APPENDIX D

White Paper: Inflow & Infiltration Benchmarking Metrics

AECOM

NATIONAL WATER & WASTEWATER BENCHMARKING INITIATIVE

CRD CAPITAL REGIONAL DISTRICT

Inflow & Infiltration Benchmarking Metrics

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Introduction & Background

Overview

As the facilitator of the National Water & Wastewater Benchmarking Initiative (NWWBI), AECOM was commissioned by the Capital Regional District (CRD) of Victoria, British Columbia to conduct a study reporting on current inflow & infiltration (I&I) methodologies and metrics used by different municipalities and utility owners.

The purpose of this paper is to collate and document current methods that are used by municipalities, while exploring some of the challenges and barriers that have prevented common metrics from being formed in the past. In order to achieve this, an industry scan has been conducted through the following means:

- Surveying of NWWBI participants;
- Interviewing technical experts in the field of I&I in Canada, USA, Europe, and New Zealand; and,
- Assessing a selection of I&I reports/studies made available by different municipalities/utility owners/research bodies.

This paper will refine, review, and compare the results derived from the industry scan with the intention of providing a pathway to further developing I&I key performance indicators (KPIs) that can be used to provide benchmarking metrics to Canadian municipalities trying to determine if their utilities have an I&I problem.

The National Water and Wastewater Benchmarking Initiative (NWWBI)

The NWWBI is a response to a need for Canadian municipal water and wastewater utilities to measure, track and report on their utility performance. The NWWBI is a high level metric benchmarking process; however it has developed into a network and information base for Canada's most progressive municipal utilities. The ultimate goal of the NWWBI is to improve quality and performance. The Canadian National Water and Wastewater Benchmarking Initiative has started in 1998 and has since grown to 50 member municipalities participating in stormwater, water and wastewater benchmarking.

The I&I topic was introduced into the NWWBI partnership at the 2005 NWWBI annual workshop, where participants helped establish the I&I Task Force. Since its inception, there has been information shared between members on developing, implementing, and managing I&I reduction programs via conference calls, surveys, and dedicated I&I Task Force workshops and sessions at the annual NWWBI workshop.

This paper serves as a common foundation to extend process benchmarking of I&I management strategies across Canada through the NWWBI.

Key Terms and Abbreviations

Inflow and infiltration are terms for the ways that water and storm water make their way into sanitary sewer pipes and eventually get treated, unnecessarily, at wastewater treatment plants. I&I is significant problem because it takes up fixed capacity in sewerage interceptors and within wastewater treatment plants during wet weather event and allows for misrepresentation of actual peak demands. Infiltration occurs when groundwater seeps into sewer pipes through cracks, leaky joints or deteriorated maintenance holes. Inflow occurs in direct proportion to rainfall. Typical inflow sources are water from rain leaders, basement sump pumps (which are designed to capture water that enters basements) or foundation drains illegally connected directly to a sanitary sewer pipe.

Key Terms and Abbreviations

Table 1: Glossary

Average Day Demand (ADD)	The daily mean of an annual user based potable water measurement.
Average Dry Weather Flow (ADWF)	The average sanitary flow value measured during a period of dry weather and consisting of complete daily cycles. The sanitary flow is composed of base sanitary flow plus groundwater infiltration. (ADWF = BSF + GWI)
Base Sanitary Flow (BSF)	All wastewater flow from residential, commercial, industrial and institutional sources. In instances where properties have water meters this can be calculated as a fraction of the water usage. (BSF = ADD x RTS). Sanitary flow is a diurnal pattern; however Base Sanitary Flow commonly refers to the daily average. (BSF = ADWF – GWI)
Combined Sewer	A sewer that is intended to convey both sanitary sewage and stormwater runoff.
Diurnal Pattern	Pattern describing the variance in sewage flows over a day
Ground Water Infiltration (GWI)	Groundwater infiltration that enters the sanitary sewer system during dry weather periods; through breaks, cracks, misaligned joints, tree root punctures and manhole joints and covers
Inflow	Stormwater that enters the sewer through direct connections (e.g. Catch Basin leads or roof drains connected to the sanitary sewer)
Infiltration	Water that enters the sewer through defects in the sewers such as cracks, or misaligned pipe abutments.
Peak Dry Weather Flow (PDWF)	The maximum instantaneous sanitary flow value during dry weather conditions (peak of the diurnally varying BSF plus normal GWI). (PDWF = ADWF x PF)
Peak Wet Weather Flow (PWWF)	The maximum instantaneous sanitary flow value. It represents all flow contributions carried by the sanitary sewer system (sum of PDWF plus the rainfall dependent inflow and infiltration.
Peaking Factor (PF)	The multiple of the average dry weather flow used to achieve peak dry weather flow. (PDWF/ADWF = PF)
Private-Side Sewer Laterals	The sewer laterals/plumbing that services private property and connects the property to the public sanitary sewer system.
Rainfall-derived inflow and infiltration (RDII)	Inflow and infiltration that enters the sewer and can be attributed to a recent storm-event. (RDII = PWWF – PDWF)
RTK Method	Method of predicting RDII by fitting up to three unit hydrographs to an observed RDII hydrograph. The (R_i-% of rainfall volume entering the sewer as RDII, T_i-time to peak, K_i-ratio of time of recession to T_i).
Return to Sewer (RTS)	The ratio of water & wastewater that enters the sewers through plumbing systems. (RTS = ADWF/ADD)
Sanitary Sewer Overflow (SSO)	An overflow that occurs during dry weather, usually due to operations and maintenance issues resulting in a restricted sewer or unexpected peak flow.
Sewer Separation	A strategy to replace a combined sewer with separate sanitary and storm sewer systems, in an attempt to reduce CSO's.
Wet Weather Overflow (WWO)	An overflow that occurs during wet weather.

Methodology

In order to assess the I&I metrics and methodologies employed by Canadian municipalities AECOM proposed to approach the I&I Task Force from the NWWBI with a survey. The survey consisted of 30 questions that were focused on assessing how I&I is measured and reported across Canada. The survey was built and disseminated using the SurveyMonkey website. The list of survey questions and detailed results are attached in Appendix A.

To gain knowledge and understanding of what I&I metrics and methodologies are employed in other parts of the world, AECOM reached out to its contacts and conducted interviews with I&I experts in the USA, Europe, and New Zealand. AECOM also extended the invitation to fill out the 30 question I&I metrics survey to the international partners. These experts provided literature and case studies that showcase metrics and practices that measure, report and benchmark I&I.

I&I Survey Results

Fifteen (15) Canadian municipalities responded to the survey and provided their input on the topic. The survey consists of 30 questions that provide an insight into what metrics are used to report and assess I&I within a municipality and the processes used to formulate them. The survey results can be summarized with five themes:

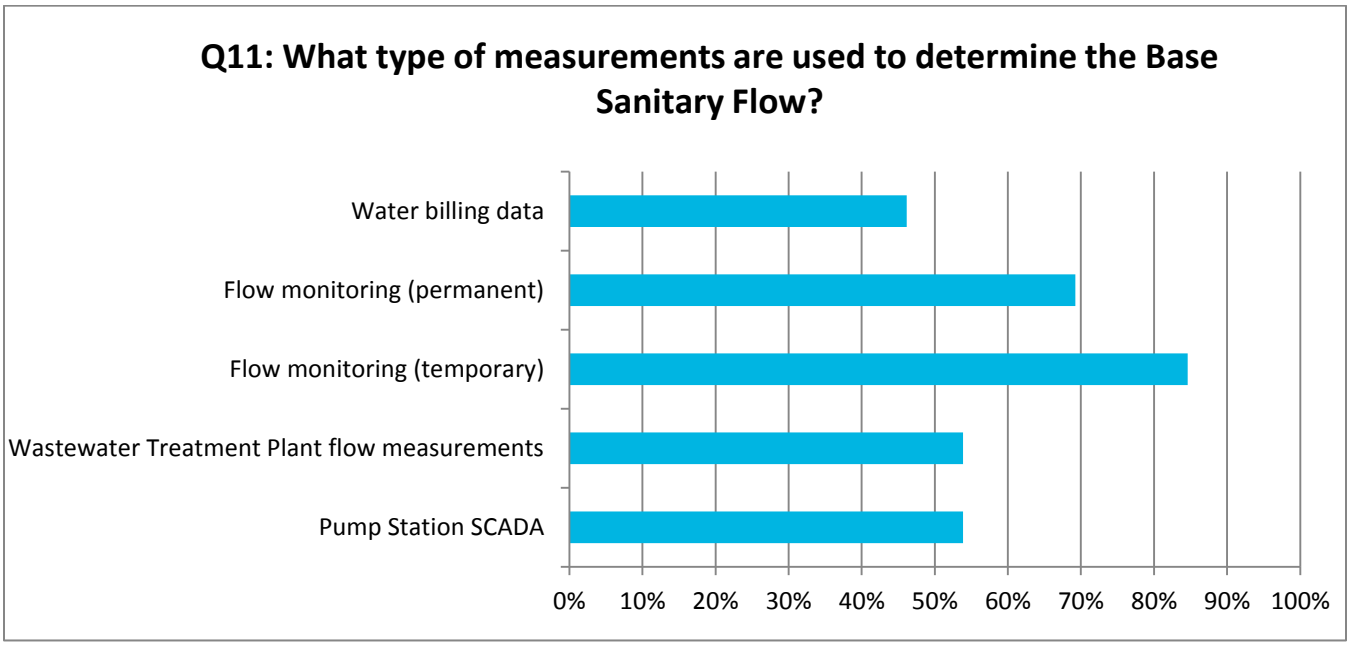
1. ***I&I is an issue for many municipalities***

From the responses of survey participants it is evident that there is genuine interest from the municipalities to develop common I&I measurement metrics for comparison with other municipalities, with 14 out of 15 respondents expressing interest in determining benchmarks that would allow for “apples to apples” comparison between municipalities across Canada. 6 out of 15 respondents indicated that they already benchmark their I&I rates and have a goal-based target. 11 out of 15 survey respondents indicated that they have an I&I reduction strategy/program. Of the 6 respondents that benchmark I&I, 4 respondents indicated that the I&I reduction target is 0.28 L/s/ha.

2. ***Design Criteria incorporate account for I&I in metrics***

13 out of 15 respondents indicated that their design criteria prescribed I&I and associated metrics. For ADWF, the responses vary between 286 L/cap/day to 365L/cap/day but all of the responses suggest that responding municipalities are able to use the same ADWF metric of L/capita/day or L/Equivalent Population/day. To determine PDWF, 8 out of 9 respondents use Harmon Peaking Factor and 10 out of 12 respondents apply I&I to the PDWF per hectare in order to achieve PWWF.

Figure 1: Summary of the survey responses to Question 11



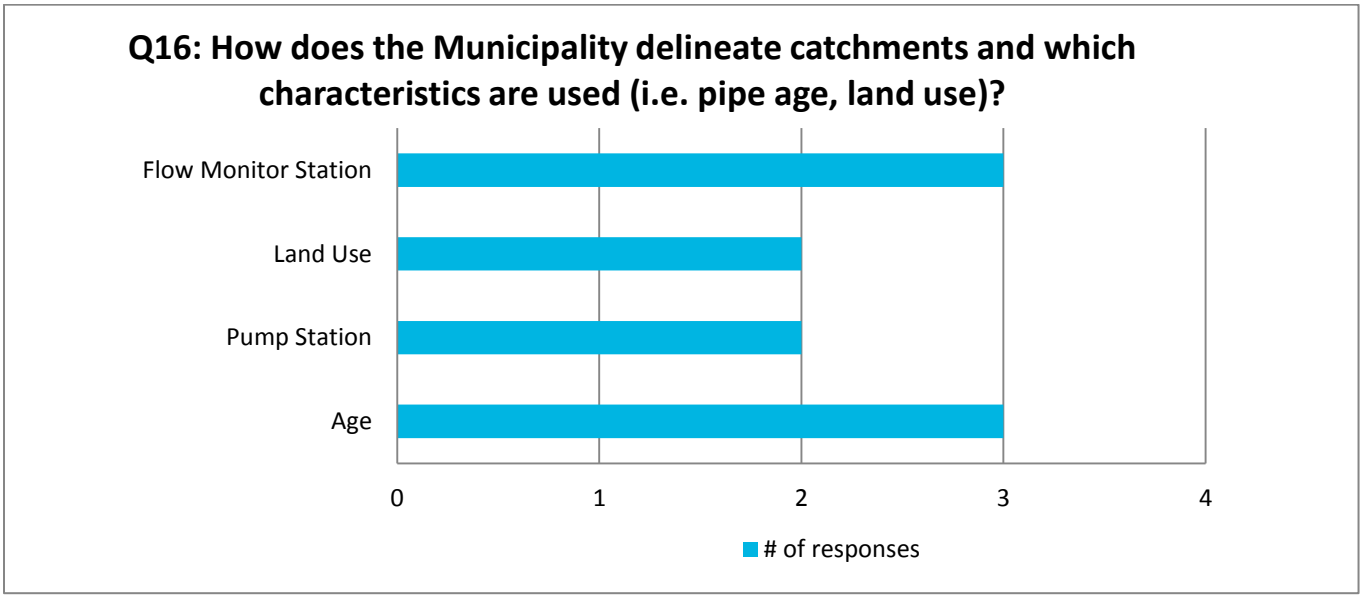
3. Flow monitoring is used extensively to determine BSF, GWI and ADWF

From the Base Sanitary Flow question above, it is evident that majority of the municipalities use flow monitoring to assess base sanitary flows. From the survey responses it should be noted that flow monitoring is also used extensively to determine groundwater infiltration (GWI), which was most commonly done by assuming GWI is equivalent to 85% of minimum nightly dry weather flow.

For Municipalities where water billing data is available to determine BSF, the return to sewer factor varies between seasons. Most of those municipalities that do use billing data specified that they assume 85% - 100% of water consumption is returned to sewer in the winter.

All of the responding municipalities indicated that they use flow monitoring to measure I&I. The flow monitoring catchments vary by size and there is no common trend in the responses to the survey. The respondents reported flow monitoring catchment sizes range from 8 hectares to 460 hectares and beyond. Three municipalities mentioned that they use other metrics to report and delineate catchment size; two municipalities mentioned that they use 3,000 linear meters of pipe to delineate a catchment and one municipality reported that their catchment size ranges from 400 to 1,000 residential units.

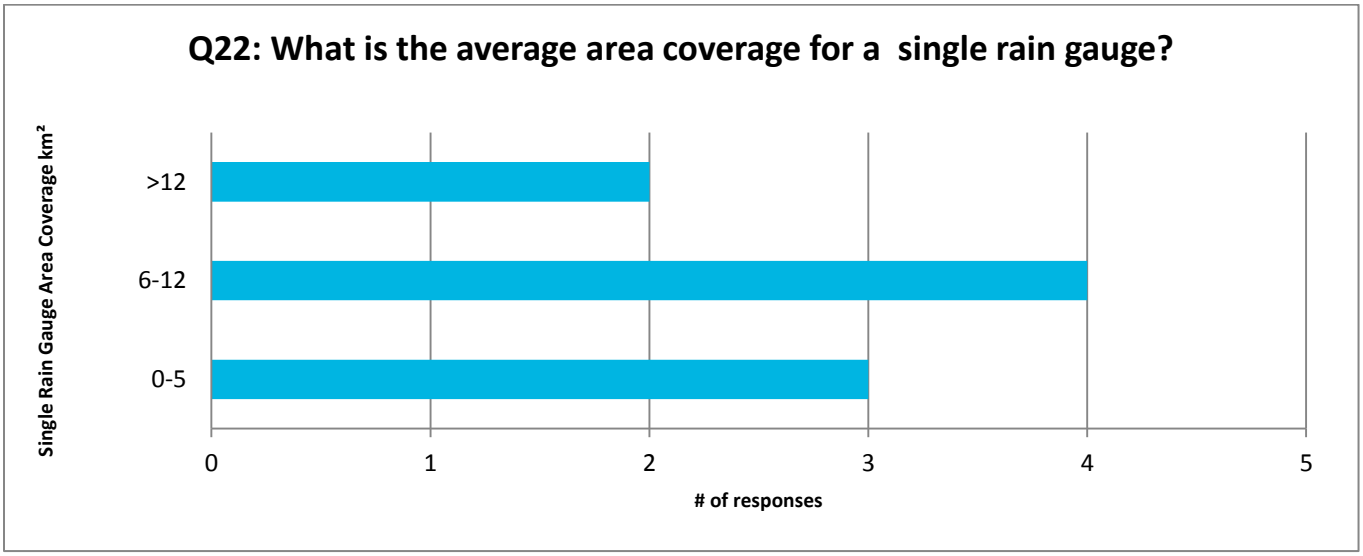
Figure 2: Summary of the survey responses to Question 16



4. Rain gauge coverage varies between municipalities

All municipalities that have responded to the survey have access to or own a network of gauges. However, the number of rain gauges and the area coverage per rain gauge installation varies across municipalities.

Figure 3: Summary of the survey responses to Question 22



5. I&I analysis metrics and KPIs

In the survey, we asked municipalities if they used flow vs. rainfall relationship analysis (such as the envelope method), RTK unit hydrograph method, peaking factors for wastewater treatment plants or pump station SCADA or other methodology/metric for measurement of I&I. 50% of the respondents indicated that they use some kind of flow vs. rainfall relationship method. One respondent indicated that they use RTK unit hydrograph method but it

depends on the sewer catchment. Two respondents indicated that they use peaking factors for wastewater treatment plants but not for pump stations. The two peaking factors indicated were 2.5 to 3 and 4. Other methods/metrics used by municipalities were hydraulic modelling, seasonal and temperature variability, CCTV inspections.

Examples of I&I Metrics and KPIs used in Canada

The survey results indicated that York Region appears to be more advanced in tracking their I&I and have developed a set of KPIs that not only quantify I&I but also allow prioritisation of catchments for I&I reduction strategies. Through follow up communication with Mike Faye, who is the I&I analysis lead for Region of York, it was noted that effective I&I KPIs include parameters such as rainfall (mm), pipe length (km or m), pipe diameter (mm), and area (ha).

Table 2: Example KPIs

KPI	Formula/Units	Description
Peak Hourly Factors	PF_1= PDWF/ADWF	Ratio of peak hourly flow to average daily flow or the amount that the average daily flow would have to be multiplied in order to equal the peak flow encountered after a storm event
Rain Derived Inflow and Infiltration (RDII)	$RDII_1$= L/day/mm*km	Liters per day of RDII that flows through the pipe (L/day) standardized by pipe diameter (mm) and pipe length (km)
	$RDII_2$= L/m*mm	Liters of RDII volume (L) in the pipe normalized by meters of pipe length (m) and millimeters of rain (mm)
	$RDII_3$= L/s/ha or L/s/km	Liters per second of RDII (L/s) normalized by area (ha) or length of pipe (km)
Percentage of Rain Entering the System	C_v= RDII Volume/Rainfall Volume on Basin's Total Area	The rainfall capture by measure of volume of rain as RDII divided by the total rain volume given the study basin's area

Peak Hourly Factors

The Peak Hourly Factor is ratio of peak hourly flow to average daily flow or the amount that the average daily flow would have to be multiplied in order to equal the peak flow encountered after a storm event. An important aspect of the ratio is its variability in relation to the catchment size. Therefore for a fairer comparison between large and small basins, the threshold peaking factors have to vary depending on the size of the catchment. The leading literature on the topic, the Metropolitan Council Environmental Services (St. Paul Minnesota Metropolitan Council Environmental Services, 2016), has published the Acceptable peaking factor chart (Figure 4). Similar breakdown of acceptable peaking factors may need to be developed for Canadian municipalities if the metric is considered as a key performance indicator.

Figure 4: Acceptable Peaking Factors (St. Paul Minnesota Metropolitan Council Environmental Services, 2016)

Table B-1 MCES Standard Peaking Factors

Average Flow (mgd)	Peaking Factor		Average Flow (mgd)	Peaking Factor
0.00 - 0.11	4.0		1.90 - 2.29	2.8
0.12 - 0.18	3.9		2.30 -2.89	2.7
0.19 - 0.23	3.8		2.90 - 3.49	2.6
0.24 - 0.29	3.7		3.50 - 4.19	2.5
0.30 - 0.39	3.6		4.20 - 5.09	2.4
0.40 - 0.49	3.5		5.10 - 6.39	2.3
0.50 - 0.64	3.4		6.40 - 7.99	2.2
0.65 - 0.79	3.3		8.00 - 10.39	2.1
0.80 - 0.99	3.2		10.4 - 13.49	2.0
1.00 - 1.19	3.1		13.5 - 17.99	1.9
1.20 - 1.49	3.0		18.0 - 29.99	1.8
1.50 - 1.89	2.9		over 30.00	1.7

Rainfall Derived Inflow and Infiltration

This metric represents the amount of liters per day of rain derived inflow and infiltration (RDII) that flows through the pipe (L/day or LPD) standardized by pipe diameter (mm) and pipe length (km) (i.e. LPD/mm*km). However, according to Mike Faye at the York Region, this metric does not compare the wet weather response to the total rainfall for the study area, which is an important factor when attempting to compare metrics in different geographical regions. Therefore, a new variation of this metric that incorporates the rainfall data into the formula would be more acceptable for a true “apples to apples” comparison.

Other Rainfall Derived Inflow and Infiltration Metrics

RDII as L/m*mm

This metric presents liters of RDII volume (L) in the pipe normalized by meters of pipe length (m) and millimeters of rain (mm). Using this metric is complementary to the flow vs. rainfall relationship metric and mitigates some of its limitations. Hence, the two metrics should be used together to maximise the use of all available information.

RDII per Area (L/s/ha) and RDII per Length (L/s/km)

This metric is widely reported in the results of the I&I survey, especially in quantification of I&I targets established by municipalities or regions. The design allowance values range from a target of 0.13L/s/ha (11,200L/ha/day) to a management goal of 0.33 L/s/ha (28,500L/ha/day).

Percentage of Rain Entering the System

This metric represents the rainfall capture by measuring volume of rain as RDII divided by the total rain volume given the study basin’s area. Based on the survey response, approximately 50% of the respondents indicated that they use some form of flow vs. rainfall relationship and the associated regression analysis. The percentage of rain entering the system is simple enough to convey I&I issues to non-technical stakeholders. However, one of the limitations of this metric is that it does not incorporate pipe network density in the calculation.

International I&I Metrics and Benchmarks

I&I in the USA

Through the preparation of this paper, AECOM consulted I&I industry experts across the USA in order to determine if similar efforts to formulate key performance indicators had been undertaken and what progress had been made into formulating a consistent methodology. These consultations found that within the topic of I&I there is a large literature base, with varying nomenclature and measuring units.

The United States Environment Protection Agency (USEPA) provides a quick seven (7) page guide titled *Guide for Estimating Infiltration and Inflow* (USEPA, 2014). This is a general guide for I&I measurements at wastewater treatment plants, however it can also be used at pump stations or any other flow monitoring site. Although the USEPA 2014 paper is a good general guide, it does not and is not intended to address many of the nuances that are encountered when trying to implement an I&I monitoring and reduction program.

Of the recommended literature reviewed, the paper written by Patrick Stevens and Peter Keefe of ADS Environmental Services (Stevens & Keefe, 2011) stood out as it specifically targets the issues faced when implementing an I&I program. Stevens' & Keefe's (2011) intention was not to provide metrics or benchmarks, but to demonstrate through lessons learned, a framework for potential programs that will be most likely to succeed and provide meaningful data despite the barriers to implementation.

Stevens and Keefe (2011) structured the paper to address the 12 hydrologic reasons for poor rehab results which are outlined below:

1. Rain Gauge Strategy – includes the density of the rain gauge network and where the rain gauges are placed.
2. Duration - not enough data (dry days and storms of differing magnitudes) to generate proper and statistically valid rain to flow relationships.
3. Key Performance Indicators – Scattergraphs and Q vs. I diagrams
4. Flow Meter Depth Technology
5. Size of Meter Basins
6. Seasons for Measurement
7. Rainfall Data Frequency
8. Pain of Subtraction
9. Faulty Method of Calculating RDII
10. Dynamics of Sewers (restricted)
11. Lack of Control Basin
12. Site Hydraulics at Metering Sewer

Stevens & Keefe (2011) also show that there are important differences when analysing data between small and large flow monitoring catchments. Large catchments can have attenuation which can make I&I rates look lower than the rates would look in a smaller catchment, due to increased opportunities for bottlenecks that can cause surcharging and increasing storage.

Our extensive review of American literature reached conclusions that are supported by some of our Canadian colleagues which is "the best RDII metrics account for three attributes: 1) RDII, 2) basin size and 3) rain; where the metrics can be extended to other rains or to different basin sizes using related parameters" (WERF, 1999).

I&I Control in New Zealand

The New Zealand Water & Wastewater Association (NZWWA) *Infiltration and Inflow Control Manual* (NZWWA, 2015) outlines information on the management of I&I, the corresponding issues and barriers, and good management practices to reduce I&I. As part of the good management practice methodologies, the NZWWA has defined five KPIs:

Table 3: Summary of NZWWA I&I KPIs [adopted from NZWWA (2015)]

KPI	Formula/Units	Description
Ground Water Infiltration (GWI) or Base Flow	$GWI_1 = GWI_{(80\% \text{ of minimum flow})} / ADWF$	GWI is approximately 80% of the minimum nightly flows; specifically in residential neighbourhoods where there is little attenuation or nocturnal discharge from ICI users.
	$GWI_2 = ADWF_{(measured)} / Population_{Theoretical}$ (L/person/day)	Population based flow indicator
	$GWI_3 = ADWF_{(measured)} / Water\ Consumption_{measured}$	Water consumption based flow factor. Requires billing data.
Rainfall Dependent Inflow and Infiltration (RDII)	$RDII_1 = Volume\ of\ RDII_{(measured)} / Rainfall\ Volume_{(measured)}$ = (Recorded Wet Weather Volume – Average Dry Weather Volume) / (measured rainfall depth x catchment area)	Total ingress parameter, measured on an individual catchment basis and a measure of the percentage of actual rainfall volume that ends up in the system.
Wet Weather Peak Flow Factor (SWI)	$SWI_1 = PWWF_{measured} / ADWF_{measured}$	Ratio of the peak flow recorded during a specific rainfall event to the measured ADWF preceding the event.

The KPIs can be measured against the typical range of values to assess if I&I is extensive. The Infiltration and Inflow Control Manual provides values that indicate I&I programs.

Table 4: Typical Ranges for KPI [adopted from NZWWA (2015)]

Key Performance Indicator	Typical Range
GWI_1	<20%
GWI_2	>170 and <270 l/p/d
GWI_3	0.5 – 1.1
$RDII_1$	<20%
$SWII_1$	<5

The NZWWA also proposes Threshold Trigger Values that identify whether pursuing an I&I reduction program through source detection and rehabilitation is likely to be successful and cost effective.

Table 5: Threshold Value Summary [adopted from NZWWA (2015)]

Key Performance Indicator	Threshold Value
GWI_1	20%
GWI_2	280 l/p/d
RDII	10%
SWII	8

Dilution of Sewage and Parasitic Sewer Flows in Belgium

Our European partners recognize that inflow and infiltration is an operational concern in their predominantly combined sewer system (approximately 95% is combined in Flanders, Belgium). A term of wastewater dilution is appropriately used as stormwater and groundwater combine to cause increased number of spills from overflows, increase risk of sewer flooding, extra pumping requirements and less efficient wastewater treatment performance. Geert Dirckx of Aquafin NV, Belgium, describes unwanted I&I as "parasitic" and accounts for approximately 50% of total flow in Flanders region of Belgium. In 2005, Aquafin put together a table that summarizes the amount of I&I as a percentage of total or dry weather flow (Figure 5) in various regions and cities in Europe and the US. Aquafin NV uses proprietary software FLEATRAP (Flow Examiner at Treatment Plant) that calculates the amount of parasitic water from the catchment area that flows to the treatment plant for a specified period. The software required daily flow data at the treatment plant and equivalent population in the catchment. The output of FLEATRAP is amounts of stormwater, raw wastewater, and parasitic water (I&I). FLEATRAP uses three methods to calculate each component – two variants of moving minimum methods and triangular method (Dirckx et al., 2009). Dirckx et al., (2009) concluded that the FLEATRAP software and methodology allows for straightforward identification of areas where inflow and infiltration are high and require to be further investigated.

Table 1 Overview of data on extraneous parasite water in Europe and the US

Location	Country	Figure
34 German CSS	Germany	sewage-SW-I/I: 30%-35%-35%
Pittsburgh	US	40% of all flow
Cordova (Alaska)	US	1.4 to 3.8 times the sanitary flow rate
18 Dutch catchments	Netherlands	70% on top of theoretical dwf
-	UK	15% to 50% of average dwf
-	UK	10-20% of total wet weather flow
Köpinge	Sweden	sewage inflow 30% of total during some months less than 15%
-	Germany	40% average in Germany (to dwf) 100% in Saarland
2 small catchments	France	42% of dwf
New York	US	50% of total flow
Costa do Estoril	Portugal	50% of dwf
Cavalaire	France	30% of total flow in winter
Montbrison	France	25% of total flow (?)
Pontaumur	France	42% of dwf
Arcachon	France	50% of total flow
5 catchments	France	10-38% of total flow in summer, 30-67% in winter
Torslanda	Sweden	33% of total flow in summer, 77% in winter
26 municipalities	Austria	average 40% of dwf (ranges from 10-60%)

Figure 5: "Parastic" water in Europe and the US as a percentage of total or dry weather flow (Dirckx, 2005).

Barriers to implementation of common I&I metrics

As has been discussed throughout this white paper, there are many different factors that contribute to I&I, many of which have been explored in depth by the NWWBI I&I Task Force. These variances and the difficulties that arise in consolidating them have resulted in no key performance indicators being accepted. The literature review of I&I metrics in Canada, USA, New Zealand and the NWWBI I&I survey results indicate that the following characteristics and parameters impact I&I calculations of a catchment and the development of consistent I&I metrics:

Meteorological Impacts

Canada is a large country with vastly different terrains and surroundings that generate different meteorological events. When designing sewer systems, municipalities and their consultants are likely to assess the system under the most common storm type for their region. This will result in design storms with different intensities and durations chosen, and can also mean the analysis of snow melt/runoff depending of the critical season and location.

These differences may not be consolidated in a national benchmarking scheme; however on a regional level municipalities should be able to adopt the storm events with the same duration and intensity. Furthermore, as a benchmark, the same frequency/s (e.g. a 1 in 5 year storm event) should be selected, either as one annual return period or an array depending upon social and environmental factors.

Hydrologic Characteristics

It has been noted in this paper, the majority of the municipalities surveyed, prescribe their inflow and infiltration rates in L/ha/d (or L/s/ha), which offers a great starting point in providing a useful key performance indicator that can be used across Canada. However, there are also important considerations to be taken into account when applying a blanket per hectare unit flow rate for I&I.

By only having one unit rate, it does not take into account the land use of the catchment being monitored which directly relates to the population density. For example an urban area built out with industrial, commercial and institutional land uses or multi-family residential apartments will not have the same I&I rates as a single family residential suburban or rural sewer catchment.

The differences noted above are due to the differences in impervious areas, as well as the population and linear meters of pipe for each catchment that will vary depending on land use.

Pipe Characteristics

Pipe age, material and depth can all influence the amount of I&I in a sanitary system. Where age and material are inter-related with I&I increasing as the sewer approaches the end of its life cycle, depth in relation to the ground water table is also an important consideration when categorising conduits.

A strategic effort is needed to achieve consistent pipe characteristics within a catchment if a like for like comparison between catchments is to be made. For example, the infiltration rates for a catchment consisting of predominantly vitrified clay sewer are likely to be much higher than one of HDPE.

Summary

The results of the NWWBI I&I survey, the expert consultations, and literature review support the initial understanding that inflow and infiltration is a big issue for Canadian municipalities and municipalities around the world. The consequences of high I&I in the system are well known and documented. However, metrics are required to provide an assessment of the level of effort required to advance I&I reduction strategies.

Various I&I metrics and methods are currently employed by municipalities throughout Canada. In some regions, municipalities prescribe to common I&I measurement metrics, methodologies, and targets. However, the metrics still vary by region.

It is believed that municipalities would prefer to keep using their current metrics unless a significant improvement was offered. Therefore, the goal of proposing that all municipalities follow an identical approach that allows for "apples to apple's" comparison of I&I metrics remains a big task.

The benefits of developing a common I&I metric that can be used to compare municipalities across Canada include the following.

1. It supports the NWWBI guiding principle that "you can't manage what you can't measure".
2. It allows municipalities to see how they compare.
3. It allows municipalities to identify municipalities that they can learn from.
4. The metric can be beneficial when municipalities communicate the status of their I&I issues.

Next Steps

CRD proposes the use of a simple I&I Benchmarking Metrics Card. A memo describing this report card is located in Appendix D. It is understood that the approach is considered draft and would require peer review and follow-up technical work before it could be finalized and approved.

The proposed I&I Benchmarking Metrics Card allows municipalities to evaluate their understanding of I&I issues within their system and enables the ability to compare their I&I reduction efforts with other NWWBI member municipalities. The key feature of the Benchmarking Metrics Card is that it allows municipalities to continue to use their current I&I metrics. It also allows municipalities to be compared based on mapping of their sewer system (i.e. GIS), overflows, investigation work, and cost of investigation and rehab work.

Based on the results of the survey in this white paper, a large number of municipalities should be able to provide the data needed to fill out the I&I Benchmarking Metrics Card. In some cases, the report card could be used to help municipalities identify gaps in their I&I data.

AECOM recommends that municipalities take the time to review the Card and be prepared to discuss potential improvements during the next NWWBI I&I Task Force conference call. Once the Card has been reviewed and comments have been incorporated, AECOM would like to see NWWBI member municipalities to fill out the Card and submit it back to AECOM. This will allow the Task Force to pilot the collection, analysis, and implementation of the I&I benchmarking metrics. AECOM will invite representatives of the municipalities to discuss the results at the next NWWBI I&I Task Force meeting, which is tentatively scheduled for fall of 2017; location to be confirmed.

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Appendix A

National Water and Wastewater Benchmarking Initiative
2016 Inflow and Infiltration Survey Results

Municipality	Please leave your contact information			Do you consider Inflow and Infiltration an issue in your municipality/region		Do you benchmark your I&I rates and do you have a goal-based approach to achieve specific I&I target (i.e. Metro Vancouver target 11,200 L/ha/day citywide, or 20,000 L/ha/day in a particular catchment)			Do you have an I&I reduction strategy/program			Are you interested in a common I&I measurement metric for comparison with other municipalities			Please indicate the approximate percentage of your sewer system that is combined, fully or partially separated.			Does your Design Criteria prescribe I&I and associated metrics (i.e. ADWF, Peaking factors, land use based loading rates, etc.)		What is the ADWF of the Municipality s design criteria (i.e. L/EP/day or L/cap/day) EP stands for Equivalent Population	What formula or method does the Municipality use to determine the PDWF	How does the Municipality apply I&I to the PDWF in order to achieve PWWF	Does the Municipality have or endorse different loading rates for different land uses Please specify your response in the comment box (i.e. loading rates for single family vs. multi family vs. ICI)		
	Name	Phone	Email	Yes	No	Yes	No	If Yes, please specify your I&I target	Yes	No	Please provide commentary on your I&I program	Yes	No	If No, please explain why	Combined	Fully Separated	Partially Separated	Yes	No				Yes	No	Please provide comments on your situation
Region of York	Ranin Nseir Robert Major		ranin.nseir@york.ca robert.major@york.ca	●			●	We have a benchmark of I/I rate but no goal based approach.	●		http://york.ca/inflowandinfiltration	●		The difference in the parameters used may limit usage	0%	100%	0%	●		Varies per municipality and building type (Details can be requested by email, answers need to be coordinated with modelling group)	Harmon Peaking Factor	Per hectare	●		RESIDENTIAL, COMMERCIAL, INDUSTRIAL, INSTITUTIONAL, HOSPITAL SPECIFIC
Region of Peel	Italia Ponce	905-791-7800 ext.4583	ponceitalia@peelregion.ca	●			●			●		●			0%	100%	0%	●		305 l/cap/day	Harmon Peaking Factor	Per hectare	●		
City of Kitchener	Denise McGoldrick	519-741-2600 ext. 4657	Denise.McGoldrick@kitchener.ca	●			●	We will be starting to benchmark them		●	We are in the process of developing a strategy. We have programs in place to identify the sources but not an overall strategy for it.	●			0%	100%	0%	●		302 L/cap/day	Harmon Peaking Factor	Peaking factor	●		
City of Halifax	Shawn Rowe	902-240-4305	shawnr@halifaxwater.ca	●			●		●		Current pilot program to investigate removal rates associated with various flow reduction/management techniques. Cost benefit analysis will be applied to entire sewershed based on results gathered from pilot program.	●			20%	30%	50%	●		The allowance is 300 litres (0.30 m³) per person per day for residential development.	ADWF x Peaking Factor (Harmon Formula) with a minimum permissible peaking factor shall be 2.0.	Per hectare	●		
City of Thunder Bay	Tom McConnell	(807) 684-2617	tmcconnell@thunderbay.ca	●			●			●		●			3%	97%	0%	●				Peaking factor	●		
City of Calgary	Sebastian Kukulka	403-268-1070	sebastian.kukulka@calgary.ca	●		●		0.28 L/s/ha	●		Identification of catchments that exceed I&I metrics and flagging for more detailed field investigations followed by implementation of mitigation measures.	●			0%	100%	0%	●		315 L/cap/day	Calibrated diurnal curves for modelling - used for trunks (pipes 300/375 mm and larger). Harmon peaking factor for traditional spreadsheet approach - typically used for pipes smaller than 300 mm)	Per hectare		●	
City of Kelowna	Fred Schaad	250-469-8706	fschaad@kelowna.ca		●		●			●		●			0%	100%	0%	●		300		Per hectare	●		people per lot or unit changes with density
City of Ottawa	Eric Tousignant	613-580-2424 x 25129	eric.tousignant@Ottawa.ca	●			●	WE use an I/I rate in design (0.28 L/s/ha) but we do not have a target for existing systems.	●		AT this time, we are managing I/I instead of aggressively removing it. We have found that we can manage I/I and minimize flooding impacts by dealing with obvious and easier remedial measures. Larger removal projects such as foundation drain disconnections, would be looked at only at the time of sewer renewal.	●			5%	65%	30%	●		350 L/c/day however we are in the process of revising this figure since we find it too high.	We use Harmon, but again we are in the process of revising this by adding a factor to the formula (o.6 to 0.8) since find it too high.	Per hectare	●		Residential is L/c/day while ICI is L/ha/day.
Unknown				●			●		●			●			0%	100%	0%	●		L/EP/d		Per hectare	●		
Unknown					●	●			●			●			0%	100%	0%	●		As per "Guidelines for Assessing Sewerage Works" prepared by BC Ministry of Environment					
Capital Regional District	Jim Mcaloon	250-360-3309	jmcaloon@crd.bc.ca	●		●		5-year, 24 hour I&I of 28,500 l/ha/day for our I&I management plan. We also use hourly l/ha/day and ratio of ADWF to PWWF	●		CRD has created an I&I management plan that identifies catchments that should be investigated and a rational approach for addressing the investigation results.	●			2% and there's a plan for it's separation	98%	Could be up to 10% based on flow data results but officially this doesn't exist.	●							
City of Markham	Li Jing Xu	905-477-7000 x 2967	bu@markham.ca	●		●		We don't have specific L/ha number as our I/I reduction target rather to provide service level at 100 year basement flooding protection. Flow data are used to calibrate sanitary system hydraulic model to verify HGL related to the basement level.	●		Council approved city-wide sanitary system downspout disconnection program; sanitary manhole pick holes sealing with rubber plugs; sanitary system design stand and update to improve the construction method for water tight sanitary system.	●			0%	100%	In some older areas of the City some foundation drains may connected to the sanitary system from our historical knowledge but don't have solid records.	●		365 L/Cap/Day	use Harmon's peaking factor	0.26 L/s/ha of I/I allowance in the sanitary sewer design			DWF rate (365L/cap/day) are the same for residential and ICI if using equivalent population. if population information is not available, 180,000L/gross land area in ha/day is used to estimate sanitary flow from ICI land.
ACRWC	Mike Darbyshire	780-416-9962	mdarbyshire@acrwc.ab.ca	●		●			●		We have developed a strategic framework and are working with our member municipalities to develop a regulatory framework and a user-pay cost recovery mechanism. We are still very much in a data collection phase to understand the sources of I&I before we can fully implement our strategy.	●			0%	100%	0%	●		320 l/c/d	2.6*(Population/1000)^-0.1 for residential. Commercial and industrial areas: • Sewage generation rate of 6170 liters/hectare/day • Peaking factor of 3 ICI is 3	.28 l/s/ha for residential: ICI is included in peaking factor (3X)	●		Can send our criteria if required.
Unknown				●			●		●		known high I&I areas are being investigated, MH and service rehab are being implemented.	●			80%	10%	10%		●						
City of Burnaby	Ron Weismiller	604.294.723	ron.weismiller@burnaby.ca	●		●		11,200 target with a goal to manage down to 25,000	●		We follow the Regional LWMP, Liquid Waster Management Plan targets	●			12%	85%	3%	●		286 L/cap/day	Harmon peaking factor	Per hectare			
City of Victoria	Jack Hu	250 883 0722	jhu@victoria.ca	●		●		25,000 L/ha/day	●			●			1%	95%	2%	●		250 L/cap/day	Harmon	Per hectare	●		
Aquafin Belgium	Ruben Vanleene	+3 248 555 9719	ruben.vanleene@aquafin.be	●		●		No specific target	●		Listing (and potential) rehabilitation of known inflow points. No program for infiltration.	●			88%	4%	8%	●		150 L/EP/day	Peak factor of 1,7, resulting in PDWF of 225 L/EP/day	Peaking factor	●		Only in specific cases
City of Waterloo, Iowa, USA	John Lapointe (Interim WW Supt. City of Waterloo, Ia. 2015 - 2016)	763-248-9882	john.lapointe@aecom.com	●		●		Consent Decree defines the target. It is based on preventing SSOs/bypassing during certain storm events.	●		Capacity, Management, Operations and Maintenance (CMOM) Program mandated by Consent Decree.	●			0%	75%	25%	●		Residential: 100 gallons per capita per day Commercial: 775 gallons per acre per day Industrial: 1,300 gallons per acre per day	The sanitary sewer system was modeled using SWMM.	SWMM Modeling	●		Residential, Commercial, Industrial

Municipality	What type of measurements are used to determine the Base Sanitary Flow (Please check all that apply)					How do you determine groundwater infiltration (GWI)	If water billing data is used, what return to sewer factor is applied	Does the City use flow monitoring to measure I&I		How big are the flow monitoring catchment in general	How does the Municipality delineate catchments and which characteristics are used (i.e. pipe age, land use)	For what extent/period of time are the flow monitors installed for	Does the Municipality have SCADA installed at all of its pump stations that are relied upon for I&I calculations		What data inputs does the pump station SCADA have Please list all relevant (i.e.wet well level, pump run hours, pump start/stop levels, inflow rates, outflow rates, etc.)	At what minimum time interval can SCADA be acquired (i.e.1min, 5min, 1 hour)	Does the Municipality have access to a network of rain gauges, either through ownership or external partners and contractors	What is the average area coverage for a single rain gauge	What duration storm does the Municipality identify as being most common to its region (i.e. 6 hour, 12 hour, 24 hour)	What duration storm does the Municipality identify as having the largest impact on the sanitary system
	Pump Station SCADA	Wastewater Treatment Plant flow measurements	Flow monitoring (temporary)	Flow monitoring (permanent)	Water billing data			Yes	No				Yes	No						
Region of York		●	●	●	●	Stevens- Schutzbach, BOD Data, Water Billing Data (Potable Water Use Method)	100% during winter months (under review)	●		15 ha - 460 ha The majority are 150 - 200 ha for long term monitoring. Approx. 3 km of pipe for mini-basin monitoring prior to SSES decisions.	Refer to the Audit Basin Delineation Report that stipulates a number of rules - can be provided upon request	Over 250 are installed for long term and approx. 15 per year for temporary monitoring of approx. 6 months or 3 - 6 signifcant events at a minimum.	●		wet well level, pump run hours, pump start/stop levels, inflow rates, outflow rates - mostly inflow and outflow rates	5 min	Yes, both.	7 - 12 km^2 density	Unknown	Unknown
Region of Peel	●	●	●	●	●	Through CCTV inspection PACP codes.		●		Varied based on project needs.	For the purposes of flow monitoring, delineated by project limits - typically all-structure full reconstructions; and known areas of I+I.	Typically 2 to 3 months.		●	all have wet well level, pump run hours, pump start/stop levels; some have outflow rates	1min; all have the same controller	Stormwater utility operates two rain gauges.	Approximately 6915 hectares.	6 hour as lower duration storms are more frequent for events with the same rainfall intensity	Not identified.
City of Kitchener		●	●	●	●	Through flow monitoring and billing data	85% and compare it with Flow monitors	●		varies	Topography, land use	depend on the study. We have permanent flow monitors for all our trunk sewers	●		We have data for some pumping stations. Data inputs are wet well level, inflow rates, outflow rates	1 min	yes	varies	12-hr	depends, for flooding, it is 25yrs-100yrs storm; for budget 5-25 yrs
City of Halifax	●	●	●	●	●	For specific sewersheds, RDII analysis leads to determination of GWI. High level approximation of GWI is based 85% of night time ADWF.	Only used on individual design and engineering projects. There is no standard "return to sewer" factor due to GWI variations. It is determined on a case by case basis.	●		They vary. Generally are based on our pumping station sewersheds. Larger catchments are sometimes used for sewer modelling. They vary a lot ranging from 10 to upwards of 100 HA.	Typically by pumping station catchments. They can also be delineated based on project specific requirements.	varies greatly depending on data use. As short as 2 weeks to multiple years.	●		pump current, wet well level, wet well level alarm, pump status, flow measure if installed, overflow sensor if installed, pump run hours. there are more but these are the ones used for II calculations.	3 seconds for upgraded systems and ~ 5 minutes for the older systems.	Yes we have access to a network of our own rain gauges, 1 via a consultant and data available from Environment Canada.	7 for our service boundary.	24 hour	High intensity downpours after sustained periods of rain.
City of Thunder Bay		●	●					●			Pipe age	1-2 years, more if necessary		●				City owned.		12 hour	12 hour
City of Calgary			●	●		Flow monitoring. Typically is considered a component of baseflow and is not accounted for separately.	Depends on the time of year. Summer may be 50/60 but winter may be 80/90. Typically the City does not use water billing data for sanitary flow determination due to this reason.	●		FM for modeling applications vary widely based on a number of factors. But general rule of thumb for I&I monitoring catchments is to include approximately 3,000 lineal meters of pipe.	Catchments are delineated upstream of flow monitoring locations. There is no specific parameter that determines the extent of the catchments.	Every year from beginning of May until the end of September.		●	Pump station SCADA is not typically used for I&I.		Yes.	The City operates a network of rain gauges (about 41) which are spaced evenly throughout the City by being located on Fire Hall roofs.	24 duration design storm is used for sanitary modelling purposes.	Storms 24 duration or longer.
City of Kelowna	●	●		●	●	previous studies	winter consumption	●		varies		meters on trunks are permanent. laterals about 30-60 days.	●		wet well level, pump run time, pump start/stop intervals, outflow	we use 5min intervals	yes, we have 17 rain gauges located throughout the city that we own and maintain.	10-12 km2	likely 1-hour duration is most common	
City of Ottawa	●		●	●	●	From flow monitoring data	We use winter time water records (no outdoor use) and determine a pattern. 100% of that flow is assumed going to the sewer.	●		They vary in size from a thousand hectares to just a few hectares. It depends on the study. Permanent stations usually measure in the hundreds and thousands of hectares.	Land use and system type (separated, partially separated and combined).	Four months	●		Wastewater Pumping stations: Wet well levels, Forcemain flows, Forcemain pressures, Pump states, Pump speeds, Pump flows	10 seconds	Rain gauges and radar rainfall data	Rain gauges are approximately 1 per 100km2. Radar rainfall can provide a 1 km2 grid.	Depends on the use. For storm peak flows it's 3 hour and 6 hour, for volume it's 12 hour and 24 hour for sanitary I/I its 24 hour	24 hour
Unknown	●					CCTV and SCADA		●				24/7	●		all	1 min	yes	about 3km2	12 hour	
Unknown	●		●					●					●		pump run hours					
Capital Regional District	●	●	●	●		85% of the minimum hourly dry weather flow		●		For the I&I management plan, between 30 and 100 hectares. Some are bigger if the I&I is very low.	When possible, using pump station and Regional sewer billing meter catchments. If the catchments are too large, then temporary flow meters may be used to create additional catchments.	The temporary meters are generally installed for a few years to get enough good storm event data.	●		level, pump on/off, run times. I personally convert the data to flow data for I&I purposes.	Data is stored at the meter locations and retrieved every few minutes. Data isn't lost. In general, new data is stored if it is more than 3% different (in measurement span) than the previous reading.	yes	5 km	12 hours is what we use for peak I&I rates. 24 hours to relate to regulatory requirements.	Back to back larger storms (i.e. 3 large storms over 5 days can affect all of our municipalities. Generally large storms start having an impact after 12 hours for the older leakier municipalities
City of Markham			●	●		85% of minimum DWF rate	we don't use water billing data	●		the size of monitoring catchment area varies, 10ha -more than 100 ha. <50 ha is ideal	yes it is based on the land use, system age.	the flow meters are installed for a minimum 12 month to capture seasonal variation. some flow meters are long-term based.		●	time series of wet well level, pump run time, outflow rate and volume	1 min	city has 13 rain gauges installed covering the entire city. City owns the rain gauges and hires consultants to do maintenance	within 3 km radius		
ACRWC	●	●	●	●	●	Through interpretation of flow monitoring graphs.	None.	●		Varies. No standard. Dependent on suitable flow monitoring site location.	N/A	Permanent. (Temporary monitors may be installed for wet weather flows or for study purposes)	●		wet well level, pump run hours, pump start/stop levels, inflow rates, outflow rates	5 min	Yes	Varies	No typical return frequency. Impacts observed from less than an hour (short-term intense storms) to 24 hour region-wide events.	Short duration intense storms impacts locally. 24-hour region wide weather system will impact plant
Unknown						not calculated in our		●		8KM squared	pipe age and know areas with high water table	in our problem area up a year.	●		wet well level, pump run hours, pump start/stop levels, inflow rates, outflow rates	1 min. interval.	Yes, we own our own.		6 Hours	
City of Burnaby			●			Through flow monitoring analysis		●		400-1000 residential units are ideal.		Six months, over winter or wet-weather conditions.		●	All of the above, except for no 'inflow' typically	5 min	yes	5 gauges City-wide (100 km2)	24 hour	24 hour storms are used in I&I analysis
City of Victoria	●	●	●	●	●	percentage of Minimum night flow	80 percent	●		270000 square meter	pipe age, land use, the flow network	4 years	●		wet well level, pump run hours, pump start/stop levels, inflow rates, outflow rates	10min	yes	7400000 square meter	It is depends on the return storm event.	24hr
Aquafin Belgium	●	●	●			Theoretical screenings by comparison of elevation of pipes with groundwater depths.		●		Very diverse (ranging from 100 PE to 300.000 PE). We have around 300 catchments.	1 flow meter for each catchment at the treatment plant. 1 treatment plant per catchment	Indefinitely		●	wet well levels, pump start stop levels, pump run hours, Outflow rates only in case of flow meters (roughly at 15% of all pumping stations)	1 min	Yes, publically available network	190 km²	Unknown to us	Unknown to us
City of Waterloo, Iowa, USA	●	●	●	●	●	SWIMM Modeling and groundwater elevations.		●		A total of 25 flow monitoring stations (area-velocity meters) were spread across the city of Waterloo, IA, population 68,000.	Every catchment area in the entire town was delineated and modeled. 2,706 total. Min. pipe size = 8-inch dia.	Long-term flow monitoring for 15 years was specified in the Consent Decree.	●		VoluCalc flow monitoring devices record inflow, outflow, pump starts/stops, pump run times and wet well elevations.	Adjustable. Not certain what SCADA time interval is currently set at.	Yes. A network of 10 rain gauges have been installed across the city. They also use the nearby airport rain gauge.	2 - 3 square miles.	The system was modeled for three storm events; 2-year, 6-hours; 5-year, 6 hours; and 10-year, 6 hours, so I assume the 6 hour event is the most common.	Based on the modeling I assume a 6-hour event has the most impact.

Municipality	Does the Municipality have a specific design storm event and what is it	How does the Municipality account for snow melt runoff in the analysis of its sanitary system (if applicable to your Municipality)	Does the Municipality use the envelope, Q vs. I, or other flow vs. rainfall relationship method			Does the Municipality use the RTK unit hydrograph method			Does the Municipality use peaking factors for either WWTPs or PS SCADA			Does the Municipality use other methods/metrics for measurement of I&I that were not covered in the questions above		
			Yes	No	If Yes, what is the benchmark storm event and I&I rate?	Yes	No	If Yes, what is the benchmark storm event and I&I rate?	Yes	No	If Yes, what is the benchmark storm event and I&I rate?	Yes	No	If Yes, what is the benchmark storm event and I&I rate?
Region of York	Yes, a 25 year custom hyetograph	No	●		We use Q vs I for regression of a 25 year storm that is also used for capacity analysis. We use Cv Low <5 Medium 7.5 < High, L/m*mm Low < 3.42 Medium 5.86 < High, 1 Hour averaged Peak flow L/s/ha, Low < 0.26 Medium < 0.58 < High, and peak hour averaged L/s/km, Low < 3 Medium 6 < High, Hour averaged Peak flow compared to ADF - graduated benchmark depending on size of ADF. For less than 4 l/s, Low < 4 Medium 6 < High - the table for acceptable comes from St. Paul Minnesota paper.		●			●	For I/I we use peaking factors in our smaller basins.	●		We are starting to look at temperature.
Region of Peel	5 year storm design	Not applicable.		●			●			●			●	
City of Kitchener	SCS type II	no		●			●			●		●		CCTV inspection data, Hydraulic Modelling
City of Halifax	Not with respect to II calculation. Our storm systems is designed by a major and minor conveyance system. The minor system (pipe system, ditches, culverts, structures, etc.) is designed to handle a 1 in 5 year storm. Curb and gutter and cross culvert components of the minor system are designed to handle a 1 in 10 year storm. The overland flow system (major system) is designed for a 1 in 100 year storm.	We note it. We have a design consideration for winter storms in the combined system.	●		The pilot program is currently using a 10 year return normalized by the Q to i regression analysis. We don't yet have an II rate. They are being determined via the pilot program.		●		●		Our combined WWTF are designed to treat 4x ADWF for 2021.	●		We are calculating removal rates (peak flow response for volume and instantaneous as well as ADF).
City of Thunder Bay	5 year return period storm; Regional (Timmins) storm for maximum	No		●			●			●			●	
City of Calgary	50 yr third quartile Huff 24hr duration storm.	Snow met is not accounted for. The typical we weather period where I&I is a problem in Calgary is mid May until mid July, by that time the snow melt is not a significant factor. Due to chinook winds the snow accumulation and spring runoff is not a significant in Calgary.	●		50 yr 24 hr storm; 0.28 L/s/ha		●			●		●		Mike Urban model; using RDI module to simulate wet weather response; Calgary wet weather response is sensitive to soil moisture content
City of Kelowna	1:5-year for the minor system, 1:100-year for the major system	N/A	●		any significant rain event and change to inflow at treatment plant		●			●		●		we use a formula base on people/unit and factored flows based on land use
City of Ottawa	WE have a modified Hurricane Frances storm from September 2004. This storm was scaled down to represent the 100 year volume.	L/s/ha based on 40 years of flow monitoring data.		●		●		It depends on sewershed characteristic. It varies too much from area to area to provide such a figure.						We currently use 0.28 L/s/ha of I/I for the design of sewers under free flow conditions, but we are looking to adding a figure of 0.55 L/s/ha as a 100 year I/I that would be used to assess the HGL in a sanitary system.
Unknown		N/A		●			●						●	
Unknown														
Capital Regional District	Regionally, we design for 25 year or 100 year events depending on the overflow receiving environment.	We rarely get these events (i.e. twice in 10 years). As a result we treat them as anomalies and exclude them from the I&I analyses.	●		Peak 1-hr I&I Rate (l/ha/day); 5-yr, 24-hr flows compared to ADWF ; 5-yr, 24-hr I&I Rate (l/ha/day); whether or not catchment flows more than double during short intense summer thunder storms		●	Would be interested in looking into it.		●			●	
City of Markham	we use 25&100 year 24 hour Chicago design storm to evaluate the system performance.	don't account for snow melt runoff although we had observed some high I/I response during snow melt event. we currently still use intensive summer storm.	●		we previously had used relationship between peak flow vs. peak rain intensity derived from flow monitoring data. Now City has calibrated sanitary system hydraulic model and we are using the model to do more analysis.		●				N/A. City does not have WWTP. we only have local collection system and Region looks after the WWTP and large trunk system.		●	
ACRWC	24-hour 25-year	Usually less than 24-hour 25-year events		●			●		●		PF of 2.5 to 3 for plant. Not used for pump stations.	●		Comparison between dry season and wet season.
Unknown		No		●			●			●			●	
City of Burnaby	design pipe using the 10 year return	n/a	●		I&I envelope, 5 year 24 hour		●			●			●	
City of Victoria	1/2hr, 2hr, 6hr, 12hr, 24hr duration and 10yr, 100yr design storm	N/A	●		envelope		●			●			●	
Aquafin Belgium	Yes, composite design storms that entail all statistical characteristics for each return period	None		●			●			●		●		Moving minimum, antecedant minimum and trianglar method based on daily flow registrations
City of Waterloo, Iowa, USA	6-hour	Long-term modeling using A-V meters will catch the snow melt runoff events.	●		6-hour	●			●			●		Televising of sewer segments during periods of high groundwater table.

Appendix B

Section 6 of Volume I of the
New Zealand Water & Wastewater Association's
Infiltration and Inflow Control Manual

6. Key Performance Indicators

Historically, I/I analysis projects carried out in New Zealand, Australia, and the USA have been done using a range of parameters that quantify the various sources of I/I as referred to previously in Section 5.1.2 (Water Services Association of Australia, 2013).

These parameters, or Key Performance Indicators (KPIs), are commonly defined as follows:

- Groundwater Infiltration (GWI) or base flow;
- Rainfall Dependent Inflow and Infiltration (RDII); and
- Wet Weather Peak Flow factor, defined by stormwater inflow (SWI).

KPIs proposed here are consistent with those outlined in the WSAA Guidelines document (WSAA 2013).

It should be noted that these parameters have been developed for primarily residential areas with contribution from commercial and retail development. Areas with large industrial contributions should be analysed judiciously.

It is recommended that the KPIs be calculated on an individual flow monitor or pump station catchment basis. Refer to Section 12 for information on pre-rehabilitation monitoring and analysis.

6.1 Dry Weather (Groundwater) Infiltration

There are a number of indicators that have been used to assess a systemôs performance with regard to permanent GWI These indicators have tended to evolve based upon the ancillary data sources that are readily available.

In upstream residential catchments, where flows are largely unaffected by attenuation or nocturnal non-residential discharges, approximately 80% of the minimum nightly flows are due to GWI. This approximation is a ñrule-of-thumbòfactor that originates from observational experience of past projects. The first indicator for GWI is:

$$GWI_1 = GWI_{(80\% \text{ of minimum flow})} / ADWF$$

If GWI_1 is greater than 20% it is an indicator that GWI is greater than expected.

Population-based flow indicators are also recommended, that is the ratio of the measured ADWF to the estimated population.

$$GWI_2 = ADWF_{measured} / Population_{theoretical}$$,where the unit is l/person/day

As guideline values, when the ratioôs value is below 170 l/p/d, it is indicative of exfiltration and when the value is greater than 270 l/p/d, then significant groundwater infiltration is likely to be occurring.

As a further indicator that can be used, a water consumption-based flow factor, being the ratio of the measured ADWF to the metered water consumption (where available).

$$GWI_3 = ADWF_{measured} / Water\ Consumption_{measured}$$

The normal expected range is 0.7 to 0.9.

When the value is below 0.5, it is indicative of exfiltration. When the value is greater than 1.1, then significant groundwater infiltration is likely to be occurring.

6.2 RDII Volume

A percentage of total ingress parameter, measured on an individual flow monitor or pump station catchment basis, which is the measure of the percentage of actual rainfall falling on a catchment that ends up in the wastewater system.

$$RDII_1 = \text{Volume of RDII}_{measured} / \text{Rainfall Volume}_{measured}$$

= (Recorded Wet Weather Volume - Average dry weather volume) / (Measured rainfall depth x catchment area)

Typical values for an older system in good condition are in the range 2-5%. Values greater than 20% indicate high levels of wet weather response.

6.3 Peak Wet Weather Flows (PWWF)

A wet weather flow peaking factor, which represents the extent of Storm Water Inflow (SWI) is the ratio of the peak flow recorded during a specific rainfall event to the measured ADWF preceding that event.

SWI_1 = PWWF $_{measured}$ / ADWF $_{measured}$.

This parameter can be measured at any flow monitoring point. Historical design practice was to set this number at 5.0. Studies have encountered values as high as 30, indicating a significant number of direct inflow sources in the associated catchments.

6.4 KPI Summary Table

The KPIs discussed in this section are summarised in Table 6-1, and the typical range (little to no infiltration) for each KPI is also shown.

Table 6-1 Typical Ranges for Key Performance Indicators

Key Performance Indicator	Typical Range
GWI_1	<20%
GWI_2	>170 and <270 l/p/d
GWI_3	0.5 ï 1.1
$RDII_1$	<20%
SWI_1	<5

6.5 Threshold Trigger Values

Whether pursuing an I/I reduction programme is justified will depend upon the performance and operational problems that are being addressed in the system. In addition, an options assessment on the viability of an I/I reduction programme in comparison to the other I/I management options outlined in Section 2 may be warranted.

It is useful however to have some idea of threshold or trigger values of the various I/I KPIs to determine whether pursuing an I/I reduction program through source detection and system rehabilitation is likely to be successful.

Many water agencies have recognised that when the measurable $RDII_1$ parameter is less than 8-10%, the success of rehabilitation programmes aimed at reducing I/I is much more difficult to quantify and therefore the associated works are more difficult to justify (WSAA 2013).

A threshold value of the $RDII_1$ parameter of 10% is therefore recommended.

Unless there are other one-off reasons such as a localised overflow that would benefit from such a programme, where the $RDII_1$ parameter is less than 10%, consideration of system-wide rehabilitation as an improvement measure to reduce system wet weather volumes is not recommended.

Similarly, the same research has identified that appropriate threshold values exist for the GWI and SWI parameters as follows:

Groundwater Infiltration (GWI_1) - greater than 20% of ADWF

Groundwater Infiltration (GWI_2) ï 280 l/p/day

Wet-Weather peaking Factor (SWI) ï 8.

The threshold trigger values discussed in this section are summarised in Table 6-2.

Table 6-2 Threshold Trigger Values

Key Performance Indicator	Threshold Value
RDII	10%
GWI_1	20%
GWI_2	280 l/p/d
SWI	8

Appendix C

National Water and Wastewater Benchmarking Initiative
Inflow and Infiltration Task Force Scope Sheet

Inflow and Infiltration (I&I): Process Task Force Objectives & Approach

Participation Eligibility and AECOM Contact

This Task Force is open to any utility that is participating in the NWWBI Wastewater Benchmarking Module. For current information on this Task Force or Task Force Deliverables, please contact

David Main (AECOM): 604-444-6491 or david.main@aecom.com

Task Force Objectives

1. To investigate current I&I reduction related policies, procedures, tools and approaches of the benchmarking participants.

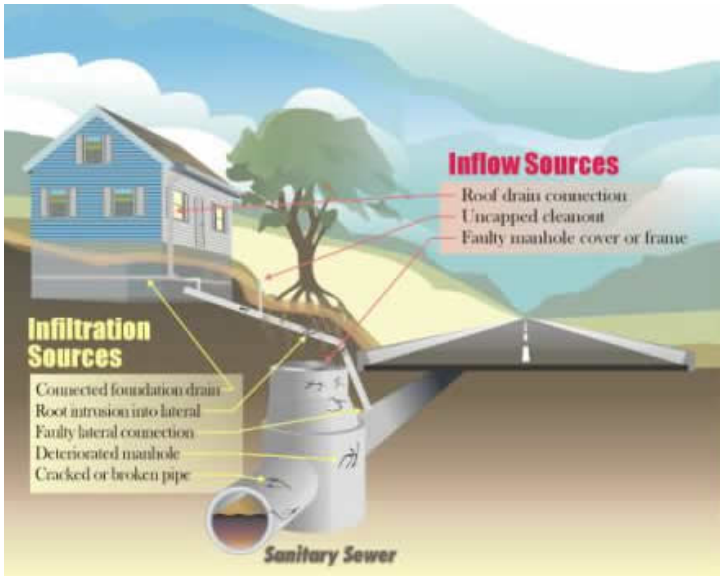
2. To investigate the key drivers behind I&I reduction strategies, and determine what are the obstacles to better I&I management.

3. To investigate the costs and benefits of successful I&I reduction programs, and determine what initiatives provide the best results per dollar spent.

4. To leverage the practical experience and knowledge of benchmarking participants in improving the knowledge of I&I management in Canada.

Background

Inflow and infiltration (I&I) are terms for the ways that clear water and storm water make their way into sanitary sewer pipes and eventually get treated, unnecessarily, at wastewater treatment plants. I&I is a problem because it takes up fixed capacity in sewerage interceptors that is needed to convey wastewater. It can also be costly to communities; once clear water gets mixed in with wastewater, communities are charged for the treatment of all the water.



Infiltration occurs when groundwater seeps into sewer pipes through cracks, leaky joints or deteriorated maintenance holes. Inflow is by far the larger problem, and occurs in direct proportion to rainfall. Typical inflow sources are water from rain leaders, basement sump pumps (which are designed to capture water that enters basements) or foundation drains illegally connected directly to a sanitary sewer pipe.

NWWBI collects data for many performance measures pertaining to wastewater system management however, for I&I, the data that is being collected is municipality-wide data (not specific to a single catchment area) and as such it will tend to underestimate the extent of I&I problems. Furthermore I&I is also difficult to measure and compare year after year because it is highly dependant upon rainfall. For example, an extremely wet year followed by an extremely dry year could look like a municipality has made significant progress in reducing I&I even though they had actually done nothing. As such, the I&I task force will focus on sharing detailed and specific information regarding I&I management and initiatives.

Status of the I&I Task Force

Many participants in the NWWBI partnership are in various stages of developing, implementing and managing I&I reduction programs. A lot of information has been shared between members since the topic was first introduced at the 2005 NWWBI annual workshop. Task Force conference calls, surveys, dedicated Task Force workshops and sessions at the annual NWWBI workshop has helped to advance this group. Common issues have been revealed, which include the following:

- The costs of finding and fixing I&I issues versus benefits achieved are hard to justify.
- There is uncertainty about the “savings achieved” by various rehabilitation methods, and evaluating the savings with the numerous impacting variables.
- Budgets are hard to defend year over year as “memory” about historical events is seemingly short term for decision makers.
- There have been a number of I&I reduction programs completed at the pilot scale, but few full scale implementations. The costs of programs are high, and it is a challenge to justify full scale implementation and determine how and by whom these programs should be financed. (Who pays for work on the private side, subsidy programs etc.)
- There are numerous challenges associated with the private side:
    - Downspout disconnections seem to be an easy solution to help reduce peaks, but may result in other issues.
    - Complexity of household drainage systems makes finding sources difficult and costly.

    - Finding mechanisms to address inflow and infiltration on the private side is challenging. (Right to enter and inspect, who pays, creating / enforcing a Lateral Certification/Inspection Programs in high priority areas or at point of sale, etc).
- Developer Pressure (developers leading I-I projects in exchange for "credits").
- Consistency / Determining the right way to assess an organizations inflow and infiltration problem – e.g. what storm do you analyze (I/D/F)?

Task Force Work Plan for 2015-2016

A lot of ground has been covered over the years, and a great deal of information shared among Task Force Members. During the 2015 Annual Benchmarking Workshop, it was confirmed that the dedicated I&I workshops are a great forum for learning and sharing information. The original Task Force objectives are still relevant, and the members are still interested in meeting to discuss inflow and infiltration programs and challenges. As such, a dedicated workshop was held at in Delta, BC at the Annacis WWTP (MetroVancouver). Focus areas for the workshop included:

- Cost benefit analysis for I&I programs
- How to develop a business case when resources are limited
- Development of I&I target levels – should they be based on a set target level or based on effort expended and percent reduction realized
- How to approach and manage private side laterals

In 2016, the Task Force will establish and confirm its own work plan for the 2016-17 iteration. Communication amongst members will occur through e-mail discussion, telephone discussion, and teleconferences. AECOM will provide logistical and technical support as a component of the Benchmarking fees.

Appendix D

Capital Regional District Proposed I&I Benchmarking Metrics Card

Benchmarking Municipal Inflow & Infiltration Programs

1) Overview

The National Water and Wastewater Benchmarking Initiative (NWWBI) represents 43 of Canada's leading municipalities and regional districts from coast to coast representing a population of over 21 million people. AECOM oversees the initiative and provides administration and technical support. The initiative was started in 1997 and focuses on wastewater collection and treatment systems, water treatment, supply and distribution systems and stormwater management systems. The objective of the benchmarking project is to develop a high-level tool or model that the majority of Canadian Water and Wastewater Utilities can use to assist and improve on managing and monitoring their performance with the use a standardized Key Performance Indicators (KPIs).

Using comparative KPIs amongst similar agencies to guide management strategies is known as metric benchmarking. This is what the NWWBI was originally designed to accomplish. However, it quickly became apparent that most Canadian water and wastewater utilities were struggling with many similar technical and financial challenges. The NWWBI program responded with selected process benchmarking to begin drilling down into specific managerial and technical areas of utility concern. The objective was to leverage energies and conduct Best Practice investigations into specific processes amongst a wider group of similar agencies. NWWBI called these exercises Process Task Forces. Due to the agreed need amongst a large group of Canadian wastewater utilities, the NWWBI initiated the Inflow & Infiltration Task Force in 2007. The task force generally meets once a year and is a valuable forum for sharing information between municipalities and presenting ideas. Even though this Task Force has shared considerable information and data with each other and have discussed many technical aspects of I&I management over the years, as of 2016, the task force did not have any agreed benchmarking KPIs or metrics that could serve nationally to guide I&I management and reduction; largely due to:

- The large variety of I&I metrics currently used across Canada;
- Variation in I&I issues across Canada (i.e. winter storms vs. summer storms vs. spring thaw, etc.);
- Incomplete information regarding I&I metrics used around the world.

Under the NWWBI guiding principle taken from Peter Drucker "you can't manage what you can't measure", in 2016, the Capital Regional District hired AECOM to prepare a white paper documenting I&I metrics used across Canada, the USA, Europe and parts of the world with similar sewers / conditions. NWWBI municipal members contributed to the white paper by completing a survey. The paper confirmed that a large variety of I&I metrics are used around the world and that "perfect" I&I metrics for benchmarking do not exist.

In early 2017, the Capital Regional District developed a potential solution to the problem of finding a common I&I rate metric for use in benchmarking (Section 4). The CRD then proceeded to design a draft I&I benchmarking table (Section 5). On March 14, the approach was presented to AECOM Benchmarking staff and a representative from the City of Burnaby for comment and discussion. It was decided that the approach looked sound and ready for greater peer review. To move the idea forward,

AECOM will introduce the idea at the NWWBI Summary Workshop in Winnipeg in April and will make it a key part of the I&I Task Force meeting planned for the fall.

It's understood that the approach would need to be peer reviewed and approved by the I&I Task Force prior to acceptance. The approach will also require follow-up technical work and municipal review before it can be moved from a draft concept to an approved benchmark.

2) Considerations

The proposed "draft" I&I benchmarking table is meant as a high level tool to compare I&I related work between municipalities. Care should be taken when interpreting the table because:

- Municipalities with older sewers will generally have more I&I related issues, regardless of how well the sewers are managed.
- Sewer metering technologies are relatively new so municipalities may not have known that they've had I&I issues until recently (i.e. last 15 years).
- Sewer mapping (GIS) is relatively new (i.e. last 15 years).
- I&I work can be very expensive and requires significant budget and/or a long-term plan to address.

3) I&I Rate Metrics

Municipalities around the world use a variety of I&I metrics. At a high level, the metrics are used to identify areas that may have problems related to capacity, overflows, structural issues or combined sewers. Municipalities generally don't have the budget to investigate all of their catchments so they rely on I&I metrics to prudently focus resources on catchments with potential problems. I&I metrics are generally used to answer the following questions:

- Is I&I a problem in a catchment?
- Is follow-up investigation warranted?

I&I can be divided into two categories of sewer problems; inflow and infiltration. Inflow comes from direct pipe connections and can rapidly increase flows in the sewer system. Infiltration comes from groundwater entering sewer pipes through cracks, etc., and the sewer response is generally delayed and lasts longer. It is beneficial to have I&I metrics for both inflow and infiltration because they benefit from different types of follow-up investigation and rehabilitation works.

4) Proposed I&I Rates Metrics for Benchmarking

The proposed I&I metrics for benchmarking has three key components:

1. It's based on flow data from appropriately sized catchments.
    - The AECOM white paper contained a survey of municipalities. For I&I catchments, it was found that preferred maximum catchment sizes ranged from 100 to 400 hectares.

2. It is based on up to date flow data
    - For the purpose of the metric, I&I data should be less than 10 years old.

3. It allows municipalities to continue to use their current I&I metrics.
    - AECOM would create a table summarizing the metrics used across Canada along with corresponding thresholds, for both inflow and infiltration. The thresholds would define the levels when inflow and/or infiltration becomes a problem in a catchment or follow-up investigation warranted.
    - To compile the metrics, AECOM would ask municipalities for their existing municipal catchment I&I rates, catchment sizes, and average pipe ages in catchments. AECOM would then convert the data to municipal values that could be documented in the benchmarking table.

The I&I rate benchmarks would be summarized similar to what's shown in Table 1.

Table 1: Sections of the Proposed I&I Benchmarking Table that Relate to I&I Rates

Sewer System Summary		Muni A	Muni B	Muni C	Muni D
Flow Metering					
% of Municipality with appropriately sized long-term monitoring catchments *(appropriately sized will be defined by I&I Taskforce, i.e. 400 hectares maximum)*		100	100	100	100
% of Municipality with up to date flow data (i.e. under 10 years old)		100	100	100	100
I&I Rates [1]					
Percentage of municipality that:	• Is under both I&I thresholds	100	15	100	80
	• Exceeds the inflow threshold only (i.e. 4x peak hourly flow)	---	5	---	5
	• Exceeds the infiltration threshold only (i.e. 4x ADWF)	---	70	---	10
	• Exceeds both the inflow and infiltration thresholds	---	10	---	5

[1] *The threshold for the infiltration category would consider the age of the sewers in the catchment. This would acknowledge the fact that I&I naturally increases in catchments over time and that when sewers are "acting their age" I&I reduction generally isn't cost effective. See the following link for more info:* https://www.kwl.ca/sites/default/files/IandI-paper-OCR.pdf

5) Proposed "Draft" I&I Benchmarking Table

The I&I Benchmarking matrix would contain much more than just comparative I&I rates. It would also include the following categories:

- sewer system summary;
- overflows;
- flow metering;
- I&I rates;
- structural inspections of public pipes and manholes;
- cross-connection inspections;

- manholes;
- public portion of laterals;
- private laterals; and
- budget related.

The table is intentionally set up to have the most basic I&I related work noted at the top with progressively more "advanced" I&I related work as you move down the table. Excluding the categories related to the I&I rate metrics (Section 4), most of the categories are relatively easy to understand and are well positioned to be discussed the I&I Task Force meeting and refined.

A copy of the draft benchmarking table is located in Table 2.

Table 2: Draft Proposed Benchmarking Table

Sewer System Summary	**City A**	**City B**	**City C**	**City D**
• Separated sewers (%)	100	100	100	86
• Combined sewers (%)	---	---	---	14
• Sewer system in GIS (yes / no)	√	√	√	√
Overflows				
Municipal overflow locations are mapped and in GIS	√	√	√	√
Overflow locations with a potential to overflow are monitored	√	√	√	√
Typical number of I&I related overflows in a year	0	0	0	13
Flow Metering				
% of Municipality with appropriately sized long-term monitoring catchments *(appropriately sized will be defined by I&I Taskforce, likely as hectares for ease)*	100	100	100	100
% of Municipality with up to date flow data (i.e. under 10 years old)	100	100	100	100
I&I Rates				
% of municipality that:				
• Is under both I&I thresholds	100	10	100	5
• Exceeds the inflow threshold only (i.e. 4x peak hourly flow)	---	5	---	10
• Exceeds the infiltration threshold only (i.e. 4x ADWF)	---	70	---	5
• Exceeds both the inflow and infiltration thresholds	---	10	---	80
Structural Inspections Data (under 15 years old and coded to industry standards)				
• % of public sewers with CCTV data	90	100	95	10

• % of public manholes with proper inspection coding	0	0	0	0
Cross Connection Inspections				
• For the portion of the municipality that exceeds the inflow threshold (see I&I rates section), the percentage that has been smoke tested.	n/a	85	n/a	10
Manholes				
Laterals (under 15 years old and coded to industry standards)				
• % of sewer laterals with cleanouts at the property line.	85	30	100	20
○ % of which is reliably mapped in GIS				
• % of public property portion of laterals with camera inspections	70	2	85	2
• % of private property portion of laterals with camera inspections	70	2	85	2

Table 2: Draft Proposed Benchmarking Table (continued)

Typical Unit Costs	**City A**	**City B**	**City C**	**City D**
Typical Investigation Cost				
Temporary Flow Metering (per month)				
CCTV (per km)				
Smoke testing				
Typical Rehab costs				
Relining (cost/m)				
Manhole repair (cost/mh)				
Typical Municipal Budget				
As a percentage of replacement value				
I&I Studies				
# of sewer remediation studies available for Benchmarking members to learn from.				

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About AECOM

AECOM is built to deliver a better world. We design, build, finance and operate infrastructure assets for governments, businesses and organizations in more than 150 countries. As a fully integrated firm, we connect knowledge and experience across our global network of experts to help clients solve their most complex challenges. From high-performance buildings and infrastructure, to resilient communities and environments, to stable and secure nations, our work is transformative, differentiated and vital. A Fortune 500 firm, AECOM companies have annual revenue of approximately US$18 billion. See how we deliver what others can only imagine at aecom.com and @AECOM.

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APPENDIX E

Private Property Sewers and Drains: Stakeholder Engagement Background Report

Private property sewers and drains

Stakeholder engagement background report

CAPITAL REGIONAL DISTRICT

February 22, 2017

Submitted to: James McAloon, Capital Regional District

Submitted by: Cariad Garratt
Principal, Pinna Sustainability Inc.

Pinna Sustainability

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1 Introduction

The network of underground sewer and drainage pipes linking houses to municipal infrastructure is often left unmaintained until a problem presents itself (i.e. sewage or rainwater floods the home's basement). Unfortunately, such problems result in significant disruption, cost and potential health hazards for inhabitants. Leaky sewer pipes can also allow groundwater to enter the public sanitary sewer system increasing conveyance costs and potentially contributing to sewer overflows.

The CRD is interested in developing an education program to improve the maintenance of these pipes in order to protect homeowners from these events, while also supporting regional objectives to reduce the amount of rainwater entering the public sewer system. The approach will focus on working with professional groups that interact with homeowners with respect to sewers and perimeter drains (e.g. plumbers, home inspectors). A key outcome of the project is to achieve consistent messaging and guidance for homeowners on this topic that all relevant stakeholder organizations agree with, and are willing to distribute through their membership. To be effective, the messaging will need to be reviewed and "negotiated" with each of the relevant stakeholder groups until consensus is reached.

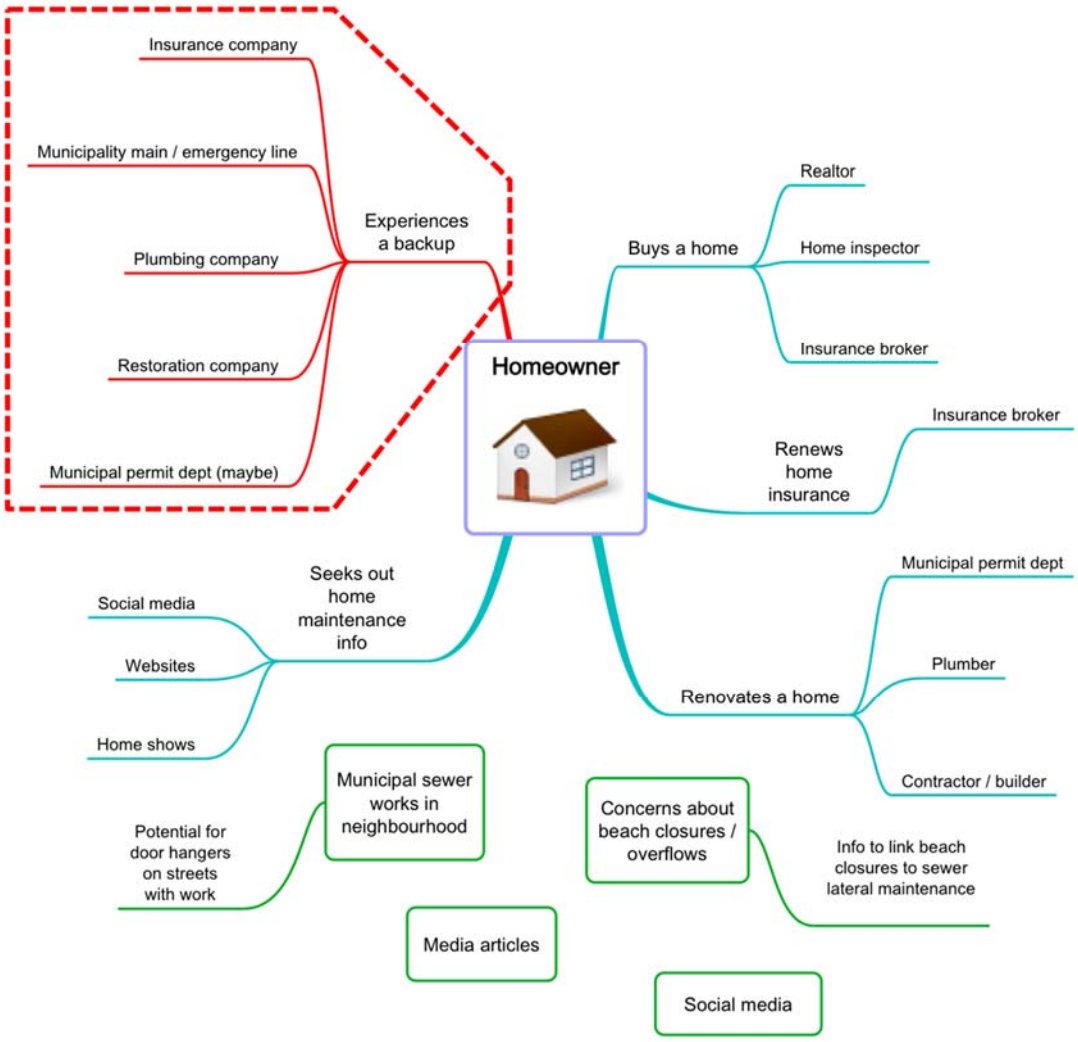
A copy of the project charter for the overall project is located in Appendix A. This report covers Phase 1 of the project. The report also contains notes from a workshop held with Metro Vancouver focused on developing broad inflow and infiltration messages for the public.

2 Opportunities to inform homeowners

Raising awareness about an issue that may not currently be on a homeowner's radar will require identifying natural opportunities where the homeowner is more open to learning about the issue, and more likely to take action with the new information. **Error! Reference source not found.** illustrates the most likely events where a homeowner may be more open to learning about the condition of their home's sewer and drainage pipes. The diagram groups the events by colour as follows:

- Red lines show access points related to a backup or basement flooding (reactive opportunity).
- Blue lines show times when the homeowner naturally engages with professionals that relate to sewer and drainage pipes (proactive opportunity).
- Green lines show potential municipal media options.

Figure 1. Opportunities to engage with homeowners about sewer and drainage pipes



3 Stakeholders that inform homeowners

The professionals who interact with homeowners during the contact points outlined above are often associated with a broader organization – to represent their profession, or to provide professional training or other services for their profession. These professional organizations often have well-established channels of communication with their membership. Engaging these organizations provides a path to deliver key messages out to professionals, who can then deliver them to homeowners at opportune times.

Table 1 identifies the professional organizations that interact with homeowners during events related to sewer and drainage pipes. Research was conducted to develop profiles for each of these organizations, including a summary of their membership base, points of contact, current practices in relation to this topic, and opportunities for further engagement (see Appendix B).

Table 1. Summary of professional organizations and contact points with homeowners

Professional	Contact points	Event types	Associated organizations
Realtor	• Buying a home	• Proactive	Victoria Real Estate Board BC Real Estate Association
Home inspector	• Buying a home	• Proactive	Home Inspectors Association of BC Canadian Association of Home and Property Inspectors (BC chapter)
Insurance broker/ agency	• Obtaining a new policy • Response to a backup or flooding event	• Proactive • Reactive	Insurance Brokers Association of BC Insurance Bureau of Canada Institute of Catastrophic Loss Reduction
Municipality	• Response to a backup or flooding event • Renovating a home Municipal works in area	• Reactive • Proactive • General	Municipality: general information line Municipality: building permit department Plumbing Officials Association of BC Building Officials Association of BC Municipality: operations or engineering
Contractor	• Renovating a home	• Proactive	Victoria Residential Builders Association Vancouver Island Construction Association Canadian Home Builders Association (Vancouver Island)
Plumber	• Response to a backup or flooding event	• Reactive	No formal organization
Restoration company	• Response to a backup or flooding event	• Reactive	TBD
Social media, website, brochures, home	• Government publications	• General	Canadian Housing and Mortgage Corporation (Regional office) Home Protection Office, BC Housing CRD and municipality outreach departments

shows, etc.			
Non-profit or citizen groups	• Environmental awareness	• General	TBD
Print and online news	• Media	• General	Numerous

4 Determining the magnitude of the issue

Establishing a strong education program for private property sewers and drains requires creating a clear picture of the issue, including its relevance to homeowners and to the stakeholders that interact with homeowners, as well as the degree of urgency of the issue. Creating key messages that are based on relevant, local data can be an effective means to establishing strong key messages.

For the key messages, it will be helpful to have certain contextual information, and this may be derived from various sources. Examples of the type of data that may be needed when defining the issue include:

- Number or percent of houses that are potentially vulnerable due to age, pipe material or location (i.e. no-corrode pipes installed in many houses between the 1950's and 1970's are at an elevated risk of failure.)
- Number of backups annually or dollar value of damage related to sewer backups or basement flooding. Potential sources for this information include:
    - **Insurance industry**: discussions are ongoing about the potential to obtain this information at an aggregated level for the region from large insurers (see Section 5).
    - **Municipalities**: homeowners often call municipalities when they experience a backup, however this is not explicitly tracked. Municipalities could begin collecting data based on calls into main or emergency lines. The CRD core area municipalities generally appear to track if these issues are related to public infrastructure, however, there is not clearly any tracking of incidents that result from issues with private infrastructure.

Following a request to CRD core municipalities for records about this topic, the following was received:

- Colwood: does not have records of receiving any complaints about basement flooding or sewer backups.
- Oak Bay: tracks both flooding related backups correlated to big rain events, and maintains a list of claims against the Municipality.
- Saanich: keeps records, though these were not available or summarized.
- Victoria: tracks claims made against the City (since the mid 1980's). The City also tracks total number of blockages in sewer and service connections, split by cause (roots, grease, debris, structural failure, unknown causes) in mains and service connections (however, the data does not appear to include blockages in private connections).

Further investigation and discussion with municipalities may be warranted to put in place a system to specifically track: a) number of calls received about sewer backups and basement flooding; b) number of these calls that were the result of issues with public infrastructure.

5 Insurance industry considerations

Damage from water and climate-related perils has emerged as the largest source of claims for Canada's property and casualty insurers in recent years (Canadian Institute of Actuaries, 2014). As a result, the insurance industry is beginning to strengthen its models to incorporate various considerations into its assessment of potential risk, including: climate change, ageing and inadequate infrastructure, construction-related issues, etc. rather than purely basing risk on historical trends. However, this is not reported or summarized in a central format. **Individual insurers track this as proprietary information** based on their own claims records and use it for underwriting, pricing and modelling purposes, according to a representative of Insurance Bureau of Canada.

Furthermore, there is **currently no standard "Loss code" specific to sewer backups and/or basement flooding**. Instead, these are captured under a broader category of "39 – Special" water damage, which includes sewer backups, seepage or infiltration flooding, stormwater related flooding, overland flooding, and plumbing failures. This makes them a poorly understood grouping when analyzed at an aggregated level. The Institute for Catastrophic Loss Reduction (ICLR) has published a report recommending that the insurance industry refine the loss code as follows ("Improving Industry Loss Data: Refining Personal and Commercial Kind of Loss Codes for Water Damage, Flood, Fire Wind and Hail" 2014):

Table 6: Proposed Loss Codes, Personal Property Water Damage [4]

Codes to be added to standard, building (30) and standard, contents (31)*:

- Plumbing failure
  - Appliance failure
  - Sprinkler system failure
  - Pipe freeze
- Water damage associated with ice damming
- Sump failure
- Sewer backup, seepage, overland influx
  - Sewer backup
    - Regional event
    - Isolated event
  - Seepage, groundwater
  - Overland influx

*Denotes an already existing code

The report notes that this is a first step of a long process to update the codes, however, there appears to be a high level of support from industry stakeholders to adopt this approach and improve industry claims information.

One company was identified that offers Canadian insurers with a **tool designed to help underwriters more accurately assess the risk of sewer backup and basement flooding** (www.corelogic.com), however when contacted, they were not aware of Canadian data being available at this time.

Although this is a growing concern at the national level, the **issue of sewer backups and basement flooding appears to be fairly small for the CRD region** relative to other insurance concerns, according to

input from a local insurance brokerage. Overland flooding is a much larger area of concern. Discussions indicate there may be potential to obtain data directly from large insurers in the region (at an aggregated scale) to determine approximate numbers of claims due to sewer backups. These discussions are ongoing at the time of writing this report.

6 Framework for stakeholder engagement

The objective of the stakeholder engagement is to disseminate consistent messaging to homeowners from various stakeholder organizations that interact with them in order to significantly improve awareness of homeowner maintenance responsibilities, and better prepare them to understand the state of their sewer and drainage pipes. The proposed approach includes:

- Creating clear messages for homeowners that stakeholders review and agree on,
- Identifying available channels for reaching professionals that engage with homeowners,
- Developing engaging material to present the messages, and
- Developing a plan to disseminate the key messages through stakeholder organizations to their members (who interact with homeowners).

The section concludes with a discussion of the need to setup mechanisms to track the extent of reach, and how well the messages are being received in order to inform future years of the education program.

6.1 Preferred Method for Addressing Stakeholders

Based on discussions held with several stakeholders to date, there is a preference to provide input on a developed set of messages, rather than starting from a blank slate. In addition, some stakeholders expressed a preference for reviewing with internal committees as opposed to having one representative attend a workshop to provide input.

6.2 Develop clear messages for homeowners

The first step proposed is to develop clear, succinct messages for homeowners that all stakeholders are comfortable with. Therefore the following is proposed:

- Review education material developed by other regions. Focus on key messages, but also make note of media, channels and metrics being employed elsewhere.
- Develop a clear problem statement specific to CRD. This may be based on data from the insurance industry, municipalities and/or the plumbing industry (see Section 5 of the report). It may also be based on input that has already been collected from stakeholders (e.g. no-corrode pipe is at high risk of failure).
- Develop a draft set of key messages and guidance based on a clear consistent lexicon.
- Provide the draft messages to identified stakeholders for review and input.
- Request input on what tools might be useful for members to use when engaging homeowners. It may be best to gather this information in a workshop setting.
- Revise and update the key messages and guidance based on stakeholder feedback.
- Identify issues where further work is necessary to align messages to homeowners.

The outcome of this task will be a **draft guidance document containing key messages** with input from stakeholders incorporated. A preliminary outline of potential messages is provided in Section 7 based on conversations held to date.

6.3 Consider available channels to disseminate information to professionals

The following table identifies potential channels for disseminating information to professionals that engage with homeowners on the topic of underground pipes.

Profession	Interest in topic or standard of practice	Channels for information
Realtor	• Standard of care to alert clients of potential risks with older houses, particularly if issues are known in area • Topic is often included in contract subjects, but this varies by brokerage recommendations and region • Property Disclosure Statement is very broad; PDS generally not the best avenue to improve awareness	• **Victoria Real Estate Board**: emails out to members; host training sessions – ideal if these are approved for professional credit; brokerages create checklists from this information • **BC Real Estate Association**: approve training sessions for professional credits • **Real Estate Errors & Omissions Insurance Corporation**: participate in annual presentations to realtors and recommend standard subjects to include in contracts
Home inspector	• Foundation drainage and yard piping are explicitly outside scope of inspection in the ASTTBC Property Inspectors Standards of Inspection • In scope: Interior sumps and pumps; Report on any observed evidence of current/past water penetration and/or condensation • Consumer Protection BC adopts the national standard of practice; note that inspection report template is not mandated	• **ASTTBC Property Inspectors**: Opportunity to incorporate recommendation for camera inspection into standard procedure for specific homes (e.g. older than specified years old) in short term (early 2017) • **Home Inspectors Association of BC**: bring forward at annual meeting to raise awareness with home inspectors; email Executive Director information and will disseminate to membership • **Canadian Association of Home and Property Inspectors (national)**: Suggestion to conduct joint survey of inspectors to clarify current state of knowledge and practice; public web resources • **Consumer Protection BC**: TBD
Insurance broker/ agency	• Interest in reducing risks of property damage from sewer backups and basement flooding • Sewer backup coverage is included in basically all policies in this region (note some other	• **Insurance Brokers Association of BC**: potential to conduct survey to obtain data about sewer backup claims; disseminate education material to brokerages • **Specific brokerages and/or insurers**: request data about sewer backup claims from

Profession	Interest in topic or standard of practice	Channels for information
	places add as extra cost)	brokerages or providers; include handout during policy renewal mail outs
Contractor	• Not typically considered unless building a new home • Interest in meeting code requirements	• **Vancouver Island Construction Association**: Have relationships with community colleges to inform curriculum. • **Canadian Home Builders Association (Vancouver Island chapter)**: Organize workshops that provide CPDs to members
Plumber	• Responsible for attending to sewer backups and flooding • Interest in broad, consistent message for older homes: opportunity to line vitrified clay pipes; need to replace no-corrode pipes	• Post notices on **boards at plumbing wholesale outlets** to reach individual plumbers (four locations noted: Wolseley, Emco, Andrew Sheret, Bartle and Gibson) • Social media
Municipality	• Ensure Building Code standards for new • Prevention of incidents	• Include information in **building permit packages** • Direct **emergency calls** from homeowners to materials online • Send **notice with municipal tax mail out** targeting older homes • **Plumbing Officials Association of BC**: can send email out to members, as appropriate, to disseminate information

Note that many of these organizations have websites or social media presence with information targeted at homeowners, and this is an additional channel for disseminating key messages.

6.4 Develop engaging educational materials

Based on input from stakeholders about appropriate channels for disseminating information (above), the next step will be to identify and develop appropriate communication tools to support delivery of the key messages. These may include:

- Paper and online brochures
- Video clips for web distribution
- Sound bites and slogans for social media (i.e.: twitter)
- Presentation decks for conferences and training events
- Information booths and accompanying materials
- Full courses that meet professional development credits for certain organizations

It may be beneficial to invite participating stakeholder organizations to be listed and/or have logos displayed on materials produced to demonstrate that the information has been reviewed and agreed to by those organizations. These organizations may be more engaged and willing to distribute the information when they are included in this manner, which further enforces the consistent messaging that this project aims to accomplish.

6.5 Create an outreach plan

Developing an outreach plan can help ensure smooth implementation of the approach. The following items may be included in the outreach plan:

- Summary of all outreach opportunities
- Priorities for the first year of the program
- Materials and channels for dissemination
- Timelines for outreach
- Identified lead for each participating organization

6.6 Longer term: tracking uptake and refining the program

The objective of this engagement program is to raise awareness of homeowners in the core area of the CRD. In order to assess if this program is successful, a monitoring program should be developed. It should include:

- Targets for number of events, professionals engaged, and homeowner engaged
- Mechanism for tracking progress toward targets (to be determined in partnership with stakeholders)
- Mechanism for tracking whether awareness is being raised. This may include:
    - Municipalities track and report on private sewer and drainage issues when they are made aware of them (through emergency line calls and/or related permits)
    - Municipalities track and report number of permits obtained for sewer or drainage replacement (note this will not capture repairs as these are done without permits)
    - Insurance providers track and report on claims
- A feedback mechanism to gather input from professionals on how messages are being received. This may include information on
    - How to update and improve key messages
    - Opportunities for training / outreach of professionals interfacing with homeowners

7 Workshop Summary: Developing Key Messages for the Public

On November 15, 2016, a workshop was hosted by Metro Vancouver focused on developing key messages for general inflow and infiltration-related education. The target audience for the key messages was the general public. The messaging was intentionally simplified and may not be appropriate for professionals (i.e. plumbers, realtors). In attendance at the workshop were representatives from Metro Vancouver, the CRD, and two invited consultants considered to have expertise on the topic. The rest of this section contains the key meeting notes from this workshop.

- The group classified stakeholders as being primary or secondary as summarized in the following table.

Audience(s)	Primary/Secondary (for Ph. 1)	Considerations
Real Estate	P	• Liability/risk/fear • P.D.S. – framing
Homebuilders	S	• Indifferent • Renovations
Insurance	P?	• Create perception of problem – don't exaggerate • Just question in Ph. 1
Home Inspectors	P	• Scope • Time
Building and Plumbing Officials	S	
Municipal Staff	P	• Different audiences/different messages
Homeowner Protection Office	S	
Plumbers (private)	P – individual S – association	• Hard to get info • Business opportunity • Mechanical contractors
Homeowners (neighbours)	S	
Media	S	
Restoration workers		

- The group discussed the need for agreed upon terminology. It was understood that the general public may not even understand terms for sewer laterals, etc. More work is needed on this topic and the group moved on due to time constraints. The following table was built during the discussion.

Term (e.g. inflow)	Translation (layperson description)	OK to use?
Private lateral	• Sewer connection. • Private sewer pipe – always use the visual… • Underground sewer pipes and move sewage/rain from your home to public/city pipes (system). • Drainage.	
Side sewer		No

- An exercise was carried out to initiate the creation of key messaging. The following four tables show those messages. Follow-up work will be needed to further refine the key messaging.

"The What"

KEY MESSAGE Homes have underground pipes that need to be maintained * present visually	
Supporting Fact A	• Usually two pipes, one sewage and one rainwater, keep your property dry. [need something on perimeter drains] [need visual]
Supporting Fact B	• Homeowners are responsible for maintaining these pipes. [use existing CRD graphic]
Supporting Fact C	
Supporting Fact D	
Other Comments	• Know what you are buying. Inspect your pipes first. • Have you had the sewer/drain pipes inspected? (question to homeowner) • Homeowners don't always see what they are getting. The state of buried infrastructure can be a costly surprise.

"The Why"

KEY MESSAGE When not maintained, this leads to serious problems	
Supporting Fact A	• Sewage can back up into basements – gross, health, costs, etc. • Sewer pipes in poor condition can lead to basement flooding or sewer backups. • Sewer backups and leaks are common and pose serious health, financial, etc. issues.
Supporting Fact B	• Added up, leaking pipes ? overflows in municipal systems. • Sewage can leak out into the environment – can get into streams or beaches.

	• CRD – beach closure? • See attached CRD FAQ document.

Supporting Fact C	• Happens because:
	  ○ Clogs, tree roots and grease
	  ○ Aging pipes can break or collapse.

Supporting Fact D	• Pipes may be made of clay, cardboard or (see CRD bullets on life expectancy).
Other Comments	• You fix your roof – why not fix your pipes. • "Don't cause a beach closure. Maintain your sewer connection." • Pipes don't last forever. Maintain them to prevent the mess. • How old is the sewer pipe? (question to homeowner) • Best insurance is keeping your infrastructure in good repairs – inspect and fix your sewer connections. • Private sewers are an issue that requires home owner/buyers/sellers attention. • Left unmanaged, private sewers can limit/reduce development capacity.

"The How"

KEY MESSAGE You (homeowners) can prevent these problems	
Supporting Fact A	• CCTV camera inspection to look for clogs and other problems.
Supporting Fact B	• If there's a problem, be proactive and get it fixed.
Supporting Fact C	
Other Comments	

KEY MESSAGE CRD/MV would like to work with industry to find solutions and protect homeowners	
Supporting Fact A	• 2017, engaging realtors, plumbers, inspectors, etc. to develop common approaches to help homeowners to protect their homes.
Supporting Fact B	• Over the long term, we hope to greatly reduce the risk to homeowners (possible key message?).
Supporting Fact C	
Supporting Fact D	
Other Comments	• MV/CRD is working with stakeholders to protect homes.

Appendix A: Project charter

Appendix B: Stakeholder profiles

7.1 Insurance industry

7.1.1 Insurance Brokers Association of BC

Description: The Insurance Brokers Association of B.C. serves as the voice of the general insurance brokerage industry and promotes its members as the premier distributors of insurance products and services in British Columbia.

Website: http://www.ibabc.org

Region: British Columbia (140 communities in BC)

Membership: Represents 882 property and casualty insurance brokers, employing 8,400 people.

Communication channels to members:

- Education: primary provider of pre-licensing and continuing professional education for general insurance brokers in B.C., and the primary examiner for pre-licensing and licensing courses.
- Communications: members are kept informed through BC Broker magazine and other timely communications.
- Public Affairs: represents the interests of the public and its member brokers to all levels of government and to industry stakeholders.

Other opportunities:

- Data collection: potential to survey members to assess number of sewer lateral claims annually in the region, but uncertain whether good response / uptake. Also suggested potential to get data directly from Intact Insurance providers.

Contact: Shawn Fehr, Area Director Vancouver Island, 250-478-9110

Status: Interviewed December 2016, sent email after requesting data
Follow-up when need further input

7.1.2 Insurance Bureau of Canada

Description: IBC is the national trade association for the companies that insure the homes, cars and businesses of Canadians.

Website: www.ibc.ca

Region: National

Membership: Most home, car and business insurance companies and insurance industry associates (e.g., insurance brokers) in Canada

Communication channels to members:

- IBC provides issues management services to members, including policy development, communications and legal services

Contact with homeowners: Direct to homeowners:

- General: website information about preventing sewer backups and flooding http://www.ibc.ca/pe/home/risk-management/mitigation-techniques

Other Opportunities:

- Developed MRAT to support municipalities in planning and focusing efforts on areas with most problems, but municipalities were concerned how the data would be used by insurance industry (impacting rates). MRAT now transferred to private entity.

Contact: Lapo Calamai, Director, Catastrophe Risk and Economic Analysis Insurance Bureau of Canada (IBC), 647.236.8089
Steve Kee, Director, Media & Digital Communications, IBC, 416-362-2031 x4387

Status: Left messages, no direct contact with Steve
Emails with Lapo; only follow-up if have further questions
Follow-up by phone needed with Steve to assess communication channels

7.1.3 Institute of Catastrophic Loss Reduction

Description: The Institute for Catastrophic Loss Reduction (ICLR) is a world-class centre for multi-disciplinary disaster prevention research and communications. ICLR was established by Canada's property and casualty (p&c) insurance industry as an independent, not-for-profit research institute affiliated with Western University.

Website: www.iclr.org

Region: Canada-wide

Membership: N/A (independent research institute)

Communication channels to industry: Research papers to various audiences:

- E.g. recommendations to insurance to add new loss codes for sewer backups
- Best practices guide: Management of inflow and infiltration in new and urban developments, ICLR, 2015
  https://www.iclr.org/images/I_I_Best_Practices_Guidelines.pdf

Contact with homeowners:

- Homeowner safety brochures in English and French

Contact: Dan Sandink, Manager Resilient Communities and Research, dsandink@iclr.org, 416-364-8677 x3212

Status: Interviewed November 2016
Future follow-up on NSERC research project from U of Guelph by Prof Andrew Binns (*Lot level practices to control urban flood risk and mitigate basement flooding in Canada*)

7.1.4 Canadian Institute of Actuaries

Description: "The national organization of the actuarial profession. Member driven, the Institute is dedicated to serving the public through the provision, by the profession, of actuarial services and advice of the highest quality. In fact, the Institute holds the duty of the profession to the public above the needs of the profession and its members."

- Promotes the advancement of actuarial science through research;
- Provides for the education and qualification of members and prospective members;
- Ensures that actuarial services provided by its members meet extremely high professional standards;
- Is self-regulating and enforces rules of professional conduct; and
- Is an advocate for the profession with governments and the public in the development

Website: http://www.cia-ica.ca/home

Region: Canada-wide

Membership: 3,900

Communication channels to industry:

- Conduct research to inform insurance rates, e.g.: http://www.cia-ica.ca/docs/default-source/2014/214020e.pdf?sfvrsn=2#results

Contact: Bonnie Robinson, 613-236-8196, bonnie.robinson@cia-ica.ca

Status: Interviewed December 2016
Email follow-ups to obtain more information
No further follow-up currently needed

7.2 Real estate industry

7.2.1 Victoria Real Estate Board

Description: The Victoria Real Estate Board is an association of approximately 1,300 REALTORS® who work and live in the communities of Greater Victoria and the Southern Gulf Islands. The Board provides its members with the tools and education they need to provide the best possible service to their clients during the buying and selling of a home.

Website: www.vreb.org

Region: Greater Victoria, Sooke, and the Southern Gulf Islands

Membership: 1,300 Realtors

Communication channels to members:

- Provide education to realtors, including courses for professional development credits; currently CRD provides an "Underground systems" 3-hour course for credits and they are happy to discuss providing other courses
- Real Estate Errors & Omissions Insurance Corporation annually presents to Boards across BC – CRD could join this workshop session to disseminate information
- Provide guidance on standard conditions to include in contracts

Contact with Homeowners:

- Web resources for homebuyers and sellers
- Through members who provide guidance during the sale of a home to sellers and buyers

Other opportunities:

- Have committees that can review and provide input on materials and messages – e.g. professional development, government relations and others – bring forward materials or ideas for discussion at committee
- Noted that Property Disclosure Statements are not preferred path to use for this issue; focus more on education and awareness

Contact: Kim Mantle, Manager, Education and Member Service

Status: Interviewed December 2016
Follow-up when need further input

7.2.2 BC Real Estate Association

Description: The Real Estate Council of British Columbia regulates real estate in the public interest. It's role it to enforce standards of conduct, investigate complaints from the public against licensees, and impose disciplinary sanctions under the *Real Estate Services Act*. Their mandate is to ensure the public is well served by real estate licensees.

Website: https://www.recbc.ca/

Region: Province of BC

Membership: 22,000 individuals and brokerages engaged in real estate sales, rental property and strata management.

Communication channels to members:

- Education

Contact with Homeowners:

- Direct, through a buyers and sellers information guide
- Proactive: Offers a comprehensive list of considerations for buyers and sellers to make sure they are entering a purchase / sale agreement with full information about a property. Currently included a plumbing inspection in the list of inspections one may wish to consider when purchasing a property " **Plumbing Inspection:** an inspection of the plumbing and drainage components of a property outlining any deficiencies".
- Indirect, through members offering advice to potential buyers and sellers
- Proactive: Offering advice during the sale of a home, and offering advice in advance of a sale and purchase

Other opportunities:

- Have the RECBC share information with homeowners on their website,
- - Share materials though education activities with their members,
- - Suggest to their members that plumbing inspections be made on homes of a certain vintage, and
- - Work with relevant stakeholders to include private sewer laterals and perimeter drain disclosures on the Property Disclosure Statement.

Contact: Coline Allen, Education & Licensing Officer, 604.683.7702
Marilee Peters, Communications Officer, 604.683.7702

Status: Left messages, no direct contact
Potential for follow-up

7.3 Home inspection industry

7.3.1 ATTSBC Property Inspectors

Description: ASTTBC continues as the certifying body of property inspectors ensuring they maintain the highest industry standards to enhance protection of the public. All ASTTBC Certified Property Inspectors are qualified and experienced in property inspection and in preparing informative reports for clients.

Website: http://www.asttbcpi.org/

Region: Province-wide

Membership: All home inspectors accredited through ASTTBC

- CHI or Certified House Inspector – this designation relates to the standard house inspection that might be carried out by a prospective home purchaser.
- CPI or Certified Property Inspector – members with this designation may do house inspections, but are also certified to carry out various types of commercial property inspections.

Communication channels to members:

- Set the standards for what is included in home inspections; currently this is out of scope and only recommended by individual inspectors as they see fit.
- Currently updating BC standards – draft is in for review. Still an opportunity to incorporate this item and interest in doing so, however short timeline. Ideally comes with support of other regional districts (e.g. MV).
    - Provide specific criteria – e.g. age of home where inspector should recommend camera inspection; make it location specific as needed
    - Can include recommendations for perimeter drains and sewer pipe

Contact with Homeowners:

- Members conduct home inspections, following standards set by the organization

Contact: Barry Brooks, Manager House and Property Inspection Program, bbrooks@asttbc.org, 250-275-7499

Status: Interviewed December 2016
Follow-up quickly with specific messages for inclusion in updated standard; involve MV in coordinated request

7.3.2 Home Inspectors Association of BC

Description: Home Inspectors Association BC is a not-for-profit association of professional home and property inspectors. We are committed to protecting consumers through our stringent membership requirements, mandatory ongoing training programs, and our detailed Scope of Inspection & Code of Ethics. We were instrumental in seeking provincial regulatory control of the home inspection industry which came into effect April 1, 2009. All BC practicing home and property inspectors must now be licensed through CPBC. The HIA has been critical of lax laws and non-existent inspection standards since our inception in 1991, work with CPBC and the Government to close loopholes that allow insufficiently trained inspectors to conduct home inspections, and raise standards to ensure every home buyer gets a comprehensive and accurate home inspection from the industry.

Website: http://hiabc.ca/

Region: Province-wide

Membership: Represent over 65% of the industry throughout 265 regions of British Columbia

Communication channels to members:

- Bring forward this topic at the annual meeting to raise awareness with home inspectors
- Email membership through the Executive Director to disseminate materials

Contact with Homeowners:

- Offer advice on quality of home, usually at time of sale, and recommend whether additional inspections are warranted (e.g. oil tank, exterior plumbing)

Contact: Helen Barton, Executive Director, 250.491.3979

Status: Interviewed November 2016
No need for further follow-up

7.3.3 Canadian Association of Home and Property Inspectors

Description: The Canadian Association of Home and Property Inspectors represents the interests of its members through promoting and enhancing members' professionalism and competency. They have an objective to 'Develop and support programs that are beneficial to Canadian home and property inspector provincial/regional associations and their individual members.'

Website: http://www.cahpi.ca

Region: National (note that BC Chapter is now HIABC)

Membership: Do not have a BC Chapter, but work through HIABC, which represent 65% of the industry in BC

Contact with industry:

- Electronic newsletter for information sharing with home inspectors

Contact with Homeowners:

- Homebuyer resources tab on their webpage
- Publish The Canadian Consumer Handbook, which contains helpful tips and information on housing, as well as over 40 other consumer issues. It also includes a directory of government and non-government contacts specific to each consumer issue and province or territory. The Handbook was created and is updated by the Consumer Measures Committee, a joint committee of federal, provincial and territorial governments.

Other opportunities:

- In 2012, CAHPI coordinated with IBC to share information with members about sewer backflow valves.
- Suggestion to conduct a joint survey of inspectors to clarify current state of knowledge

Contact: Sharry Featherston, Executive Director, 1-888-748-2244, sharry@cahpi.ca

Status: Interviewed November 2016
Follow-up when need further input

7.4 Plumbing industry

7.4.1 Plumbers (direct)

Description: Because the plumbing industry does not have a defined professional organization or association that communicates with members, this section outlines opportunities for reaching plumbers and plumbing companies directly.

Region: Greater Victoria

Membership: N/A

Communication channels to members:

- To reach plumbers, best to post notices on boards at the wholesale plumbing supply shops, including: Wolseley, Emco, Andrew Sheret, Bartle and Gibson
- Social media may be another channel to plumbers

Contact with Homeowners:

- Plumbing companies discuss these topics on their websites (e.g. http://www.victoriadrains.com/ has videos and suggestions for pipe bursting and drain repair)
- Some plumbing companies have a social media presence and would send material out this way
- Print material and web resources are useful to point to when engaging with homeowners

Other opportunities:

- Plumbing companies willing to provide input on education and social media
- Eco Plan conducted a survey of plumbers for Metro Vancouver to gauge their experience dealing with private lateral maintenance. Some findings include:
    - Most calls result in cleaning and root cutting; 20% result in replacing the laterals
    - Maintenance calls are extremely rare, primarily emergency calls
    - Most issues result with older (30+ year old) trees nearby

Contact: Good Grade Plumbing and Gas, 250-686-9857
Victoria Drains, 250-818-1609

Status: Interviewed both companies December 2016
Follow-up when need further input

7.4.2 Industry Trades Association (BC)

Industry Trades Association (ITA) BC: Provincial government body that sets the standards for becoming a Red Seal certified plumber, approves training providers, and administers certification exams. There is a technical training requirement for plumbers typically met through full-time school training, though sometimes it can be met through distance education. Full certification takes approximately 4 years, during which there is a minimum of 780 hours of technical training.

Website: www.itabc.ca

Region: BC

Membership: N/A

Communication channels to members:

- No communication to plumbers as a group, only provide examination
- No professional development or further examination required after completion of ticket

Contact with Homeowners:

- None

Other opportunities:

- None identified

Contact: General line: 778-328-8700

Status: Call to general line December 2016
No further follow-up currently needed

7.4.3 Plumbers Union Local 170

Description: "Our craftsmen receive thousands of hours of classroom instruction and hands-on training at our State-Of-The-Art facilities. They begin with a comprehensive four-year apprenticeship. And then they upgrade their skills with journeyman training throughout their careers. We fully support the highest standards in the industry. That includes mastering the latest materials and techniques, as well as in-depth knowledge of regulations like the British Columbia Plumbing Code. We're dedicated to ensuring public health and safety through using the proper procedures and complying with all applicable codes."

Website: http://www.ualocal170.com/Sub11/Layout10.cfm

Region: BC

Membership: Unknown

Communication channels to members: Unknown

Contact with Homeowners: Through plumbers (see section above)

Other opportunities:

- Potential avenue to provide training or awareness for plumbers that are already certified

Contact: General line, 604-526-0441

Status: Left messages, no direct contact made
Potential to follow up re: size of membership and training opportunities

7.4.4 Plumbing Officials Association of BC

Description: Association of Plumbing inspectors in BC. Provides certification for members. In light of pending changes to the Building Act that requires all Building and Plumbing Officials to become members of BOABC, POABC has postponed membership renewal notices for 2017.

Website: http://www.bcplumbingofficials.com

Region: BC

Membership: 100+ (number not obtained)

Communication channels to members:

- Monthly newsletters
- Email list of members can disseminate key information
- Annual conference

Contact with Homeowners:

- During inspections of work requiring permits (replacement of laterals and drainage – not engaged for repairs)

Other opportunities:

- Can review education materials for accuracy and local context (e.g. age of homes that have vitrified clay pipes, no-corrode and ABS/PVC/plastic)

Contact: Brian Husband, President (also chief plumbing inspector at City of Victoria), 250-361-0345, ext 1, bhusband@victoria.ca

Status: Interviewed December 2016
Follow-up when need further input

7.5 Construction industry

7.5.1 Victoria Residential Builders Association

Description: Since 1940, VRBA has been the professional industry voice of residential construction. Our builders, renovators, designers, trades and suppliers are committed to designing and building the finest sustainable West Coast homes. We are at the forefront of advocating industry issues including mandatory education and training for builders and a uniform building code – both recently introduced by the BC government. We continue to advocate for a renovation tax credit to help address costs of asbestos mitigation, as well as other concerns important to housing affordability and professionalism.

Website: http://www.vrba.ca

Region: Greater Victoria

Membership: 165 members

Communication channels to members:

- Monthly Newsletter and blog
- Education and training
- Awards

Contact with Homeowners:

- Consumer resources page on website where they share information with homeowners that may be considering renovations, and connect them to appropriate resources
- Members offer advice to homeowners that are constructing a new home or extensive renovations of an existing one

Contact: Casey Edge, Executive Director, 250.383.5044, cedge@vrba.ca

Status: Interviewed December 2016
No further follow-up currently needed

7.5.2 Vancouver Island Construction Association

Description: VICA's primary goal is to support the construction industry and building community. VICA offers comprehensive services, programs and resources to owners, consultants, engineers and architects, and construction contractors. VICA has been helping the industry and its members excel since 1912 and provide education and networking support to grow a business.

Website: http://www.vicabc.ca/

Region: Victoria Island, Victoria and Nanaimo Offices

Membership: 500 on Vancouver Island

Communication channels to members:

- Website
- Events including lunch and learns and courses

Contact with Homeowners:

- Members offer advice to homeowners that are constructing a new home or extensive renovations of an existing one

Other opportunities:

- Have relationships with community colleges to inform curriculum

Contact: Chenelle Falconer, Education Coordinator, 1-877-847-6471, education@vicabc.ca

Status: Not contacted
No further contact currently needed

7.5.3 Canadian Home Builders Association (Vancouver Island)

Description: The Canadian Home Builders' Association (CHBA) is comprised of three levels: Local, Provincial and National. In September 2014, CHBA-Central Vancouver Island and CHBA-Victoria united into one association: CHBA-Vancouver Island. CHBA-VI membership includes new homebuilders, renovators, developers, trades, manufacturers, suppliers, lenders and other professionals across Vancouver Island. Membership is a voluntary affiliation made up of building professionals who are committed to industry excellence. CHBA also promotes a members' code of ethics that requires high standards in customer relations and business practices.

Website: http://www.chbacvi.com/

Region: Central and Southern Vancouver Island

Membership: 100+

Communication channels to members:

- Provide members with technical information; specialized education and training courses related to professional accreditation (CPD Credits)
- Special events and conferences

Contact with Homeowners:

- Website provides information to homeowners thinking about a major construction project
- Members offer advice to homeowners that are constructing a new home or extensive renovations of an existing one

Contact: Kelsey Botting, Executive Director, 250-755-1366, kelsey@chbavi.com

Status: Not interviewed
No further follow-up currently needed

7.5.4 Building Officials Association of BC

Description: We are an association representing local government Building Officials and those involved in building design, construction, testing and research. The Building Officials' Association of BC fulfills the following objectives: consistent Code interpretation; a forum for discussion; education, standards of Code knowledge, and a technical certification program for our membership. BOABC members serve on many provincial committees that review building regulatory issues in the Province of B.C. We liaise with inter-provincial and international councils of Building Officials to bring about greater national and international understanding of harmonization of Codes, acceptance of accreditation, and recognition of commonality of our respective endeavours. We are closely affiliated to our colleagues in the building industry and interact through zone meetings, seminars, executive meetings, workshops, our annual conference and annual general meeting, various association committees, appointments to various building industry committees and provincial committees.

Website: http://boabc.org

Region: Province-wide

Membership: 700 members

Communication channels to members:

- Courses, seminars, seasonal conferences, sharing of presentations related to innovation, study sessions, newsletters
- 99% of members receive information via email

Contact with Homeowners:

- Members who ensure a high quality of buildings through home inspections and approvals

Contact: Michael Mark, VP Education, vpeducation@boabc.org, 250.746.3125

Status: Left message, no direct contact made
No further follow-up currently needed

7.6 Government bodies: policy and education

7.6.1 Home Protection Office, BC Housing

Description: Provincial agency that provides training and education related to home protection and maintenance. Focused on new construction.

Website: https://hpo.bc.ca

Region: Province-wide

Membership: As of 2016, the Homeowner Protection Act now requires BC home builders to take Continuing Professional Development credits to renew a license with general contractor status. HPO specifies what type of training is acceptable and maintains an education registry listing training opportunities.

Communication channels to members/industry:

- Prepare guidebooks and disseminate these through website
- Education registry listing training opportunities for CPD credits

Contact with Homeowners:

- Guidebooks and information available on website – none currently related to sewer or drainage pipes

Contact: Cynthia Moran, Research Branch, 778-452-6454

Other opportunities:

- Obtain letter of support for education materials, request for review / input

Status: Left email and voice messages, no direct contact made
Follow-up with phone contact

7.6.2 Canadian Housing and Mortgage Corporation (Regional office)

Description: Federal authority on housing. Conducting National Housing Strategy consultation currently.

Website: https://www.cmhc-schl.gc.ca

Region: National

Membership: N/A

Communication channels to members/industry:

- Conduct research and prepare guidebooks and disseminate these through website – none currently on this topic. Resources are limited and this is not currently a focus area.
- Water efficiency group meets periodically from all regions – could follow up with Glenn Pleasant (Durham region) to determine if sewer laterals are included

Contact with Homeowners:

- Guidebooks and information available on website – none currently related to sewer or drainage pipes except "Guide to sustainable plumbing in the home" which mentions CSA standards about backflow preventers

Contact: Kate, CMHC Regional Office, 613-748-2284

Status: Interviewed November 2016
No further follow-up currently needed