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

January 2020

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NORTON ENGINEERING

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Dedication

This document is dedicated to the hundreds of women and men in building departments across Ontario and Canada working for municipalities and endeavouring to improve the design, construction, inspection, testing and acceptance 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 from a dozen municipalities in Ontario for this, and related, research since 2015. **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. Norton published a companion to the current document, *Best Practices to Reduce the Risk of I/I on the Public Side* in October 2019. Norton's publications may be found on their website, www.nortonengineeringinc.ca.

Target Audience of This Document

This document will be useful to municipal staff, primarily CBOs and building staff, but also engineering and development staff and leadership. It includes recommendations for issues that Building Code officials may want to consider. It will likely also be useful to consultants working on I/I projects, developers, builders, plumbers, drain layers, suppliers and any others working in the construction industry.

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 wide 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 is constantly receiving new information, recommendations, feedback and input.

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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.

Suggested Citation:

Robinson, B., 2020. Manual of Best Practices to Reduce Risk of Inflow/Infiltration (I/I) in Private Side New Sewer Construction. Kitchener: Norton Engineering Inc.

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.

BC Housing
Brant County
Capitol Region District (Victoria)
City of Barrie
City of Belleville
City of Brampton
City of Brantford
City of Brockville
City of Burlington
City of Calgary
City of Cambridge
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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

Executive Summary

This report summarizes nearly five years of research into reducing the risk of inflow and infiltration on the private side (under the Building Code) of the property line. The rationale and research behind each recommendation is covered in detail in the body of this report. The report recommendations are provided here for ease of use by building officials. Recommendations are summarized by the person/entity who will need to take the action (but there is some overlap).

1.1 Policy Recommendations to Reduce the Risk of I/I on Private Side Sewers

Building Official Training

It is recommended that CBOs & building officials be provided with regular training on inflow and infiltration and the important role they play in reducing the risk of I/I on the private side.

Communication with Drain Layers and Builders

It is recommended that prior to the issuance of any building permits, developers, drain layers and builders be made aware that flow monitoring will be used to confirm leak-free infrastructure on the private side.

Installation of SBS by Mainline Sewer Contractor

It is recommended that municipalities investigate having the mainline sewer contractor install the SBS.

Standardization of the Interpretation and Application of the OBC Between Municipalities

It is recommended that municipal building departments from each province work together on common interpretation of different Code requirements around sewers and drainage.

Working with Developer Groups

It is recommended that municipalities engage regularly with developer groups in their area (e.g. homebuilders associations). It is recommended that workshops or other forums be held concerning I/I on the private side and workable solutions be developed.

1.2 Recommendations to Reduce the Risk of I/I in Private Side Sewers

CBOs and Building Officials

Discharge of Foundation Drains or *Subsoil Drainage Pipe* (e.g. Foundation Drains) to the Sanitary Sewer

It is recommended that CBOs & building inspectors be aware that discharge of foundation drainage to sanitary sewers is prohibited by bylaw in most jurisdictions in Ontario.

Discharge of *Storm Drainage Systems* to *Sanitary Sewage* Works

It is recommended that CBOs & building inspectors be aware that discharge of storm water to sanitary sewers is prohibited by most sewer use bylaws in Ontario.

Inspection of Connection of Sanitary Building Sewer to Public Side Lateral at Property Line

It is recommended that the CBOs & building inspectors carefully inspect the connection at property line, in accordance with OBC, to confirm that it is properly supported and adequately jointed.

Inspection of Storm Building Sewer

It is recommended that the CBOs & building inspectors inspect the storm drainage system, in accordance with OBC, to confirm that it has been correctly installed. The storm connection at property line, if any, should also be inspected as recommended for the sanitary building sewer.

Support for Horizontal Piping

It is recommended that CBOs and building officials be aware that the support for horizontal piping in the OBC does not cover piping outside the building.

PVC Pipe

Summary of PVC Pipe Recommendations

It is recommended that building departments insist upon SDR28, PVC Gasketed Pipe for the SBS and Storm Building Sewer, and that they be installed with haunching and without the use of clear stone as bedding. It is recommended that the SBS be push camera inspected from the cleanout to the property line following backfill operations.

Details of PVC Pipe Recommendations

Canadian Standards for PVC Pipe: CAN/CSA B1800

It is recommended that CBOs & building officials become familiar with the requirements for laying PVC pipe according to CSA specifications.

It is recommended that OBOA and other provincial associations request that CSA B1800 be added to the list of specifications available to their members.

PVC Pipe System Type (Use of Solvent Welded Pipe Systems)

It is recommended that CBOs & building inspectors not permit the use of solvent-welded PVC pipe systems, as they are not explicitly permitted in the standards.

Recommended PVC Wall Thickness (Standard Dimension Ratio (SDR)) Rating

It is recommended that CBOs & building inspectors require SDR28 pipe for the SBS.

Use of Clear Stone for SBS Pipe Bedding

It is recommended that the CBOs & building inspectors, not permit the use of clear stone as bedding for the SBS.

Haunching for SBS Pipe

It is recommended that CBOs and building inspectors insist that the SBS be installed with haunching as required by CAN/CSA 182.11.

Jointing of PVC Pipe by Solvent Weld

If solvent welds are used:

It is recommended that the CBOs and building inspectors request product specifications for the solvent cement being used and confirm the need for two-step welding.

CCTV Push Camera Inspection of SBS

It is recommended that CBOs & building inspectors insist upon CCTV inspection of the SBS, in accordance with CAN/CSA B182.11.

Backflow (Backwater) Valves

It is recommended that municipalities that wish to require mandatory backwater valve installation satisfy themselves that the appropriate conditions exist in the SBD and SBS or amend those conditions as appropriate.

Design Standards for Private Sewer Systems

It is recommended that where a development includes private sewers, that the building department clarify the inspection standard and appropriate arrangements are made for inspection, testing and acceptance of these sewers to MOE/OPSS/OPSD standards.

Code Officials

Discharge of Foundation Drains or Subsoil Drainage Pipe to the Sanitary Sewer

It is recommended that Code Officials revise the Acceptable Solutions in the OBC to clarify that foundation drainage or subsoil drainage pipes to sanitary sewers is prohibited.

Discharge of Storm Drainage Systems to Sanitary Sewage Works

It is recommended that these Code Officials revise the Acceptable Solutions in the OBC to remove the ambiguity to around the term "sewer", and that it be changed to "storm sewer".

Inspection of Connection of Sanitary Building Sewer to Public Side Lateral at Property Line

It is recommended that Code Officials revisit the wording in the Code to explicitly include the inspection of the connection at property line in the Prescribed Notices.

Support for Horizontal Piping

It is recommended that Code Officials develop an appropriate Acceptable Solution that covers support for horizontal piping used for storm sewage outside the building.

PVC Pipe

Summary of PVC Pipe Recommendations

It is recommended that building departments insist upon SDR28, PVC Gasketed Pipe for the SBS and Storm Building Sewer, and that they be installed with haunching and without the use of clear stone as bedding. It is recommended that the SBS be push camera inspected from the cleanout to the property line following backfill operations.

Details of PVC Pipe Recommendations

Canadian Standards for PVC Pipe: CAN/CSA B1800

It is recommended that OBOA request that CSA B1800 be added to the list of specifications available to OBOA members.

PVC Pipe System Type (Use of Solvent Welded Pipe Systems)

It is recommended that Code Officials satisfy themselves that solvent weld pipe systems are approved for use in buried applications, by contacting PVC pipe manufacturers.

Recommended PVC Wall Thickness (Standard Dimension Ratio (SDR)) Rating

It is recommended that Code Officials specify the use of SDR28 pipe for the SBS in the Codes.

Use of Clear Stone for SBS Pipe Bedding

It is recommended that Code Officials explicitly prohibit the use of clear stone as bedding in the Codes.

Haunching for SBS Pipe

It is recommended that Code Officials specify the requirement for haunching directly in the Codes.

Testing and Inspection of PVC Pipe

It is recommended that Code Officials revisit the requirements in the Code that the SBS be tested before it is covered.

Backflow (Backwater) Valves

It is recommended that Code Officials revisit the specifications in the Codes for backflow (backwater) valves.

Design Standards for Private Sewer Systems

It is recommended that Code Officials clarify information in the Codes around the need for private sewer systems to be designed according to public side standards.

1.3 Recommendations Around Mechanisms to Reduce the Risk of I/I

Reducing Risk of I/I for Acceptable Solutions Currently Included in the Codes

It is recommended that CBOs & building inspectors offer the Alternative Solution of installing the SBS with haunching, without the use of clear stone, CCTV inspected after backfilling, in lieu of leak testing.

It is recommended that CBOs & building inspectors offer the Alternative Solution of installing gasketed, SDR 28 pipe in lieu of correct application of solvent cement.

Reducing Risk of I/I for Acceptable Solutions Not Currently Included in the Codes

It is recommended that CBOs & building inspectors directly impose requirements not called for in the Code that reduce the risk of I/I in the SBS for items, such as requiring SDR28 pipe for the SBS.

Use of Subdivision Manuals and Subdivision Agreements

It is recommended that CBOs and Building Departments work with engineering departments to implement the concept of Alternative Solutions and imposing requirements not in the Codes, within Subdivision Manuals and Subdivision Agreements.

Proactive Use of Sewer Use Bylaws on New Subdivision Sites

It is recommended that municipalities investigate the opportunity to have bylaw officers become more active in new construction.

1 Introduction

1.1 Inflow and Infiltration in New Construction

Inflow and Infiltration (I/I) is ground water and rain water that enters sanitary sewer systems (on both the public side, ultimately owned by the municipality, and the private side, ultimately owned by the property owner) that should not be there. This work addressed “excess” I/I, which is I/I in excess of the amount included in the design of sanitary sewers. The issue of I/I and the resulting negative impacts in sanitary sewer systems has become chronic across North America. The impacts of uncontrolled I/I are social, economic and environmental. I/I can also be very costly (see Box).

“Uncontrolled infiltration/inflow in sanitary sewers can have very detrimental effects on social, economic and environmental aspects of urban areas. Excessive flows can severely limit the capacity of existing sewer systems to serve expanded populations. They also generate sewer backups, basement flooding and health risks, increase the operation and maintenance costs of the treatment and pumping facilities, and give rise to overflow of wastewater to streets or watercourses.”

Source: Infiltration/Inflow Control/Reduction for Wastewater Collection Systems: A Best Practice by the National Guide to Sustainable Municipal Infrastructure Canada: FCM and NRC, 2003

Furthermore, with the advent of climate change impacts, the need to reduce the risk of basement flooding is becoming urgent. Recent publications have highlighted the impact of poorly constructed infrastructure on basement flood risk (see Box).

Basement flooding can be caused by different mechanisms, including overland flooding entering through above-grade and/or below-grade openings, sewer backup from the sanitary or storm systems, or infiltration due to elevated groundwater levels or missing, damaged, or poorly constructed infrastructures.

CAN/CSA Z800: Guideline on Basement Flood Protection and Risk Reduction, 2018

In recent years, it has become apparent that newly constructed sewer systems, long assumed to be leak-free, are generating excessive I/I. 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 was requested from municipalities across Ontario. Thirty-five data sets were received. In 34 out of the 35 subdivisions, excessive levels of I/I were identified by the owner of the data. Since then, information has been provided to Norton indicating that some additional 60 subdivisions across Ontario (and a few other provinces) demonstrate excessive I/I.

Subsequent to these initial flow monitoring results, hundreds of men and women (stakeholders) across Ontario and Canada have been consulted to determine the causes and conditions which are contributing to the formation of this I/I. Stakeholders include municipal building and engineering staff, consultants, regulators, 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. These results align closely with other findings in this space: e.g. that excess I/I persists largely due to human factors and our inability (or unwillingness) to address them (see Box).

> *"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.**

In the fall of 2019, *Manual of Best Practices to Reduce Risk of Inflow and Infiltration (I/I) in Public Side New Construction of Sanitary Sewers*[2] was published by Norton Engineering. That report provided practical and feasible recommendations for reducing I/I in new construction on the public side.

This report concerns I/I in new construction on the private side. Industry experts now estimate that I/I from private property sources accounts for 50 to 60% of total I/I in our sewer systems.[3] Although the prevalence of substantial I/I on the private side has been widely acknowledged for some time, municipalities in Ontario (and Canada) have been largely unsuccessful at tackling this I/I, because it originates on the private side, a regime that is largely unfamiliar to engineers working in the I/I field. However, municipalities across Canada are starting to recognize that I/I from private laterals must be addressed to achieve I/I reduction (see Box).

> *"Review of inflow and infiltration reduction programs confirms that controlling inflow from private laterals is generally required to achieve significant reductions in inflow and infiltration rates."*
>
> **Inflow and Infiltration Allowance Assessment: A Liquid Waste Management Plan for the Greater Vancouver Sewerage & Drainage District and Member Municipalities, 2014**

A foundational report which contains the then-current research findings for I/I on the private side, *Building Code Regulations and Engineering Standards as they relate to I/I in Sanitary Sewer Systems* was published by Norton in 2018.[4] Some of the background research referred to in this report is provided in detail in that report.

1.2 Inflow and Infiltration on the Private Side in New Construction

The private side of sanitary sewer systems is regulated under the Building Codes in Canada. It should be noted that when the Codes (and public side sewer regulations) were developed in Canada, I/I was not yet an issue of concern, so was accordingly not afforded much consideration. Of particular import for this document is that under the Building Codes in Canada, **zero leakage (I/I) is permitted in pipes in *Drainage Systems* (which include the *Sanitary Building Sewer* (SBS) and the *Storm Drainage System*)**. Note that for simplicity in this report, reference is made only to the sanitary building sewer (SBS). However, most findings relate equally to the storm drainage system sewers.

The detailed research in this report was undertaken on the Ontario Building Code (OBC). However, issues discussed concerning specific Code references related to I/I appear to be the same as in the National Plumbing Code of Canada. So, references are to “the Codes” throughout the documents, for simplicity. A summary comparison of content in the OBC and the NPCC around items examined in this report are found in Appendix A so that readers across Canada can make use of the findings in this report. Readers should independently verify these comparisons.

The next chapters describe the various means by which building officials, sometimes working with development engineering staff and/or code officials, can minimize the risk of I/I on the private side in new construction. Note that in this report, recommendations refer to the sanitary building sewer, but all recommendations apply equally to the storm building sewer.

1.3 Sources Consulted for Recommendations in this Report

This report contains a wide variety of recommendations. These have been based on wide consultation with a wide variety of stakeholders over the past 5 years. In addition, they have been arrived at based on careful study of the regulations and the primary sources that they reference (e.g. ASTM, CSA). And finally, the author’s own 30 years of experience as a professional civil engineer working with all aspects sewer systems.

The term “consultation” in this report includes the following:

- Formal surveys of 35 municipalities in 2016 (see *"Project to Address Unacceptable Inflow and Infiltration (I/I) in New Subdivisions: Phase 1 final report (2015-2017)"* by Norton Engineering Inc., York Region, City of London, City of Windsor, Institute for Catastrophic Loss Reduction and Region of Peel), 2017. When this report is specifically referenced, the term "survey" is used.

- A detailed study of all aspects of the Ontario Building Code that represent increased risk of I/I (see *"Building Code Regulations and Engineering Standards as they Relate to I/I in Sanitary Sewer Systems"*, Norton Engineering Inc., 2018.

- Ongoing consultations with building officials across Ontario and Canada via a *building officials stakeholder group* developed by Norton for the purposes of this work.

- Ongoing consultations with municipal staff across Ontario and Canada via a *municipal staff stakeholder group* developed by Norton for the purposes of this work.

- Comments received directly from the *building officials stakeholder group* as a result of specific questions posed to them about behaviors, regulations, Code applicability, etc.

- Discussions with a wide variety of building officials by telephone, email, or in person at the Ontario Building Officials Association Conferences, at which Norton has presented for the past 3 years.

- Information obtained during the development of *CSA Z800, Guidelines for Basement Flood Protection and Risk Reduction (CSA, 2018)*, which Norton chaired. The Technical Review Committee included 25 experts from across Canada.

- Information obtained during the development of *"Reducing the Risk of Inflow and Infiltration (I/I) in New Sewer Construction: A National Foundational Document (Standards Council of Canada, 2019)"* which Norton co-authored. The Expert Stakeholder Committee comprised 25 experts from across Canada.

- Norton's direct experience working with municipalities across Ontario on I/I programs.

- Norton's direct experience working with developers in Ontario on I/I issues.

- Other ongoing consultations with other municipal staff, consulting engineers, regulators, University professors, contractors, pipe and other suppliers, etc.

2 Best Policy Practices for Building Departments

This section presents recommended policy practices which can be used by building departments to reduce the risk of excessive I/I in sewer systems. Some of these policy practices will need to be undertaken in cooperation with development planning/engineering groups.

2.1 Building Official Training Concerning I/I and its Impacts

Norton's consultations strongly indicate that I/I is not well understood by building departments. In most cases, building officials have received no training nor exposure to this issue. The Code suggests that advice on design, where appropriate, be sought from other professional sources (see Box).

> *"The Building Code Compendium states that "the Ontario Building Code is essentially a set of* ***minimum provisions*** *respecting the safety of buildings with reference to public health, fire protection, structural sufficiency, accessibility and energy efficiency. It is not intended to be a textbook on building design, advice on which should be sought from professional sources."*
>
> **MMAH, Building Code Compendium, 2012**

Building inspectors do not always understand the reasons behind certain provisions in the Codes, (e.g. required procedure for the installation of PVC pipe), making them less likely to enforce them. However, during Norton's research and outreach, building staff have shown enthusiastic interest in learning more about I/I and how they can do their part to reduce the risk that it occurs on the private side. Unless staff are trained to spot risks with respect to I/I, and the importance of preventing it, it is difficult for them to enforce the Code meaningfully.

It is recommended that CBOs & building officials be provided with regular training on inflow and infiltration and the important role they play in reducing the risk of I/I on the private side.

2.2 Communications with Developers, Drain Layers and Builders Prior to the Issuance of Building Permits

Communication with developers, drain layers and builders is essential in producing leak-free infrastructure, since they are constructing the private side infrastructure. These groups should be made aware that the municipality will be using flow monitoring at the downstream end of the subdivisions (see recommendations in Best Practices – Public Side) to confirm this status.

While developers are generally made aware when flow monitoring will be undertaken (municipalities in Ontario have recently started to include this provision in subdivision agreements), recent experience in Ontario[5] suggests that builders on site may not know about the flow monitoring, so the opportunity to have flow monitoring change behavior (e.g. build leak-free infrastructure) is lost. This appears to be a lost opportunity to improve how sewers are built on the private side.

This messaging is also 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-free. Developers have indicated that they have the ability to enforce the contract with individual builders.[6]

It is recommended that prior to the issuance of any building permits, developers, drain layers and builders be made aware that flow monitoring will be used to confirm leak-free infrastructure on the private side.

2.3 Installation of the SBS by Mainline Sewer Contractor

Municipalities should consider requiring the mainline sewer contractor to construct the Sanitary Building Sewer (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.

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).

This sewer 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.

Both the public side and private side of the sewer lateral are required to be constructed to CAN/CSA 182.11 (B1800: Thermoplastic Nonpressure Piping Compendium) which is discussed in detail in further chapters. Water main and sewer contractors are familiar with this standard, as it is applied fairly consistently on the public side.

It is recommended that municipalities investigate having the mainline sewer contractor install the SBS.

2.4 Standardization of the Interpretation and Application of the OBC Between Municipalities

Consultation with building officials indicate that the OBC is interpreted differently by different CBOs (who have the responsibility to interpret it for their municipality). For example, the interpretation of the need for a backwater valve (BWV) varies across Ontario. A common, agreed upon interpretation of Code issues with respect to sanitary sewers would help building staff and developers alike, since requirements would be consistent between municipalities.

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) previously published a “Model Sewer Use By-law” (1988: currently archived) for municipalities to adopt.

It is recommended that municipal building departments from each province work together on common interpretation of different Code requirements around sewers and drainage.

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

Many 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 building 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 with less I/I 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.

It is recommended that municipalities engage regularly with developer groups in their area (e.g. homebuilders associations). It is recommended that workshops or other forums be held around I/I on the private side and workable solutions be developed.

3 Best Practices Using the Building Code to Reduce the Risk of I/I (Clean Water) Entering Sewers

There are many provisions in the Codes that have a direct impact on I/I risk. In some cases, the Codes are not appropriately specific to ensure that I/I risk is reduced, and in some cases the Codes are specific enough, but the provisions therein are not generally being applied. Good practices around each group are presented in the following sections. In some cases, building departments will need to work together with development engineering groups to reduce the risk of I/I on the private side.

3.1 Provisions in the OBC that are Not Protective of I/I

3.1.1 Discharge of Foundation Drains or *Subsoil Drainage Pipe* to the Sanitary Sewer

The first area where the OBC is not sufficiently protective of I/I is in allowing the connection of a foundation drain or subsoil drainage pipe to be connected to a sanitary drainage system. This is found in OBC 7.4.5.3. and 9.14.5.1.; see box. Defined terms from the Code are as follows:

> ***OBC 7.4.5.3.***
> ***Connection of Subsoil Drainage Pipe to a Sanitary Drainage System***
>
> (2) Where a *storm drainage system* is not available or soil conditions prevent drainage to a culvert or dry well, a foundation drain or *subsoil drainage pipe* may connect to *sanitary drainage system.*
>
> ***OBC 9.14.5.1.***
> ***Drainage Disposal***
>
> *(1) Foundation drains shall drain to a sewer, drainage ditch or dry well.*
>
> *(2)* Where gravity drainage is not practical, a covered sump with an automatic pump shall be installed to discharge the water into a sewer, drainage ditch or dry well

"Sanitary drainage system means a drainage system that conducts *sanitary sewage."*[7]

"Storm drainage system means a drainage system that conveys *storm sewage"*[8]

"Subsoil drainage pipe means a pipe that is installed underground to intercept and convey subsurface water, and includes foundation drain pipes."[9]

In both clauses of the OBC, the discharge of foundation drains to the sanitary sewer is permitted. In most places in Ontario and Canada, municipal bylaws explicitly prohibit this discharge. Foundation drain discharge is the source of much I/I in older sewer systems (see Box). It is therefore unwise and not in keeping with modern sanitary sewer design, to allow for such discharge in the building Codes.

(Semi-Combined) systems (sanitary sewers with permitted foundation drain connections) were the historic norm in most of Canada and are usually referred to as sanitary sewers even though they respond very rapidly to rainfall, have high rates of inflow and infiltration and exhibit similar hydrologic characteristics as fully combined sewers.

Inflow and Infiltration Allowance Assessment: A Liquid Waste Management Plan for the Greater Vancouver Sewerage & Drainage District and Member Municipalities, 2014

Since building inspectors are not necessarily familiar with sanitary sewer design principles[10], nor with applicable bylaws, it is possible that such connections may be allowed occasionally, if the inspector is interpreting the code literally. These provisions should be modified to explicitly prohibit discharge to the sanitary sewer.

It is recommended that CBOs & building inspectors be aware that discharge of foundation drainage to sanitary sewers is prohibited by bylaw in most Ontario jurisdictions.

It is recommended that Code Officials revise these Acceptable Solutions in the OBC to clarify that foundation drainage or subsoil drainage pipes to sanitary sewers is prohibited.

3.1.2 Discharge of *Storm Drainage Systems* to *Sanitary Sewage* Works

Another area of the Code that represents I/I risk is the treatment of *storm drainage systems.* First, the Code is quite clear in Article 7.1.5.2 that *storm drainage* should not be connected to the *sanitary sewage* works (see Box).

OBC Part 7 Plumbing

7.1.5.2. Storm Drainage Systems

(1) Every storm drainage system shall be connected to a public *storm sewage* works or a designated storm water disposal location but shall not be connected to a *sanitary sewage* works.

However, in other sections of the Code (Part 5: see Box), reference is made to “where downspouts are not connected to a sewer”. Since *sewer* is a defined term in the Code, and can mean either sanitary or storm *sewer,* there may be confusion around this issue for building inspectors, since sewer can refer to either.

It is recommended that CBOs & building inspectors be aware that discharge of storm water to sanitary sewers is prohibited in Ontario.

OBC Part 5 Environmental Separation
***5.6.2.2.* Accumulation and Disposal**

(3) Where downspouts are provided and are not connected to a sewer, provisions shall be made to,

(a) divert the water from the *building*, and
(b) prevent *soil* erosion.

OBC Part 9 Housing and Small Buildings
9.26.18.2. Downspouts

(1) Where downspouts are provided and are not connected to a sewer, extensions shall be provided to carry rainwater away from the *building* in a manner that will prevent *soil* erosion

It is recommended that these Code Officials revise the Acceptable Solutions in the OBC to remove the ambiguity to around the term "sewer", and that it be changed to "storm sewer".

3.2 Provisions in the Building Code That Are Protective of I/I but are Vague or Unclear

3.2.1 Inspection of Connection of *Sanitary Building Sewer* to Public Side Lateral at Property Line

The inspection of the connection of the SBS to the public side lateral at property line is essential to ensuring that I/I does not occur (see also Section 2.3). Since the sanitary sewer system on the public side, including laterals to property line, are constructed, buried and tested before Building Permits are issued, the inspection of this connection falls to Building Departments (at this point in the development process the engineering groups are not typically involved).[11]

There is a prescribed notice that calls for the permit holder to notify the building department of readiness for inspection and testing of the "*drainage systems*" (see Box).

The OBC defines *drainage system* as follows:

"Drainage system means an assembly of pipes, fittings, *fixtures* and appurtenances on a property that is used to convey *sewage* and *clear water waste* to a main sewer…"

OBC 2012
1.3.5.1. Prescribed Notices

(2) The person to whom a permit under section 8 of the Act is issued shall notify the *chief building official* of,

(i) readiness for inspection and testing of,
(i) building sewers and building drains,
(iv) drainage systems

Since the connection at property line is part of the assembly of pipes in question, the wording in the Prescribed Notices suggests that the connection at the property line be included in the inspection. However, it does not explicitly say so, and surveys[12] indicate that this connection is reportedly not being undertaken in many places in Ontario.

It is recommended that the CBOs & building inspectors carefully inspect the connection at property line, in accordance with OBC, to confirm that it is properly supported and adequately jointed.

It is recommended that Code Officials revisit the wording in the Code to explicitly include the inspection of the connection at property line in the Prescribed Notices.

3.2.2 Inspection of *Storm Building Sewer* on the Private Side

Surveys across Ontario[13] suggest that at least half of building departments are not inspecting the *storm drainage system* on the private side. Since *storm sewer* is a defined term in the OBC and fall under the term *sewer*, the OBC requires this inspection (per the sections in the OBC noted above).

Leaking storm sewers present a big risk in the face of climate change. Storm sewers are designed to convey the flow from a specific return period (e.g. 1:5 year storm). If the storm sewers are not leak free, the I/I allowed to enter is reducing the protection afforded to the area to a smaller storm. With the advent of climate change impacts, this is an unacceptable risk.

It is recommended that the CBOs & building inspectors inspect the storm sewer drainage system, in accordance with OBC, to confirm that it has been correctly installed. The storm connection at property line, if any, should also be inspected as recommended for the sanitary building sewer.

3.2.3 Support for Horizontal Piping

Homebuilders have for some time been strapping storm drainage features to the side wall of the home, before directing it towards storm sewer drainage systems, and then backfilling the installation.

Inspectors have been looking to OBC 7.3.4.5. for information on strap spacing and material. However, it does not appear that Sentence 7.3.4.5. was ever intended as a guide to strapping that is outside the building and intended to be buried. All of the information in this Paragraph refers to pipe that is **inside a building** and not subject to burial. Strapping to support underground horizontal piping is covered in OBC 7.3.4.6. (see box). This Article contains no information on sufficiency of compliance; presumably an engineered design is required. The strapping cited in 7.3.4.5. of the OBC is not relevant here.

It is not clear that it is appropriate to hang ABS or PVC pipe to the outside wall of a house and then backfill it. There appears to be a risk of damaging or pulling the pipe away from the wall during backfilling, which would result in storm water going down the wall of the house to the foundation drain, increasing flood risk.

It is recommended that CBOs and building officials be aware that the support for horizontal piping in the OBC does not cover piping outside the building.

> ***OBC 7.3.4.6.***
> ***Support for Underground Horizontal Piping***
>
> **(1)** Except as provided in Sentence (2), *nominally horizontal* piping that is underground shall be supported on a base that is firm and continuous under the whole of the pipe.
>
> **(2)** *Nominally horizontal* piping installed underground that is not supported as described in Sentence (1) may be installed using hangers fixed to a foundation or structural slab provided that the hangers are capable of,
>
> (a) keeping the pipe in alignment, and
>
> (b) supporting the weight,
>
> (i) of the pipe,
>
> (ii) its contents, and
>
> (iii) the fill over the pipe.

It is recommended that Code Officials develop an appropriate Acceptable Solution that covers support for horizontal piping used for storm sewage outside the building.

3.3 Provisions in the Building Code That Are Protective of I/I but are Not Being Fully Observed

This Section describes essential components in the building Codes for reducing the risk of I/I in sanitary and storm sewers. Since these provisions exist in the Codes now, it is essential that building inspectors start insisting that they be followed in new construction. As has been identified across Canada, private lateral quality inspection is an essential component in reducing I/I (see Box).

> *"Sewer use bylaw enforcement and private lateral quality inspection play important roles in the long-term reductions in inflow and infiltration, particularly as neighbourhoods are redeveloped."*
>
> ***Inflow and Infiltration Allowance Assessment: A Liquid Waste Management Plan for the Greater Vancouver Sewerage & Drainage District and Member Municipalities, 2014***

This section addresses the design, installation, inspection, testing and acceptance of PVC pipe on the private side. First, a summary of the governing Standard is presented, and then the specific Code items that fall under this standard follow.

3.3.1 Canadian Standard for PVC Pipe: CAN/CSA 1800

This section will refer numerous times to the CAN/CSA 1800 Standard, **Thermoplastic Nonpressure Piping Compendium**, the standard that governs the use of PVC pipe. CAN/CSA B182.1 and B182.2, which are referenced in the Codes, and used for the

SBS, fall under this compendium. Components of this Compendium are therefore described briefly here.

CSA B182.1-18 is the standard that specifies requirements for plastic drain and sewer pipe and pipe fittings (note that the -18 indicates that the standard was updated in 2018: current OBC reference is to -11, but there has been no change in this part of the Standard). CSA B182.2-18 is the standard that specifies requirements for PSM ("Plastic Sewer Main") -type polyvinylchloride (PVC) sewer pipe and fittings. SBD pipe being installed in Ontario appears to conform to one of these two material standards.

B1800 also includes CSA B182.11-18, standard practice for the installation of thermoplastic drain, storm, and sewer pipe and fittings. B1800 includes the following statement:

> "This Standard **specifies requirements for the installation and testing** of thermoplastic… used for the conveyance of drain, storm and sanitary effluent in gravity flow systems."
>
> "This Standard applies to pipe manufactured in accordance with CSA B182.1, CSA B182.2…"

Therefore, CSA B182.11 specifies the requirements for installing SBSs stamped with CSA B182.1 and B182.2. That is, the majority of pipe being installed as SBSs in Ontario.

Given the importance of the CAN/CSA B1800 Standard to building departments performing their duties, it is recommended that it be added to the list of Standards that are available to Ontario Building Officials Association (OBOA) members free of charge. Equivalent access is recommended to users in other provinces.

It is recommended that CBOs & building officials become familiar with the requirements for laying PVC pipe according to CSA specifications.

It is recommended that OBOA and other provincial associations request that CSA B1800 be added to the list of specifications available to their members.

3.3.2 Installation of PVC Pipe in the Codes

The OBC includes Section 7.3. which provides instructions on Support for Underground Horizontal Piping (see box) but does not explicitly reference CAN/CSA B182.11. Consequently, the requirements for installation of PVC pipe for the SBS is not explicit in the Codes.

Because the CAN/CSA B182.11 installation standard is not currently being observed in Ontario, major PVC Pipe manufacturers in Canada were contacted regarding their installation requirements. Manufacturers indicated that they recommended that PVC pipe be installed per CAN/CSA B182.11; indeed, this information is included in their installation specifications.

OBC 2012

7.3. Piping

7.3.4. Support of Piping

7.3.4.6. Support for Underground Horizontal Piping

(1) Except as provided in Sentence (2), *nominally horizontal* piping that is underground shall be supported on a base that is firm and continuous under the whole of the pipe.

> **Volume 2 Compendium to OBC (Appendices are not legally part of OBC):**
>
> **OBC Sentence A-7.3.4.6.(1)**
>
> Plastic piping installed underground must be support (sic) on a base that in (sic) continuous under all piping and fittings with a recommendation of at least 100mm of loose fill surrounding the piping. Plastic piping buried up to depths greater than 2.5m…. must have backfill that is free of large stones or frozen each, tamped by machine or poured as a wet slurry containing one part 6mm pea gravel and one part 12mm crushed stone.

7.3.5.1.(1) Backfill of Pipe Trench

Where piping is installed underground, the backfill shall be carefully placed and tamped to a height of 300 mm over the top of the pipe and shall be free of stones, boulders, cinders and frozen earth.

> **Volume 2 Compendium to OBC (Appendices are not legally part of OBC):**
>
> **OBC Reference A-7.3.5.1.**
>
> This page in Appendix A shows a drawing of a pipe in a trench box and repeats Sentence 7.3.5.1.(1). In addition, it states "Standard Dimension Ratios for piping in deep fill, under vehicle driveways or parking facilities may not be sufficient requiring heavier schedule piping to be used along with engineered compaction for the full depth of the trench"

The IPEX Installation Manual (Volume II, Sewer Piping Systems Design), includes the following statement:

> "Much of the installation information can also be found in Canadian Standards Association (CSA) Standard B182.11, entitled, "Recommended Practice for the Installation of Thermoplastic Drain, Storm and Sewer Pipe and Fittings"…"

In addition, p. 36 of the Manual refers to bedding, haunching, initial backfill, final backfill, and embedment materials, mirroring the requirements of CAN/CSA B182.11. Other pipe manufacturers literature contain similar instruction.

In order to clarify the requirements of pipe manufacturer versus the provisions of the OBC, Norton contacted MMAH. The following response was provided:

"It is the responsibility of manufacturers themselves required to provide their own piping installation instruction to the installation contractors.

The installation contractors must follow the Building Code applicable requirements and the manufacturers installation instructions (i.e. the most restricted will govern) *(emphasis added). This is based on the fact that NO local officials will know all the manufacturers installation instructions because they can be different, and the instruction may change over time."*

"It will be helpful to the local officials if the manufacturers themselves provided their own piping installation instruction ahead of time before the site inspection is requested for each project."

~ MMAH Representative[14]

~ Reference: IPEX 2014

It appears that since the most restrictive requirements will govern, the recommendations of the PVC pipe manufacturer must be followed. In this case, that requires installation per CAN/CSA B182.11, which is the same as is required for the same pipe type on the public side of the property line. It cannot be otherwise; PVC pipe does not function as designed and will not reach its design life in the absence of side soil support.

Recommendations to improve on the status quo are included below.

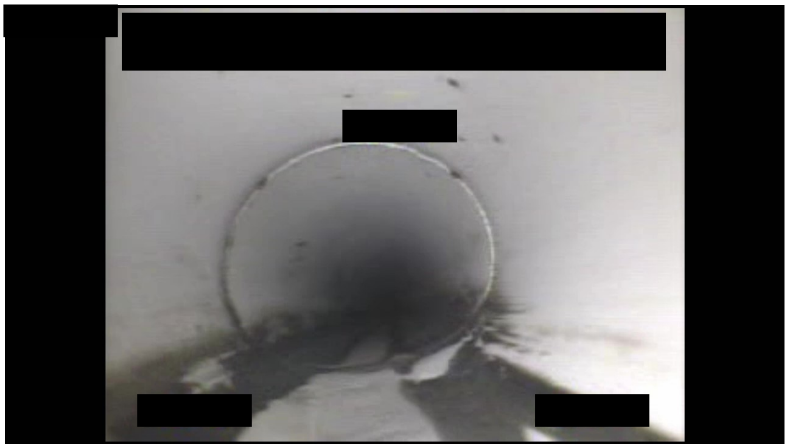
3.3.2.1 PVC Pipe System Type (Use of Solvent Welded Pipe Systems)

Extensive consultation with PVC pipe manufacturers across Canada and the US over the past several years has not identified any document or standard that "approves" the use of solvent welds in buried applications. Indeed, Norton has been told independently by two sources from PVC manufacturers (who prefer to remain anonymous for commercial reasons) that glued pipe was never intended to be buried.

Even a well-constructed solvent-welded pipe system for the SBS will result in a continuous run of rigid pipe from the house to the property line. Any imperfection in the bedding could easily result in the failure of one or more of the rigid joints. And, any differential deflection between pipe sections could result in the failure of one or more of the rigid joints.

Figure 1 shows a still shot from a CCTV inspection of an unassumed SBS (location identifying information blacked out) and clearly shows the deflection at the joint. Where a joint deflects, it is unlikely that the solvent welded joint will remain intact, introducing significant risk of I/I into this sewer (increasing the risk of flooding). Already, there is evidence if infiltration at the joint (note that stills from CCTV inspection of sewers are poor quality).

FIGURE 1: CCTV STILL PHOTO OF NEW SBS SHOWING DEFLECTION AT JOINT



CSA, ASTM and the Uni-Bell Handbook of PVC Pipe all refer to gasket-jointed PVC pipe, and all testing and specifications refer to gasketed pipe. It is not clear by what mechanism solvent welded pipe became commonly used on the private side; it is not permitted on the public side. It is recommended that PVC pipe manufacturers be requested to produce such documentation if it is continued to be used.

The new CSA Z800 Guideline for Basement Flood Protection and Risk Reduction (2018) states that, “Pipe used for the sanitary building sewer should be gasketed”[15].

Pipe used in Canada must be approved by ASTM standards, as referenced in the Codes. However, these standards include all of the testing requirements for *gasketed pipe* only. No such testing appears to be available for solvent-welded pipe. Gasketed pipe can be installed correctly much more quickly than solvent-welded pipe (given manufacturer’s required set times), in all weather conditions. Gasketed pipe provides a small amount of flexibility at each joint, avoiding the inherent risks of a single run of pipe which has no flexibility and is at risk of failure if differential settlement is experienced.

The mechanism by which building departments can achieve this recommendation is discussed in the next section.

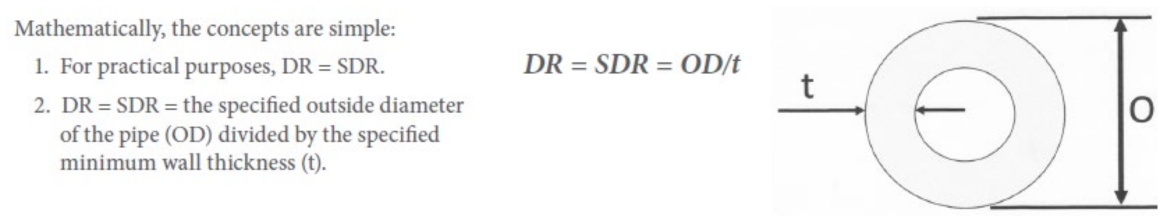
It is recommended that CBOs & building inspectors not permit the use of solvent-welded PVC pipe systems, as they are not explicitly permitted in the standards.

It is recommended that Code Officials satisfy themselves that solvent weld pipe systems are approved for use in buried applications, by contacting PVC pipe manufacturers.

3.3.2.2 Recommended PVC Wall Thickness (Standard Dimension Ratio (SDR)) Rating

All other variables being equal, a thicker-walled PVC pipe is stronger than a thinner walled one of the same size. Wall thickness for PVC pipe is indicated by the SDR rating, which is depicted in Figure 1. A 100mm pipe that is SDR28 has thicker walls, and is therefore stronger, than SDR35 pipe.

FIGURE 2: GRAPHIC OF DR OR SDR FOR PVC PIPE



Source: PVC Pipe Association Technical Brief, 2019

Currently, 100mm SDR35 PVC pipe is in common usage on the private side, although the SDR rating for this pipe *is not specified* in the Codes (although it was previously). On the public side, the strength rating of the pipe is specified by an engineer based on site conditions. Previously, SDR35 was in common usage on the public side, but many municipalities are now requiring SDR28 pipe in current specifications, given the knowledge that sewer laterals are a significant source of I/I, and stronger pipe is expected to be more robust. Since the sewer lateral is installed and frequently forgotten, a better pipe is a wise investment in longer sewer life.

It is recommended that CBOs & building inspectors, in concert with development engineering, require DR28 pipe for the SBS.

It is recommended that Code Officials specify the use of SDR28 pipe for the SBS in the Codes.

3.3.2.3 Use of Clear Stone for SBS 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.

On the public side, the only bedding permitted for use with PVC pipe are Granular A, Granular B (Type I, II or III), or Unshrinkable Fill (see OPSS.MUNI 401, CONSTRUCTION SPECIFICATION FOR TRENCHING, BACKFILLING, AND

COMPACTING (2015): 401.05.02 and 401.05.02). The use of clear stone is not permitted.

> *"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."*
>
> **US Environmental Protection Agency, 1990, pp. 2-6, 2-7, 2-12**

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. It is desirable to not allow sewer bedding to act as a french drain, since this allows any groundwater in the vicinity of the pipe to flow to the next available pipe defect (leak) where it can enter the sewer (see Box). In engineered designs, designs sometimes specify clay plugs (trench plugs) to avoid such an eventuality.

Table 1 of CAN/CSA B182.11 (Description of Embedment Material Classifications) lists the soil classes and types to be used for haunching. Clear stone is not listed. Absent a geotechnical engineered design of the SBS in accordance with the technical requirements of Table 1, it is recommended that only Granular A or B (or unshrinkable fill) be permitted as bedding and haunching of the SBS.

It is recommended that the CBOs & building inspectors, not permit the use of clear stone as bedding for the SBS.

It is recommended that Code Officials explicitly prohibit the use of clear stone as bedding in the Codes.

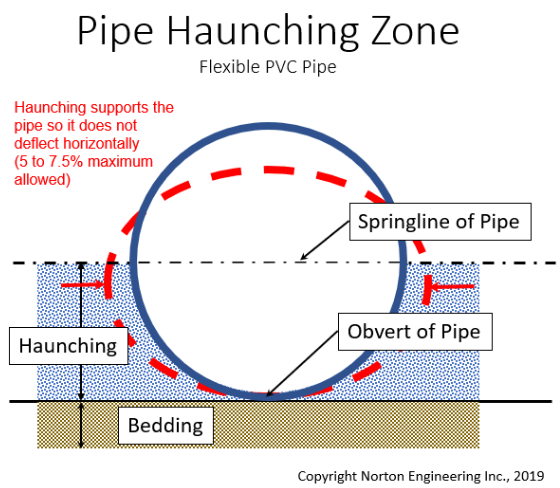
3.3.2.4 Haunching for SBS Pipe

Plastic pipe must be installed with flexible pipe principles that recognize that performance is primarily dependent upon proper bedding, side support and haunching of the embedment material (see quotations in this section). This report focuses on PVC pipe, as this is the most common pipe used for the SBS in Ontario. As shown in Figure 1, unlike concrete pipe (which has its own structural integrity) PVC pipe is subject to compression by the weight of soils above it. Embedment of the side soils (the haunching area shown in Figure 1) gives the soil the strength to hold the pipe round against deflection.

There are specifications for allowable deflection of PVC pipe (5 to 7.5% according to PVC pipe manufacturers), depending on conditions (which are not described). Indeed, per the Ten State Standards[16] used on the public side of the property line, "Deflection

Tests: No pipe shall exceed a deflection of 5%. If deflection exceeds 5%, the pipe shall be excavated."[17] This deflection is measured by passing a "mandrel", a device with go/no go proving rings, through the pipe. The mandrel will not pass if deflection exceeds the set amount. CSA B182.11 calls for mandrel testing of PVC pipe after it is buried.

FIGURE 3: PIPE HAUNCHING ZONE FOR FLEXIBLE PIPE



Current practice in Ontario is far from meeting the requirements for installation of PVC pipe as required by specification and recommended by the manufacturers, and it appears to the author that this is likely a significant source of I/I on the private side. Obviously, we need to improve this practice, but it is likely infeasible to expect that achieving the full requirements of CAN/CSA 182.11 can be achieved in one step. Therefore, a first step is recommended.

Haunching is universally identified as the most important factor affecting pipe performance, according to CAN/CSA 182.11, the Handbook of PVC Pipe Design and Construction and NAPCO Royal Pipe (see Figures 4, 5 and 6).

FIGURE 4: HAUNCHING RECOMMENDATIONS PER CAN/CSA 182.11

5.3.6 Haunching

The haunching material shall be placed and consolidated under the pipe haunch to provide adequate side support to the pipe while avoiding both vertical and lateral displacement of the pipe. Where coarse materials with voids have been used for bedding, the same coarse material as used for bedding shall also be used for haunching, and consideration shall be given to using wide trench construction. Haunching material shall be placed up to the springline.

Note: *The most important factor affecting pipe performance and deflection is the haunching material and its density.*

Source: CAN/CSA B182.11-18

Figure 5: Haunching Recommendations per Handbook of PVC Pipe Design and Construction

The Handbook of PVC Pipe (considered the premier source of information on PVC pipe design for engineers, states:

> "The factor that most affects pipe performance and deflection is haunching material and density. Material should be placed and consolidated under the pipe haunch (Fig. 12.4) so adequate side support is provided to the pipe without causing displacement from its proper alignment (either vertical or horizontal). Where coarse materials with voids have been used for bedding, the same coarse material should also be used for haunching; consideration should be given to native soil migration. Haunching is placed up to the pipe's springline."

Source: Handbook of PVC Pipe Design and Construction
Uni-Bell PVC Pipe Association, 5th Edition, 2012

Figure 6: Haunching Recommendations per NAPCO Royal Pipe and Fittings

A flexible buried pipe will vertically deflect when placed under a load which is then partially transferred to and supported by the strength of the embedment material on each side of the pipe. As a result, the ability of PVC pipe to withstand soil and surface loads without exceeding maximum deflection limits is directly related to the quality of the installation and compaction of the embedment material around the pipe.

Source: NAPCO Royal Pipe and Fittings, Technical Bulletin, 2019

The importance of, and necessity for, haunching of PVC pipe, is well documented. It appears that haunching of pipe could be incorporated into current practices used for the laying of the SBS in Ontario. Therefore, it is recommended that Building Departments start requiring haunching to be used in the installation of the SBS and *storm drainage system* pipes. This is recommended as a reasonable first step towards the full compliance with CSA B182.11 required by the Codes.

It is recommended that CBOs and building inspectors insist that the SBS be installed with haunching as required by CAN/CSA 182.11.

It is recommended that Code Officials specify the requirement for haunching directly in the Codes.

3.3.2.5 Jointing of PVC Pipe by Solvent Weld

Concerns with the use of solvent-welded piping systems in underground applications were discussed in Section 3.3.2.1. If solvent welded joints are permitted, however, the following issues identified in consultations should be noted, as follows:

- The initial set times required for solvent-welded joints are not being observed.
- The use of a single step welding process does not appear to be recommended and is explicitly prohibited in cold weather conditions.

Consultation has indicated that it is common practice in Ontario to use a single step cementing process (e.g. the solvent and the cement are applied as a single product). It is not clear that this has ever been tested or approved. Indeed, the relevant standards are quite specific as demonstrated below. OBC 7.2.5.10. (Materials) explicitly references CAN/CSA B182.11, which provides clear instructions on the use of solvent cement on “Plastic Drain and Sewer Pipe” (see Box).

FIGURE 7: CAN/CSA 182.11 RECOMMENDATIONS FOR SOLVENT CEMENTED JOINTS

The following procedures *shall* be followed when solvent cementing pipes:

a) Pipe ends shall be squarely cut. If the cut is made in the field and not in the factory, all burrs shall be removed from the inside an outside with a knife or file. Pipe shall be bevelled in accordance with Clause 6.3.1.
b) Pipe and fittings shall be checked for fit before cementing. The best condition for tapered fittings is one in which the dry pipe enters the dry socket to about 75% of the socket depth with only gentle hand pressure.
c) Pipe shall be wiped using a clean, dry rag to remove all dirt, grease, and moisture from the pipe end and fitting socket. In some instances, it can be necessary to use a solvent cleaner.
d) The right applicator for the size of pipe or fitting to be joined shall be used. For pipe sizes through NPS-24, a roller or paintbrush about half the pipe diameter in width shall be used.
e) Primer shall be applied with a scrubbing motion to penetrate all surfaces to be bonded.
f) If the coated surface is not soft, another coat of primer shall be applied.
g) While surfaces are still wet, appropriate cement shall be applied. The cement shall be smooth and free-flowing. Puddling shall be avoided.
h) A second full, even layer of cement shall be applied to the pipe is there is still a loose fit between the pipe and fitting.
i) The pipe and fitting shall be assembled without delay. Enough force shall be used to ensure that the pipe bottoms in the socket. If possible, the pipe shall be given a one-eighth to one-quarter turn as it is inserted.
j) The assembly shall be held for 5 to 30s to eliminate “pushout”.
k) After assembly, the joint shall have a ring or bead completely circling the juncture. If voids in the ring are present, sufficient cement was not applied and the joint could be defective.
l) Excess cement shall be removed with a rag. Care shall be taken to ensure that the joint is not disturbed.
m) The newly assembled joint shall be handled carefully until the joint has set. See Table 3 for recommended curing times.

After the initial set, the joints shall withstand the stresses of a normal installation (a badly misaligned installation will cause excessive stresses in the joint, pipe and fittings).

The Standard is clear that a two-step solvent weld process is required. The Standard is also clear about required initial set times, which are shown in Table 1. As Table 1 demonstrates, the Standard calls for recommended "careful handling time" for 100mm PVC sewer pipe of between 1 and 12 hours, depending on the temperature.

TABLE 1: RECOMMENDED CURING TIMES FOR SOLVENT WELDING PVC PIPE

Table 3
Recommended curing times, h
(See Clause 6.3.3.)

	Temperature range during initial set time		
NPS	**–20 to 5 °C**	**5 to 15 °C**	**15 to 40 °C**
3–8	12	4	1
10–14	24	8	2
16–24	48	16	4

Source: CAN/CSA 182.11, from B1800-18 Thermoplastic Non-Pressure Piping Compendium

The manufacturers' specifications for solvent welds were also consulted. Review of the installation instructions of many different brands of solvent cement used in Canada all provide the same instructions for set times for the cementing. As shown in (Norton) Table 2, the *initial set time* for solvent cement is 30 minutes for temperatures of 60º F (15.6º C) or warmer. The term *initial set time is defined as the necessary time to allow before the joint can be carefully handled;* it is referenced in part (m) in the box above.

TABLE 2: INITIAL SET SCHEDULE FOR SOLVENT CEMENTING OF PVC PIPE

AVERAGE INITIAL SET SCHEDULE
FOR IPEX PVC/CPVC SOLVENT CEMENTS**

Temperature Range	Pipe Sizes 1/2" to 1-1/4"	Pipe Sizes 1-1/2" to 2"		Pipe Sizes 2-1/2" to 8"	Pipe Sizes 10" to 15"	Pipe Sizes 15" +
60º - 100ºF	2 minutes	5 minutes		30 minutes	2 hours	4 hours
40º - 60ºF	5 minutes	10 minutes		2 hours	8 hours	16 hours
0º - 40ºF	10 minutes	15 minutes		12 hours	24 hours	48 hours

Note: Initial set schedule is the necessary time to allow before the joint can be carefully handled.

Source: IPEX Solvent Welding Guide, 2016

The IPEX manual cited above says, "In certain materials and in certain situations, it is necessary to use a primer"[18]; however, these materials and situations are not specified. It would be difficult for a building inspector to interpret these materials and situations, absent an engineering recommendation thereupon. Since leaking joints in the SBS are frequently identified in existing systems, the two-step process for jointing is essential.

Furthermore, in the specific condition of cold weather, jointing *must* be two-step, per the manufacturers' recommendation. For example, in the IPEX Solvent Welding Guide, *Joining Plastic Pipe and Fittings in Cold Weather*, the following instructions are provided:

FIGURE 8: IPEX GUIDE TO SOLVENT WELDING IN COLD WEATHER

Working in freezing temperatures is never easy. But sometimes the job is necessary. If that unavoidable job includes solvent welding plastic pipe, it can be done successfully with IPEX Solvent Cements.

By following our standard instructions and using a little extra care and patience, successful solvent welded joints can be made at temperatures even as low as -26ºC (-15ºF). In cold weather, solvents penetrate and soften the plastic pipe and fitting surfaces more slowly than in warm weather. Also the plastic is more resistant to solvent attack. Therefore it becomes even more important to pre-soften surfaces with an aggressive primer. And, because of slower evaporation, a longer cure time is necessary. Our cure schedules allow a margin for safety, but for colder weather more time should be allowed.

Use an IPEX Primer to soften the joining surfaces before applying cement. More than one application may be necessary.

Source: IPEX Solvent Welding Guide, Jointing Plastic Pipe and Fittings in Cold Weather, 2016

Furthermore, referring to Norton's Table 2 initial set times, for temperatures between 4.4º C and 15.6º C, the recommended set time is 2 hours, and colder than 4.4º C the set time is 12 hours.

If solvent welds are used:

It is recommended that the CBOs and building inspectors request product specifications for the solvent cement being used and confirm the need for two-step welding.

It is recommended that the CBOs & building inspectors confirm the initial set time for the solvent cement and require that this be observed by contractors.

It is recommended that CBOs & building inspectors require that special instructions from the manufacturer are followed during cold weather conditions, to ensure proper welds.

It is recommended that when inspecting the sanitary building sewer installation, the building inspector confirm that the joints are integral (e.g. solid).

3.3.2.6 Testing and Inspection of PVC Pipe

The OBC requires leak testing of every pipe in a *drainage system* (e.g. the *sanitary building sewer* and the *storm drainage system*). See Box.

The OBC specifies that an air or water test be performed after a section of drainage system has been roughed in but not yet buried. *Drainage system* is a defined term in the OBC and refers to pipes on a property used to convey *sewage* to a main sewer. As previously noted, *sewage* in the Codes refers to sanitary sewage and storm sewage. Sentence 7.3.6.2.(1) specifies that every pipe in a drainage system should be leak-free. Therefore, this test refers to both the SBD and the external sewer system SBS.

In Ontario, however, surveys[19] indicate that the majority of building departments are not performing this essential test. Building officials have reported that this is due to the difficulty in performing the test (access to cleanout, need for fitting, etc.). It is likely that because the test requires that the section must be kept filled with water 15 minutes, it is not favored by developers, because it would slow down production. However, given how costly it is to allow unacceptable I/I into our sewer systems, enforcement of this OBC must be reconsidered.

OBC 2012

7.3.6.1. Tests and Inspection of Drainage or Venting Systems

(1) After a section of drainage system has been roughed in, and before any fixture is installed **or piping is covered**, a water or an air test shall be conducted.

(2) Where a CBO **requires** a final test, it shall be carried out after every fixture is installed and before any part of the drainage system is placed in operation.

7.3.6.2. Tests of Pipes in Drainage Systems

(1) Every pipe in a drainage system shall be capable of withstanding without leakage a water test, air test and final test.

7.3.6.4. Water Tests in Drain, Waste and Vent Systems

(1) Where a water test is made, all joints shall be tested with a water column of not less than 3 m.
(b) The system or the section **shall be kept filled with water for 15 min**.

Another important issue is that this test is called for in the OBC prior to backfilling. While this is likely more convenient for building departments, since they can observe the test while doing the prescribed inspection for the SBS, it does not align with CAN/CSA 182.11, which calls for the air or water tests to be undertaken after installation.

Since the activity of backfill and compaction is likely to cause a significant majority of pipe defects, it is essential that this issue be revisited by Code officials to determine how to align the Code with the requirements of CAN/CSA 182.11.

It is recommended that Code Officials revisit the requirements in the Code so that the tested of the SBS be undertaking according to the pipe specifications CAN/CSA 182.11 (after burial).

3.3.2.7 CCTV Push Camera Inspection of SBS

CAN/CSA 182.11 calls for CCTV inspection of every PVC sewer following backfill operations (since backfilling is likely to cause shifting of joints). This approach (using push-camera inspection launched from the cleanout) is being undertaken by several municipalities in Ontario, who report excellent results[20] with respect to achieving leak-free infrastructure. Recent national guidelines recognize the importance of this inspection (see Box).

> *5.3.2 Sewer Lateral Inspections*
>
> *CCTV inspections should be conducted for the entire drainage system, extending from the vent stack to the connection with the public sewer main.*
>
> **CSA Z800-18: Guideline on Basement Flood Protection and Risk Reduction**

A push camera CCTV inspection is relatively inexpensive (estimated $400 per lateral bulk pricing) and can provide information on the condition of the lateral following burial. Issues such as joint integrity, sags, and horizontal and vertical deflections may be visible on this CCTV inspection (see Figure 1). Note that CCTV inspection is even more instructive if it undertaken after the lateral has been in use for a time, since staining of the pipe assists in interpreting joint integrity and deflections.

It is recommended that CBOs & building inspectors insist upon CCTV inspection of the SBS, in accordance with CAN/CSA B182.11.

3.3.2.8 Summary of Recommendations for PVC Pipe

It is recommended that building departments insist upon SDR28, PVC Gasketed Pipe for the SBS and Storm Building Sewer, and that they be installed with haunching and without the use of clear stone as bedding. It is recommended that the SBS be push camera inspected from the cleanout to the property line following backfill operations.

3.3.3 Backflow (Backwater) Valves

The OBC covers Protection from Backflow in Sentence 7.4.6.4. (see Box). Note that in engineering, the term “backflow” is only used in relation to water systems, and the term “backwater” is used for sewer system. So, a backwater valve (BWV) is what is used on the sanitary building drain.

The reference publication for backwater valves is CAN/CSA 182.1 (see Box). This standard, however, includes only the instruction, “Manufacturers shall provide adequate installation instructions with each backwater valve.” Since neither the OBC nor the CSA Standard give any additional information, it is necessary that the backwater valve be installed according to manufacturer’s instructions.

> **OBC 2012**
>
> **Section 7.4. Drainage Systems**
>
> **7.4.6.4. Protection from Backflow**
>
> **(2)** A *backwater valve* may be installed in a *building drain* provided that:
>
> (a) It is a “normally open” design confirming to,
>
> (iv) CAN/CSA-B182.1, “Plastic Drain and Sewer Pipe and Pipe Fittings”

The Mainline Fullport Backwater Valve appears to be the most common BWV used in sanitary sewers in Canada, although several others are on the market. The instructions on the unit itself include the statement, “**To the Installer: Place Level on bolts, allow 2% grade.”**

Since the OBC only requires a 1% slope on the SBD and the SBS, these units may not be suitable for use in new construction unless these two slopes are increased. Although this valve is CSA approved, the testing required by CSA is done with *water* so does not adequately reflect the site conditions to be encountered by a backwater valve in sanitary sewage conditions. It is not certain that BWVs will perform adequately on the SBD/SBS with a 1% slope upstream and downstream.

It is recommended that municipalities that wish to require mandatory backwater valve installation satisfy themselves that the appropriate conditions exist in the SBD and SBS or amend those conditions as appropriate.

It is recommended that Code Officials revisit the specifications in the Codes for backflow (backwater) valves.

3.3.4 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 consultations have reported much confusion around the requirements for private sewer systems (e.g. those collecting sewage from a condo or townhouse complex) which have sewers within them.

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…*"

OBC 2012:

Section 1.4. Terms and Abbreviations

1.4.1.2. Defined Terms

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…*

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.

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

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".

It is recommended that where a development includes private sewers, that the building department clarify the inspection standard and appropriate arrangements are made for inspection, testing and acceptance of these sewers to MOE/OPSS/OPSD standards.

It is recommended that Code Officials clarify the treatment of private sewers in the Codes.

4 Additional Mechanisms for Reducing Risk of I/I on the Private Side

This section describes the mechanisms that appear to be available to municipalities to reduce the risk of I/I on the private side within the existing framework of legislation and custom. The section begins with a discussion of the interpretation of the Code by building officials and then a representative from the Ministry of Municipal Affairs and Housing (MMAH). The MMAH is responsible for administering the Building Code Act, 1992 (BCA) and Building Code (Code) in Ontario. This discussion sets the framework for the recommendations that follow.

4.1 Ability of Municipalities to have Requirements that Exceed Building Code

Consultation with building officials across Ontario (via the *building officials stakeholder group*) has indicated that some municipalities are using mechanisms to reduce the risk of I/I in private side construction, specifically via the Subdivision Manual or the Subdivision Agreement. However, others reported that this is not permitted. Results are presented below to demonstrate that this is an issue that is not clear to either building officials, engineering/planning staff, or both. Recommendations follow.

4.1.1 Building Officials

Building officials were specifically asked if it was permissible for them to impose requirements more stringent than the Code. One group of building officials advised that the BCA has seniority, while a second group did not appear to interpret it this way. These are included to underline the complexity CBOs and building officials face when interpreting the OBC for their municipality. Under the Building Code Act, the local municipality is the authority having jurisdiction for enforcing the Act and its Regulations. Comments received (edited for length and clarity) are summarized below.

Comments from CBOs and building officials indicating that building officials *cannot* adopt requirements more stringent than the Code:

- It is illegal for municipalities to create/adopt technical requirements that exceed OBC requirements. If the OBC is silent on a technical requirement, then a municipality may prescribe a requirement.
- Under the BCA, Building Officials are afforded immunity from an action provided they act in good faith when discharging their duties under the Act or the regulations. Provided we function within

the framework of the Building Code we have that protection; however, when asked to enforce items which are not codified (including Applicable Law), there is no such protection unless the municipality decides to provide it through their own legal counsel or insurer.

- When we are asked to inspect above code for something which has been imposed by the Region or contained in an agreement with another department or outside agency, we suggest they satisfy themselves that it is in compliance.

- Other than these specific powers (e.g. special legislation through the province such as that used to enact green roof standards), a municipality cannot pass a bylaw imposing technical standards above those contained in the Building Code.

- Some municipalities will impose higher standards through subdivision and site development agreements or through other (dis)incentive programs. These are not enforceable by Building Officials.

- I can only enforce the minimum code standards as that is all that is required, even if more stringent standards are included in a site development agreement.

Comments from CBOs and building officials indicating that building officials *may be able to* adopt requirements more stringent than the Code. The last comment

- We do have a number of subdivisions that are bound to the agreements created. Rarely are we in building consulted on such things but, we enforce those measures as we would the code. Generally, they are things not necessarily covered by code but, imposed by development engineering.

- If the applicant wants to build above and beyond the regulations he can. Whatever is on the approved drawings is what must be built.

- Unfortunately there is sometimes a bit of a disconnect because those imposing these over-reaching requirements don't necessarily understand the limitations Building Officials operate under when enforcing the Building Code Act (BCA). In some cases the requirements have little technical merit and can actually void product warranties.

The second two comments above suggest that non-Code officials may be specifying more stringent requirements, but it is not clear who/how the requirements are to be reviewed in the field.

One of the most important issues messaged to Norton by CBOs during this consultation is that building officials may be at risk legally if they impose and inspect requirements above the Code. One CBO described it to Norton as follow:

> "Under the BCA, Building Officials are afforded immunity from an action provided they act in good faith when discharging their duties under the Act or the regulations. Provided we function within the framework of the Building Code we have that protection; however, when asked to enforce

items which are not codified (including Applicable Law), there is no such protection unless the municipality decides to provide it through their own legal counsel or insurer." ~ CBO in Ontario

Legal interpretation of the Code is well beyond the scope of this report. However, protection of CBOs and other building officials is essential so this concept must be kept in mind as solutions are sought to reduce I/I in the SBS.

4.1.2 Opinion of Representative from MMAH

A representative from MMAH[21] working with the Building Code was consulted regarding the ability of building officials to call for requirements above Code. Norton was provided with a quotation directly from the Building Code Act. It appears that the BCA supercedes all municipal by-laws (see Box).

Building Code Act, 1992

S.O. 1992, Chapter 23

Municipal By-Laws

35(1) This Act and the building code supersede all municipal by-laws respecting the construction or demolition of buildings.

Different Treatments

(2) In the event that this Act or the building code and a municipal by-law treat the same subject-matter in different ways in respect to standards for the use of a building described in section 10 or standards for the maintenance or operation of a sewage system, this Act or the building code prevails and the by-law is inoperative to the extent that it differs from this Act or the building code. 1992, c. 23, s. 35(2); 1997, c. 30, Sched. B, s. 18(1).

Interpretation

(3) For the purpose of this section, a municipal by-law includes a by-law of an upper-tier municipality and a local board as defined in the *Municipal Affairs Act*. 2002, c. 17, Sched. F, Table.

Note that bylaws are passed by municipal councils to approve development manuals, subdivision agreements and other policy instruments. It appears that the Building Code Act (BCA) has seniority over these agreements (note that the author is not an expert on the Building Code Act nor Municipal bylaws).

4.1.3 Conclusion

It appears that it would be wise for building departments to avoid risk by not imposing and inspecting requirements that exceed those in the Code itself. However, the same ends can effectively be achieved by the use of Alternative Solutions. The use of Acceptable Solutions and Alternative Solutions is discussed in the next sections.

4.2 Reducing Risk of I/I for Acceptable Solutions Currently Included in the Codes

The CBO has the authority to accept an Alternative Solution provided that it achieves the same level of performance called for via the Objectives and Functional Statements which lay the groundwork for the Code (See Box). The Functional Statements that appear to be primarily of interest here relate to health & safety and demand on infrastructure, as summarized in Table 3.

The Functional Statements of the OBC set the framework towards which "Acceptable

TABLE 3: FUNCTIONAL STATEMENTS FROM OBC

Item	Number	Function
11.	F112	To provide adequate treatment of sanitary sewage and effluent.
	F113	To minimize the risk of injury as a result of contact with sanitary sewage or partially treated effluent.
13.	F132	To limit excessive demand on the infrastructure.
	F133	To limit excessive peak demand on the infrastructure.

Solutions" are applied. Leaking SBSs and/or urban flooding decreases a municipality's ability to achieve any of the goals shown in Table 3. An alternative means of achieving these goals is proposed in this section.

The CBO is free to accept an Alternative Solution to ensure Compliance with Division B (Acceptable Solutions), as stated in OBC Section 1.2., Compliance (see Box).

So, a municipality can message to potential developers that in order to achieve leak free sanitary building sewers, the CBO will accept *Alternative Solutions*. It is recommended that these solutions be applied in lieu of the stringent requirements in the OBC (e.g. CAN/CSA B182.11) that are not commonly being met. Since these requirements already exist clearly in the Code, this should be simple for building departments to do. Two *Alternative Solutions* recommended immediately are as described as follows.

In lieu of performing the **required leak testing per OBC Sentence 7.3.6.2.(1)**, building departments can accept the *Alternative Solution* of installation of the pipe with haunching, constructed without clear stone, and CCTV tested after backfilling (for the reasons described in Section 3). Since leak testing takes time to set up, and the test must hold, leak free, for 15 minutes per SBS, it is presumed that the higher cost of materials associated with the *Alternative Solution* will be offset by this time saved.

OBC 2012

Section 1.2. Compliance

1.2.1. Compliance with Division B

1.2.1.1. Compliance with Division B

(1) Compliance with Division B shall be achieved,

(a) by complying with the applicable *acceptable solutions* in Division B, or

(b) by using *alternative solutions* that will achieve the level of performance required by the applicable *acceptable solutions* in respect of the *objectives* and *functional statements* attributed to the applicable *acceptable solutions* in MMAH Supplementary Standard SA-1, "Objectives and Functional Statements Attributed to the Acceptable Solutions".

(2) For the purposes of Clause (1)(b), the level of performance in respect of a *functional statement* refers to the performance of the *functional statement* as it relates to the *objective* with which it is associated in MMAH Supplementary Standard SA-1, "Objectives and Functional Statements Attributed to the Acceptable Solutions".

In lieu of respecting required hold times for solvent cemented joints per **OBC Article 7.2.5.10 (Materials)**, it is recommended that building departments accept the *Alternative Solution* of the use of gasketed, SDR 28 pipe for the SBS. Since solvent cement initial set times are listed as up to four hours, depending on site conditions, it is presumed that the higher cost of materials associated with the *Alternative Solution* will be offset by this time saved.

This concept can be used for any risk factors that building departments wish to address to reduce the risk of I/I. The two suggested *Alternative Solutions* appear to be those that will have the most substantial impact on new construction at least disruption to current construction methodologies.

It is recommended that CBOs & building inspectors offer the Alternative Solution of installing the SBS with haunching, without the use of clear stone, CCTV inspected after backfilling, in lieu of leak testing.

It is recommended that CBOs & building inspectors offer the Alternative Solution of installing gasketed, SDR 28 pipe in lieu of correct application of solvent cement.

4.3 Reducing Risk of I/I for Acceptable Solutions Not Currently Included in the Codes

Consultation with building officials has indicated that where an item is not addressed in the Codes, municipalities are free to impose their own requirements. It appears that this can be achieved through a development agreement, engineering standard, or bylaw. This is one mechanism by which municipalities may be able to insist on leak-acceptable infrastructure.

As an example, the connection of the SBS to the SBD is not explicitly specified in the Code (although it is implied). Therefore, building departments could insist that this connection be made by a fitting (which is more robust) and not a glued joint.

This concept could be very useful to building departments.

It is recommended that CBOs & building inspectors directly impose requirements not called for in the Code that reduce the risk of I/I in the SBS for items, such as requiring a fitting to connect the SBS to the SBD.

4.4 Use of Subdivision Manuals and Subdivision Agreements

It is recommended, in light of the preceding sections, that CBOs and building inspectors rely on the concepts of *Alternative Solutions* and prescribing requirements not currently included in the Codes, to achieve leak-acceptable SBSs. These *Alternative Solutions* can be included in Subdivision Manuals and Subdivision Agreements, so they are clear to potential developers before they begin a new development. This approach should reduce the potential risk to CBOs discussed in Section 4.1.1.

It is recommended that CBOs and Building Departments work with engineering departments to implement the concept of Alternative Solutions and imposing requirements not in the Codes, within Subdivision Manuals and Subdivision Agreements.

4.5 Proactive Use of Sewer Use Bylaws on New Subdivision Sites

Across Ontario and Canada, most sewer use bylaws make it illegal to discharge stormwater or ground water to the sanitary sewer. It has been widely reported by engineering and building staff, however, that homebuilders frequently drain their excavations to the sanitary sewer.[22] This discharge represents an inflow to the sanitary sewer and should not be permitted. Alternatively, municipalities can monitor these flows and charge the developer the regular sewer rate for the discharge, as is being implemented in a few places in Ontario.

> *Sewer use bylaw enforcement and private lateral quality inspection play important roles in the long-term reductions in inflow and infiltration, particularly as neighbourhoods are redeveloped.*
>
> ***Inflow and Infiltration Allowance Assessment: A Liquid Waste Management Plan for the Greater Vancouver Sewerage & Drainage District and Member Municipalities, 2014***

Norton's consultations, however, indicate that sewer use bylaws are being interpreted in various ways across Ontario (by both engineering and building staff). It has been reported variously during consultations that bylaws apply to the user, not the constructor and that bylaws are enforceable on developer sites (prior to assumption). This information suggests that the application of sewer use bylaws may not be well understood. 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.[23] As Metro Vancouver has noted, however, (see Box) sewer use bylaw enforcement plays an important role in long term I/I reduction.

It is not common for bylaw inspectors to inspect new construction sites (although consultation has indicated that this happens in a few locations in Ontario). However, it appears that municipalities have the ability to enforce sewer use bylaws on private property at their discretion, since unassumed developments are by definition “private” property. Municipalities should investigate the opportunity to have bylaw officers become more active around new construction.

It is recommended that municipalities investigate the opportunity to have bylaw officers become more active around new construction.

5 Conclusions

The recommendations in this report are the result of five years of research into the causes and conditions that result in I/I on the private side. A review of the Ontario Building Code, and the standards that it references, has revealed some important information. The research has included direct consultation with hundreds of building officials and others across Ontario and Canada.

Municipalities across Canada and the US have identified the importance of addressing I/I on the private side. Many municipalities working to reduce I/I have recognized that it is essential that I/I on the private side be addressed. Strategies for reducing I/I on the private side in existing sewers are currently being developed (Norton Engineering, ICLR, and Engineers Canada, for Standards Council of Canada). However, since I/I on the private side is being observed in new construction, it is essential that municipalities take steps to minimize this I/I.

This report has provided concrete, actionable recommendations for building officials, CBOs, code officials and municipalities, to begin the important work of reducing I/I on the private side. Most of these recommendations can be undertaken immediately under the existing legislative regime. Proposed issues to be considered for Code Changes (which will take longer) have also been included in the report.

More work needs to be done in the area of practical recommendations to reduce I/I on the private side. It is hoped that this report provides a good starting point for the discussion. The next step in this work is to have a nationally vetted document on this topic developed under the appropriate agency.

Appendix A: Comparison of National Building Code of Canada and OBC with Respect to I/I Related Items

This section contains a summary of the differences between the OBC and the NPCC specifically around issues that are related to I/I and discussed in this report. It is included to allow users outside Ontario to make use of this report.

Table A1: Comparison of OBC to NPCC: Acceptable Solutions

Ontario Building Code (2012)	National Plumbing Code of Canada (2015)
OBC 7.4.5.3. ***Connection of Subsoil Drainage Pipe to a Sanitary Drainage System*** (2) Where a *storm drainage system* is not available or soil conditions prevent drainage to a culvert or dry well, a foundation drain or *subsoil drainage pipe* may connect to *sanitary drainage system.* ***OBC 9.14.5.1.*** ***Drainage Disposal*** *(1) Foundation drains shall drain to a sewer, drainage ditch or dry well.*	***NPC 2.4.5.3*** ***Connection of Subsoil Drainage Pipe to a Sanitary Drainage System*** (1) Where a *subsoil drainage pipe* is connected to a *sanitary drainage system*, the connection shall be made on the upstream side of a *trap* with a *cleanout* or a trapped sump **NPC Sentence A-2.4.5.3.(1)** This Code does not regulate the installation of subsoil drainage pipes, but does regulate the connection of such pipes to the plumbing system.
Part 5 Environmental Separation ***OBC 5.6.2.2.*** **Accumulation and Disposal** (3) Where downspouts are provided and are not connected to a sewer, provisions shall be made to, (a) divert the water from the *building*, and (b) prevent *soil* erosion. **OBC Part 9 Housing and Small Buildings** **9.26.18.2. Downspouts** (1) Where downspouts are provided and are not connected to a sewer, extensions shall be provided to carry rainwater away from the *building* in a manner that will prevent *soil* erosion	
OBC 7.2.5.10. Plastic Pipe, Fittings and Solvent Cement used in Buildings (1) Plastic pipe, fittings and solvent cement used underground outside a *building* or under a *building* in a *drainage system* shall be certified to, (a) ASTM F628 "ABS Schedule 40 Plastic Drain, Waste and Vent Pipe With a Cellular Core", (b) CAN/CSA-B181.1, "(ABS) Drain Waste and Vent Pipe and Pipe Fittings (c) CAN/CSA-B181.2 "(PVC) and (CPVC) Drain, Waste, and Vent Pipe and Pipe Fittings."	***NPC 2.2.5.9. Plastic Pipe, Fittings and Solvent Cement used in Buildings*** (1) Plastic pipe, fittings, and solvent cement used inside or under a *building* in a *drainage* or *venting system* shall conform to (b) CAN/CSA-B181.2 "(PVC) and (CPVC) Drain, Waste, and Vent Pipe and Pipe Fittings." **Fewer pipe types are permitted in the NPC**

(d) CAN/CSA-B182.1, "Plastic Drain and Sewer Pipe and Pipe Fittings (e) CA/CSA-B182.2 PSM Type PVC Sewer Pipes and Fittings (f) CAN/CSA-B182.4, "Profile PVC Sewer Pipe and Fittings", (g) CAN/CSA-B182.6, Profile PE Sewer Pipe and Fittings fr Leak Proof Sewer Applications", (h) CAN/CSA-B137.2, "PVC (i)	
OBC 7.2.5.11. Transition Solvent Cement (1) Plastic pipe, fittings, and solvent cement used inside or under a *building* in a *drainage* or *venting system* shall conform to Solvent cement for transition joints shall conform to, (b) CCN/CSA-B181.2 "PVC and CPVC Drain, Waste and Vent Pipe and Pipe Fittings".	***OBC 7.2.5.11. Transition Solvent Cement*** (1) Plastic pipe, fittings, and solvent cement used inside or under a *building* in a *drainage* or *venting system* shall conform to Solvent cement for transition joints shall conform to, (b) CCN/CSA-B181.2 "PVC and CPVC Drain, Waste and Vent Pipe and Pipe Fittings".
OBC 2012 ***7.3.4.6. Support for Underground Horizontal Piping*** (1) Except as provided in Sentence (2), *nominally horizontal* piping that is underground shall be supported on a base that is firm and continuous under the whole of the pipe. Volume 2 Compendium to OBC (Appendices are not legally part of OBC): **OBC Sentence A-7.3.4.6.(1))** Plastic piping installed underground must be support (sic) on a base that in (sic) continuous under all piping and fittings with a recommendation of at least 100mm of loose fill surrounding the piping. Plastic piping buried up to depths greater than 2.5m…. must have backfill that is free of large stones or frozen each, tamped by machine or poured as a wet slurry containing one part 6mm pea gravel and one part 12mm crushed stone. (NPC: Support for Underground Piping. Permitted installations are shown in Figure A-2.3.4.6.(10(a). In both OBC and NPC, figures show pipe laid on sand, crushed rock or firm earth, with a bell hole for the joint (see figure in Appendix A).	**NPC *2.3.4.6 Support for Underground Horizontal Piping*** (1) Except as provided in Sentence (2), *nominally horizontal* piping that is underground shall be supported on a base that is firm and continuous under the whole of the pipe. **NPC Sentence A-2.3.4.6 (1)** Permitted installations are shown in Figure A-2.3.4.6.(1)(a). The methods of support shown in Figure A-2.3.4.6.(1)(b) are not permitted because the base does not provide firm and continuous support for the pipe. [Shown in Figure A-2.3.4.6.(1)(a): pipes are laid on: sand, crushed rock, or firm earth, itself on top of rock; a layer of concrete; firm earth, with a bell hole noted; and a concrete encasement.] [Shown in Figure A-2.3.4.6.(1)(b): pipes are laid on: unstable fill between piers; planking; and earth with a boulder in it.]
OBC 2012 **7.3.6.1. Tests and Inspection of Drainage or Venting Systems** (1) After a section of drainage system has been roughed in, and before any fixture is installed **or piping is covered**, a water or an air test shall be conducted. (NPC: same) (2) Where a CBO **requires** a final test, it shall be carried out after every fixture is installed and before any part of the drainage system is placed in operation. (the final test is smoke). **7.3.6.2. Tests of Pipes in Drainage Systems**	**NPC** **2.3.6.1. Tests and Inspection of Drainage or Venting Systems** (1) Except in the case of an external *leader*, after a section of a *drainage system* or a *venting system* has been roughed in, and before any *fixture* is installed or piping is covered, a water pressure test or an air pressure test shall be conducted. (2) After every *fixture* is installed and before any part of the *drainage system* or *venting system* is placed in operation, a final test shall be carried out when requested. **2.3.6.2. Tests of Pipes in Drainage Systems**

(1) Every pipe in a drainage system shall be capable of withstanding without leakage a water test, air test and final test. **7.3.6.4. Water Tests in Drain, Waste and Vent Systems** (1) Where a water test is made, all joints shall be tested with a water column of not less than 3 m. (b) The system or the section shall be kept filled with water for 15 min. **7.3.6.5. Air Tests** (1) Where an air test is made, it shall be conducted in accordance with the manufacturer's instructions for the piping materials, and, (a) Air shall be forced into the system until a gauge pressure of 35 kPa is created, and (b) **This pressure shall be maintained for at least 15 min** without a drop in pressure.	(1) Pipes in a drainage system, except an external *leader* or *fixture outlet pipe*, shall be capable of withstanding without leakage a water pressure test, air pressure test and final test. (2) Pipes in a *drainage system* shall be capable of meeting a ball test. **2.3.6.4 Water Pressure Tests** (1) A water pressure test shall consist in applying a water column of at least 3m to all joints (2) (b) the system or the section shall be kept filled with water for 15 min. **2.3.6.5 Air Pressure Tests** (1) Air pressure tests shall be conducted in accordance with the manufacturer's instructions for each piping material, and (a) air shall be forced into the system until a pressure of 35 kPa is created, and (b) this pressure shall be maintained for at least 15 min without a drop in pressure.
OBC 2012 **1.3.5.1. Prescribed Notices** (2) The person to whom a permit under section 8 of the Act is issued shall notify the chief building official of…, (i) readiness for inspection and testing of, (i) building sewers and building drains…, (iv) drainage systems	

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