Manual of Best Practices to Reduce Risk of Inflow and Infiltration (I/I) in Public Side New Construction of Sanitary Sewers

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Norton Engineering Inc.
243 Glasgow Street
Kitchener ON N2M 2M3

NORTON ENGINEERING

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Dedication

This document is dedicated to the hundreds of men and women across Ontario and Canada working for municipalities and endeavouring to improve the design, construction, inspection, testing and operation of new sewer infrastructure, sometimes in the face of challenges. The information in this report is strongly informed by the expertise of these men and women.

Acknowledgements

The authors would like to acknowledge the significant funding support for this research provided by the following since 2015. They include:

Region of Halton
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Additional municipalities/regions provided funding for this work but requested that they not be identified.

The information, suggestions, recommendations and conclusions in this report are strictly the opinion of the author and not any funding supporters.

About Norton Engineering

Norton Engineering Inc. was established in 2015. Norton's primary area of interest is inflow and infiltration (I/I), particularly in new construction, a topic Norton's founder, Barbara Robinson, has been working on since the mid-2000s. Norton leads a variety of ongoing projects looking at all aspects of this phenomenon across Ontario and Canada. Every year, Norton delivers dozens of presentations, workshops, training and media spots on this and related topics. Norton staff chaired the CSA committee that developed *CSA Z800: Basement Flood Protection and Risk Reduction Guideline (2018)*, and was a primary author (along with D. Sandink of ICLR and D. Lapp of Engineers Canada) of *"Reducing the Risk of Inflow/Infiltration (I/I) in New Sewer Construction: A Foundational Document",* published in 2019.

Use of This Document

The information contained in this document is for information purposes only. Many of the issues discussed have only recently been identified as risk factors for long term I/I. Recommendations have been developed based on input from a variety of sources and represent what appear to be the best available solutions to issues identified. In most cases these have already been implemented in some locations with some success. However, in most instances, long term monitoring of solutions is not yet available. Furthermore, this topic is evolving constantly, and Norton continues to receive new information, recommendations, feedback and input.

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No part of the foundational document should be considered prescriptive or adopted as a vetted best practice by any agency.

It is recommended that measures discussed in this document be piloted, monitored, and reported upon, and that this document be revisited regularly as more information is available.

Municipalities/Agencies whose Staff has Contributed

Staff from the following municipalities (and others) have provided recommendations, feedback or reviews of Norton's work. Norton is grateful for this feedback.

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Town of Saugeen Shores
Town of South Bruce Peninsula
Town of Tecumseh
Town of the Blue Mountains
Town of Wasaga Beach
Town of Welland
Township of Centre Wellington
Township of King City
Township of Minden Hills
Township of Oro-Medonte
Township of Ramara
Township of Woolwich
University of Alberta
Utilities Kingston

1 Introduction

1.1 Inflow and Infiltration in New Construction

The issue of Inflow and Infiltration (I/I) and the resulting negative impacts in sanitary sewer systems have become chronic across North America. Sanitary sewers are designed to account for long term I/I, which is expected to gradually increase over time as a system get older.

In recent years, however, sources of I/I originating in new construction have been identified. In a 2015 to 2017 study of Unacceptable I/I in New Subdivisions in Ontario,[1] recent flow monitoring data from the downstream end of new subdivisions were collected from municipalities. In 34 out of 35 subdivisions, excessive levels of I/I were observed. This early work revealed that the specific sources of the excessive I/I were typically not yet identified by the municipality (whether the source was construction on the public or the private side was unknown). The causes and conditions of this I/I, which are wide-ranging, were discussed in detail in that report. The I/I appears to be a result of issues on both the private side and the public side.

Subsequent to the initial flow monitoring results, Norton has spent the past 3 years interviewing hundreds of men and women across Ontario working to determine the causes and conditions which are contributing to the formation of this I/I.

Industry experts now estimate that I/I from private property sources accounts for 50 to 60% of total I/I.[2] The private side is regulated under Building Codes in Canada. So, this work includes a thorough examination of both the public and private sides of the sewer system. An additional report was published by Norton, Building Code Regulations and Engineering Standards as they relate to I/I in Sanitary Sewer Systems (2018),[3] specifically addressing private side issues.

The findings of Norton's work presented in this Best Practices Manual are the result of detailed interviews with hundreds of stakeholders in the development industry over ten years. Stakeholders include municipal engineering and building staff, consultants, contractors, developers, drain layers, plumbers and other related groups. Stakeholders helped to identify gaps in guidelines, standards and codes, construction practice, inspection and testing, certification, jurisdiction, education and process, which contribute directly to the issue of excess I/I in new construction.

Inflow and infiltration can be a costly affair.[4] On both the public and private sides, it is a potential factor in basement flooding (with associated health risks)[5] and can cause significant reduction in the hydraulic capacity of sanitary and storm sewers. Such diminished hydraulic capacity may become even more consequential, given the more intense and more frequent peak flows associated with climate change. These impacts are extensively documented elsewhere.

> *"The causes of I&I are almost entirely due to human factors related to design, construction, quality assurance, inspection, monitoring and maintenance. Performance problems can also be further exacerbated by environmental factors such as soils and groundwater conditions, as well as the quality of materials. It is not for a lack of materials, methods and technology that I&I problems continue to be witnessed in sanitary sewer systems, rather it is a failure to account for all of the factors impacting performance and then to address them in an effective manner."*
> Kesik, T. 2015. Management of Inflow and Infiltration in Urban Developments. Toronto: Institute for Catastrophic Loss Reduction.

This report is intended to be read by professionals working on the public side (typically engineering staff) and the private side (building staff), since it would benefit the industry to have both groups more knowledgeable about the others' work. A Manual of Best Practices to Reduce I/I on the Private Side is to follow as a companion document.

1.2 Description of "Excessive" Versus "Unacceptable" I/I in New Subdivisions

Norton's research refers to two terms when describing I/I in new subdivisions, in accordance with how the information received has been evaluated.

The term "excessive" is used by the US EPA[6] to describe I/I. For the purposes of Norton's research, "excessive" refers to I/I that is obviously (to the person undertaking the assessment) higher than it should be, without actual measurement or comparison to a known standard. The original data set from 35 subdivisions collected by Norton can be characterized as having excessive I/I.

> **What is leak-acceptable infrastructure?**
>
> Leak-acceptable infrastructure is infrastructure that meets acceptance testing when it is installed. This is the sum of acceptable leakage on the public and private sides. This value can be calculated for each sewershed based on area, number of houses or pipe length. Norton has coined this term for use in this kind of research.

The term "unacceptable" has a specific meaning in the context of Norton's research. I/I is defined as unacceptable when the amount of I/I exceeds the amount allowed at inception, as calculated per existing standards, codes and guidelines. There are allowable I/I values (e.g., leakage) at acceptance prescribed in Ontario Provincial Standards (OPS), Ministry of Environment (MOE) documents, and the Ontario Building Code. The sum of the allowable leakage in each component of a sewer system (on both the public and the private sides) is the allowable leakage for the subdivision. Therefore, the term “unacceptable” is used when the I/I has been compared to allowable and exceeds it.

These terms are explained in more detail in other documents.

1.3 Introduction to Next Sections

The next sections are divided according to the stage of development at which they can be applied. These are organized into:

- Good Policy Practice in Development Engineering

  These include practices which can be considered during the conception of new developments, including by Planning Departments and during Pre-consultation.
- Best Practices During Pre-Design to Reduce Risk of I/I

  These include practices that can be implemented at the early stages of new development, including when initial layout and setting of elevations is being considered.
- Best Practices During Design to Reduce Risk of I/I

  These practices include the design details which should be considered and included as final design occurs and drawings are prepared.
- Best Practices During Construction to Reduce Risk of I/I

  These include practices that can be implemented during construction to improve the likelihood of leak-acceptable infrastructure, and in many cases are simply proactive implementation of standards and guidelines which already exist.
- Best Practices after Construction to Reduce Risk of I/I

  These include practices that can be considered after construction, to reduce the risk of I/I as the infrastructure starts to go into service.

In addition, Norton has developed some good engineering practices in the management of a sewer system. Although this information does not strictly apply to new sewer systems, the need for this information was strongly identified by contributors to this research. Norton Engineering Inc., ICLR and Engineers Canada have been retained by Standards Council of Canada, to develop a Foundation Document for the Management of I/I in Existing Sewer Systems, and this work will be fleshed out in great detail in that document.

However, in the meantime (development of a National Standard of Canada is likely at least 2 years away), this preliminary research is included as the final chapter for municipalities to consider.

2 Good Policy Practice in Development Engineering

This section presents some good policy practices which can be used to reduce the risk of excessive I/I in sewer systems.

2.1 All City Documents related to Development should be Updated with a Lens on I/I Reduction/Leak-Acceptable Infrastructure

All City documents (Official Plans, Development Charge Bylaws, Engineering Standards, Climate Change Related documents), either intentionally or in the normal course of business, should be updated with the latest best practices in leak-acceptable infrastructure, both in new and existing developments.

It is recommended that municipalities use every opportunity to introduce/normalize the need for leak-acceptable infrastructure in all of their standard documents. This practice will provide redundancy to the required work of improving the planning, design, construction, inspection and acceptance work which is the subject of this manual.

2.2 All Inspectors (City, Consultant and Building) should Receive Regular Training Concerning I/I and its Impacts

Norton's research has strongly indicated that I/I is not well understood by many inspectors, both consulting, municipal and building. Development inspectors are frequently reported to be inexperienced[7], and therefore may not have had the opportunity to learn about I/I.

Inspectors do not always understand the reasons behind certain provisions (e.g. mandrel test), making them less likely to enforce them (e.g. survey results concerning Mandrel testing indicated that pipes failing a Mandrel test are rarely dug up and replaced[8], which is the required course of action). The Ten State Standards (2014) recommends that any pipe whose deflection exceeds 5% shall be excavated.[9]

This recommendation is made to ensure that inspectors are aware of the issue of I/I and are able to inspect critical components of infrastructure that may affect risk of I/I over the lifespan of the infrastructure.

2.3 Cities should not Permit Construction or Re-building in Flood Plains

This recommendation is designed to reduce any "grey areas" with respect to development in the floodplain[a]. Despite the experience of riverine flooding across Ontario in recent years, rebuilding and in fact new builds in flood plains continue to persist in Ontario.

This recommendation is intended to assist developers in achieving leak-acceptable infrastructure. Conservation Ontario[10] reports that there are currently 133,000 buildings in the province which are in the flood plain (Norton has reported 350,000 persons in the media). And, in many locations which have experienced flood and are at risk of flood, residents are permitted to rebuild in the same location (sometimes with conditions). Conservation Authorities report[11] that the ability to build in a flood plain is a grey area. It is not absolutely forbidden, and developers have some ability to fight CA recommendations.

> *Politicians are beginning to ask whether it makes sense to allow residents to rebuild in flood-prone areas.*
>
> CBC, 2019 (See endnote 12).

Allowing development to proceed or persist following a flood in flood plains is considered by the author to be very poor public policy. When a development proceeds in a flood plain, the developer and the municipality benefit (the developer makes a profit, and the municipality collects development charges and taxes from the new homes). To date in Ontario, flooded communities are typically provided with disaster funding from the province or the federal government, so the general taxpayer is paying to help flooded residents to reconstruct or relocate. This may change as flooding becomes more common and taxpayers start to object to this type of funding.[12]

It is the author's belief that the financial risk should remain with the entity who takes a profit from an endeavour (e.g., the developer and indirectly, the municipality).

2.4 Sewer Use Bylaws Can be Used Proactively

This recommendation is made because it appears that municipalities have the ability to enforce sewer use bylaws at their discretion. Across Ontario and Canada, it illegal to discharge stormwater or ground water to the sanitary sewer. Preventing these discharges is essential to reducing the risk of I/I and associated flooding.

Norton's research has determined that Sewer Use Bylaws are being interpreted differently across the province (by both engineering and building staff). It has been

[a] The definition of "flood plain" is not defined here but is presumed to be the 1:100 year floods, as determined by *recently updated* flood mapping.

reported variously that bylaws apply to the user, not the constructor and that bylaws are enforceable on developer sites (prior to assumption).

Municipalities should investigate the opportunity to have bylaw officers become more active around new construction. It is not common for bylaw inspectors to inspect new construction sites (although it was reported in one location in Ontario[13]).

It has been widely reported that homebuilders drain their excavations to the sanitary sewer,[14] which suggests that building inspectors are probably not familiar with Sewer Use Bylaws. It has been noted elsewhere that building inspectors and development engineering staff might benefit from receiving training and perhaps delegated authority in the proper enforcement of Sewer Use Bylaws.[15]

Further, building inspectors across Ontario have reported that residents illegally connect to the sanitary sewer after house purchase. It is likely that this is occurring to reduce the need to depend on sump pumps, and/or to reduce the risk of flooding. This after market use of sanitary sewers to (illegally) discharge stormwater and groundwater to the sewer system may be placing a burden on existing systems. The magnitude of this problem is as yet undefined.

City of Sudbury Sewer Use Bylaw (2010):

No person shall directly or indirectly discharge or permit the discharge of sewage containing water originating from a source other than the City's water system into a sanitary sewer, municipal or private sewer connection…

Also from the website: **"Customers who do not comply with the by-law are liable for a fine of between $5,000 and $10,000 per day for a first offence. Corporations are liable for a fine of up to $50,000 per day for a first offence."**

https://www.greatersudbury.ca/live/water-and-wastewater-services/sewer-use-by-law/

2.5 Private Lateral Maintenance and Inspection

Municipalities should take steps to increase homeowner awareness of their responsibilities with respect to maintaining and managing the private-side sanitary sewer (where it is owned by the homeowner, as is typical in Canada).

Residents are largely unaware that they own the sewer from the house to the street (with a few exceptions: London, Windsor) and that it needs to be maintained, much like the laterals and sewers on the municipal Right of Way. Municipalities should implement measures to increase building owner awareness of sewer connections and encourage residents to maintain their private-side lateral.

This can be achieved by education, subsidy, mandatory measures, time-of-sale requirements and related measures. ICLR has excellent resources on this topic and related ones.[16] Assessing Local Mandatory Measures explored by ICLR[17] include:

- Disconnection of improper connections to sanitary systems (including downspouts and foundation drains)

- Requirements to maintain private sewer laterals and remedy defects
- Requirements to allow city officials onto private property for the purposes of inspections and recommendations for remediation of private-side infrastructure
- The conducting of remediation work at the expense (or partial expense) of homeowners
- Time of sale requirements for inspection and repair of sewer laterals
- Time of renovation or redevelopment requirements for inspection and repair of sewer laterals.

Inspection of Lateral at Real Estate Transfer or Building Permit over $100,000 should be investigated. The real estate transaction process is a decision point at which it is possible to reduce private-side I/I on an ongoing basis. This approach has been successfully implemented in several jurisdictions in California. Metro Vancouver has investigated this approach[18] since the mid-2000s but has not implemented it.

2.6 Municipalities should Consider having the Mainline Sewer Contractor Construct the Private Side Lateral

Municipalities should consider requiring the mainline sewer contractor to construct the private-side lateral (known in the Building Codes as the Sanitary Building Sewer, or SBS). This measure is intended to eliminate multiple construction-related issues on the private side, including the risk of I/I that exists at the interface between the public and private sides. Having one contractor construct the entire sewer lateral could reduce this risk substantially.

This work should be designed and constructed according to public-side standards and inspected by someone with experience in pipe-laying requirements. This measure is currently being piloted in Hamilton (although results have not been published). London also has some experience with this approach. In Halifax and Fredericton, the municipality routinely constructs the lateral to the building.

The stub-to-SBS connection is a frequent source of I/I in new construction, since it is a common source of infiltration in existing sewer systems. Municipal-side sewers are constructed first in a subdivision, followed by private-side SBSs. The result is the potential for differential settlement, straining the joint between the SBS and municipal stub. Inconsistencies between private- and public-side sewer construction guidelines also result in risk of excess stress placed on this connection (i.e., differential bedding and backfill requirements).

Both the public side and private side of the sewer lateral are required to be constructed to CAN/CSA 182.11. Water main and sewer contractors are familiar with this standard, as it is applied fairly consistently on the public side.

2.7 Municipalities should Work Together or with Other Agencies to Create Standardized Development Processes and Procedures at the Provincial Level

Municipalities within each province should create and implement standard development processes and procedures (with options where required). Currently, each municipality develops and implements their own procedures, and these can vary widely across Ontario. This recommendation is intended to improve efficiency in development processes and to identify and implement standard procedures to assist in delivering leak-acceptable infrastructure.

A standardized approach will assist in identifying and standardizing best practices to reduce I/I risk across regions. This approach has been used with sewer use by-laws in Ontario: the Ontario Ministry of Environment (now Ministry of the Environment, Conservation and Parks – MECP) used to publish a "Model Sewer Use By-law" for municipalities to adopt.

This initiative could be undertaken by AMO (Association of Ontario Municipalities), or other Ontario-wide organization.

2.8 Real Estate Industry Messaging

A number of municipalities report meeting with their real estate industries to help them keep informed about issues surrounding flooding, sanitary sewer laterals, drainage, etc. (e.g. City of Windsor).

Real estate agents and homebuyers are largely unaware of the importance of a sound private-side lateral in reducing basement flood risk. While many buyers will engage a home inspector prior to purchase, undertaking a plumbing-specific inspection of the sanitary sewer (including CCTV inspection) is rare. Home inspectors could also be trained in the importance of this inspection, although home inspection is an unregulated vocation in Ontario and in any case, a plumber is required to do the CCTV inspection.

It is recommended that municipalities start working with their local real estate communities to educate them about the benefits of a plumbing inspection of the private sewer prior to purchase. Norton is messaging to the public through media work that anyone purchasing a new or older home should have the lateral CCTV inspected as a component of the home inspection.

2.9 Cities should work with Developer Groups in their Area to Find Improvements to Development Processes

Municipal staff have widely reported to Norton an uneasy, if not adversarial, relationship with developers and their consultants during the development process. Developers and the consulting engineers with whom they work frequently express frustration with the bureaucracy, time delays and sometimes lack of technical skill of municipal staff.

It is beyond the purview of this technical report to discuss this issue. However, it appears that an improvement in the process by which development is approved (and this is specific to each individual municipality) would also serve to improve the process by which sewer systems are conceived, planned, designed, constructed, inspected, tested and monitored. Better infrastructure would surely result.

Regular engagement with developer groups to share information and engage in continuous improvement, should be undertaken. This engagement already taking place in many municipalities, including Peel, Niagara, London and Windsor.

3 Best Practices During Predesign to Reduce Risk of I/I

There are many important steps which can be undertaken during the predesign stage of a project which can reduce the risk of unacceptable I/I. These are presented in the following sections.

> *The best time to minimize future risk of water ingress into a structure is during the original site selection and design phase of a project.*
>
> A Builder's Guide to Site and Foundation Drainage – Best Practices for Part 9 Houses. December 2017 Draft.

3.1 Pipe Slopes in the Upstream Reaches of Dead-End Sewers Should be 2% Until 20 Single Family Units are Connected

This recommendation is made based on information collected across Ontario, and directly by Norton Engineering, indicating that upstream legs in new subdivisions do not have sufficient velocity to reduce the deposition of solids in the upstream reaches of sewer systems. With the advent of low water use fixtures, flows in upper reaches of new sewer systems are often insufficient to reach flushing velocity, resulting in deposition of solids. This can become a maintenance issue and/or lead to blockage, which can increase risk of sewer backup flooding.

In order to address this problem, auto flushers are sometimes installed to reduce maintenance costs in this sewer leg. Introducing potable water into the sewer system to solve a maintenance issue is a source of unacceptable inflow and should not be used to solve a design problem.

Most sanitary sewer design sheets calculate the velocity at actual flow, but velocities well below the recommended minimum of 0.6m/s are frequently ignored. Municipalities should insist that this calculation be included on all sanitary sewer design sheets, and check them carefully before approving them.

> **Haldimand County Design Criteria (2017)**
>
> For Residential Areas, minimum diameter shall be 200 mm. The minimum grade on a 200 mm sanitary sewer is 0.40% if minimum 13 units are connected. Where there are only a few dwelling units connected to the upper section of a 200 mm sanitary sewer, the minimum grades shall be adjusted as follows:
>
> | | |
> |---|---|
> | 1 to 5 units | 0.65% |
> | 6 to 8 units | 0.55% |
> | 9 to 12 units | 0.45% |
>
> If the minimum flowing full velocity cannot be achieved on the uppermost run of sewer in a system using a 200mm pipe, then 150mm pipe at a minimum slope of 1% may be permitted.

It is recommended that the upstream legs in a sewer system be installed with a 2%

slope[b] until 20 single family units are connected, or at whatever slope can achieve the recommended 0.6 L/s velocity. This slope was also confirmed using a sanitary sewer design sheet, assuming 20 homes at 3.25 people per unit with an average lot area of 325m^2, a peak long term I/I value of 0.25 L/s/ha, and a pipe size of 200mm. The slope returned was 0.54 m/s. This is an estimation only but suggests that 2% slope may be required for the first 20 units, or about the first two sewer runs at 90m spacing.

This standard slope is recommended for simplicity. Municipalities across Canada are starting to implement a number of variations to achieve the same end (see box).

Norton surveyed Ontario municipalities to determine whether the upstream sewer could be reduced to a 150mm diameter. Several municipalities identified concerns with "blowback" during flushing of smaller diameter sewers. It was not determined whether the flushing technique was modified for flushing smaller sewers. However, in northern Ontario, including Sudbury, 150mm diameter sewers are used and issues with blowback are not reported.

3.2 PVC Pipe used for Sanitary and Storm Laterals should be Different Sizes and Colours

This recommendation is made to virtually eliminate the risk of cross connection of storm to sanitary sewers. Cross connections are frequently found in existing sanitary sewer systems during I/I studies. Since how sewer systems are constructed has not changed in the past 30 years, it is presumed that the cross connection of sanitary and storm laterals continues. A number of municipalities in Ontario have already implemented a similar differentiation between sanitary and storm.

It is recommended that all municipalities in Ontario adopt the following standard for single family residential lots in new subdivisions:

- **Sanitary** public and private side lateral sewers should be **SDR28, 100 mm in diameter and green in colour.**
- **Storm** public and private side lateral sewers should be **SDR28, 125 mm in diameter and white in colour.**

The recommendation to use sewer SDR28 (Sanitary Dimension Ratio describes the correlation between the pipe outside diameter and the thickness of the pipe wall: Pipes with a lower SDR are stronger) on both public and private side laterals is made to

[b] The 2% slope was arrived using Manning's Equation, with d/D_{full} of 0.10 to achieve 0.6m/s velocity.

reflect the fact that the lateral should approach the same design life as the home which it services, and it is assumed that SDR28 is a more suitable product.

It is also recommended that Ontario universally adopt a standard with the sanitary pipe always on the right side facing the street, and the storm on the left.[c,d]

Note that this recommendation must include a similar requirement on the private side per the Building Codes. It has been reported to Norton across Ontario that where pipes are different sizes on public and private sides, failure to use an appropriate fitting occurs, substantially increasing the risk of I/I.

[c] This is already stipulated in Quebec.
[d] The feasibility of this should be confirmed with developers.

3.3 Slope of Sanitary Sewer Laterals

It is recommended that the slope of the sanitary sewer lateral to the property line be required to be a minimum of 2%. It does not appear that this will represent much change (in Ontario). The City of London already requires a 2% slope on this pipe.

Equally, Norton is recommending that the private side lateral (sanitary building sewer) be a minimum 2% (Building Codes currently recommend 2% but accept 1%, meaning that 1% is usually laid). This is to support the function of backwater valves, which require a 2% slope upstream and downstream to function properly (this issue is discussed in more detail in the Private Side Best Practices Manual). This information has been shared widely with building officials in Ontario. Building Code Change Requests in this regard will be developed and submitted.

3.4 Wye Connections to Service Two Homes Should Not be Used

This recommendation is made to reduce the flood risk which is introduced when Wye connections at property line are used. It has been reported in Ontario that when one homeowner on a Wye connection makes changes to their house plumbing (e.g. installs a backwater valve, sump pump, etc.), the other homeowner may experience flooding. This appears to introduce legal risk which is probably best avoided.

Use of Wye connections in new construction is relatively rare in Ontario.

3.5 Connections to Storm and Sanitary Sewer should be Extended 1m onto Private Property to Minimize Risk of Interference from/with Other Utilities (Gas, Electric, Utility Cables).

This recommendation is made to reduce the congestion which is experienced at property line due to the number of utilities being located there. The risk of damaging adjacent utilities is reduced with great separation between them.

This practice is already being adopted by several municipalities across Ontario.

Note that damage to water stops at new homes (beyond the purview of this work) post-occupancy has been widely reported as a time-consuming and frustrating issue for developers. Some thought should be given to resolving this.

3.6 New Pumping Stations Should be Designed to Operate Effectively Under All Operating Conditions

This recommendation is included based on municipal (particularly operations staff) input indicating that when pumping stations in new developments first come online and flows are low, they are not always performing well. This sometimes results in the need to introduce potable water (and hence inflow) into the wet well to exercise the pumps, sometimes for years.

It is recommended that municipalities require that Predesign briefs of new pumping stations include plans for operation under all flow conditions.

3.7 Design Standards for Private Sewer Systems

Private sewers (e.g. sewage collections systems to be privately owned once a development is complete, such as within a condo or townhouse complex) must be designed according to MECP Guidelines, per the Ontario Building Code.

This clarification is included because much confusion is reported as to the requirements for private sewer systems (e.g. those collecting sewage from a condo or townhouse complex) which have sewers within them.

> OBC 2012:
>
> *Private Sewer* means a sewer other than a *building sewer* that…
>
> (b) receives drainage from more than one *sanitary building drain* either directly or through more than one *sanitary building sewer*…

The Ontario Building Code is very clear. Private sewer is defined in the OBC as "*a sewer other than a Building Sewer that a) is not owned or operated by a municipality, MOE or another Public Agency, b) receives drainage from more than one sanitary building drain either directly or through more than one sanitary building sewer…*"

Thus, any sewage collection system on private property must be designed and constructed according to public side specifications and standards. Provision for the inspection of these sewers must be made by the municipality, since building officials do not have the training to inspect to MOE/OPSS/OPSD requirements.

> OBC 2012
>
> **Part 7: Plumbing**
>
> Section 7.1 General
>
> 7.1.5.5. Private Sewers and Private Water Supply
>
> (2) Private sewers shall be designed and installed according to MOE PIBS 6879, "Design Guidelines for Sewage Works".

This information is also being messaged to building officials to assist in clarity around this issue.

3.8 LID Features should be Carefully Designed

It is recommended that LID features be thoughtfully designed to discharge away from sanitary and storm laterals (recognizing that care must be taken to ensure that the water does not enter foundation drains)[19]. Discharging to the rear yard may achieve this.

LID features that introduce clean water into the ground in the vicinity of sanitary and storm laterals and bedding may increase I/I in these pipes. Potential implications of LID systems with respect to infiltration of excess surface water into sanitary conveyance systems should be considered as part of the design process.

The USEPA reported that "Underground linear infrastructure that are the sewers, waterlines and utility ducts servicing communities create an extensive French drain system when trench backfill and pipe bedding are permeable materials. Permeable utility trenches drain their service area, conveying rainwater runoff and groundwater to the lowest trench points. As sanitary sewer trenches are typically constructed lower than other utility trenches, the other trenches will drain to the sanitary sewer and cause sanitary sewer pipes, joints, tie-ins and laterals to become submerged in trench groundwater — I&I will then enter sanitary sewers through any open defect." [20]

Furthermore, maintenance of LID features by residents is unlikely (based on residents' poor performance in maintaining sump pumps and backwater valves); LID designs should take this into account.

3.9 Use of Clear Stone for Pipe Bedding

It has become customary in places in Ontario for contractors to use clear stone as bedding for their pipes. While the material cost is higher, contractors report that since clear stone does not need to be compacted, labour costs are lower.

OPSS.MUNI 401 (Construction Specification for Trenching, Backfilling and Bedding) calls for bedding to be one of Granular A, Granular B (Type I, II or III), or Unshrinkable Fill. It does not permit the use of clear stone.

Clear stone acts as a french drain (e.g. conveys water easily), whereas other granular material ("A" and "B") is less free flowing with time. Since it is desirable to not allow sewer bedding to act as french drains (e.g. simply conveying the water the next available pipe defect where it can enter), it is recommended that only Granular A or B (or unshrinkable fill) be permitted as bedding of new sewers, in accordance with OPSS.MUNI 401.

Designers should carefully consider the use of clear stone, and perhaps require the use of trench plugs if necessary, when specifying pipe bedding.

4 Best Practices During Design to Reduce Risk of I/I

4.1 Location and Venting of Maintenance Holes and Sewers

Maintenance holes should be located at the high point of the roadway to reduce the introduction of I/I through the pick holes or around the frame and grate during rainfall events. This recommendation is made to reduce the risk that stormwater overland flow routes will direct water over manholes and manhole covers. Manholes in low lying areas are a known source of inflow and infiltration.

If it is necessary to locate a manhole in a lower-lying area, the designer must come up with a means of preventing entry of overland flow (e.g. external wrap, special frame and grate, lid, etc.). This requirement is starting to appear in design manuals across Ontario (e.g., London, see box).[21] The onus is on the designer to come up with a leak-acceptable solution.

> *"All precast maintenance hole section joints shall contain an approved rubber gasket. In areas of high groundwater, exterior joint collars or external wrapping (e.g. 'Cretex' waterproofing or equivalent, installed as per manufacturer's specifications)"*
>
> City of London Design Manual, 2018

It should be noted that most of the ventilation of a sewer system occurs through the vent stacks in homes, where there are sealed traps between the street sewer and the plumbing vent.[22] Since sanitary sewers can be seen to be venting in the winter though the pick holes during cold weather, the manhole picks appear to serve a venting purpose. Plumbers throughout Ontario have confirmed the necessity of MH pick holes to assist with venting.[23] Since not venting through the MH picks likely increases the risk of buildup of dangerous sewer gases, it is recommended that these pick holes be maintained.

Thus, plugging MH pick holes or using inflow protectors (a dish location immediately beneath the MH lid to catch water) should only be implemented in selected locations at risk of inflow, not across a sewer system.

4.2 Location of Sewers and Maintenance Holes in High Groundwater Conditions

Where sewers are located below the seasonally high groundwater elevation, I/I is inevitable. This I/I carries a long-term cost, which should not be borne by residents. If a developer wishes to build in a high groundwater area, the cost should be assumed by him. Given the impact of I/I on our communities, engineering designs should take site conditions into account accordingly. Engineer design is always required to take site specific conditions into consideration during design, and in cases of high groundwater, this should be no different.

Municipalities across Ontario are starting to reduce the potential I/I load on foundation drain systems by requiring that the building/building foundation drain system be separated from the seasonally high groundwater table.[24]

This information has been provided to the Ministry of Environment, Conservation and Parks during the development of proposed new Sanitary Sewer Design Guidelines (2019, ongoing).

It is recommended that where the invert of the sewer is below seasonally high groundwater elevation, the sewers be designed to be watertight (e.g. to drinking water standards). Various products are commercially available which can achieve this goal. MHs should be also constructed with watertight techniques as discussed above.

4.3 Maintenance Hole Riser Ring Joints should be protected from I/I

Maintenance hole riser ring joints are a common source of long term I/I.

It is recommended that that the exterior (or interior) of all manholes be wrapped or otherwise waterproofed in all new sewer construction.

4.4 Maintenance Hole Frame and Grate should be an Integral Unit

Maintenance hole frame and grate (along with lift rings) are a common source of I/I long term.

It is recommended that new technologies, which are currently available and include an integral frame and grate, be investigated (possibly as a pilot project). These units have been approved for use in various locations in Ontario (e.g., Durham, Peel, Vaughan, Pickering, Markham. Evaluation of results of the use of these units should be undertaken long-term.

4.5 Provision for Flow Monitoring should be Provided at the Downstream End of New Subdivisions

Flow monitoring has been established to be an indispensable tool to allow municipalities to determine whether infrastructure is leak-acceptable. However, in some cases it is difficult to isolate the flows from the subdivision as there is not a suitable location.

It is recommended that municipalities require that a suitable location for flow monitoring be available near the outlet of the subdivision (e.g. a straight-through manhole) to allow for accurate flow monitoring. Accurate flow monitoring requires laminar flow (since it uses Manning's equation to calculate the flow), best achieved by a straight through (or nearly straight through) MH with similar slopes upstream and down.

This measure is already in place in multiple municipalities across Canada (e.g. Woolwich, London, Innisfil, Lincoln and various local municipalities within the GTA).

4.6 Lateral Connections to Mainline Sewer should be Designed Based on Site-Specific Conditions

The connection of the lateral to the mainline sewer is a frequent source of long term I/I.

A factory-made saddle is required in all cases, in accordance with OPSS.PROV 410 (see box).

If sewers are to be located below seasonally high groundwater level, an appropriate leak tight technology should be specified (it is not clear if this technology currently exists). This is not yet current practice in Ontario, but it is recommended to reduce the risk of I/I at a known entry point.

> OPSS.PROV 410 (2015) specifies required saddles, as follows:
>
> *"Service connections to the main pipe sewer shall be made using factory made tees or wyes, strap-on-saddles, or other approved saddles. Factory made tees or wyes shall be used for all service connections where the diameter of the main pipe sewer is less than 450 mm"*

4.7 The Public Side Lateral should be provided with a Cleanout at Property Line, which will also serve as a Fitting for the Connection of the Private Side Lateral (SBS)

Many municipalities in Ontario are requiring a cleanout on the sanitary sewer at property line (Lincoln, Fort Erie, Niagara, Windsor, etc.). This cleanout allows a municipality to readily confirm if a future blockage is on the public or private side of a sewer lateral. It also minimizes the risk of difficulty accessing the lateral in the event that a homeowner blocks access to the cleanout inside the house.

In addition, this fitting will serve as a convenient location for air or water testing of the private side lateral as called for in the Building Codes. The difficulty of providing a test tee at property line to perform this test has frequently been cited by building officials as a reason for not performing these tests[25].

And finally, connection of lateral at property line has been identified as a common and significant source of I/I in new construction. The Ontario Building Code has no specifications as to how this connection is to be made, and the public side contractor leaves the public side lateral with a watertight cap or plug, not a fitting. If the public side contractor left a fitting, this would serve as a factory-made tee or wye, similar to what is required for connection of lateral to mainline sewer in OPSS.PROV 410 (see above).

> *"The connection of the sanitary lateral at property line is a major source of I/I in Existing system. This is likely because of differential settlement due to the timing of the installation of the pipes on each side of the property line, as well as the disparate pipe types used and the need to connect them with appropriate fittings."*
>
> Robinson, B. Environmental Science & Engineering, 2018

5 Best Practices During Construction to Reduce Risk of I/I

5.1 During the Pre-construction Meeting, all Parties should be Made Aware that Flow Monitoring will be Used as a Tool to Confirm Leak-Acceptable Infrastructure

This recommendation reflects the fact that all constructors on site need to be aware that only leak-acceptable infrastructure will be acceptable. Based on experience in one subdivision in Ontario,[26] it is possible that this will result in better constructed sewers.

While developers are generally made aware that flow monitoring will be undertaken, recent experience in Ontario[27] suggests that contractors on site may not be aware of the flow monitoring and are behaving accordingly (e.g. not producing leak-acceptable infrastructure).

This requirement holds true where multiple builders are working on the same subdivision site. The developer has a contractual relationship with the Municipality, so it is his responsibility to ensure that the construction work is leak-acceptable. Developers have indicated that they have the ability to enforce the contract with individual builders.[28]

5.2 The Inspector should Always be On-Site During Laying of Sewer Pipe and Setting of Maintenance Holes

This recommendation is made to ensure that inspections specified in the contract documents (typically full-time inspection) are completed for all pipe and manhole installations. Consequences for non-attendance should be developed by the municipality in cooperation with the development community.

It has been reported across Ontario that consultant inspectors are not always on-site during periods when they should be. Some components of a sewer system are not visible after construction (e.g. gaskets on MH riser rings). Although leak testing after construction should identify this issue, redundancy in quality control is best practice. Addressing inspections is intended to assist in increasing construction quality.

5.3 Sediment Traps On-Site Should be Inspected Regularly

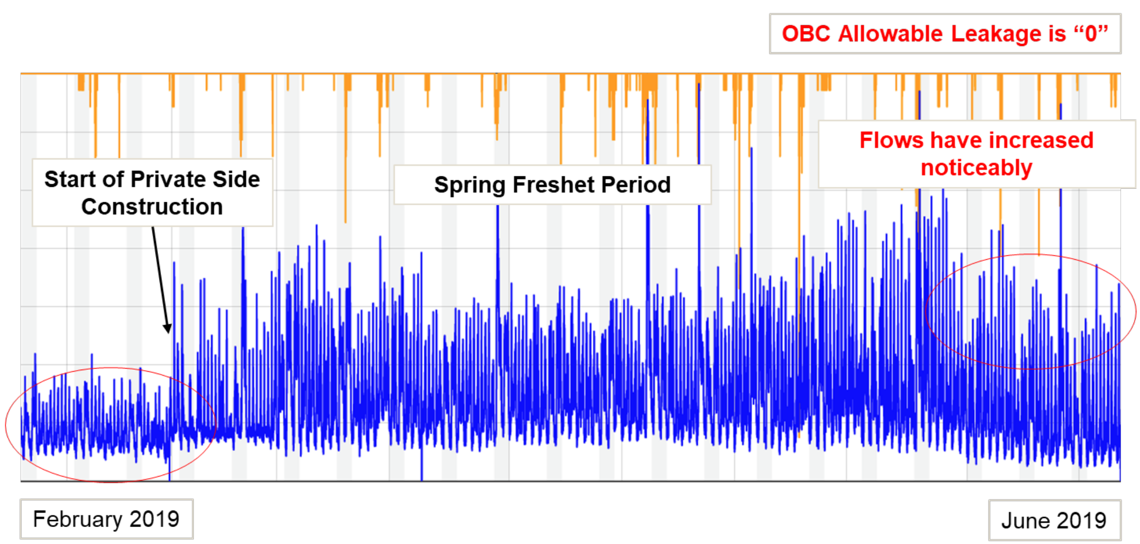
This recommendation is made to minimize flood/blockage risk, which may result in inflow to the sanitary sewers. Maintenance of the sediment traps should include removal of collected solids, which should be disposed of according to material quality.

This measure reflects experience that these traps are frequently not being cleaned/maintained as intended.

5.4 Flow Monitoring should be Established as soon as the First Sewers are Constructed

This recommendation is made to monitor performance of the entire sewer system, in a way that captures flows from each of the public and private sides. It is important to continue flow monitoring as new buildings (e.g., homes) are constructed to ensure that private side sewer connections are not contributing excess I/I to the municipal system. Figure 1 shows a recent example of how flows increased in a new subdivision once private side activity began (with allowance for spring freshet considered). In Figure 1, peak flows have nearly doubled with private side site works (no occupancy). In a case like this, it is recommended that flow monitoring continue so that it can be determined whether the additional flow was a result of short-term site activity (e.g. draining excavations through the sanitary cleanout), which is still illegal, or long term I/I, which is substantially more costly (since it can be expected to continue for the 75-year life of the sewer system).

FIGURE 1: FLOW MONITORING WHILE PRIVATE SIDE ACTIVITY BEGINS



Source: Norton Engineering Inc., Municipal client, 2019.

Flow monitoring can be discontinued once the infrastructure is shown to be leak-acceptable for one year.

5.5 Municipalities should Consider doing their Own Site Inspection of New Developments

It has been widely reported to Norton across Ontario that allowing the developer's agent (the consulting engineer) to perform inspection of his work represents a conflict of interest[29]. This could be eliminated by having the municipality directly retain the services of a consulting engineer to undertake the inspection of the work. That way, the interests of the municipality (e.g. leak-acceptable infrastructure) are directly served. This approach is already being undertaken in some locations in Canada (Chadham, Halifax).

5.6 Municipal Staff Should be Trained Around I/I Issues

It was widely reported during Norton's research[30] that municipal staff working on both the public and private sides of the property line do not have sufficient understanding of the causes and conditions of I/I, and simple steps they can take to minimize the risk of its occurrence. Engineers are not trained in the building codes and building inspectors (unless they are also plumbers) are not trained in piping. Lack of knowledge is a gap that is easily remedied by education.

It is recommended that municipalities regularly train their employees (and perhaps insist on the same for consulting inspection staff working in their municipality) on I/I, its impacts, and all aspects of the construction of leak-acceptable infrastructure.

6 Best Practices After Construction to Reduce Risk of I/I

6.1 Municipalities should Insist on CCTV Inspection of New Sewers (Including Laterals) for All New Construction

This recommendation is made to ensure that the public side sewers have been constructed according to specifications. Norton research across Ontario[31] indicates that only thirty percent of municipalities call for this required testing.

> OPSS MUNI 409 (2017) specifies the requirements for CCTV inspection of new pipelines, as follows (excerpt):
>
> *The work shall include a CCTV inspection of new and existing pipelines, which include storm and sanitary sewers, watermains, pipe culverts or other accessible conduits and the preparation of all video, digital, and written reports.*

OPSS MUNI 409 (see box) is clear regarding the requirement to CCTV all sewers, including storm. The specification includes new sewers that are accessible, which necessarily includes the lateral to property line.

CCTV inspections should be reviewed accordingly. Consideration should be given to conducting final inspections when ground and surface water conditions are likely to result in high risk of I/I (e.g., spring/snowmelt periods). Conducting inspections at this time will help ensure that active I/I is more likely to be observed.

CCTV inspection should include lateral camera launch, since leakage can also form in the public side lateral. Evidence of I/I does not generally form on new sewers (e.g. weeping joints, calcification, rust), so leakage can only be identified if it is seen happening. Indeed, PVC pipe manufacturers indicate the following (see box).

> 36 IPEX PVC Sewer Pipe Installation Guide
>
> **Videos**
>
> The use of video cameras to inspect the interior of newly installed sewer pipe is very common today. The idea of videotaping the inside of sewer lines was first conceived to fulfill the need to evaluate the decaying condition of older sewers made from traditional pipeline materials such as clay, brick or concrete. The only practical benefit of videos with regard to newly installed PVC sewer pipe is in detecting glaring installation deficiencies such as leaking joints or excessive deflections. Although videos are able to pinpoint the location of a deficiency, they are unable to quantify the magnitude of a problem or whether the deficiency is within allowable limits.

It should be noted that IPEX Sewer Pipe Installation Guide suggests that the utility of CCTV inspection of new pipe is limited.

Research across Ontario by Norton suggests that municipalities are CCTV inspecting new sewer pipes two to four times. It is recommended that a more targeted approach to CCTV inspection be considered.

6.2 Municipalities should Insist on Leak Testing of Manholes for All New Construction

Public side maintenance hole (MH) Infiltration/Exfiltration tests provide information to the municipality regarding how watertight new MHs are when they are first constructed.

It is recommended that municipalities insist on this testing which is required per OPSS 410 (see box).

This recommendation is made based on Norton's research that 74% of municipalities do not require the performance of infiltration or exfiltration tests on new maintenance holes[32]. One municipality reported the application of incorrect testing procedures.

Note that *the designer must specify the testing in the contract documents.* OPSS states that the testing, if specified, shall be performed.

OPSS.PROV 410 2015: 410.07.16.03 and .04

For both infiltration and exfiltration testing:

"The leakage at the end of the test period shall not exceed the maximum allowable calculated for the test section. Allowable leakage shall be calculated as 0.075 litres/millimetre diameter/100 metres of pipe sewer/hour."

Note that maintenance hole risers are typically adjusted prior to the laying of final asphalt, which usually occurs after the undergrounds are accepted. As such, the test performed per OPSS would not confirm the water tightness of these final risers. Resolution of the I/I associated with these risers is discussed elsewhere in this report.

6.3 Municipalities should Undertake a Visual Inspection of All MHs

It is recommended that even if other testing methods cannot be employed, municipal forces should undertake a visual inspection of all sanitary and storm manholes.

Visual inspection should begin at the upstream end of the system. Using the sewer and storm sewer drawings as a reference for pipe size and slope (hydraulics change when these change), manholes should be systematically inspected. Flow (if any) can be observed without entry. Often, a change in flow characteristics can be observed between MHs. If there has not been a large change in slope or a pipe size change, this may indicate issues in the sewer leg in between.

Note that if flow above allowable leakage values is observed in a storm system when it is not raining, there is I/I and the storm system no longer provides protection up to the design storm value (e.g. a 1:5 year storm system is no longer providing that level of protection). Although outside the purview of this document, many of the observations made here apply to storm sewers also.

6.4 Written CCTV Reports should be Compared to CCTV Tapes

It is recommended that the CCTV videos undertaken in new construction be reviewed against the written report. This should be required of the consulting engineer and a letter stating that they match should be provided to the municipality.

This recommendation is made based on survey results across Ontario, which indicate that at times the written report neglects to pick up defects which are shown on the tape.

6.5 Municipalities should Carefully Review their Requirements for the Engineers' Sign Offs Following Construction

It has been reported in Ontario[33] that municipalities are requesting that the developer's engineer submit a letter prior to final acceptance of sewer systems that may not accurately reflect the engineer's role during construction. There is a risk that existence of a letter signed (and therefore, assumed to be sealed) by a professional engineer might suggest to senior management and Council that a standard of care existed which potentially did not.

> *"Sealing of drawings with record information might imply to some parties that the engineer is providing some type of warranty or certification of the construction. This is never the case, since the contractor is responsible for construction."*
>
> ~ Use of the Professional Engineer's Seal, PEO, November 2008

It is beyond the purview of this work to recommend modifications to this process. Municipalities should review their current sign-off requirements, and, if necessary, consult PEO on whether the wording reflects what the engineer is able to guarantee. And, if the municipality is requiring wording to the effect that the project was constructed according to all guidelines, standards and Codes (this wording is being used in Ontario)[34], they should ensure that they are requiring all of the appropriate testing and inspections.

7 Good Engineering Practice in the Management of a Sewer System

This Section relates to existing sewer systems and is included to assist municipalities in a selection of basic principles of good operation of a sewer system. Inflow and Infiltration is best considered routinely, not just in the context of a specific study or issue. Ongoing engineering management of sewer systems is a very important component in reducing the risk of I/I. And, a thorough understand of the behaviour of an existing sewer system makes it easier to detect I/I from new development, especially in smaller sewersheds.

7.1 Collect and Plot Wastewater Treatment Plant (WWTP) Data against Water Use Data (Billed Water) or other Available Data

This recommendation represents a simple, low cost means of I/I tracking in a sewer system using data which already exists.

It is recommended that municipalities regularly plot daily WWTP data against daily billed water (if metered). This simple exercise can provide great information about the performance of the wastewater collection system and indicate trends which may be occurring, using existing data. It may be useful in some circumstances to plot WWTP data against population or sewershed data.

In addition, more granular data (at the lowest interval available at the WWTP meter) can be plotted after wet weather events, to determine the shape of the I/I response at the plant. This will indicate whether the response is short and peaky, or longer, or both, which can indicate inflow and/or infiltration. This understanding will help municipalities decide on I/I investigations, if any. This data can be combined with Wastewater Pumping Station (WWPS) data and in-sewer monitoring data, if any.

7.2 Collect and Plot WWPS Data Monthly

This recommendation represents a simple, low cost means of I/I tracking in a sewer system using data which already exists.

It is recommended that municipalities regularly plot WWPS data to track I/I behavior in a system. This simple exercise can provide great information about the performance of the wastewater collection system and indicate trends which may be occurring in WWPS sewersheds, particularly if new development is occurring upstream, using existing data. Flows may also be usefully compared to other parameters such as sewershed area or pipe length.

More granular data (if available) can be plotted after specific events to determine the shape of the I/I response in the SPS sewershed. This information can be used to inform further I/I investigations in the area.

Note that if pump run times are used to estimate flow, the engineer should be aware that pumps may not be operating on their pump curves, so actual flow values may vary. Trends, though, will still be valid. A drawdown test of the wet well can confirm more accurate flow readings.

In addition, pumping station overflow data (if overflows occur) should be tracked and analyzed as a measure of I/I.

Rainfall data, if local to the sewersheds, can be used with any of the above metrics to further refine the system's response to rainfall.

7.3 Maintain, Update and Calibrate Wastewater Model Regularly

This recommendation is included to remind municipalities who use a wastewater model of their system, that the model is a dynamic tool and needs regular maintenance and update. In addition, staff need to understand the use of the model (e.g. a trunk model should not typically be used for local flow assessment). A wastewater model is only accurate for the storms to which it was calibrated. In addition, as the wastewater system grows, the model needs to be continually updated to remain accurate.

If a municipality intends to develop a wastewater model, it should be understood that this is a long-term commitment which will require yearly budget dollars to maintain.

This recommendation is included based on the author's observation that models are not being accurately used in some municipalities, which could result in poor decision-making with respect to capacity.

7.4 Engage Operations Staff in all Inflow and Infiltration Related Works

This recommendation is intended to improve information sharing at all points in the operation of a wastewater collection system.

Operations staff have an enormous amount of information about inflow and infiltration but are not always consulted to the degree that they should be. Valuable information about the system may be being lost absent meaningful input from Operations.

The issue of I/I in new subdivisions, certainly upstream of pumping stations, has long been known by operations staff (based on personal communication), since they are responsible for operation pumping stations once in service. Much of the data received by Norton Engineering at the initial stages of research[35], came from pumping station flow monitoring (since in-sewer monitoring of new subdivisions was relatively rare at the time).

Although efforts to include operations staff in engineering projects is common, it is reported that fulsome input is not being solicited/obtained/acted upon.

7.5 CCTV Inspections should be Examined in Context

This recommendation is intended to remind municipal staff about the limitations of CCTV inspection in identifying I/I in new construction.

CCTV inspection in new sewer systems will typically only show I/I if it is active during the inspection (so ideally is undertaken during spring freshet). New PVC pipe does not yet show the evidence of I/I (e.g. calcification, staining) that is visible in older pipe. Therefore, it is essential that staff examining CCTV be cognizant of the time of year and the weather conditions which existed at the time the inspection was undertaken. It is probably impractical to try to schedule all CCTV inspections for spring conditions.

7.6 Enforce Sewer Use By-Law Provisions Inspections

Municipalities should consider their ability to enter property to ensure that there are no illegal connections to the sanitary sewer. This action would allow them to ensure conformance with regulations and by-laws concerning I/I on the private side of the property line to reduce the risk of private-side I/I.

Sewer use by-laws can also be enforced during new construction if the contractor is using the sanitary sewer to drain excavations, which is prohibited under commonly applied sewer use by-laws.

Municipalities should consider the cost/benefit of deploying resources in this way (for various purposes, including reducing flood risk), as opposed to other uses of bylaw officers.

7.7 Educate Homeowners on their Responsibility to Maintain their Private Lateral

Municipalities should work to increase homeowner awareness of their responsibilities with respect to maintaining and managing the private-side sanitary sewer (where it is owned by the homeowner, as is typical in Canada).

Residents are largely unaware that they own the sewer from the house to the street and that it needs to be maintained, much like the sewer on the street. Municipalities should implement measures to increase building owner awareness of sewer connections and encourage residents to maintain their private-side lateral. This can be achieved by education, subsidy, mandatory measures, time-of-sale requirements and related measures.

CSA Z800, Guideline for Basement Flood Protection and Risk Reduction ((2018) (Section 5.3.2.)[36] contains extensive information on measures which can be taken by homeowners on their private property to reduce the risk of I/I and flooding.

7.8 Encourage CCTV Inspection at Time of Sale

Municipalities should encourage residents buying a new or older home to insist on a CCTV inspection of the private side lateral as part of the home inspection process. This will serve to inform potential homebuyers of the risks of flooding associated with a potential purchase, as part of the window of opportunity associated with the real estate purchase/sale process.

This messaging can also take place through the real estate industry, as discussed in Section 2. CSA Z800, Guideline for Basement Flood Protection and Risk Reduction ((2018) lists real estate professionals as potential users of the document (Section 0.2) contains extensive information on measures which can be taken by homeowners on their private property to reduce the risk of I/I and flooding.

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