizontal separation between the sanitary sewer and storm sewer (O.D. to O.D.) will be permitted to allow for common trench construction if the inverts of both sewers are at the same relative elevation. Should sewer inverts vary by more than 1.0 m within a common trench, a 3.0 m horizontal separation shall be maintained to allow for proper access during subsequent excavation.

New pipes shall be designed so that its depth and location remain outside the of Zone of Influence of existing or future structures or foundations.

Regarding clearances from other utilities, the Designer must adhere to all relevant and up to date Ministry of the Environment, Conservation and Parks (MECP) and the local Public Utilities Coordinating Committee (PUCC) guidelines. The Designer shall ensure that the most up to date PUCC requirements for the applicable Area Municipality are being used. As an example, only, a sample of PUCC utility clearances for the City of Mississauga are outlined in the Appendix, Table A-0-1.

3.4.2.2. Watercourse Crossings

A permit shall be obtained from the relevant conservation authority before crossings are constructed. A vertical clearance guideline of 2.0 m from bottom of watercourse bed to top of pipe, or 2 times the tunnel diameter, whichever applies, is recommended. However, this clearance is contingent on the results of the geomorphic study and consultation with the relevant authority. Sanitary sewers crossing creeks and rivers shall be designed to cross the stream as nearly perpendicular as possible. Sanitary sewers shall not change grade while crossing watercourses.

Erosion Control

Where the potential for erosion exists, the following requirements shall be met:

- Re-contour the creek bed to its original state and design and implement mitigation measures that prevents scouring, erosion, and siltation upon completion and in future
- Where applicable, turbidity barriers may be used to prevent erosion and control sedimentation
- Control surficial water flow at the crossing location
- Monitor sites with areas of erodible soils to ensure successful plant cover where appropriate for long-term site stability
- Maintenance holes shall be located to ensure ease of access, and setback sufficiently with consideration for future meandering and erosion, per the geomorphic study

3.4.3. Bedding and Backfill

Sanitary sewers shall be installed with bedding as per Region's STD DWG 2-3-1 and design must be compatible with the type of pipe material selected. All granular bedding and material shall conform to the requirements of OPSS 1010. All granular material shall be placed in the trench in 150 mm lifts (maximum) and compacted to 100% SPMDD.

Bedding and backfill requirements must be based on the recommendations from geotechnical and hydrogeological investigations. The backfill material should be as specified for the project, geotechnical and hydrogeological report requirements, and in collaboration with the authority having jurisdiction. All concrete bedding material shall conform to the requirements of OPSS 1350 with a nominal minimum twenty-eight (28) day compressive strength of 20 MPa.

All approved native material shall be free from frozen lumps, cinders, ashes, asphalt refuse, organic matter, rocks and boulders or other deleterious materials. In rock and shale excavation, the Designer shall determine the required thickness of compressible material (minimum 50 mm layer) between the trench walls and any concrete encasement.

With regards to excess soil requirements, the Designer shall ensure they have a qualified person (QP) and that they adhere to all requirements of Ontario Regulation (O.Reg.) 406/19: On-Site and Excess Soil Management during design, investigative service work, and construction.

3.5. Easements

3.5.1. Easement Alignment and Access Requirements

No Regional infrastructure shall be installed in a trench whose lines of influence encroach on the foundation of any present or proposed permanent structure. Pipe location/depth must take the foundation location/depth into consideration to ensure failure of asset does not compromise the structural integrity of the structure and vice versa.

Line of influence – To be calculated as a slope of 1:1 taken from the deepest point of the permanent structure towards the easement in question unless ground and hydrogeological conditions necessitate a more conservative approach. The zone of influence would therefore be all areas underneath the line(s) of influence.

Easements for sanitary sewers with a pipe invert between 1.7 m to 3.6 m depth require a total easement width of 8.0 m. The sanitary sewer should be offset within the easement as illustrated in Figure 3-1.

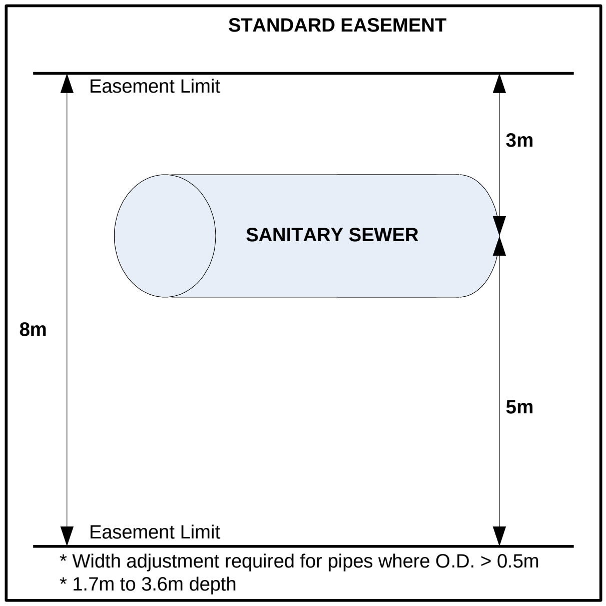

Figure 3-1 Standard Easement Limits

An adjustment of easement width is required for sanitary sewer pipes with an outside diameter (O.D.) greater than 500 mm. Required easement width is directly related to the pipes outside diameter.

Additional easement adjustments may be necessary for installation of new large diameter sewers adjacent to existing permanent structures.

Example: for sanitary sewer pipe with an O.D. of 800 mm, assuming standard depth of bury, the minimum easement width shall be 8.3 m (3.0 m + 5.0 m + (800 mm – 500 mm)). Refer to Figure 3-2.

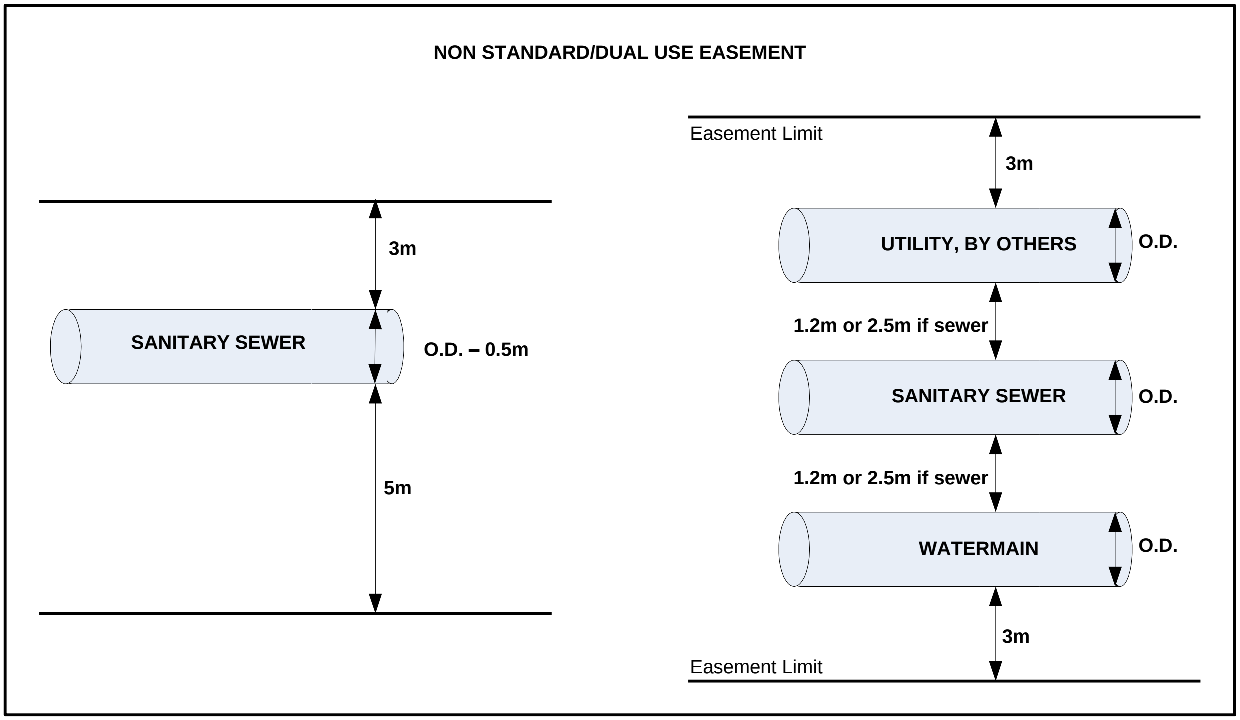

Figure 3-2 Non-Standard/Dual Use Easements Limits

For sanitary sewer pipe at a depth greater than 3.6 m, the easement width shall be designed such that the infrastructure can be installed by conventional excavation methods with the operation totally contained within the easement limits. Furthermore, the pipe location within the easement should not be within the zone of influence of any existing or proposed permanent structure. Considerations need to be made to accommodate 1:1 slope above the shoring box (3.6 m). For each metre of depth below 3.6 m, the width of the easement will need to increase by 2.0 m.

Certain restrictions apply with respect to easements as per the documents registered on title. The easement shall be kept clear of buildings, structures, or obstructions. The permitted uses for the easement lands are restricted to lawn, flowerbed, roadway, driveway, or parking area which cannot be paved with a hard concrete surface. Maintenance vehicles and equipment must be able to easily access infrastructure in the easement.

4. Forcemains

This section is related to forcemain piping that begins 1.0 m outside of the wall of a sewage pumping station. For piping within pumping stations, forcemain flow requirements and number of forcemains, refer to the Region's Sewage Pumping Station (SPS) Design Standard. In general, forcemains should follow the guidelines outlined below:

- Smooth transition of flow from the forcemain to the receiving gravity sanitary sewer through the discharge maintenance hole.
- Forcemains shall be designed on a project specific basis and designed to withstand transient, surge, and full vacuum pressures.
- Forcemains shall discharge to the receiving gravity sanitary sewer system no more than 0.3 m above the flow line, per Region's STD DWG Series 2-10 (under development).
- The Designer shall take special considerations into the length of the forcemain to reduce dynamic head losses and the production of odour and/or corrosive gases.
- For output flows, number of pumps, etc., refer to the Sewage Pumping Station Design Standard.
- Design to accommodate insertion and retrieval of appropriate and preferred Region inspection tools with minimal enabling works required to undertake inspections, or other maintenance requirements, as appropriate for the forcemain design. Access shall be equal to the forcemain and shall avoid 90-degree points of entry.
- All sanitary forcemain shall be designed and sloped to maintain full-flow condition and achieve the stipulated minimum velocity.
- All pressure pipe joints on-site shall be designed for thrust restraint without the use of concrete thrust blocks. Restraints shall be designed to withstand applicable test pressures and transient pressures, whichever is higher.

4.1. Flow Velocities

The Designer must provide supporting calculations to demonstrate that, minimum velocity and maximum velocity are maintained to ensure correct operation of the forcemain.

Forcemain velocities shall be calculated using the Hazen – William's formula as outlined below:

$$H_f = \left[\frac{Q}{0.2785 \times C \times D^{2.63}}\right]^{1.852} L$$

Where: H_f = Head Losses in the pipe section, m
Q = Flow in the pipe section, m^3/s
C = Hazen William Coefficient (C-Factor)
D = Diameter of pipe section, m
L = Length of pipe section, m

The Hazen William Coefficient for all pipes shall be 140.

4.1.1. Minimum Velocity

Forcemains shall be designed to maintain minimum fluid velocity of 1.0 m/s. In systems with variable speed drives on pumps, forcemains can operate at a minimum of 0.8 m/s, provided flushing velocities above 1.0 m/s can be achieved on a weekly basis.

4.1.2. Maximum Velocity

The maximum flow velocity shall not be greater than 3.0 m/s.

4.2. Pipe Size and Materials

4.2.1. Pipe Sizing

The minimum allowable pipe size for forcemains servicing municipal sanitary pumping stations and sewage pumping stations is 100 mm. Pipes shall be sized to minimize head loss and maintain minimum velocities outlined in Section 4.1.

4.2.2. Pipe Material

The Designer is to select appropriate pipe materials for forcemain applications, based on the matrix shown in Table 4-1. Designer shall consider alternative pipe materials and gasket materials in areas with high hydrocarbons.

Table 4-1 Forcemain – Pipe Materials and Size Matrix

MATERIAL	MAIN SIZE DIAMETER[1]	PIPE TYPE	JOINT TYPE	STANDARDS / SPECIFICATIONS	ADDITIONAL REQUIREMENTS
Pressure Tested Pipe – Forcemain Applications					
Polyvinyl Chloride (PVC)[2]	100 mm to 600 mm	Flexible	Rubber gasket, bell and spigot	AWWA C900; AWWA C909 ASTM D3139; CSA B137.0; CSA B137.2; CSA B137.3	pipe selection to be based on project specific design to accommodate expected flow regime from SPS and geographical specific requirements.
High Density Polyethylene (HDPE)	100 mm to 600 mm	Flexible	Welded (butt fused)	AWWA C906 CSA B137.0; CSA B137.1; ASTM F714; ASTM D3350	
Concrete Pressure Pipe (AWWA C30*X*)[3]	600 mm and above	Rigid	Rubber gasket, steel bell and spigot	AWWA C301; AWWA C303	Complete with approved protective lining[4,5]
	900 mm and above	Rigid	Rubber gasket, steel bell and spigot	AWWA C300; AWWA C302[2]	

[1] All pipe sizes are internal pipe diameter.

[2] On a case-by-case basis and as required to meet project specific design requirements at the Region sole discretion

[3] The Designer is to consider all testing requirements with special attention to pipe component pressure restrictions before specifying AWWA C302 pipes.

[4] All joints shall be internally grouted/pointed per manufacture's recommendation for all AWWA C30*X* series pipes prior to completing in field protective lining requirements at joint assemblies.

[5] Refer to Section 3.2.4 for Region approved concrete protective liners.

4.2.3. Protective Liners

Protective liner requirements shall be in accordance with Section 3.2.4.

4.3. Pipe Selection and Design

4.3.1. Forcemain Redundancy

All forcemain designs shall incorporate redundancy (i.e., pipe twinning) as required by the Region's Sewage Pumping Station Design Standard.

4.3.2. Rigid Pipe Design

4.3.2.1. Open Cut Installation

All design and loading calculations related to open cut installation of rigid forcemains are to be carried out according to Section 3.3.1.1, and consideration of internal pressures, as appropriate.

4.3.2.2. Trenchless Installation

Trenchless installation of rigid forcemains shall be in accordance with Section 3.3.1.2.

4.3.3. Flexible Pipe Design

4.3.3.1. Open Cut Installation

All design and loading calculations related to open cut installation of flexible forcemains are to be carried out according to Section 3.3.2.1. and consideration of internal pressures, as appropriate.

4.3.3.2. Trenchless Installation

Trenchless installation of flexible forcemains shall be in accordance with Section 3.3.2.2.

4.3.4. High Water Table Conditions

High water table conditions requirements shall be in accordance with Section 3.3.3.

4.3.5. Thrust Restraint

4.3.5.1. Thrust Blocks

The use of thrust blocks is not permitted.

4.3.5.2. Restrained Joints

Mechanical restraints must be designed at all fittings and adjacent pipe sections to prevent pipe movement and joint failure. The Designer shall design the joints and any modifications to the pipe design to allow the proper operation of the pipe during normal operation, transient conditions, and field testing. Designer shall reference Region's STD DWG 1-5-9.

4.3.6. Transient Analysis

A transient analysis is mandatory for all forcemain designs, considering the worst-case failure scenario involving the most critical pump and forcemain-in-service combination. The transient analysis shall be used to size and locate all protective devices, including but not limited to air release valves, vacuum breaker valves, combination valves, surge valves, surge tanks, etc.

All pipes, associated joints, as well as joint restraint shall be designed to withstand the maximum operating pressure plus the surge pressure that would be created by stopping a water column moving at the higher of 0.6 m/s or the theoretical velocity in the forcemain. The forcemains shall be designed such that pipes, joints, fittings and valves are able to withstand full vacuum pressure.

4.4. Pipe Depth, Location, and Bedding

4.4.1. Pipe Depth

4.4.1.1. Minimum and Maximum Depth of Cover

Minimum and maximum depths of cover shall conform to the requirements set out in Section 3.4.1.1, with the following caveats:

- At air valve chambers, height of chamber from top of pipe to chamber roof shall be minimum 2.3 m to accommodate needed space for air valve assembly and appurtenances, i.e., vent piping.
- At drain and isolation valve chambers, height of chamber from top of pipe to chamber roof shall be minimum 2.1 m to accommodate the needed space for the valve assembly and operational accessibility.
- Refer to Region’s STD DWG 2-10 series. (Under development)

4.4.1.2. Insulation

Insulation requirements for forcemains shall conform to those outlined in Section 3.4.1.2.

4.4.2. Pipe Location

4.4.2.1. Minimum Clearances

Minimum clearance requirements shall conform with those set out in Section 3.4.2.1.

4.4.2.2. Watercourse Crossings

Watercourse crossing requirements shall conform with those outlined in Section 3.4.2.2.

4.4.3. Bedding and Backfill

Bedding and backfill requirements shall conform to those outlined in Section 3.4.3 and Region’s STD DWG 2-3-1.

4.5. Forcemain Appurtenances

The Designer is to avoid local high points or low points and wherever practically feasible continuously rise forcemain towards the outlet. For all forcemains, provision for air release and drainage is required at the high and low points, respectively. For details of design for such appurtenances, the Designer is to refer to Region's STD DWG series 2-10 (under development) and requirements as provided herein.

4.5.1. Chambers

4.5.1.1. Air and Vacuum Release

Air and vacuum release valves and chambers are to be provided to allow for removal of all trapped air at high points per design calculations and the results of the transient analysis.

4.5.1.2. Drain Valve

Drain valves and chambers to be provided at low points in locations that allow for complete drainage of the line for maintenance purposes.

4.5.1.3. Isolation and Maintenance Access

Isolation and maintenance access chambers are to be provided at spacing that allows for reasonable and feasible access of inspection equipment. Forcemain access shall be located at spacing agreed upon with the Region. The Designer shall provide sufficient access to forcemain to provide for bypass, swabbing, and investigations through insertion and retrieval of appropriate and preferred Region approved inspection tools with minimal enabling works. Access shall be equal to the forcemain and shall avoid 90-degree points of entry. Designer shall provide at least one location on the forcemain for pressure monitoring devices.

4.5.2. Tracer Wire

Tracer wire shall be installed on all non-metallic forcemains and concrete pressure pipe (AWWA C30*X*) as per the Region's STD DWG 2-10 series. (Under development) Test stations shall be located at intervals agreed upon with the Region.

Tracer wire for pipes installed by trenchless methods must be specified for such applications, including a heavier gauge with multiple strands, per project specific requirements.

5. Laterals

5.1. General

5.1.1. Connection Protocol

Sanitary laterals shall conform to all the requirements outlined in Table 5-1 below.

Table 5-1 Connection Protocol for Laterals

SERVICE TYPE	REGION'S STD. DWG.	PIPE TYPE	MINIMUM PIPE SIZE	MH REQUIREMENT AT PROPERTY LINE
Residential Gravity Service (Single Residential Dwelling)	2-4-2	Flexible	125 mm	N
New Residential Development Connections	2-4-4	Flexible	125 mm	N
Residential Gravity Service (Multi-Residential Units)	2-4-3	Flexible	150 mm	Y
Industrial, Commercial Institutional Gravity Service	2-4-3	Flexible	150 mm	Y
Forcemain From Grinder Pump to Gravity Service (Single Residential)	2-4-7A	Flexible	125 mm	Y
Forcemain From Grinder Pump to Gravity Service (Multi-Residential or ICI)	2-4-7B	Flexible	150 mm	Y
Large Scale Greenfield or Brownfield	2-4-8	Flexible	150 mm	Y

All service laterals should be laid to the property line and connect to the main line sanitary sewer above springline, Within the first leg of a mainline sewer run, (at the top of the system branch), the service lateral shall be connected to the mainline using a wye fitting, and not connected directly into the top-of-the-line maintenance hole.

5.1.2. Non-Permitted Uses

Non-permitted uses shall be in accordance with Region By-law 53-2010. Connections from foundation, weeping tile drainage or groundwater collection systems, roof drainage, or any other extraneous non-revenue, source of effluent are not permitted to discharge into the sanitary sewer system.

Laterals shall not be permitted to connect to pipelines 600 mm or larger (sub-trunk or major trunk) unless approved in writing by Region of Peel Director of Engineering

5.2. Pipe Size and Materials

5.2.1. Pipe Sizing and Grade

5.2.1.1. Residential

For all residential connections, the minimum diameter shall be 125 mm, with grades of 1% (minimum) and 2% (maximum).

5.2.1.2. Industrial, Commercial, and Institutional

In ICI areas, the minimum connection size shall be 150 mm in diameter, with grades of 1% (minimum) and 2% (maximum).

5.2.2. Pipe Material

All sanitary sewer laterals shall be green in colour (PVC only), with material properties as outlined in Table 5-2 and Table 5-3.

5.2.2.1. Residential

Table 5-2 Sanitary Sewer Laterals – Size and Material Matrix (Residential Areas)

MATERIAL	LATERAL SIZE DIAMETER[1]	JOINT TYPE	STANDARDS / SPECIFICATIONS
Non – Pressure Tested Pipe – Gravity Applications			
Polyvinyl Chloride (PVC)	125 mm (min)	Rubber gasket bell and spigot	CSA B182.1; ASTM D3034
High Density Polyethylene (HDPE)	125 mm (min)	Welded (butt fused)	CSA B182.6; ASTM F714

[1] All pipe sizes are internal pipe diameter.

5.2.2.2. Industrial, Commercial, and Institutional

Table 5-3 Sanitary Sewer Laterals – Size and Material Matrix (ICI Areas)

MATERIAL	LATERAL SIZE DIAMETER[1]	JOINT TYPE	STANDARDS / SPECIFICATIONS
Non – Pressure Tested Pipe - Gravity Applications			
Polyvinyl Chloride (PVC)	150 mm (min) mm	Rubber gasket bell and spigot	CSA B182.1; ASTM D3034

MATERIAL	LATERAL SIZE DIAMETER[1]	JOINT TYPE	STANDARDS / SPECIFICATIONS
High Density Polyethylene (HDPE)	150 mm (min) mm	Welded (butt fused)	CSA B182.6; ASTM F714

[1] All pipe sizes are internal pipe diameter.

5.3. Pipe Selection and Design

5.3.1. Open Cut Installation

All design and loading calculations are to be carried out according to Section 3.3.2.1.

5.3.2. Trenchless Installation

Trenchless installation of laterals shall be in accordance with Section 3.3.2.2.

Trenchless installation methods such as horizontal directional drilling and pipe bursting, to avoid conflicts, will be allowed.

5.4. Pipe Depth, Location, and Bedding

5.4.1. Pipe Depth

5.4.1.1. Minimum and Maximum Depth of Cover

A minimum depth of 2.3 m and maximum of 2.75 m is required for residential connections. For ICI or multi-residential (at property line), the minimum depth is 2.3 m, and the maximum depth will be as required per design. If necessary, risers shall be provided for connection with the main sanitary sewer as per Region's STD DWG 2-4-1, 2-4-2 and 2-4-4. These risers are to be shown on the profile portion of the design drawings.

5.4.1.2. Insulation

For insulation requirements the Designer is to refer to Section 3.4.1.2 .

5.4.2. Pipe Location

5.4.2.1. Minimum Clearances

All clearances and locations are to be designed in accordance with Region's STD DWG 2-4 series. For clearances from utilities, refer to Section 3.4.2.1.

5.4.3. Bedding and Backfill

All bedding and backfill requirements shall be in accordance with Region's STD DWG 2-3-1 and Section 3.4.3.

6. Maintenance Holes

6.1. General

6.1.1. Spacing

The maximum allowable horizontal spacing (centre to centre) between maintenance holes shall be as specified in Table 6-1.

Table 6-1 Maintenance Hole Spacing Requirements

PIPE SIZE	MAXIMUM SPACING
200 mm – 525 mm	200 metres
600 mm and greater	190 metres
Any pipe size installed deeper than 10 m or installed via trenchless methods	Per Region's discretion and Project Specific Design Requirements.

6.1.2. Location

Maintenance holes should be located with consideration for ease of access at time of construction, as well as for the asset's full lifecycle. , Maintenance holes should be located away from sidewalks, curbs and gutters, and low points to reduce excess inflow entering the sanitary sewer system. Maintenance holes which cannot be located as stated will be evaluated by the Region on a project specific basis. The Designer is to ensure that in locations where maintenance holes may be difficult to access, permanent access roads are designed and constructed to facilitate ingress and egress of region vehicles and maintenance equipment.

Maintenance holes shall be designed to ensure that unobstructed vertical and horizontal access be maintained for appropriate access of equipment required for H&S and hoisting equipment. Horizontal access clearance shall be a min of 3.0 m on three sides, and a min of 1 m on the fourth side. Vertical access clearance of 5.0 m shall be maintained within this perimeter. A sanitary marker post is to be located at all sanitary sewer chambers outside the right-of-way (ROW) unless the chamber access is located on a pedestrian or vehicular thoroughfare, as per Region's STD DWG 2-6-17.

6.1.3. Changes in Flow Direction

For all pipelines, a 90° change of flow direction shall be avoided, where possible. In sanitary sewers 600 mm and greater, pressure series, changes in direction shall be done by one of the following:

- In a “cross type” maintenance hole (Region’s STD DWG 2-7-2 to 2-7-5) the branch inlets and outlets can be articulated to meet the desired angle (not greater than 90°).
- In a “tee type” maintenance hole (Region’s STD DWG 2-7-6 to 2-7-8), the adjacent bends shall be used to meet the desired angle (not greater than total of 31° per adjacent bend).

6.1.4. Drops and Drop Structures

6.1.4.1. Maintenance Hole Drops

Drops through sanitary maintenance holes shall be based on below:

For 200 mm to 300 mm diameter pipes, the drop limits between the inlet and outlet pipes shall be:

Minimum drop = 0.030 m
Maximum drop = 0.200 m

For pipes greater than 300 mm in diameter, drops are to be calculated as per the formula below:

$$Velocity\ Head = \frac{V^2}{2g}$$

90 Degree Bends = ½ Velocity Head

45 Degree Bends = ¼ Velocity Head

Where: V = Flow velocity (m/s)

$g = 9.81 m/s^2$

At maintenance holes where pipe sizes change, the criteria above shall be altered such that the obverts of the pipe are matched. At no time will matching inverts be permitted. Flow from a larger pipe to a smaller pipe will not be permitted.

6.1.4.2. Maintenance Hole Drop Structures

It is recommended that the Designer explore all other options before proposing the use of a drop structure. However, the Designer is also discouraged from using steep sewer grades as a method of avoiding drop structures, refer to Section 3.1.3. The economic feasibility of providing a deeper sanitary sewer instead of a drop structure shall be explored.

For sanitary sewers up to 525 mm in diameter, drop structures to be provided for differences in invert elevations of 0.9 m, or greater. The drop pipe shall be one size smaller than the sewer line (minimum 200 mm diameter). The use of a 45º bend and wye for drops is acceptable. No drop structures will be accepted between 0.9 m and the requirements above (velocity head formula).

For systems 600 mm and larger, drop minimums are based on lay lengths of the required fittings (i.e., length of appropriate fittings, distance to points of inflection etc.).

For details on the actual design aspects of drop structures, refer to the Specialized Structure Section (Section 7.3).

6.1.5. Pipe to Maintenance Hole Connection

All connections to maintenance holes shall be watertight, using flexible rubber connectors either cast in place or installed on site, as per Region's STD DWG 2-5 series. For connections 600 mm or greater, connections shall be as per Region's STD DWG 2-7 Series.

6.1.6. Watertightness

All maintenance hole joints shall be watertight. Watertight covers shall be provided on maintenance holes located in all areas susceptible to flooding by overland flows, such as located in ground surface low lying areas, near or adjacent to watercourses, flood plains, etc. Waterproofing details as per Region's STD DWG 2-5 series. In areas prone to flooding or overland flows and containing multiple sealed "waterproof" frames and covers, every third chamber shall be vented to atmosphere to minimize air flow restrictions. Vents shall be designed with flooding mitigation measures and all other requirements as per STD DWG 2-5 series.

6.1.7. Benching

6.1.7.1. Benching Area and Slope

Top of benching to match pipe obvert to improve hydraulics. Benching must be sloped a minimum of 2%, and a maximum of 4%, per Region's STD DWG 2-5-20.

6.2. Maintenance Hole Design

For sanitary sewers up to 525 mm, precast maintenance holes shall be used as per Region's STD DWG 2-5 series, unless otherwise required by project design.

For sanitary sewers 600 mm or larger, pressure tested designs are required as per Region's STD DWG 2-7 series. Rectangular chambers shall be designed as per American Concrete Institute (ACI) CODE-350, as applicable.

Precast maintenance hole sizes are to be based on project specific requirements. The Designer shall ensure that pipe size and number of proposed connections, inclusive of flexible rubber connection, shall be accommodated by minimum maintenance hole sizing and upsize as required. The Designer shall consider maintenance hole size to accommodate inspection and maintenance operations with minimal enabling works.

6.2.1. Maintenance Hole Tees

Tangent Tee type maintenance holes can be used for pressure designed sanitary sewers 1500 mm or larger. Refer to Region's STD DWGs. 2-7 series.

6.2.2. Protective Liners and Coatings

On all maintenance holes located in ICI areas or areas noted to have high H_2S, all internal horizontal surfaces on the underside of precast flat caps or transition sections shall be provided with microbiologically induced corrosion (MIC) protection, as per the Region's STD DWG 2-5 series and to Section 3.2.4 herein, for approved concrete protective liners.

6.2.3. High Water Table Conditions

6.2.3.1. Design Against Flotation

The Designer shall determine all uplift forces acting on the maintenance hole, based on the geotechnical and hydrogeological investigations and reports. The Designer shall subsequently design against the uplift force using one or more of the methods below:

- **Modified Concrete Slab:** Recommend that base slab extensions be provided to prevent uplift on precast maintenance holes where required. At depths greater than 9.0 m, specialized base slab designs shall be required.
- **Increase Thickness of Concrete:** Recommend increasing concrete thickness in the base slab and/or walls to counteract the uplift forces.
- **Rock Anchors**: Use rock anchors to drill and secure the MH and counteract uplift forces.

6.3. Accessibility

The Designer shall ensure surface access be situated to limit restrictions of access egress and line of sight from surface to bottom of chamber. All access to terminate on either benching and/or platform to ensure entrant is kept out of wastewater flow.

6.3.1. Maintenance Hole Frame and Cover

Standard 660 mm frame and cover units are to be used on maintenance holes with connections 525 mm or less. For maintenance holes with connections 600 mm or larger standard 745 mm or larger frame and cover units may be used. Refer to Region's STD DWGs 2-5 and 2-6 series for both non-pressure and pressure design sanitary sewers.

Frame and covers shall be clear of the curbs and any surface obstructions in new construction. In non-vehicular/ pedestrian traveled areas, frame and covers are to be raised 150 mm per Region's STD DWG 2-5 and 2-7 series. Watertight frame and covers shall be provided on maintenance holes located in areas susceptible to surface flooding or other inflow sources like overland flow routes. Bolt down frame and covers shall be provided on maintenance holes located in areas where maintenance holes are susceptible to unauthorised access egress and/or vandalism, (i.e., parks, school yards or easements where limited accessibility exists but risk of overland flooding does not exist).

Additional details are outlined in Region's STD DWGs 2-6-1 to 2-6-6.

6.3.2. Maintenance Hole Steps

Steps (or rungs) shall be aluminum, coated or uncoated, in accordance with Region's STD DWG 2-6-11 for pipelines 525 mm and smaller. Aluminum steps are not to be installed in pressure tested sanitary systems (600 mm and greater).

6.3.3. Maintenance Hole Ladders

Fibreglass reinforced plastic (FRP) (preferred) and aluminum ladders shall be installed as per Region's STD DWGs 2-6-9 and 2-6-10 respectively. In areas with high H_2S concentrations, aluminum ladders are not permitted.

Ladders shall have a width of 400 mm and be a minimum distance of 150 mm from the maintenance hole wall. Ladder rungs shall be a maximum of 300 mm apart and have a non-slip finish.

6.3.4. Safety Platforms

Safety platforms are required in chambers greater than 5.0 m deep, as well as in chambers with a sanitary sewer pipe size 600 mm and greater, regardless of depth. Refer to Region's STD DWG series 2-5, 2-6, and 2-7. New safety platforms to be FRP.

6.4. Inlet and Outlet Air Flow, and Odour Management

6.4.1. Ventilation to Atmosphere

To maintain air flow while controlling odour, air flow design shall maintain negative pressure, with design flows that minimize turbulence. Where significant sections of sanitary sewers are provided with watertight covers, chamber vents will be required at every third maintenance hole as per Region's STD DWG 2-5-22. Flood Prevention valves and combination odour control vents are to be provided based on project specific requirements.

6.4.2. Odour Management

All areas containing turbulent sanitary flow regimes (proposed drop structures, forcemain discharges, supercritical to subcritical transitions, etc.) shall be evaluated for increased odour release and hydrogen sulphide accumulation, and Microbial Induced Corrosion (MIC). Furthermore, all proposed drop structures shall be evaluated for the effects of air entrainment and pressurisation of the receiving sanitary sewer. Adjustments in the drop structure design may be required to minimize corrosive conditions and odour release effects, such as the use of oversized drop, air return piping and other methods.

6.4.3. Sampling Maintenance Holes

6.4.3.1. Industrial, Commercial, Institutional (ICI) Developments

Sampling maintenance holes are required for all ICI properties and shall meet the requirements in accordance with the Region's STD DWG 2-4 and 2-5 series, and any other relevant Region Standard, Guideline, or Bylaw.

6.4.3.2. Greenfield and Brownfield Developments

Large scale greenfield and brownfield developments require flow monitoring maintenance holes upstream of the existing municipal connection point, as per Region's STD DWG 2-4-8.

7. Specialized Structures

7.1. Inverted Siphons

The Region will not permit the installation of inverted siphons.

7.2. Diversion Chambers

Flows may be required to be diverted from one sanitary sewer to another. Where this is required a Diversion Chamber or multiple Diversion Chambers will be required. All diversion structures should facilitate smooth, steady flow prior to entry into the inlet, minimizing turbulence where flows converge. Diversion chambers are to be designed in collaboration with the Region, in alignment with the Region's real time control (RTC) strategy, and contain all appurtenances as deemed necessary by the Region and project specific design.

7.3. Drop Structures and Energy Dissipaters

The Designer shall explore all other options before proposing the use of a drop structure and/or energy dissipater on large diameter sewers (600mm or greater). The Designer shall complete Computational Fluid Dynamic (CFD) modelling, inclusive of deaeration requirements for all specialized structures and drop structures with large diameter (600mm or greater) sanitary sewer connections. The CFD modelling is to be used to confirm design parameters and support design and subsequent construction. Based on the results of these models, the economic feasibility of providing a deeper sanitary sewer instead of a drop structure and/or energy dissipater shall be explored.

7.3.1. Standard Drops

7.3.1.1. External Drop Pipes

External drop pipes shall be designed in accordance with Region's STD DWG 2-5-26, and wye fittings may be used in lieu of tees. Special designs will be required for external drops in the Region's STD DWG 2-7 series on a project specific basis.

7.3.1.2. Internal Drop Pipes

Internal drop pipes, if external drop pipes are not feasible, and if approved by the Region, shall be designed in accordance with Region's STD DWG 2-5-27. Special designs will be required for internal drops in the Region's STD DWG 2-7 series on a project specific basis.

7.3.2. Specialty Drops

In all cases H_2S concentrations could pose an issue and mitigation measures need to be incorporated into design.

7.3.2.1. Vortex Drop Structures

Vortex drop structures shall be designed on a project specific basis, at the discretion of the Region, typically in areas with large pipe diameters, deep drops, and high anticipated flows. Depending on the type of design, these structures could require the addition of a deaeration chamber with an air vent at the base of the structure. The Designer is to determine the nature of flow using the Froude's number equation in Section 2.9.1, as well as CFD modelling.

7.3.2.2. Plunge Drop Pipes

These structures will require the addition of a deaeration chamber with an air vent at the base of the structure. These will be designed on a project specific basis and at the discretion of the Region.

7.3.2.3. Baffle Drop Structures

These will be designed on a project specific basis and at the discretion of the Region.

8. Rehabilitation

8.1. Selection Considerations for Assessment and Rehabilitation Methodologies

Prior to considering rehabilitation, a pre-design inspection and subsequent condition assessment, utilizing the most current and applicable inspection and condition assessment technologies and methodologies as per project needs, Region Standards and Guideline, and with approval of the Region, shall be completed. Where existing CCTV or other inspection data is insufficient, the Designer shall make recommendations for additional testing as required and indicate what design purpose the testing will serve. Testing shall in no way compromise the functionality of the sanitary sewer. Where additional testing poses a risk to functionality or overall operation of the sanitary sewer, the Designer shall provide a conservative rehabilitation or renewal design assuming partial or full deterioration and state these assumptions.

The Region encourages the use of rehabilitation over replacement whenever possible. However, the following shall be adhered to:

- Rehabilitation shall consider and allow replacement as an alternative except for those instances where replacement is not possible due to existing physical and hydraulic conditions or other constraints (such as cost, geographic limitations, environmental, social, etc.).
- If multiple rehabilitation methodologies are chosen for a project, the Designer must ensure compatibility between the methods. The Designer will be responsible for the design of all transitions.
- Rehabilitation methodologies should not reduce the current level of service or original hydraulic capacity of the pipeline unless hydraulic analysis shows acceptable results, surplus capacity is not needed, and as permitted by the Region. The Designer is to submit calculations that show improved hydraulic conditions based on a lower Manning's number, for acceptance by the Region on a project specific basis.
- During pre-design and technology selection phase of the project an analysis of capacity requirements shall be undertaken. If the calculations indicate a larger sewer is required, then consideration of replacement rather than rehabilitation shall be reviewed with the Region and additional modelling and design work shall be completed.

8.1.1. Additional Pre-Design Inspection

Any additional pre-design inspections shall conform with Region standards, guidelines, or any project specific requirements, regarding inspection, condition assessment etc.

8.1.2. Condition Assessment Methodology

The Condition Assessment Methodologies accepted by the Region can be found in the Linear Condition Assessment Guidelines document. Remote and other acceptable visual condition assessment should be completed according to the most recent version of National Association of Sewer Service Companies (NASSCO) Guidelines (Pipeline Assessment Certification Program – Canadian Edition) by a NASSCO certified person (PACP for mainlines, LACP for laterals and MACP for maintenance holes). Condition assessment results and rehabilitation recommendations shall ensure the rehabilitated asset maintains current level of service requirements. Assets that are in fair condition that would not normally trigger immediate action that are located adjacent to, or between segments that are in poor, or worse condition triggering immediate action shall be considered for rehabilitation on an opportunistic basis (e.g., the segment being within the same bypassed section, contractor mobilization cost advantages). For additional guidance regarding trunk sanitary sewer rehabilitation recommendations refer to the Region's "Sanitary Trunk Sewer Rehabilitation Decision Framework"

8.1.3. Multi-Criteria Assessment (for Rehabilitation Methodology Selection)

If specific rehabilitation methodology is to be determined as part of the design project, the Designer is required to carry out a Multi-Criteria Assessment (MCA) to select the most feasible alternative. The criteria used should mutually be agreed upon with the Region, including, but not limited to:

- Cost
- Flow Control and Bypass Requirements
- Access Requirements
- Availability of Skilled Installers
- Construction Program
- Longevity of Rehabilitation Options
- Pipeline Attributes (shape, condition, material, length, size, alignment, etc.)
- Impact to Customers
- Compatibility with the Existing Structure
- Hydraulic Capacity Impacts

8.2. Mainline Gravity Sanitary Sewers and Forcemains Rehabilitation

8.2.1. Spot Repairs

Spot repairs may be used to correct isolated or severe problems in a pipeline segment and can be completed as a stand-alone repair, or as an initial step before the use of other rehabilitation methods. These repairs are usually limited to the rehabilitation or replacement of only a short portion of a pipeline or lateral connection. All spot repairs must adhere to the Regions or manufacturer specifications, as applicable, including all surface cleaning, installation, and bypassing requirements.

For the Region's purposes, if greater than three structural defects exist (i.e., fracture or greater) within a MH-to-MH segment, that will warrant a full-length repair or replacement.

8.2.1.1. Carbon Fibre

Carbon fibre wrapping may be used in situations where substantial strength augmentation in the vicinity of the defect is required, if root intrusion is not a concern, and in pipes that allow person-entry. The Designer is to give special consideration to internal and external pressures (including hydrostatic pressures), watertightness, and prevailing site conditions. Internal wrapping is the preferred use of carbon fibre, but external wrapping may be considered for short length defects, if site conditions allow. In either case, the design shall be for the fully deteriorated condition.

For pre-stressed concrete cylinder pipe (PCCP) design to be in accordance with AWWA C305, as applicable. Termination details shall be according to construction specifications, watertight, and terminate within the maintenance hole.

8.2.1.2. Injection Grouting

Internal grouting may be used to seal leaking sanitary sewer joints or minor cracks in structurally sound sewer pipes. The grout selected must be able to withstand expected hydrostatic pressures in gravity applications. This technique is generally used for groundwater control before installing another liner or patch. It is usually not considered robust enough to provide a long-lasting solution on its own. Should a vendor wish to use injection grouting in isolation, they must demonstrate to the Region its ability to achieve the required design life.

For additional information regarding injection grouting routing refer to the Regions “Standard Specification for Chemical Injection Grouting in Sewers and Maintenance Holes”

8.2.1.3. Cured-in-Place Pipe (CIPP) Patch

Cured-in-place pipe (CIPP) patching should only be undertaken if the cause of the defect is understood sufficiently to be sure that the cause is no longer active. Such repairs include:

- Repair to a hole in the pipe created by a third party.
- Repairing a single defective joint (e.g., wide joint with displaced ring).
- Sealing off a defective disused lateral connection.
- Repair a poorly made transition between different pipe materials.
- Repair of cracks that occur over a short distance.

CIPP patch liners must be sized sufficiently to bridge the required defect and adhere to structurally sound pipe on either side. Care should additionally be taken when CIPP patch lining over longitudinal cracks as the pressure from the packer may lead to cracks propagating. It is contingent on the Designer to understand any impacts, hydraulic or otherwise, of the patch liner.

For additional information refer to the Region's "CIPP Spot Repair Specification".

8.2.1.4. Joint Seals

Joint seals can be used when rehabilitation needs are confined to joints, or in emergency situations when infiltration requires immediate rectification. Seals should be made of a non-corrodible material, flexible, and be able to withstand up to 43 psi (30 m of head) external hydrostatic pressure, or other increased hydrostatic pressure that may exist based on site specific hydrogeological testing and monitoring. All joint seals are to be specified with test valves.

8.2.2. Full Length Cured-in-Place (CIPP) Liner

Full length CIPP liners must be designed to meet fully deteriorated conditions as outlined in the Region's Rehabilitation Standard Specifications. The Region will consider full length lining except in the following situations:

- Large deformation on the pipe > 10%.
- Very large dislocation of pipe joints that would prevent insertion of a liner or robot.
- Changes in pipe diameter or shape.
- The occurrence of obstructions and intrusions to the pipe.
- Significant and repeated problems with levels of water or returning roots.

For minimum design criteria and specifications, the Designer is to refer to the Region's CIPP Specification Documents for minimum design criteria and methodology. For non-circular host pipe (such as egg, oval, or other non-round shapes) the Designer shall propose a design method to be reviewed and approved by the Region. All lateral connections must be fully sealed/watertight using molded/seamless gaskets before lining is attempted.

8.2.3. Pipe Sliplining

When considering sliplining, the Designer is to adhere to the following:

- The method of sliplining should not reduce the original hydraulic capacity of the pipeline unless hydraulic analysis shows acceptable results, surplus capacity is not needed, and as permitted by the Region. The Designer is to submit calculations that show improved hydraulic conditions based on a lower Manning's number, for acceptance by the Region on a project specific basis.
- Both loose fit and close fit liners are permitted, providing:
- Loose fit no more than 25 mm annular space.
- All liners to be corrosion resistant.

- Joints for all pipe to be low profile jacking, fused, welded, or flush bell and spigot, complete with appropriate sealing to prevent infiltration.

It is recommended that the Designer use the following steps to appropriately size and design sliplining rehabilitation:

- Select liner diameter
- Select the largest possible diameter that can be accommodated within the host pipe without compromising installation.
- Select liner wall thickness
- Use the Standard Love's equations to determine buckling forces due to hydrostatic pressure (both internal and external), as well as grouting pressures (if using loose fit).
- Ensure that the liner pipe can withstand applicable pulling or pushing loads, and all expected dead and live loads (fully deteriorated condition).
- Determine Flow Capacity
- Determine flow capacity using Manning's for gravity and Hazen Williams for Forcemains.
- Design Necessary Accesses
- Termination points at maintenance holes must be made watertight to prevent potential infiltration (if loose fit is selected) in accordance with Region's STD DWG 2-5 series or 2-7 series (as applicable).
- Lateral connections to sliplined pipes shall utilize acceptable methods based on materials that prevent infiltration. Connections must be made after relaxation of the liner.
- Allowances must be made for any increased buoyancy or pipe deformation due to grouting.
- Facilitate access for staging, as required.

8.2.4. Spiral Wound Pipe Liner

Spiral wound liners can be considered in situations where a small construction footprint is necessary, and the pipeline does not have significant bends. The Designer is to ensure that the liner profile type is sufficient to provide the required stiffness for desired application. Lining with annular gaps will only be permitted if the Designer can demonstrate that the diameter reduction will not reduce hydraulic performance.

All liners are to be designed for the fully deteriorated condition, as outlined in ASTM F1741 Appendix X.1.2.3 (with or without grouting). Designs and calculations to be provided when requested by the Region and must bear the stamp and signature of a qualified professional engineer registered or licensed to practice in Ontario.

For minimum design criteria and specifications, the Designer is to refer to the Region's Rehabilitation Specifications.

8.2.5. Sprayed in Place Liner

For sprayed in place liner, all designs shall be guided by methodologies outlined in the AWWA Structural Classification of Pressure Pipe Linings and Region Rehabilitation Specifications where appropriate. When considering Sprayed in Place Liner, the Designer shall adhere to the following:

- The design should aim to not reduce the pipeline's original hydraulic capacity, unless permitted by the Region. Calculations that show improved hydraulic conditions based on lower Manning's number or Hazen-Williams coefficient, must be submitted for the Region to accept on a project specific basis.
- If the purpose of the liner is to fulfil a structural requirement, then the Fully Deteriorated design procedure should be used.
- If the purpose of the liner is for corrosion protection, or other non-structural purpose, then the Partially Deteriorated design procedure should be used.

8.2.5.1. Cementitious

These shall be selected based on project specific requirements and Region approval.

8.2.5.2. Polymer

These shall be selected based on project specific requirements and Region approval.

8.2.5.3. Resin Based

These shall be selected based on project specific requirements and Region approval.

8.2.6. Pipe Bursting

Pipe bursting can be considered in situations where diameter reduction is undesirable, or host pipe conditions makes it unsuitable for CIPP lining, open cut solutions would be too intrusive (trees, crossing driveways/utilities, etc.), or if an upsize of pipe is required. Bursting design is restricted to the B classification (single upsize) per the International Pipe Bursting Association (IPBA) classification system unless Region requests/approves otherwise.

Detailed geotechnical, hydrogeological and SUE data must be provided well in advance of design, as soils with high groundwater or loose soils are not good candidates. The Designer should ensure that the method chosen, and the prevailing ground conditions are such that line and grade can be maintained within a reasonable tolerance (for gravity pipe and laterals). If bursting is to occur in the vicinity of existing pipelines or utilities, the Designer is to ensure that the existing utility is two diameters of the replacement pipe offset.

Pipelines that have metallic spot repairs, or components that could potentially damage the bursting head, as well has shallow depth of cover and numerous lateral connections, are generally not suitable candidates for pipe bursting.

8.3. Maintenance Holes Rehabilitation

This section is to be used in conjunction with Region's STD DWGs 2-8 series and any other applicable standard drawings for Maintenance Hole Rehabilitation. All materials used shall be in conformance with the standard drawings and contract specifications unless unique circumstances require otherwise and only with written approval from the Region. The success of maintenance hole repairs and lining/coating installations are highly dependent on the installer following the recommendations of the product manufacturer regarding activities such as surface preparation, application requirements such as ambient temp and humidity, and post application testing. Therefore, regardless of the type of maintenance hole rehabilitation approach, the necessary installation qualifications and installation QA/QC procedures must be followed.

8.3.1. Frame and Cover Replacement

Frame and cover replacements are to be made per project specific requirements and to match site conditions and any risk mitigation requirements as identified in the condition assessment and any studies performed, based on Region's STD DWG series 2-6 and 2-8, and any other applicable standards. Further information regarding maintenance hole frame and covers is available in Section 6.3.1.

8.3.2. Grade Adjustment / Chimney Repair

Adjustment units can be rehabilitated using internal seals, epoxy, or polyurethane sealants. All joints or cracks should be injected with hydrophobic sealant to eliminate inflow and infiltration, per Region's STD DWG 2-8-8 and 2-8-9. Internal mechanical or chemical seals should be used if no excavation is permitted, or defect is not structural in nature. If any structural defect is noted, then replacement is preferred if site conditions permit, per Region's STD DWG 2-8-6.

8.3.3. Step and Ladder Replacement

If 25% or more of existing steps need to be replaced, then the remaining steps shall be removed and replaced with a new ladder (FRP preferred). If chamber requires full rehabilitation, then all existing steps and or ladders shall be removed to facilitate rehabilitation methodology then shall be replaced with ladder (FRP preferred). If existing ladder is damaged, then it shall be inspected by a competent person and be fully replaced if repairs cannot be facilitated. Further information regarding maintenance hole steps and ladders is available in Section 6.3.2 and Section 6.3.3 respectively.

8.3.4. Benching/Channel Restoration

Replacement benching (new or partial) shall be constructed to the obvert of the pipe, per Region's STD DWG series 2-8. The channel shall be formed such as the surface is smooth to facilitate acceptable flow regime.

8.3.5. Injection Grouting

Grouting in maintenance holes may be required at structural joints and/ or annular spaces at pipe or other appurtenance connections. All grout is to be hydrophobic and designed to withstand site specific ground water hydrostatic pressures, as per Region's STD DWG 2-8-2 and 2-8-3. For additional information regarding injection grouting routing refer to the Regions "Standard Specification for Chemical Injection Grouting in Sewers and Maintenance Holes"

8.3.6. Protective Linings

8.3.6.1Spray Liners

Spray liners can be used for either structural or non-structural designs and must be engineered, meet the requirements as set out in Region's STD DWG 2-8 series and bear the stamp and signature of a qualified professional engineer registered or licensed to practice in Ontario.

8.3.6.2Others

Epoxy liners shall be used, at a minimum, in the two maintenance holes downstream and upstream of the maintenance hole with a forcemain discharge or where turbulent flow conditions are present, creating corrosive environments.

Other rehabilitative lining technologies may be considered at the sole discretion of the Region. These include:

- Cured-in-Place Maintenance Hole Liners
- Composite Liners (Fibreglass Reinforced Epoxy)

- HDPE/PVC Sheet Liners
- FRP Inserts

8.4. Laterals Rehabilitation

8.4.1. Lateral Pipe Bursting

The Designer is to refer to Section 8.2.6 for guidelines on pipe bursting.

8.4.2. Cured-in-Place Pipe (CIPP) Liner

CIPP Lining for laterals to be based on design parameters established in Section 8.2.2 and ASTM F1216 and per Region Standard Specifications.

8.4.3. Injection Grouting

The Designer is to refer to Section 8.2.1.2 for appropriate parameters and design criteria governing injection grouting.

8.5. Specialized Structures Rehabilitation

As specialized structures are limited in number and are more complicated in design their rehabilitation will be based on project specific requirements, specific condition assessment, and based on industry leading best practices and engineering The Designer shall coordinate and collaborate all design effort with the Region.

9. Other Design Considerations

9.1. General

Designers shall in all case ensure design work including drawings, specifications and all other contract documents consider all phases of work including construction, testing and commissioning, asset management and project close out. Subsequent sections of this chapter include some specific considerations Designers need to account for however the information provided in this chapter is not a complete list and cannot cover contract specific risks for all projects. It is the Designers responsibility to ensure contract documents include provisions to address all contract specific risks and phases of the work.

If any conflicts are noted between this document, LINEAR INFRASTRUCTURE TESTING AND ACCEPTANCE MANUAL FOR SANITARY AND WATER ASSETS, or Vol 2, the Designer shall develop project specific Special Provisions to accommodate for any noted conflicts.

9.1.1. Site Conditions and Construction Requirements

The Designer is to ensure that the design is carried out in a manner which considers the specific conditions and constraints of the project site and can adhere to stipulated construction requirements.

9.1.2. Transporting, Unloading and Storing Pipe and Materials

The Designer is to ensure that the design is carried out is in a manner which provides consideration for ingress and egress of haulage (i.e., precast products, engineered fill, excess native materials, etc.), and other construction equipment. The unloading and storing of any materials on site shall be based on specific construction methodology and the material manufacturer's requirements.

9.1.3. Open Cut Installation of Pipelines

At all times, the Designer shall consider proper and feasible installation and available space for safe placement of pipelines, in accordance with the manufacturer's recommended procedures.

9.1.4. Pipe Bedding and Backfill

At all times, the Designer is to ensure bedding and backfill conform with Region's STD DWG 2-3-1 and understand where different conditions covered in Region's STD DWG 2-3-1 apply. If a specialized site condition exists not covered by existing Region's STD DWG 2-3-1, the Designer shall propose another methodology that will accommodate the project need.

9.1.5. Jointing Pipes

The Designer is to ensure that due consideration is given to watertightness and space requirements for facilitating jointing (inserting gasketing, homing, supporting cradling for connections to maintenance holes, joint deflection capabilities based on pipe material, etc.).

The Designer shall also understand groundwater and soil chemistry and the presence of hazardous materials (e.g., hydrocarbons), based on geotechnical and hydrogeological data, to specify the appropriate gasket material and jointing method.

The Designer is to specify that all joints for AWWA C30*X* series pipes be diapered and grouted, as well as joint parging/pointing per manufacturer's recommendations.

Designer must consider the installation of the protective liners at pipe joints. For concrete pipes installed using single pass tunnelling, the liner shall not extend to the end of the pipe (held back 35 mm from each bell and spigot end), allowing a portion of exposed concrete at the joint for inspection. Once joints are inspected and accepted the space between the joining pipes shall be grouted prior to installing the protective liner to cover the exposed concrete. The protective liner used to cover the exposed concrete at the pipe joint shall match the protective liner installed within the pipe.

For concrete pipes that do not facilitate human entry for joint inspection, the Designer shall consider specifying the manufacturer chamfer the ends of the pipe (or lightly grind the ends to remove the 90-degree edge) before installing chemically bonded protective liner and adding a rubber block (or equivalent) in the space between the joining pipe ends.

9.1.6. Construction of Maintenance Holes

The Designer shall consider proper and feasible installation with available space for safe placement, construction, and unobstructed permanent operation and maintenance access when locating maintenance holes. Consideration must be given regarding overland flows or potential flooding of the surface access. If these conditions exist, then the Designer shall include risk mitigation measures within the design or limit exposure.

9.1.7. Service Lateral Connections

The Designer shall consider the number, location, and depth of lateral services, as well as line and grade checks, and information for sanitary sewer cards. Additionally, lateral service connections will only be permitted on local collectors without written permission from Director of Engineering.

9.1.8. Sanitary Sewer Replacement

The Designer is to consider the location, and account for existing dry weather flows (DWF) and wet weather flows (WWF) for bypass pumping requirements, flow control methodology transferral of existing connections. Disposal of excess material and debris shall be in accordance with all applicable acts, regulations, and Region Requirements.

9.1.9. Trenchless Technologies

The Designer is to understand and consider site compound(s) and/or equipment location and dimensions, specialized excavation, shoring and bracing requirements, casing spacers (if applicable) and their impact on tunnel size, grouting forces, jacking and/or pulling forces, etc. For shaft design and construction, ferrous metal tiebacks for shoring and bracing will not be accepted.

9.2. Abandonment

The Region prefers abandonment to removal, except in situations where abandonment will hamper new installation or other project specific requirements.

9.2.1. Mainline Gravity Sanitary Sewers and Forcemains

To abandon mainline sanitary sewers and forcemains, all pipes are to be filled with flowable, unshrinkable fill and plugged at both ends. The condition of the pipeline will govern the method of filling and the proposed filling material. When abandoning pipes adjacent to or crossing waterways or any other utility or infrastructure, the type of fill and procedure proposed is to be approved by the relevant authority having jurisdiction.

9.2.2. Laterals

Laterals are to be plugged at the property line, capped at main then filled with unshrinkable fill.

9.2.3. Chambers and Maintenance Holes

Chambers and maintenance holes are to be removed 1.5 m below grade, with the base perforated sufficiently to provide adequate drainage and all incoming connections plugged. Maintenance holes and chambers in the road right of way should be filled with unshrinkable fill. In the boulevard, these should be filled with native material or granular material.

When abandoning maintenance holes adjacent to or crossing waterways, or any other utility or infrastructure, the type of fill and procedure proposed is to be approved by the relevant authority having jurisdiction.

9.2.4. Appurtenances

For appurtenances, it is the Region's preference that they be removed as opposed to abandoned. If removal is not possible, appurtenance is to be fully opened, encased in concrete, and all components that extend to and above surface level removed.

9.3. Submittals

The Region's representatives are required to coordinate, manage, and review all submittals from the contractor. The following submittals shall be provided understanding this sample list is not exhaustive, and the Region reserves the right to request additional submittals on a project specific basis

9.3.1. General Submittals

In general, the Region requires the following submittals for construction.

Pre-Construction

- Health and Safety Plan
- Layout/Shop Drawings prior to manufacturing (for pipelines 600 mm and larger)
- Evidence of Permits
- QA/QC Records of Product (per the Region's request at any point in time)
- Testing and Commission Plans (per project specifications) including details on bulkheading, restraints (method, types, lengths) etc.
- Bypass and shutdown plan as per Region requirements

Post-Construction

- Results of all Required Testing and Inspection
- CCTV Submittals
- Visual Inspection Logs
- Continuity Testing Results
- Asset Logging and Tagging
- As-Builts for Layout/Shop Drawings
- Decommissioning Report (for abandoned appurtenances and chambers)

- As-Built Drawings including accurate GPS (Global Positioning System) coordinates of all joints (AWWA C30*X*), PIs (Points of Intersect), and chambers, on a project specific basis
- Standard Operating Procedures Manuals (for gates, diversions etc. on a project specific basis), including training requirements, if applicable

9.3.2. Trenchless Specific Submittals

For trenchless specific works, the Region requires all items outlined in Section **Error! Reference source not found. Error! Reference source not found.**, and the following submittals for construction.

Pre-Construction

- Trenchless Method, Procedures, and Equipment Data
- Compound Details
- Shaft Details (including face support and temporary support details)
- Primary Liner Support Details
- Annular Space Filling Procedures and Material Specifications (for primary and/or carrier pipe)
- Settlement Monitoring Plan
- Noise and Vibration Monitoring Plan
- Excess Soils/Spoils Management Plan

Post Construction

- Same as general sections 10.1.1.

9.3.3. Sample Submittal Table

Table 91 Sample Submittal Table

PROJECT TYPE	STAGE	SUBMITTALS
Open Cut – AWWA C30*X* Pipe	**Pre-Construction**	• Health and Safety Plan • Evidence of Permits • Layout/Shop Drawings prior to manufacturing (piping and applicable maintenance holes) • Joint Assembly and Configuration Details • Liner details including procedures for installation, welding, and holiday testing • QA/QC Records of Product (per the Region's request at any point in time) • Detailed Testing and Commission Plan including details on bulkheading, restraints (method, types, lengths), etc.
	During Construction	• Joint Diaper and Grouting Inspection Reports • Results of Hydrostatic Test, including duration of test, test pressure, pressure drop (if any) • Bedding and Backfill Materials Testing Reports (including abandonment and decommissioning report)
	Post Construction	• CCTV Report • Visual Inspection Logs • Asset Tagging (i.e. slide gates etc.) • As-Built Drawings including accurate GPS coordinates of all joints, PI points and chambers

10. Inspection and Testing

If any conflicts are noted between this document, LINEAR INFRASTRUCTURE TESTING AND ACCEPTANCE MANUAL FOR SANITARY AND WATER ASSETS, or Vol 2, the Designer shall develop project specific Special Provisions to accommodate for any noted conflicts.

10.1.1. Gravity Sewers

10.1.1.1. Pre-Inspection Cleaning

The Designer shall specify that the Contractor shall flush and thoroughly clean all sanitary sewers. The Contractor shall provide all required equipment, water, permitting, for this operation. All materials generated from the required cleaning are the responsibility of the contractor to dispose of in a manner consistent with all applicable acts, regulations, and Region requirements.

10.1.1.2. Post-Construction Inspection

10.1.1.2.1. CCTV Inspection

For all pipelines, CCTV Inspections are to be carried out by the Contractor per contract documents, the specifications outlined in Region's CCTV specifications, and shall be fully compatible with the Region's assessment management software.

10.1.1.2.2. Visual Inspection

If CCTV or other inspection methodologies are inadequate, visual inspection shall be performed with approval of the Region and in accordance with all required guidelines.

10.1.1.2.3. Other Inspection Methodologies

CCTV is the Region's preferred method of inspection. The Region may, however, require other inspection methods where deemed appropriate.

10.1.1.2.4. Field Testing for Protective Liners

All protective liners should be subject to a delamination survey to ensure proper adherence to substrate, inspection of seams and joints, and spark testing (to detect holidays). The Designer is to refer to the appropriate ASTM standard and any other manufacturer requirements. The above does not preclude the need for factory testing and QA/QC records.

10.1.1.3. Deflection Testing and Inspection

Deflection testing shall be performed on all sanitary sewer pipes constructed using flexible pipe materials.

10.1.1.3.1. Mandrel Testing

Mandrel deflection testing shall be performed on all flexible pipe materials used for sanitary sewers. The mandrel deflection test shall be performed no sooner than thirty (30) days after final backfill to road subgrade elevation has been placed. The mandrel shall be cylindrical in shape and constructed with an odd number of evenly spaced arms or prongs, minimum nine (9) in number. The minimum diameter of the circle scribed around the outside of the mandrel arms shall be equal to the allowable deflected pipe diameter ± 1 mm. The contact length of the mandrel shall be measured between the points of contact on the mandrel arm or between sets of prongs.

The mandrel shall be checked with a go-no-go proving ring. The proving ring shall have a diameter equal to the allowable deflected pipe inside diameter ± 0.1 mm. An acceptable mandrel shall not pass through the proving ring. The proving ring shall be fabricated from steel a minimum of 6 mm thick.

For pipes up to 525 mm diameter, the allowable deflected pipe diameter is 7.5% of the base inside diameter of the pipe. For pipes greater than 525 mm diameter, the allowable deflected pipe diameter is 5.0% of the base inside diameter of the pipe. The base inside diameter is defined in the CSA or ASTM standard to which the pipe is manufactured. Any section of pipe that does not allow the mandrel to pass shall be considered to have failed the deflection test.

All sections of pipe that fail the deflection test shall be repaired and retested. Re-rounding is not accepted. Retesting shall be carried out no sooner than thirty (30) days after backfill has been placed.

10.1.1.4. Joint Assembly Inspection

All joints for flexible or rigid pipe materials are to be inspected in the field and measured to ensure joint assembly deflection is in keeping with manufacturer’s requirements. The Designer is to specify that all joints for AWWA C30*X* series pipes be diapered and grouted, as well as joint parging/pointing per manufacturer’s recommendations.

10.1.1.5. Leakage Testing Requirements

10.1.1.5.1. Leakage Testing General Requirements

All sanitary sewer pipelines up to 525 mm diameter (non-pressure design classification) are to be tested with water using either an infiltration or exfiltration test. This testing should be done between and including maintenance holes. All sources of inflow (laterals etc.) to be sealed, if applicable.

For sanitary sewer pipelines 600 mm diameter and above, hydrostatic pressure testing to 345 kPa (50 psi) will be required including maintenance holes.

Testing shall be completed prior to installing physically bonded protective liners cap strip at pipe joints or installing chemically bonded protective liners at pipe joints.

10.1.1.5.2. Leakage Testing with Water

Infiltration Test (Pipelines up to 525 mm / Non-Pressure Design Classification)

Infiltration tests (v-notch weir test or equivalent) may be conducted when the groundwater level at the time of testing is 750 mm or more above the pipe crown for the entire test section. The pipe and maintenance hole section shall be tested together as the identified test section. No leakage will be permitted.

A V-notch weir shall be installed downstream of the section being tested. The test section of the sanitary sewer pipe shall be isolated by temporarily plugging the upstream end and plugging all incoming pipes of the maintenance holes. All service laterals, stubs, and fittings shall also be plugged or capped to prevent water from entering the test section.

Exfiltration Test (Pipelines up to 525 mm / Non-Pressure Design Classification)

Exfiltration tests shall be conducted where the groundwater level is lower than 750 mm above the crown of the pipe or the highest point of the test section. The pipe and maintenance hole section shall be tested together as the identified test section.

All service laterals, stubs, and fittings shall also be plugged or capped to prevent water from entering at these sections. No leakage shall be permitted.

Pressure Test (Pipelines 600 mm and above / Pressure Design Classification)

For pipe 600 mm and above (pressure designed classification), testing shall be completed to a minimum 345 kPa (50 psi) at centreline (or springline) of pipe at the highest point of the section to be tested, including maintenance holes, as applicable. The required 345 kPa (50 psi) pressure must hold for two (2) hours with zero leakage.

Over and above the AWWA M9 manual (or other applicable AWWA manuals for other approved pipeline materials), any addition of make up water during the test period, shall restart the 2-hour pressure testing period.

All leaks shall be located and repaired. The test section shall be retested until satisfactory results are obtained. The Vendor shall be responsible for providing all equipment and required materials for testing.

Contractor shall specify, by calculation, the location, and breakpoints for all test sections as well as submit a detailed testing and commissioning plan for review prior to any field testing.

10.1.1.5.3. Testing with Low Pressure Air

Pipeline Air Testing

The Region may allow or require testing by use of air where water is not readily available (or during seasonal restrictions), or the differential head in the test section is greater than 8.0 m, or freezing temperatures exist. This does not preclude the need for a water test, in accordance with OPSS.MUNI 410. Air testing will not be allowed in pipes greater than 300 mm or in maintenance holes or chambers. All laterals and cleanouts are to be sealed prior to test.

Pipeline Joint Air Testing

Joints may additionally be tested using low pressure air for leakage/watertightness in pipes above 600 mm. To facilitate this, the Region may request testable joints. The specific method must be in accordance with the manufacturer's recommendation and does not preclude the need for a hydrostatic field pressure test.

10.1.2. Forcemain Testing and Inspection

10.1.2.1. Pre-Inspection Cleaning

Requirements for cleaning shall conform with Section 10.1.1.1.

10.1.2.2. Post-Construction Inspection

Requirements for inspection shall conform with Section 10.1.1.2.

10.1.2.3.

10.1.2.4. Joint Assembly Inspection

For forcemain joint assembly inspection the Designer is to refer to Section 10.1.1.4 for the appropriate joint assembly inspection requirements.

10.1.2.5. Leakage Testing

10.1.2.5.1. Hydrostatic Testing

For Hydrostatic testing of forcemains, the test pressure shall be 1.5 times the operating pressure (or design pressure) in the line pipe section. No pressure drop is allowed during the test period.

Contractor shall specify, by calculation, the location, and breakpoints for all test sections as well as submit a detailed testing and commissioning plan for review prior to any field testing.

All air shall be removed from the pipeline by filling the pipe slowly with water. A 48-hour absorption period shall be permitted before commencing the test.

The leakage observed is the amount of water added to the test section to maintain the specified test pressure for duration of two (2) hours. No leakage shall be permitted. All leaks shall be located, stopped, and repaired, with the section being retested until total leakage is zero. All defective appurtenances, valves, fittings, and pipe shall be replaced until leakage is zero.

10.1.3. Maintenance Holes

10.1.3.1. Pre-Inspection Cleaning

All maintenance holes should be cleaned prior to inspection, in a similar fashion to mainline gravity sanitary sewers and forcemains in Section 10.1.1.1 and Section 10.1.2.1.

10.1.3.2. Post-Construction Inspection

10.1.3.2.1. Visual Inspection

All maintenance holes shall be visually inspected for leakage, ingress of construction material, and defects during all phases of construction. Specifically, each maintenance hole shall be visually inspected for leakage after assembly and backfill, and only after sufficient time has been allowed for groundwater levels to normalize. The Designer is to ensure that they review all applicable investigations to determine groundwater recovery period to facilitate inspection.

10.1.3.3. Other Inspections

The Region reserves the right to specify additional inspection methodologies for maintenance holes. These include, but are not limited to:

- 3D Camera Inspection
- 3D Laser Scanning
- Zoom Cameras
- Sonar Method

10.1.3.4. Field Testing for Protective Liners

Protective Liners, if used, should be subject to the following inspections (per all applicable ASTM and manufacturer requirements):

- Delamination survey to ensure proper adherence to substrate
- Inspection of seams
- Spark testing (to detect holidays)

The above inspections do not, however, preclude the need for factory testing and the submission and perusal of QA/QC records.

10.1.3.5. Leakage Testing

10.1.3.5.1. Testing with Water

Infiltration Test (Non-Pressure Design Classification)

When the exfiltration test cannot be completed, and/or as directed by the Region, an infiltration water test may be conducted. Testing practices, equipment, and specification shall follow OPSS.MUNI 407.

Exfiltration Test (Non-Pressure Design Classification)

For non-pressure designed maintenance holes (per Region's STD DWG 2-5 series) an exfiltration test will be required and carried out in accordance with ASTM C969M as well as OPSS.MUNI 410.

A leakage rate of 3 l/hr will be permitted.

Pressure Testing (Pressure Design Classification)

For maintenance holes designed to Region's STD DWG 2-7 series and/or with pipelines diameter 600 mm or larger, the Designer to follow the hydrostatic testing guidelines for AWWA C30*X* gravity pipe (or other approved pipe materials), as outlined in Section 10.1.1.5.2 [Pressure Test (Pipelines 600 mm and above / Pressure Design Classification)], and as noted in Region's STD DWG 2-7 series.

For cast –in-place chambers and/or maintenance holes for pipelines greater than 525 mm, pressure testing shall be as per ACI CODE-350, Requirements for Environmental Engineering Concrete Structures.

10.1.3.5.2. Vacuum Testing

If deemed necessary, in situations where water is unavailable, vacuum testing may be permitted by the Region as stipulated in ASTM 1244M.

All joints within the maintenance hole shall be included in the test. Test equipment shall be specifically designed for vacuum testing maintenance holes.

10.1.3.6. Grade Adjustment Testing

If specified by the Region, installed chimney seals (an internal flexible rubber frame seal) shall be tested for watertightness as per manufacturers testing requirements.

10.1.4. Specialized Structures, Chambers and Accessories

All specialized structures and their associated accessories and appurtenances shall be tested as per project specific requirements and manufacturers recommendations. The Region may waive the testing requirement, at its sole discretion, if the structure was designed in accordance with ACI CODE-350, Requirements for Environmental Engineering Concrete Structures.

APPENDIX

Table A-0-1 Sample PUCC Utility Clearances for City of Mississauga

Utility Provider	Preferred Horizontal Offset	Preferred Vertical Offset (Crossing)
Bell Canada	0.6 m	0.3 m
Enbridge Gas	0.6 m 1.0 m (boring)	0.3 m 0.6 m (NPS 12)
Alectra	1.0 m	1.0 m
HCE Telecom	0.3 m	0.3 m
GT Services	0.6 m	0.3 m
Hydro One Networks	1.0 m	
Hydro One Telecom (HOT)	0.3 m	0.3 m above 0.5 m below
Region of Peel Water & Appurtenances (open cut)	1.2 m	0.3 m above 0.5 m below
Region of Peel Sanitary & Appurtenances – greater than 5m deep (standard location – open cut)	3.0 m	0.3 m above 0.5 m below
Region of Peel Sanitary & Appurtenances – less than 5m deep (standard location – open cut)	2.0 m	0.3 m above 0.5 m below
Region of Peel Sanitary & Appurtenances (non-standard – boulevard – open cut)	1.2 m	0.3 m above 0.5 m below
Region of Peel Water/Sanitary & Appurtenances (trenchless – less than 500 mm bore diameter)	1.2 m	0.5 m above 1.0 m below
Region of Peel Water/Sanitary & Appurtenances (trenchless – greater than 500 mm bore diameter)	1.2 m	2x bore diameter above/below
Region of Peel Storm & Appurtenances (open cut & trenchless)	2.5 m	0.5 m above 0.5 m below Trenchless (daylight crossing)
Region of Peel Roadway (depth of cover)	N/A	1.0 - 1.2 m
Region of Peel Noise Wall	1.5 m	1.0 m (between posts)
Region of Peel Traffic & Street Lighting	1.2 m	0. 3m above/below
Region of Peel Sightlines	As per TAC manual	As per TAC manual

[1] These offsets are taken from Mississauga PUCC Guideline document. It is the responsibility of the Designer to check for the most up to date standards at all times. If such standards have been updated, the Designer should utilize the updated standards if changes are made. In the event of any conflicts, MECP and other local guidelines will take precedence.

Table A-0-1 Sample PUCC Utility Clearances for City of Mississauga

Utility Provider	Preferred Horizontal Offset	Preferred Vertical Offset (Crossing)
Region of Peel PSN Fiber	0.6 m	0.3 m above/below
Union Gas	0.3 m	0.3 m
Rogers	0.6 m	0.3 m
Cogeco Peer 1	0.6 m (hand dig within 1.0 m)	
Zayo (Allstream)	0.6 m (hand dig within 1.0 m)	0.3 m
COM Storm	2.5m (or get approval to hand dig within 1.0 m)	0.5 m above 0.5 m below
COM Storm trenchless crossing <500m	as above (hand dig within 1.0 m)	0.5 m above 1.0 m below
COM Storm trenchless crossing >500m	as above (hand dig within 1.0 m)	2x bore diameter
COM Back of curb	0.5 m	1.0 m
COM Catch basins	0.5 m	0.5 m
COM Street lighting duct	0.6 m	0.3 m
COM PSN fiber	0.6 m	0.3 m
COM Traffic Signal duct	1.0 m	0.6 m
COM Traffic Signal above ground plant	1.0 m	
COM Depth of cover		1.0 - 1.2 m
COM Sightlines	As per TAC Manual	As per TAC Manual
COM Urban Forestry - trees in sod - trench	1.5 m (hand dig within 1.0 m)	N/A
COM Urban Forestry - trees in sod - trenchless	min. 1.2 m from trunk to edge of bore alignment (preferred).	min. 1.5 m depth from surface /600 mm below root ball of tree **at the discretion of Urban Forestry**
COM Urban Forestry - structural soil - trench	Running **parallel** to trench: 1.0 m from **edge** of structural soil corridor to **edge** of excavation. Running perpendicular to trench: **NO** crossing of structural soil trench is permitted even between trees	N/A
COM Urban Forestry - structural soil - trenchless	Running **parallel** to trench: 1.0 m from **edge** of structural soil corridor to edge of bore. Running **perpendicular** to trench: **NO** crossing of structural soil trench is permitted even between trees	N/A

[1] These offsets are taken from Mississauga PUCC Guideline document. It is the responsibility of the Designer to check for the most up to date standards at all times. If such standards have been updated, the Designer should utilize the updated standards if changes are made. In the event of any conflicts, MECP and other local guidelines will take precedence.

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