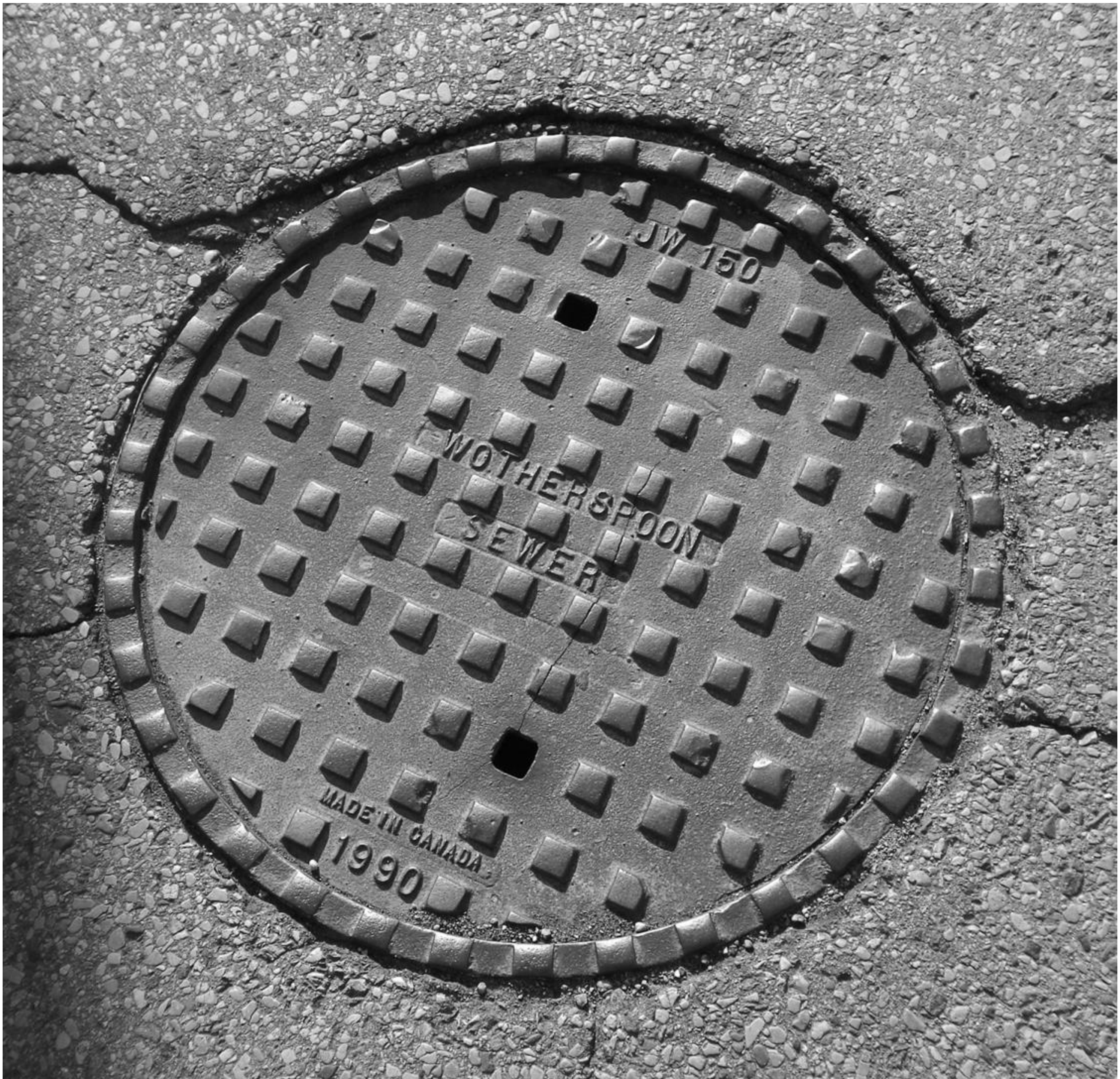

What Lies Beneath

The State of Ontario's Water and Wastewater Infrastructure

THE INFRASTRUCTURE LAB

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This report was commissioned by the Ontario Sewer and Watermain Construction Association.

About the Infrastructure Lab

The Infrastructure Lab brings together industry, government, and other experts to better understand Canada's infrastructure challenges and provide solutions. With Canada making unprecedented investments in infrastructure, our goal is to promote constructive dialogue across all stages of the infrastructure lifecycle. We aim to find effective solutions to deliver the most value for communities, governments, and companies.

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The State of Ontario's Water and Wastewater Infrastructure

Over the last decade, Ontario's 444 municipalities have made substantial progress in better understanding the state of their infrastructure. As data on municipal infrastructure assets has been collected, a clearer picture has begun to emerge on the physical state of three major asset classes: water, wastewater, and stormwater.

This information is helping to establish important baseline measurements to evaluate the long-term sustainability of this critical core infrastructure. Despite this progress, there is still much to be done to establish a more complete understanding of the state of Ontario's underground infrastructure, and to develop effective policies to ensure it can cope with the pressures of a growing population, aging infrastructure, and a more unpredictable climate.

This report examines the state of water, wastewater, and stormwater infrastructure for 30 Ontario municipalities. These communities range in size from 13,000 people to over 900,000, and together represent 30% of the provincial population.

Report Highlights

- Collectively, 20% of water, wastewater, and stormwater linear infrastructure, valued at more than $8 billion, is in poor to very poor condition in our sample alone; additionally, over $1 billion of this infrastructure remains in operation beyond its recommended useful life.
- Ontario has a highly fragmented water infrastructure network, with a total of 466 wastewater systems and 665 drinking water systems varying in size and sophistication.
- Only one municipality uses physical inspections to evaluate its water, wastewater, and stormwater infrastructure; the rest estimate asset condition based on age which does not paint an accurate picture of the true state of the infrastructure.
- The 30 municipalities evaluated saw a total of 1,677 watermain breaks and 225 sewage backups in 2016 alone.
- A number of the foundational recommendations from the Walkerton Inquiry Report and the Water Strategy Expert Panel Report remain unaddressed, particularly those related to financing and operational capacity of municipal water systems.[1] Given the significant public health issues related to contaminated water, there is an inherent risk in continuing to avoid effecting these recommendations.

Key Findings

The data suggests that 80% of the infrastructure is in fair or better condition, but this statistic is misleading for two main reasons:

1. There is uncertainty around the actual state of infrastructure, as condition estimates are mostly based on age of assets. This means decision-makers in local governments are still making long-term financial decisions under tremendous uncertainty.
2. Lack of standardization in measurement and assessment makes it very difficult to fairly and accurately compare the relative state of infrastructure between municipalities.

Recommendations

To make the best of the significant time and effort that is already being spent on collecting and analyzing asset data, it is important to close remaining gaps and provide stronger evidence for infrastructure planning. This will provide greater certainty for both utilities and private sector partners, and can significantly reduce costs over the life-cycle of the asset. To achieve this, there should be a focus on five main areas:

1. Move from age-based to inspection-based planning.
2. Make all underground infrastructure a priority.
3. Standardize approach to full-cost recovery.
4. Provide transparency on infrastructure state, risk, and impacts.
5. Drive best practices in asset management.

[1] Julie Abouchar and Joanna Vince, "Ten Years After Walkerton – Ontario's Drinking Water Protection Framework Update," (Ottawa: Canadian Bar Association, 2010), <http://www.cba.org/cba/cle/PDF/ENV11_Abouchar_paper.pdf >, 12-14.

Infrastructure Under Pressure

Water, wastewater, and stormwater infrastructure in Ontario faces three major pressure points: population growth, climate change, and deterioration due to aging. Together, these factors can have a significant impact on people's lives across Ontario on an almost daily basis.

Ontario's population is expected to grow by more than 30% by 2041, reaching 18.2 million people, with the Greater Toronto Area (GTA) expecting to see its population expand by 42% over this period to reach 9.6 million people.[2] This rapid population growth will continue to stress infrastructure beyond its intended capacity, resulting in increasing system failures across the province.

As the population grows, the importance of land-use planning and resilient infrastructure becomes increasingly important. This is exacerbated by the impacts of climate change which has made storms more frequent and severe. When infrastructure is unable to cope, it can disrupt people's lives and harm the environment, including the flooding of property, sewage backups into basements, and contaminating lakes and rivers.

Infrastructure Pressure Points

1. Growing population will put greater stress on assets.
2. Aging infrastructure may be inadequate to perform its function.
3. Climate change will cause more severe weather events and push assets beyond capacity.

Examples of this are becoming increasingly frequent. The July 2013 storm that resulted in flash flooding across the GTA caused $940 million of damage in Toronto alone, becoming the most expensive natural disaster in Ontario's history.[3] To protect homeowners from subsequent flood risk, insurance premiums have risen by as much as 20 percent in the GTA. In the summer of 2017, Windsor saw $124 million of damage with over 1,000 basements flooded.[4] In February 2018, a state of emergency was declared in various parts of southwestern Ontario, as people were forced to evacuate their homes due to heavy rain and melting snow.[5] These previously rare 100-year storm events, are becoming much more common, and current stormwater infrastructure is unable to cope.

The existing infrastructure built to ensure people in Ontario have access to clean, safe drinking water, have functioning waste disposal, and are protected from storm water, is getting older and failing. For the 30 municipalities examined in this report alone, 20% of this critical core infrastructure has been classified as poor, worse, or expired. This translates to broken watermains, drinking water contamination, sewage backups, sinkholes, flooding, and sewage overflows. Across the network, there are countless examples of pipes and mains that are well past their useful life, but cannot be replaced due to budgeting priorities being focused elsewhere.

The misfortune of underground infrastructure is that it is out of sight and out of mind when it comes to setting spending priorities. With the combination of climate change, population growth, and age all coming together to put pressure on these systems, there must be a major re-prioritization of how this critical underground infrastructure is viewed and managed in order to protect people's health, property, and prevent costs mounting up in future.

[2] https://www.fin.gov.on.ca/en/economy/demographics/projections/
[3] https://www.ontario.ca/page/climate-change-strategy
[4] http://www.ibc.ca/on/resources/media-centre/media-releases/late-august-flooding-in-windsor-region-caused-more-than-124-million-in-insured-damage
[5] http://toronto.citynews.ca/2018/02/24/southern-ontario-community-issues-state-emergency-due-flooding/

Purpose of this Report

This report identifies steps municipalities can take to ensure that their water, wastewater, and stormwater infrastructure provides the best value for tax- and rate-payers. To achieve this, municipalities must take incremental steps towards full-cost recovery, which will result in consistent and sustainable system management over the long term, and a fair and equitable share of responsibility by community members.

A full-cost recovery strategy will ensure the following are covered:

- ✓ the cost of renewal and replacement of assets that meet existing and growth-related needs
- ✓ the cost of operating and maintaining these assets
- ✓ the cost of doing periodic inspections and assessments

With the introduction of the Municipal Infrastructure Investment Initiative (MI3) in 2012, for the first time local governments across Ontario were required to produce an asset management plan (AMP) summarizing the state of their core infrastructure. They were also required to develop asset management and financial strategies to ensure their infrastructure remained in a 'state of good repair.'

This was a pivotal first step. The findings in this report build on these AMPs, and highlight some of the common challenges municipalities continue to face as they move towards full-cost recovery for their water, wastewater, and stormwater assets. The data for this report came from 30 geographically, and demographically diverse Ontario municipalities. The data sets illustrated three vital measurements:

1. the total replacement cost of each asset class;
2. the estimated condition of assets; and,
3. how these condition ratings were derived.

The condition of the asset is an essential indicator in gauging its ability to function properly and continue to provide safe service to a community. However, for most underground infrastructure, this condition is only approximated based on age, resulting in significant uncertainty and risk for long-term financial planning.

Sample Profile

To provide an accurate snapshot of the state of water, wastewater, and stormwater infrastructure across the province and the plans in place to manage it, the report examined 30 municipalities. The 2016 population of these municipalities totaled four million people, or 30% of the provincial population. This sample represented a diverse range of communities, from small rural municipalities to major cities, from central townships to northern regional hubs. The median population in our sample was 67,194. The smallest municipality was approximately 13,000; the largest was over 900,000.

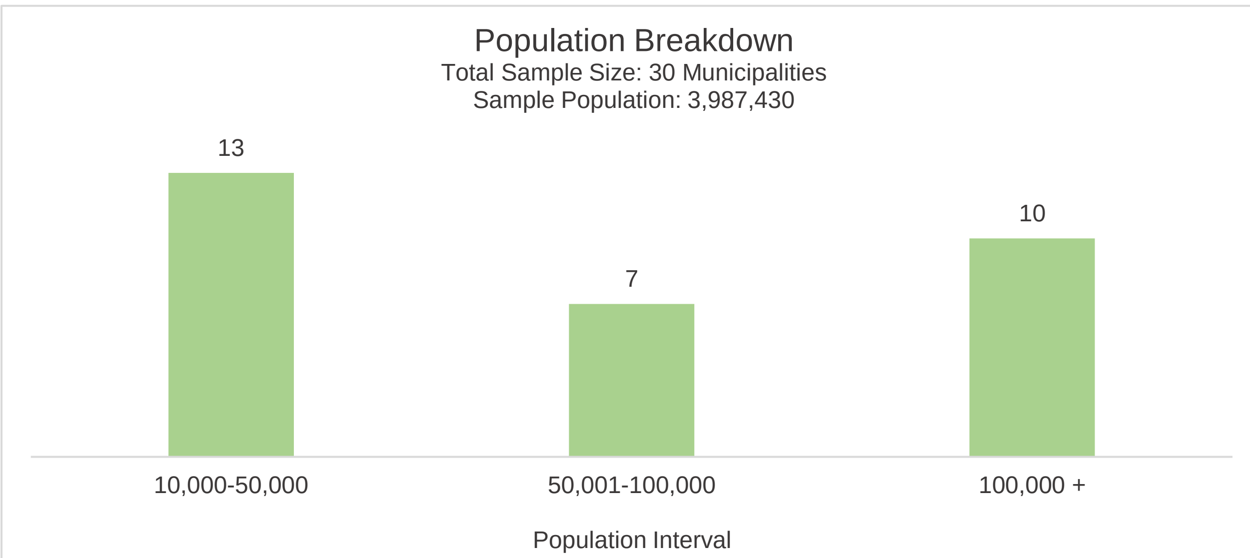


Figure 1: Population Breakdown by Intervals

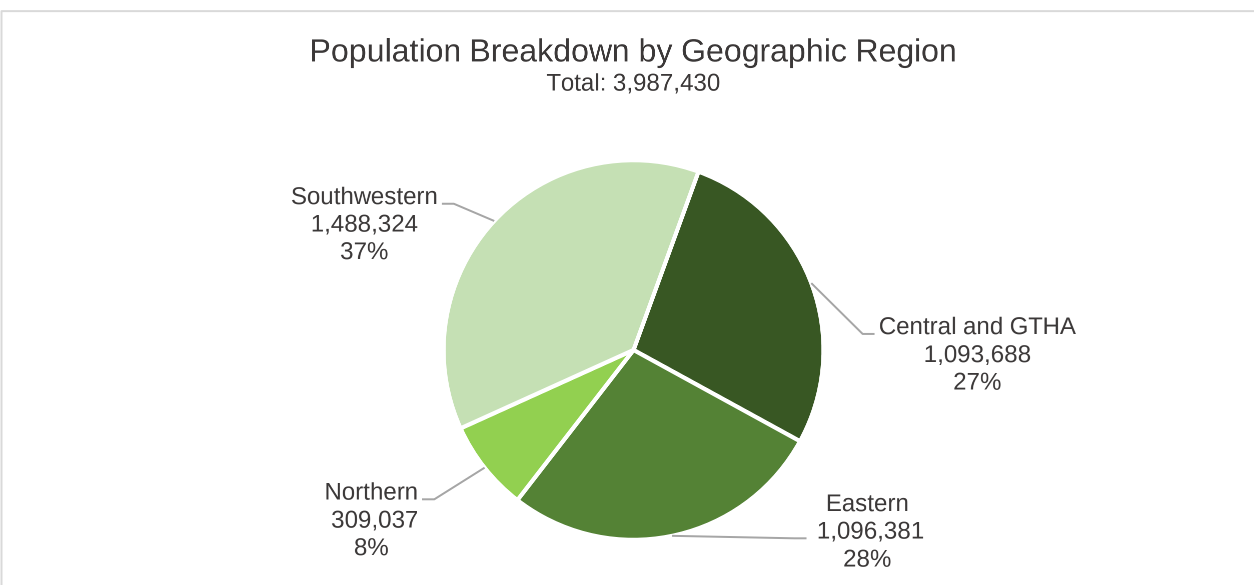


Figure 2: Population Breakdown by Geographic Region

The Scale of Ontario's Underground Infrastructure

Ontario has one of the most fragmented water systems in the world, with 466 wastewater systems and 665 drinking water systems varying in size and sophistication, providing services to the province's 444 municipalities.[6]

Using the most recent asset management plans available (2013-2016), the current, combined replacement value of the water, wastewater, and stormwater infrastructure for these 30 municipalities is $40 billion. This figure represents only linear infrastructure, which includes water mains, pipes, and laterals that connect buildings and homes to the municipal water and wastewater network. It excludes vertical infrastructure, such as treatment plants, pump stations, and other water and wastewater facilities.

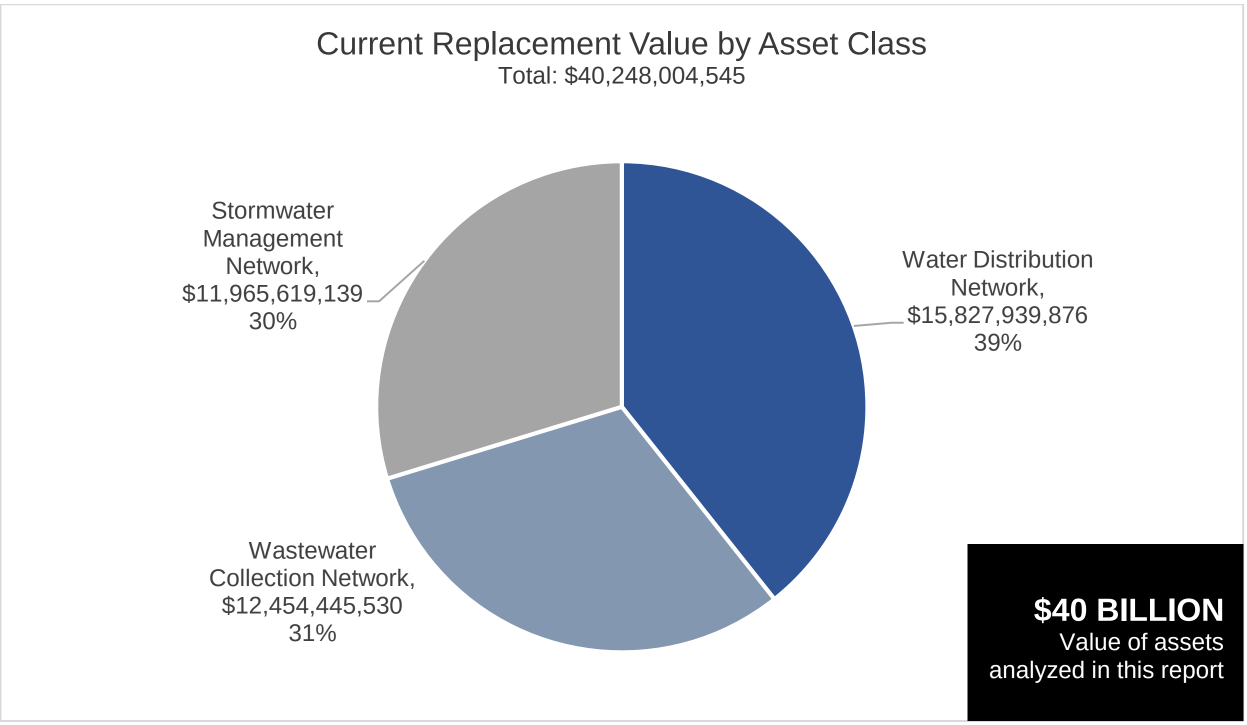


Figure 3: Current Replacement Value of Assets

Municipalities rely on various methods to reach this figure, including analyzing recent contracts and invoices, inflating historical costs, and estimates from their resident experts. Seven of the municipalities did not indicate a value for their stormwater assets, likely because they rely on their wastewater infrastructure for stormwater conveyance.

Ontario's underground infrastructure is vast. Failure at any point in the network can have serious impacts on people's lives. In addition to AMP data, we also reviewed the 2016 Financial Information Returns (FIR) as filed by each municipality with the Ontario Ministry of Municipal Affairs and Housing. The table below shows the scale and complexity of underground infrastructure municipalities in our sample alone are tasked with managing:

- The oldest watermain in our sample was installed in 1875, only eight years after the Dominion of Canada was established in 1867, and nearly 40 years before World War I.

[6] https://www.amo.on.ca/AMO-Content/Speeches/2016/AMO-President%E2%80%99s-Remarks-at-2016-OGRA-ROMA.aspx

- The underground networks for these municipalities alone could circle the world one and a half times; the linear network in any one of the asset classes is enough to circle the moon (10,921km).
- The water network in our sample can span the entire length of the land border between Canada and the U.S., twice.
- The wastewater collection network, the shortest in our sample, is more than twice the length of the Amazon River (6,992km), the longest in the world.

Portfolio Size by Asset Class: Length of Network

Asset Class	Length in Km	Megalitres of water/wastewater treated annually
Water Distribution Network	18,196	432,738
Wastewater Collection Network	14,349	349,462
Stormwater Management Network – Urban	15,738	-
Stormwater Management Network – Rural	15,167	-

Source: 2016 Financial Information Returns (FIR)

Table 1: Length of Each Network in KM

CASE STUDY

Case Study: Managing Storm Overflows in Kingston

Key Issue Impacting Kingston

- Combined sewer overflows resulting from old infrastructure

How the city is responding

- Adopted 'virtual elimination' of combined sewers by 2036
- Actively replacing existing combined sewers in the historic downtown area and beyond
- Providing full transparency on CSO incidents, refreshed every 48 hours

Combined sewers are a Canada-wide problem. These sewers make no distinction between storm runoff and wastewater and were built simply to drain this waste (known as combined sewer overflows, or CSOs) to the nearest lake or river—direct into the environment, with no treatment, rather than overwhelm the system. In addition to polluting lakes and rivers, compromising the vitality of wildlife, CSOs pose a critical risk to public health. Kingston, an old and historic city, was no exception to this.

In 2006, the city's *Combined Sewer Critical Evaluation* recommended that the best option for rehabilitating Kingston's aging sewers was to not replace them with new combined sewers, but build entirely separate sewers for waste and stormwater runoff. In its 2010 *Sewage Infrastructure Master Plan*, the city formally adopted the goal of 'virtual elimination' of CSOs in the long term.

When the master plan was developed in 2010, Kingston's sanitary system handled 139,000m^3 of CSOs. The city set a target of reducing it by 94.4% by 2036. In its 2017 *Master Plan* update, the city's scenario analysis for managing CSOs showed sewer separation as the best strategy for reducing the volume, duration, and frequency of CSOs. Sewer separation was also identified as having the lowest overall capital and operational costs.

Today, all new and replacement sewers in Kingston are separate, consisting of a two-pipe network. But the city has gone beyond infrastructure investments to provide significant transparency to the community. Utilities Kingston, which delivers the city's water and wastewater services, provides real-time visual updates of major sewer projects underway or recently completed; a map that shows the progression of sewer separation since 2000, including projections; and, updates on sewer overflow events along its waterfront on Lake Ontario, refreshed every 48 hours.

The Current State of Ontario's Underground Infrastructure

One of the key requirements in the asset management plans first published between 2013-2014 was the inclusion of the state of the infrastructure report. Municipalities were required to detail the physical health of their assets for major infrastructure classes, including water, wastewater, stormwater, roads, and bridges. Producing this data was a major achievement, and is critically important in determining how to prioritize infrastructure spending, and identify assets that may pose health and safety risks to the public and create liability for the municipality.

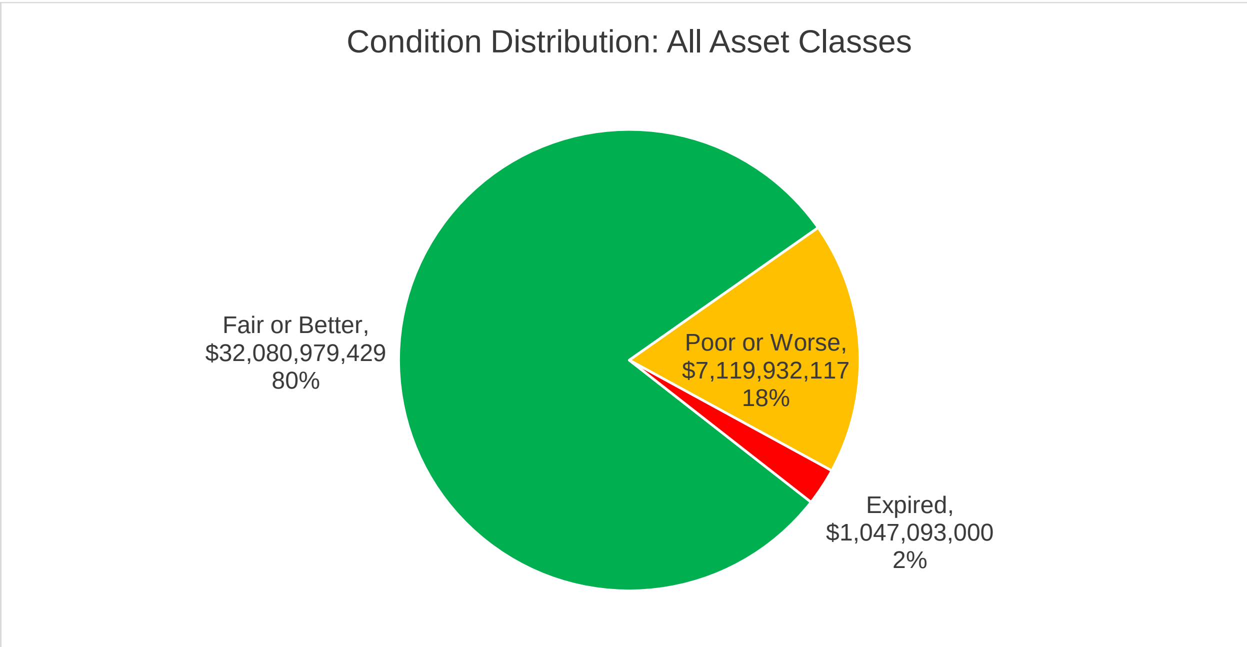


Figure 4: Condition Distribution: All Asset Classes

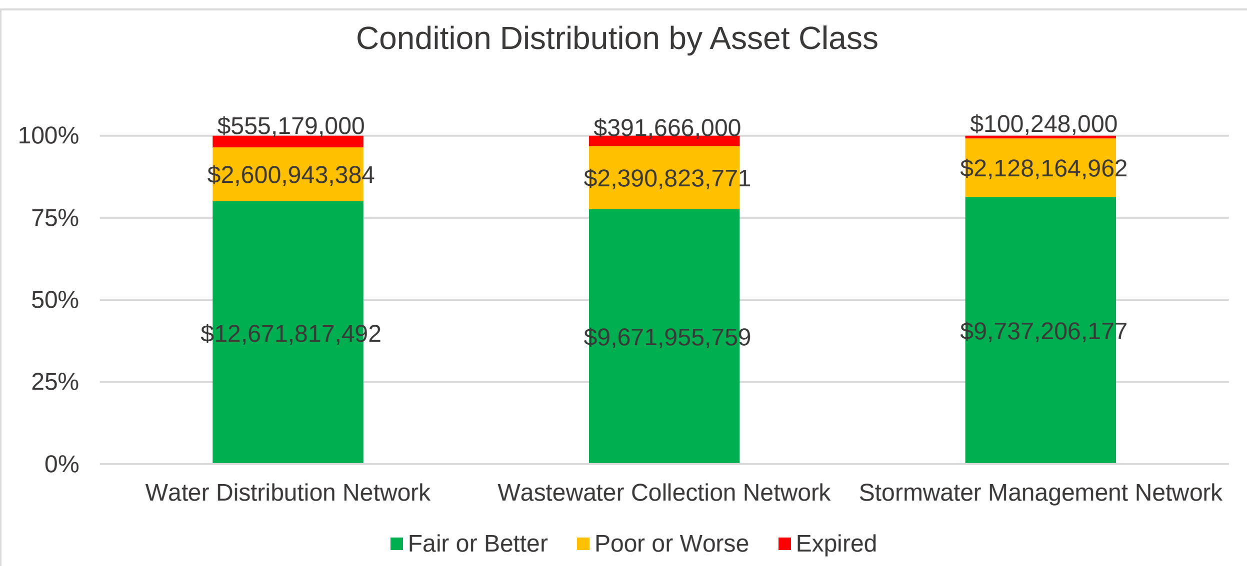


Figure 5: Condition Distribution by Asset Class

Our data shows that although 80% of all infrastructure is in fair or better condition, the 20% that is in poor or worse condition would cost $8 billion to replace. The highest portion of infrastructure in poor or worse condition was in the wastewater collection network, comprising 22% of the portfolio and valued at $2.8 billion.

One concerning aspect to note is that over $1 billion of all underground assets remains in operation beyond what is considered their established useful lives. Examples of this infrastructure can be found across the province. In Hamilton, 12% of the sanitary sewer mains are over 100 years old, requiring immediate rehabilitation or replacement.

The picture is also mixed for each municipality. According to its asset management plan, the municipality of Chatham-Kent had the highest portion of its water infrastructure in poor or worse condition, including 37% that had expired. For wastewater infrastructure, Windsor's portfolio includes 27% of assets that remain in operation beyond their useful life, the highest in the sample. Windsor also had the highest portion of its stormwater assets to have expired, at 6%.

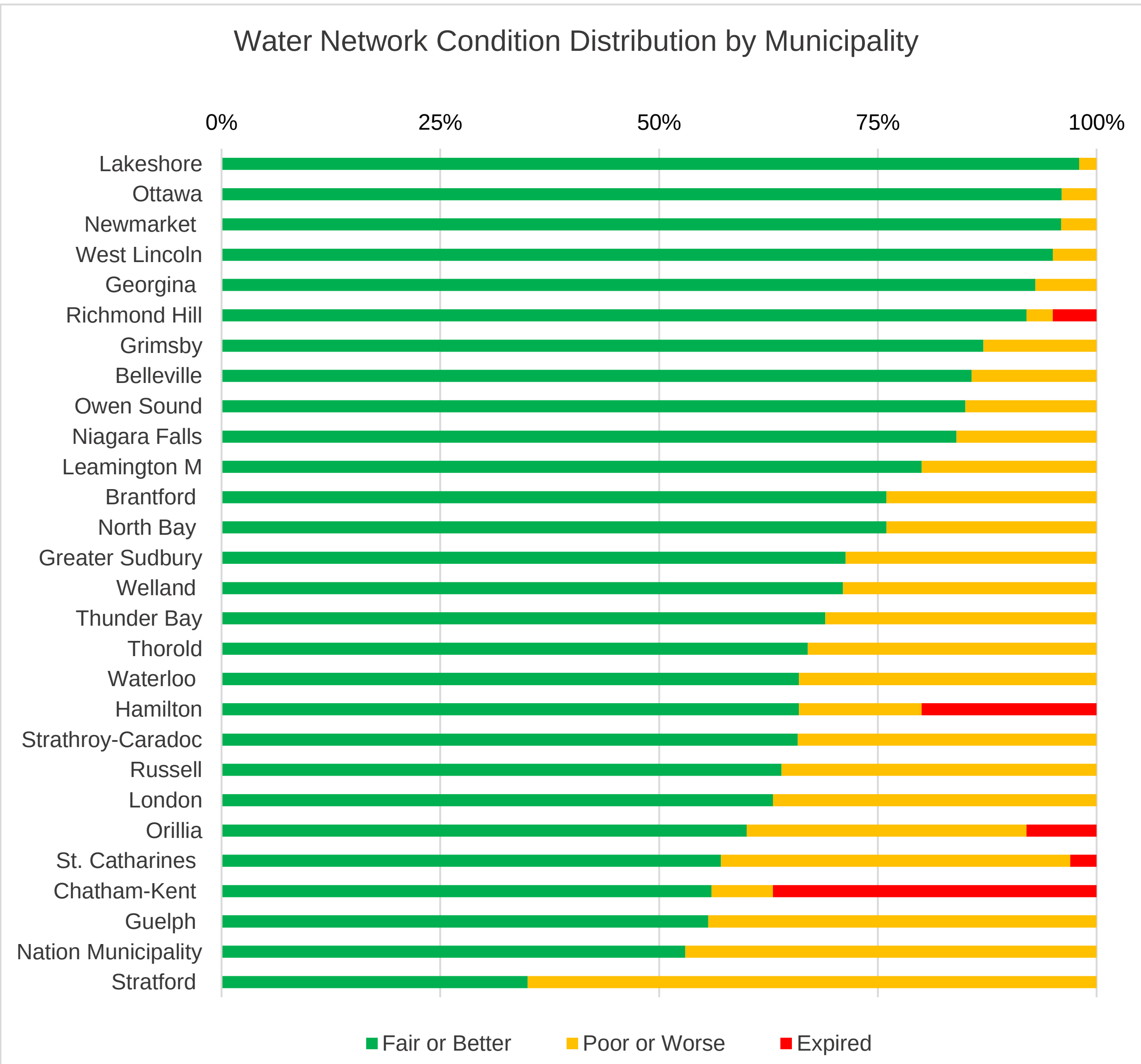


Figure 6: Water Network Condition Distribution by Municipality

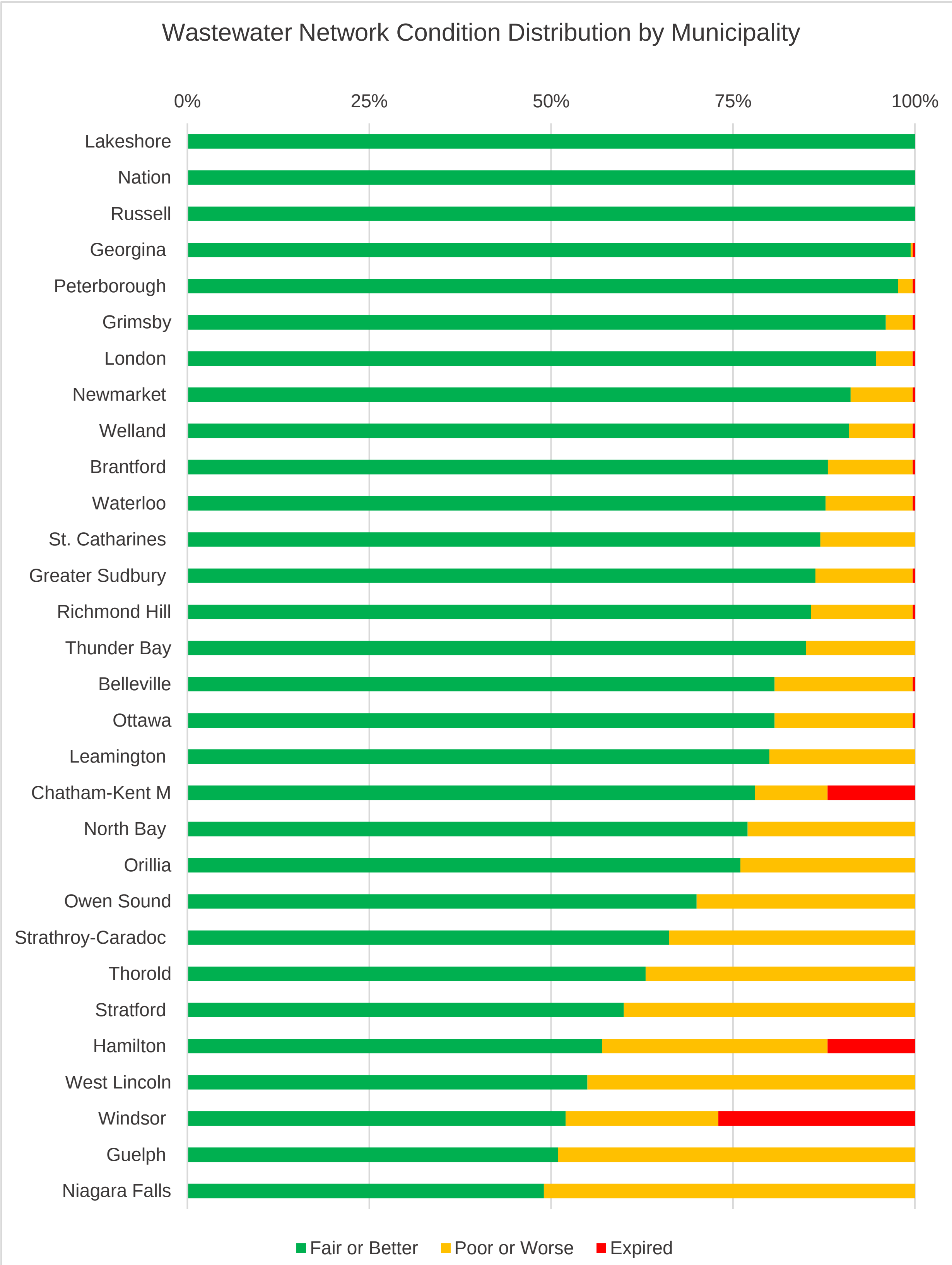


Figure 7: Wastewater Network Condition Distribution by Municipality

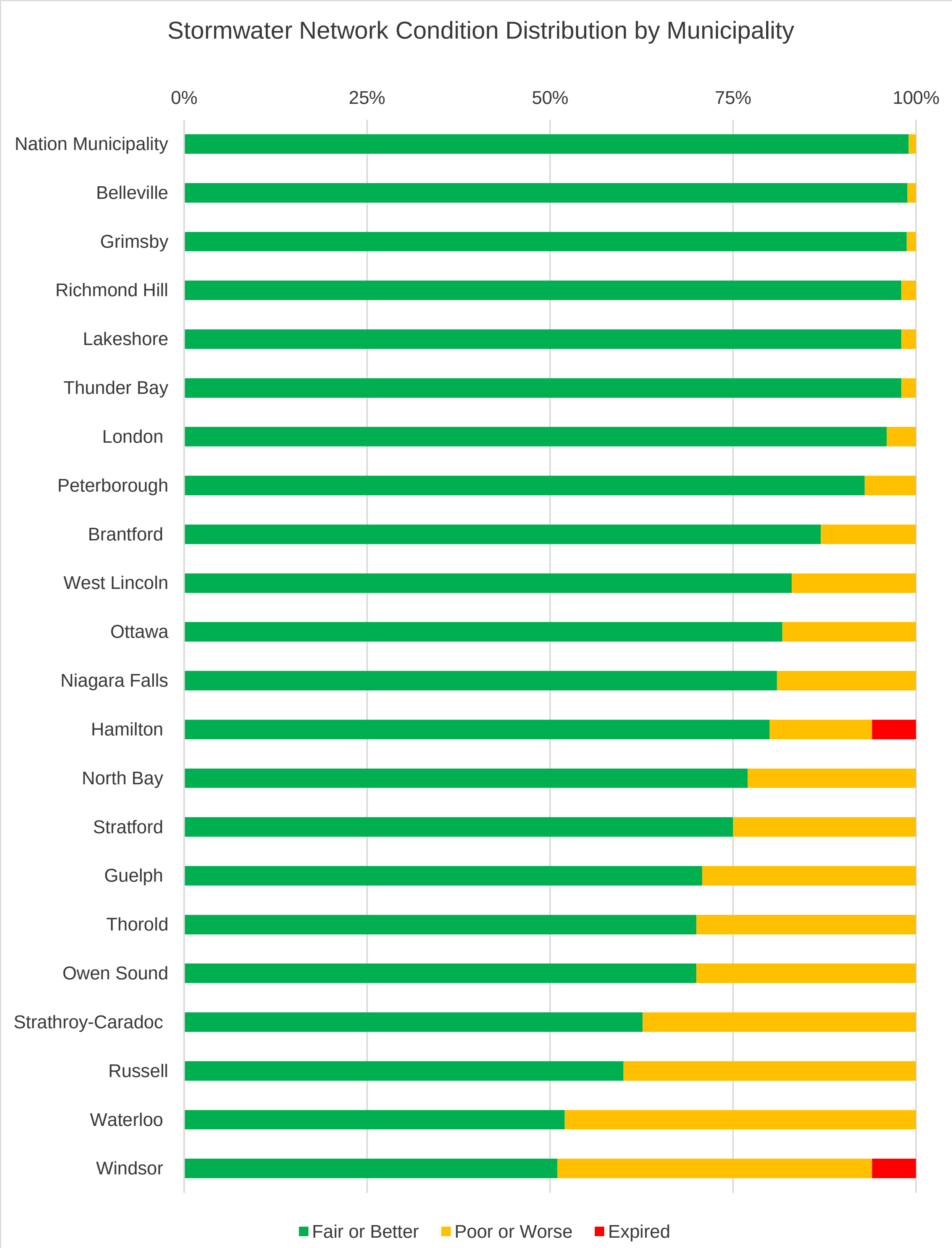


Figure 8: Stormwater Network Condition Distribution by Municipality

Pipes that Dissolve

In some cities, it is not just the age of the pipes that have caused failures, but their material. Pipes are now commonly made of PVC, steel, and concrete. But across Ontario, older pipes can be made of cast iron, lead, clay, wood, and even cardboard. For nearly two decades after World War II, many cities in Canada began installing cardboard pipes, technically known as ‘coal tar-impregnated wood fibre.’ They made installation easier and faster, which was necessary to meet the infrastructure needs of a growing baby-boomer population.

In Waterloo, Ontario, a 1994 city survey identified 100,000 homes that were serviced by such pipes. These pipes began to dissolve, and cost more than $650 million to replace at the time. In Edmonton, Alberta, a 2011 estimate suggested the city would need $1.8 billion to replace similar pipes. An engineering study revealed that the hot water from dishwashers was the catalyst behind the rapid failure of these pipes.

In addition to the state of the infrastructure data in municipal AMPs, high-level indicators are also available in municipal FIRs. These data points indicate where infrastructure is failing by measuring watermain breaks and sewage backups. In 2016, Welland had highest watermain break rate per 100 kilometres, while Ottawa had the highest incidents of sewage backups, with 43 in total. Making reliable inferences from these data sets on the state of a municipality’s infrastructure can be difficult: the lack of consistency in approach and measurement between municipalities makes a true and fair comparison virtually impossible.

2016 Watermain Break Rate and Wastewater Backup History

Asset Class	Statistical Indicator
Water Distribution Network	Total main breaks: 1,677 Break rate: 9.2 per 100-km
Wastewater Collection Network	Total main backups: 225

Source: 2016 Financial Information Returns (FIR)

Table 2: Watermain Break Rate and Wastewater Backup History

Figure 9 and Figure 10 outline break rates and backups by each municipality as reported in their respective 2016 FIRs.

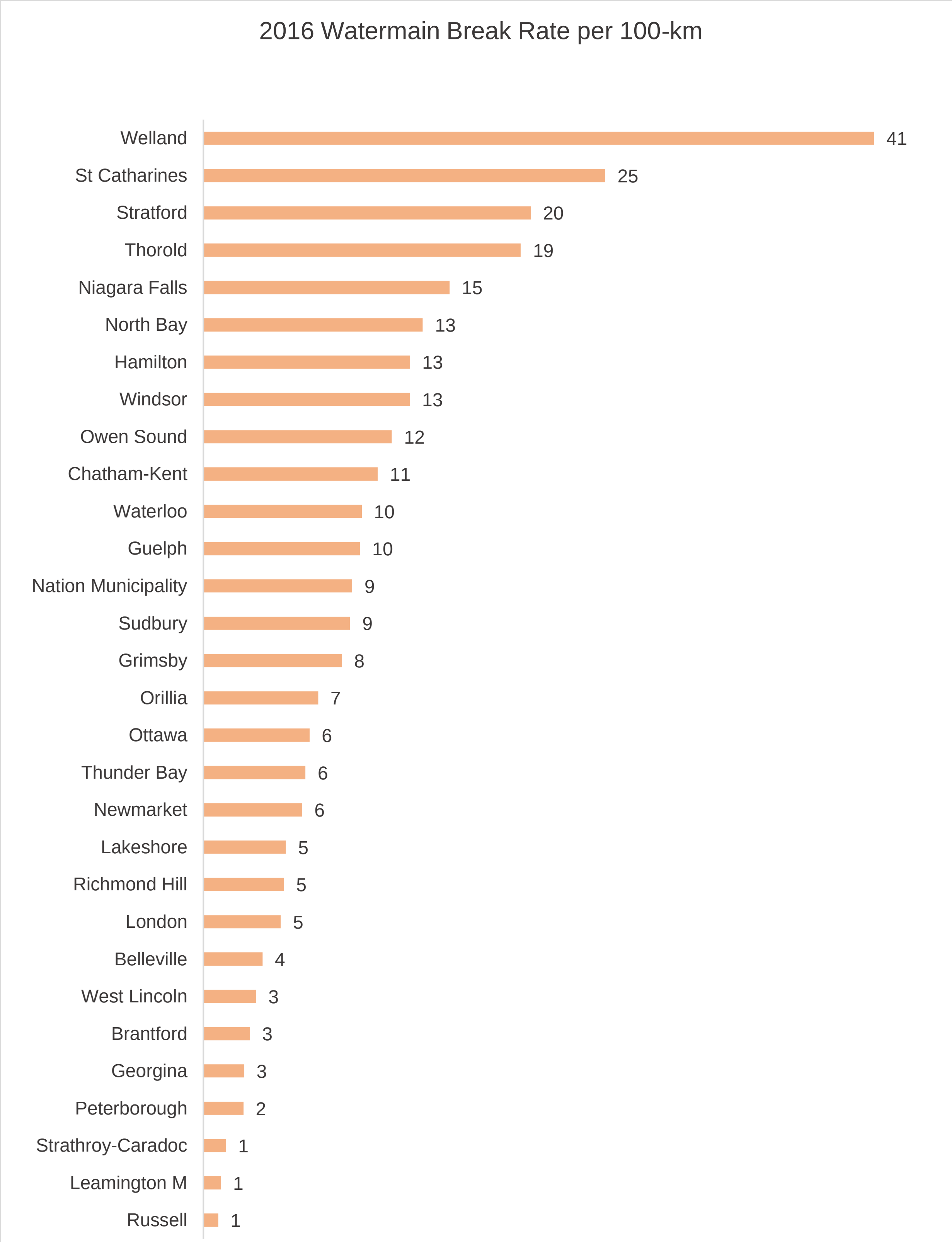


Figure 9: 2016 Watermain Break Rate per 100-km

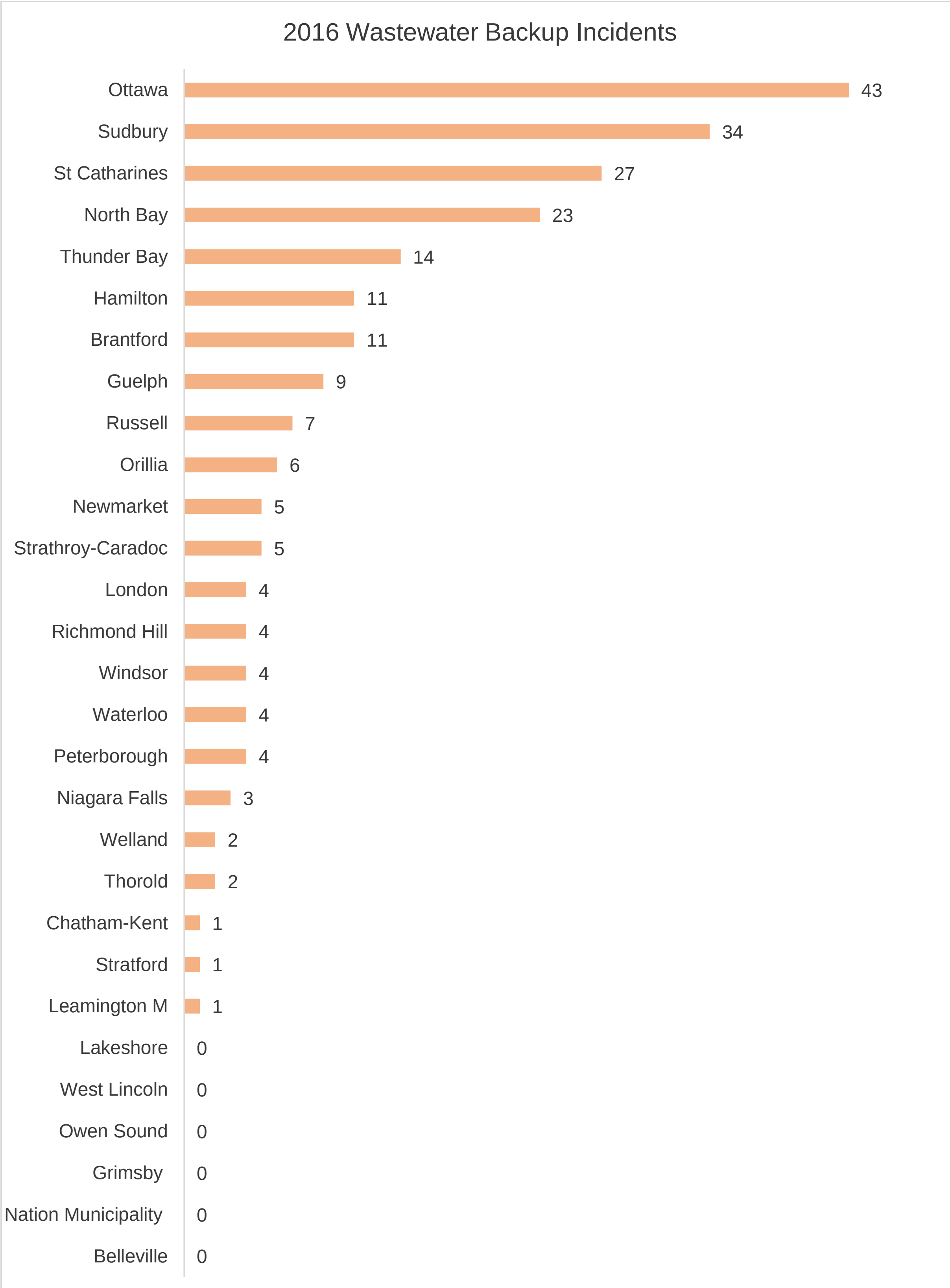
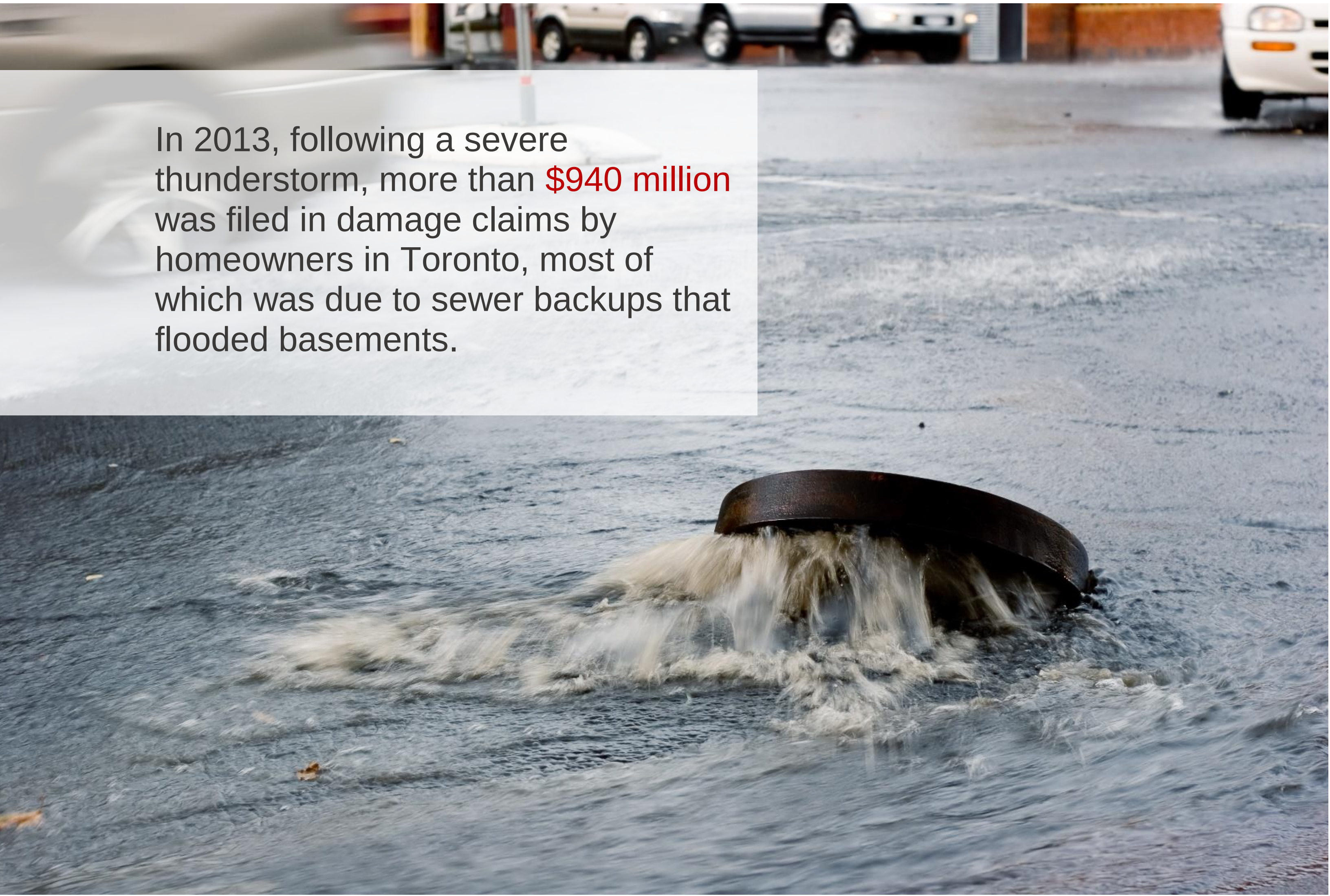


Figure 10: 2016 Wastewater Backup Incidents

If preventative maintenance is not conducted, watermains break as the infrastructure ages. Recent extreme fluctuations in temperatures have wreaked havoc on underground infrastructure across Ontario. After an extreme cold weather alert was issued in late-December 2017, the City of Toronto saw 120 watermain breaks by January 2018, an increase from just 17 breaks during the same time period last year. It is not just Toronto's water distribution network that is vulnerable to extreme weather events; so is its stormwater and wastewater. In 2013, following a severe thunderstorm, more than $940 million was filed in damage claims by homeowners in the city, most of which was due to sewer backups that flooded basements.

To address such an issue requires focus and resources. Although data has fluctuated, the City of St. Catharines saw a significant decrease in watermain breaks, from an average rate of nearly 45 breaks per 100 km in 2000 to approximately 15 breaks per 100 km in 2012. According to staff, this decrease was directly related to an increase in the city's watermain replacement budgets as well as prioritizing replacements.



In 2013, following a severe thunderstorm, more than $940 million was filed in damage claims by homeowners in Toronto, most of which was due to sewer backups that flooded basements.

Determining Asset Condition

There is a concerning lack of standardization as to how condition data was collected and a rating assigned. Municipalities can either conduct regular condition assessments and inspections, or rely on the age of the asset to estimate its health (‘age-based’). Due to their often-prohibitive cost, most municipalities in our sample, and indeed much of Ontario, rely on age to estimate the condition of their water, wastewater, and stormwater assets. The table below shows how the 30 municipalities in our sample derived their condition estimates. Of all the municipalities analyzed, only Guelph performs assessments across all three infrastructure classes; the vast majority base their condition estimates on age alone.

Source of Condition Data

Municipality	Asset Class		
	Water	Wastewater	Stormwater
Chatham-Kent	Age	Age	NA
Leamington	Age	Age	Age
Georgina	Age	Age	NA
Strathroy-Caradoc	Age	Age	Age
Greater Sudbury	Age	Age	Age
Hamilton	Blend	Assessed	Assessed
Niagara Falls	Assessed	Age	Age
North Bay	Age	Age	Age
London	Age	Assessed	Age
Guelph	Assessed	Assessed	Assessed
Windsor	NA	Age	Age
Brantford	Age	Assessed	Age
Newmarket	Age	Age	Age
St. Catharines	Age	Assessed	Age
Richmond Hill	Age	Age	Age
Stratford	Age	Age	Age
Orillia	Age	Assessed	NA
Waterloo	NA	NA	NA
Thunder Bay	Age	Age	Age
Peterborough	NA	Assessed	Assessed
Thorold	Age	Age	Age
Lakeshore	Age	Age	Age
West Lincoln	Age	Age	Age
Ottawa	Blend	Blend	Blend
Owen Sound	Age	Age	Age
Grimsby	Age	Age	Age
Belleville	Age	Age	Age
Russell	Assessed	Age	Age
Nation	Blend	Blend	Age
Welland	Age	Age	Age

Table 3: Source of Condition Data

Conducting condition inspections for water mains is a significant technical challenge, and often requires service shutdowns. However, the technology required to get a more accurate real assessment is continually evolving. Hamilton, for example, uses advanced acoustic and electromagnetic technologies to conduct 'direct assessments' and determine actual pipe condition for its high-criticality pipes, and identify distresses.

For wastewater and stormwater networks, municipalities can use closed-circuit television (CCTV) inspections, or a zoom camera analysis. While both methods pose added costs to the municipality, when viewed as a percentage of the overall replacement value of the assets, there is strong case to be made for using them. Condition assessments can help provide clear priorities for maintenance and repair to prevent major failures and extend the life of an asset.

Comparing Inspection Technologies

Asset Class	Inspection methodology	Cost per unit	Total quantity in sample	Total cost of inspection	Percentage of total asset portfolio
Wastewater	CCTV	$10,000 per km	14,349km	$143,490,000	1.14%
	Zoom	$300 per manhole	179,000mhs	$53,700,000	0.43%
Stormwater	CCTV	$10,000 per km	15,738km	$157,378,000	1.27%
	Zoom	$300 per manhole	197,000mhs	$59,100,000	0.49%

Table 4: Comparing Inspection Technologies

Using age alone to estimate the state of infrastructure is insufficient. It adds substantial risk and uncertainty to infrastructure planning as it does not reflect actual asset condition, and may over- or underestimate the capacity of the infrastructure to perform its function. In the 1950s, Toronto laid down kilometres of water mains made of spun-cast iron which was expected to last 50 to 100 years. Although this material was as strong as regular cast iron, it corroded more quickly and the pipes began to fail with increasing rates in the mid-1990s. Many older pipes, including one cast iron pipe on Jarvis street installed in 1858, continued to perform.[7]

[7] https://www.thestar.com/news/gta/2010/11/12/the_digging_begins_on_avenue_rd.html

CASE STUDY

Case Study: Hamilton's Risk-based Condition Assessment Framework

Key Issue Impacting Hamilton

- Moving from age-based data to condition assessment data

How the city is responding
- Centralized condition assessment of inspections in one department
- Uses CCTV and zoom technology to gauge actual asset conditions for its wastewater and stormwater network
- Uses a risk-based approach to assess water network

Since it first established an asset management program in 2001, Hamilton has remained at the forefront of asset management. By 2009, the city had already completed four iterations of its state of the infrastructure report, four years before most other municipalities would complete their first. Today, the city manages more than $4.2 billion of water, wastewater, and stormwater linear assets alone.

One of the city's key accomplishments in advancing its asset management program has been its approach to condition assessments. Rather than segregating condition inspections and assessments to individual departments, all of the city's conveyance infrastructure—including sewers and watermains—is managed centrally by its asset management department "to streamline and support the coordination of buried and surface work within the right-of-way." The city combines the responsibility for inspections and condition assessments, as well as renewal planning for all right-of-way assets. This makes coordination of projects much more strategic. In short, if a road needs to be resurfaced, water pipes can be replaced at the same time if it makes sense.

The asset management department regularly conducts inspections of its wastewater and storm infrastructure using CCTV and zoom technologies. Images of the assets are then shared with a trained inspector qualified to identify deterioration issues. As of its more recent asset management plan (2014), the city had conducted inspections for 94% and 90% of its total sanitary and storm sewers, respectively.

Assessing water pipes remains cost prohibitive. The city uses a risk framework to determine which assets in its water distribution network will receive attention. For assets that have a low consequence of failure, the city relies on break history to estimate its condition. However, for 'high criticality assets' whose failure poses significant financial, environmental, or public health risk, the city uses advanced acoustic and electromagnetic technologies to conduct 'direct assessments' and determine actual pipe condition and identify distresses.

Condition ratings were self-reported by each municipality which presents a challenge around consistency of the data when comparing municipalities. The ratings were based on a scale of 0-100, with most municipalities assigning a rating of fair or better if a particular asset had consumed less than 50% of its useful life. Others relied on actual condition assessments to assign condition ratings. The table below summarizes how assets were classified for municipalities that relied on age to estimate the condition of assets.

Condition Ratings and Descriptions

Condition rating	Percentage of useful life consumed	Description
Fair or Better	0-50%	Assets are new; may have minor deterioration; may need repair.
Poor or Worse	51-100%	Assets have noticeable deterioration and their function may be severely restricted; may be experiencing frequent failure events; need to be replaced.
Expired	>100%	Assets have consumed more than their recommended, and established, useful life but remain in operation.

Table 5: Condition Ratings and Descriptions

In addition to relying on age as an estimate for condition, there were three other major sources of risk and uncertainty:

1. As with other infrastructure classes, there is no policy that governs municipalities as they assign a specific useful life value to assets that are otherwise comparable in size, material, and geographic location. This value is essential in estimating condition. For example, if a useful life is below its industry standards, a municipality may prematurely classify its asset as poor or critical based on how long it has been in service. This was true for water, wastewater, and stormwater networks.

2. While the condition scale itself was virtually identical, the rating intervals used for assigning qualitative values to assets differed across the sample. For example, some municipalities considered a watermain to be ‘poor’ if it was older than 40 years, whereas others used 50 or 60 years as a minimum threshold.

3. Finally, some municipalities have still not completely identified the type of material used to construct pipes, creating more uncertainty about the true state of their assets. This further undermines condition estimates based on age as the useful life of different materials can vary considerably.

While the condition scale itself was virtually identical, the rating intervals used for assigning qualitative values to assets differed across the sample. For example, some municipalities considered a watermain to be ‘poor’ if it was older than 40 years, whereas others used 50 or 60 years as a minimum threshold

Key Findings

The data collected from this sample suggests that on the surface, nearly 80% of the water, wastewater, and stormwater management networks in our sample base is in fair or better condition. However, the reliability and validity of this estimate becomes questionable for two reasons:

1. **Uncertainty** around the true state of the infrastructure; and,
2. **Lack of standardization** in measurement and assessment.

Uncertainty

The majority of municipalities rely purely on the age of the assets to estimate their conditions, rather than evidence-based, in-field condition assessments. In the absence of adequate funding, age-based analysis is an important initial approach to estimating condition. However, the projections this method generates can be inaccurate and lead to higher risks of asset failure, and divert funding from where it is most needed. This information heavily influences a municipality's long-term planning and budgeting process. Based on this budgeting, the burden that each tax- and rate-payer bears may be too high or not enough, potentially forcing future generations to assume the costs of major capital investments.

In the absence of reliable data, municipalities may also miss opportunities to bundle projects together. A condition assessment may identify a problem in an underground pipe and create an opportunity to bundle its repair or replacement with major road work, for example.

When relying on asset age, municipalities may over-allocate funds for a particular asset class, or component, because age-based data suggests the asset is close to failure and requires immediate rehabilitation or replacement. Alternatively, municipalities may find themselves underprepared to meet actual needs because of previous, overly optimistic estimates of the condition of watermains and underground pipes.

Age is an important indicator, but there are many other factors that can impact the state of the infrastructure, such as soil conditions, usage, quality of materials used, and damage caused by external factors such as construction or compaction.

Regular condition assessments conducted by qualified professionals provide the most accurate data on the physical health of the infrastructure. This is mandated by provincial legislation for bridges and large culverts using the Ontario Structure Inspection Manual (OSIM). Municipalities are required to conduct detailed inspections of these structures every two years and assign a Bridge Condition Index (BCI). A trained, professional engineer must supervise these inspections. The index is scored from 0-100, and structures deemed to be below 60 are considered to be in poor condition and maintenance work is typically scheduled within one year. This is important for bridges, where a collapse can be catastrophic; but the failure of water infrastructure can also have very serious consequences.

The table below illustrates how the Bridge Condition Index is assigned for all structures in Ontario.

Rating	Maintenance schedule
Good BCI Range 70 -100	Maintenance is not usually required within the next five years
Fair BCI Range 60 -70	Maintenance work is usually scheduled within the next five years. This is the ideal time to schedule major bridge repairs to get the most out of bridge spending.
Poor BCI Less than 60	Maintenance work is usually scheduled within one year.

Table 6: Condition Ratings for Bridges

For most other capital assets, no such legislation or mandate exists on how, and how frequently, condition inspections should be conducted. Most municipalities do not have sufficient funding to perform assessments regularly. Therefore, the true state of the infrastructure is rarely identified, as age gives only an estimate at best. This means that much of the reporting published by municipalities, and the long-term financial planning based on this data, is done with a great deal of uncertainty.

The implications of this uncertainty are not limited just to tax- and rate-payers, but also various service providers and local contractors. Successful collaboration between municipalities and local contractors depends heavily on reliable data. If municipalities can credibly forecast upcoming infrastructure needs, the private sector can use this information to make necessary investments in people, equipment, and materials to meet these needs. Without credible data, both the public and private sectors remain in a reactive mode, and miss opportunities to get greater value from money spent.

Lack of Standardization

OSIM provides a standard approach and methodology for identifying the state of bridges and large culverts in Ontario. This uniformity in approach, data collection, and the data itself makes for better benchmarking between municipalities. Even the forms used by municipalities to conduct these inspections across Ontario are identical. Currently, no such standardization exists for most other asset classes. Municipalities generally self-report on the condition of their infrastructure assets, using their own criteria. This means that the condition rating for identical assets, providing comparable levels of service, in similar geographic locations, can vary considerably.

Not only can there be a stark difference in how the condition is rated and classified, but there is also inconsistency in how this condition rating is presented. Some municipalities display infrastructure condition based on the current replacement cost of the assets, while others display it based on the length/quantity of the assets.

CASE STUDY

Case Studies: Fully Funding Stormwater in Thunder Bay

In May 2012, Thunder Bay, located in northwestern Ontario on the shores of Lake Superior, declared a state of emergency following a major flood that overwhelmed its wastewater infrastructure and sewage treatment plant. The plant was flooded after 14 times the amount of water it would typically treat brought the facility to near breaking point; residents were asked to avoid flushing or releasing any water down their drains. It was not just the city's wastewater assets that were out of commission; in addition to residential flooding, several major highways, roads, and major parking lots were closed and washed out.

Key Issue Impacting Thunder Bay

- Lack of adequate, dedicated funding for a sustainable, stormwater infrastructure program

How the city is responding

- Created Stormwater Management Plan in 2016 that incorporates climate change adaptability
- Undergoing Stormwater Financing Study to develop 'sustainable and fair funding sources' to fully fund stormwater capital program and operations activities

In 2016, after another major flood once again tested the city's infrastructure and response capacity, the city adopted its *Stormwater Management Plan*. One of the key objectives of the plan is to "identify alternative ways to provide a dedicated, consistent, and fair funding system for the current and future needs of the stormwater management system." In doing so, the city took a major step in fully funding its stormwater program over time.

One of the options Thunder Bay is exploring in its *Stormwater Financing Study* in 2018 is the implementation of a user fee that would charge homeowners and landowners a fee proportional to the amount of stormwater their property contributes. To fund its stormwater management program, the city relies on property taxes, various grant funding, and redirects 10% of revenue collected from wastewater to stormwater operating and capital programs. This funding is not adequate, and generates an annual funding gap of $3.3 million.

Through the financing study, the city will select a financing option that will recover the full cost of managing stormwater. The financing option will provide a "long-term funding source dedicated solely to stormwater program expenditures," and one that makes funds available to support capital improvement projects, operations, and maintenance activities – and protects people's homes and businesses.

Recommendations

The development of asset management plans was a major step in the right direction to diagnose the current state of Ontario's water, wastewater, and stormwater infrastructure. It is important that municipalities evolve their approaches to build on that initial understanding and guide better future planning and delivery. To do so, they should focus on five priorities:

1. Shift from age-based to inspection-based planning.
2. Make all water infrastructure a priority.
3. Standardize approach to full-cost recovery.
4. Provide transparency on infrastructure state, risk, and impacts.
5. Drive best practices in asset management.

1. Shift from age-based to inspection-based planning.

Most municipalities use age to determine the condition of their infrastructure, rather than conducting inspections and collecting field data. The cost of conducting condition assessment is viewed as being prohibitive for water, wastewater, and stormwater infrastructure, and can require service shut downs.

Accurate condition assessments remain a fundamental component of proper asset management program, and ultimately, full-cost recovery. Without condition assessments, it is virtually impossible to undertake preventative maintenance which can extend the life of the infrastructure, or direct funds where the need is greatest. Without a strategic condition assessment framework, it is also difficult to predict potential pipe failure, and bundle repairs or replacement with major road work.

Condition assessments may appear expensive, but they can represent good value for money as they ensure funding is truly spent where it is most needed and avoids costly infrastructure failures and premature replacements. They must be explicitly factored into the cost of providing water, wastewater, and storm management services. Once the approach is standard across the province, the cost should also fall as expertise can be shared, and competition to provide services becomes less niche.

Asset Management Condition Grading Standards

Saskatchewan's Ministry of Municipal Affairs provides standardized condition rating guidelines for all asset classes.

2. Make all underground infrastructure a priority.
As water, wastewater, and stormwater infrastructure is mostly underground, it can be overlooked in favour of more visible capital investments. The *Safe Drinking Water Act, 2002*, mandated that Ontario municipalities move towards a full-cost recovery model for their water services to cover their capital and operational budgets. Under Ontario Regulation 453/07, municipalities are required to develop a financial plan for the long-term fiscal viability of their water systems every five years. However, no acts or regulations exist to include the cost of wastewater or stormwater infrastructure.

For all types of underground infrastructure, an annual maintenance budget should be ringfenced which should stand at industry recommended 2-4% of the replacement cost of the assets. Of course, the data from condition assessments may warrant additional allocations. This will provide certainty for both water utilities and contractors, and prevent deferred maintenance from mounting up, leading to costly infrastructure failures.

3. Standardize approach to full-cost recovery.
Water is a precious resource and should be treated as such. Bill 175, *Sustainable Water and Sewage Systems Act, 2002*, outlines a definition of the full cost of providing water and wastewater services:

> Water Services
> The full cost of providing the water services includes the source protection costs, operating costs, financing costs, renewal and replacement costs and improvement costs associated with extracting, treating or distributing water to the public and such other costs as may be specified by regulation.
>
> Wastewater Services
> The full cost of providing the waste water services includes the source protection costs, operating costs, financing costs, renewal and replacement costs and improvement costs associated with collecting, treating or discharging waste water and such other costs as may be specified by regulation.

While the *Act* received Royal Ascent in 2002, no regulations have been established. These definitions should be amended to explicitly account for stormwater services, and the cost of periodic, strategic condition assessments for all three asset classes.

4. Provide transparency on infrastructure state, risks, and impacts.
In the interest of public health and complete transparency, municipalities should be required to make their municipal asset management plans publicly available in one central online location. As water, wastewater, and stormwater infrastructure is largely underground, other performance measures and incidents should also be made available centrally, including:

1. untreated sewage discharges through both sewage bypasses and combined sewer overflows;
2. kilometres of combined sewer, and incidents of combined sewer overflows; and,
3. sewage backups into homes.

5. Drive best practices in asset management.
The *Infrastructure for Jobs and Prosperity Act, 2015*, is a significant step in better capital investment planning, and builds on work already done by municipalities in developing their AMPs. The accompanying regulation, *Asset Management Planning for Municipal Infrastructure*, provides a strong framework for elevating asset management to higher state of maturity. We recommend that clear guidelines should be developed for what is considered “recognized and generally accepted good engineering practices.” These guidelines can be critical in benchmarking municipal performance and raising the standard of asset management plans in the province as a whole.