City of Hamilton
Public Works Asset Management Plan

Version 1.0

March 3, 2014

Section 1 – Executive Summary

1.1 Background

Under the Province of Ontario's new Municipal Infrastructure Investment Initiative (MIII), municipalities are required to submit a detailed Asset Management Plan (AMP), in order to qualify for Provincial grant program funding. The City of Hamilton Public Works Asset Management Plan has been developed to meet these requirements, as set out in the Building Together: Guide to Municipal Asset Management Plans. Based on this guide, qualifying Asset Management Plans must include the following information:

Table 1 - Asset Management Plan Content

Part	Title	Content
1	Executive Summary	Provides a succinct overview of the Asset Management Plan, highlighting major points. It is the final section to be prepared.
2	Introduction	Provides an overview of asset management within the City and sets the overall context and expectation for the report.
3	State of Local Infrastructure	Presents information on the asset portfolio including inventory, condition, cost, etc. accompanied by information on supporting data.
4	Desired Levels of Service	Describes how service is linked to infrastructure investment and defined how service is measured and how performance goals and expectations are identified and set.
5	Asset Management Strategy	Sets planned actions that will enable the assets to provide the desired levels of service in a sustainable way, while managing risk, at the lowest lifecycle cost (e.g. through preventative action).
6	Financing Strategy	Identifies lifecycle investment requirements and appropriate funding strategies for completing the work.

The City of Hamilton owns and operates over $14.4 billion (replacement value) in core Public Works infrastructure which services the needs of residents, local businesses and visitors to the City. These water, wastewater, stormwater, road and bridge assets contribute to community health, welfare and satisfaction, and long-term prosperity and growth. In addition to meeting Provincial AMP reporting requirements, this Asset Management Plan (the Plan) sets out a strategic framework for managing these assets, aligning core infrastructure with service objectives, documenting core practices and activities, and guiding the action and investment needed to meet key business goals.

The City of Hamilton has many well established practices surrounding the planning and management of public infrastructure, and has pioneered the use of Asset Management amongst Canadian municipalities. As part of its amalgamation with surrounding municipalities in 2001, the City established an asset management section within its Public Works Department supporting infrastructure stewardship within the organization. Each of the business units compliment this centralized asset management function by taking on responsibility for various aspects of infrastructure operations, planning and renewal, and contributing to the corporate budgeting process. This Plan guides the coordinated actions of these groups in effectively managing city-owned infrastructure to meet service requirements.

As one of several core business documents within the City, the goals of this Plan clearly align with and support those of the City of Hamilton 2012-2015 Strategic Plan, as well as the City's other municipal foundation documents. These include the City's Capital and Operating Budgets, Official Plan, By-laws, and Policies, as well as business unit policies, master and area plans, and business plans.

This first iteration of the Asset Management Plan has been completed at a high-level using existing information, with the goal of meeting the minimum requirements defined by Province of Ontario and identifying data and procedural gaps and opportunities for improvement. This Plan covers Roads &

Bridges, Water, Wastewater and Stormwater assets, as prescribed in the regulations; Social Housing within the City is owned and operated CityHousing Hamilton, which has commissioned a separate Plan.

This Public Works Asset Management Plan will be revisited on a five-year cycle, and coincide with an update of the City's award-winning State of the Infrastructure (SOTI) Report. Subsequent Plans will build upon this document to cover an expanded asset-base, support the bottom-up analysis and alignment of work activities, and clarify the relationship between infrastructure investment and service outcomes.

1.2 State of Local Infrastructure

The asset inventory is made up of five major categories; Water, Wastewater, Stormwater, Road, and Bridge assets. Tables showing the breakdown of inventory, value and condition/performance by type are shown below. Condition/performance ratings are based on asset condition, funding and functional adequacy, as defined within the City's State of the Infrastructure (SOTI) reporting process. Ratings are based on updates undertaken in late 2013.

Table 2 - SOTI Asset Rating Summary

Asset Class	Value (millions)	Rating	Trend
Water	$2,771	B-	→
Wastewater	$4,419	C	→
Stormwater	$1,996	D	↓
Roads and Bridges	$5,211	C-	↓
TOTAL	$14,397	C	↓

1.3 Levels of Service

The City of Hamilton uses a range of measures and indicators to evaluate asset performance, identify trends, and benchmark operations. These measures tend to be inward facing and focus on physical properties, and technical and operational characteristics. While they provide good insight into asset health and operational efficiency, they make it difficult to evaluate and report on the quality and effectiveness of service being delivered to the public, or on the affordability of service, given its contributing asset base.

Like many progressive municipalities, Hamilton is shifting its view of asset management and moving to adopt a service-focused view of its infrastructure and investments. By adopting customer-centric level-of-service framework, measures and targets, and weighing investment based on service impact and risk, the City will establish a clear relationship between infrastructure investment and service outcomes.

For the purposes of this Asset Management Plan a preliminary Level of Service Framework has been established around nine core service goals, which have been identified as priorities for City Public Works. The City is working to further develop and refine this framework, based on input from internal and external stakeholders, for use in guiding future plans and initiatives.

Table 3 - Preliminary LOS Framework

Dimension	Service Goal	Definition
Accessible	Affordable	Costs are minimized and distributed such that access to service does not cause undue hardship to customers businesses, and the public.
	Accommodate Growth	Growth and development is not hampered by the availability of service capacity (within current plan).
Safe	Keep employees safe	Employees are safe in doing their jobs
	Protect the Public	Services delivered and/or supporting infrastructure, do not pose undue risk to public safety.
Reliable	Sufficient Quality /Quantity	Services are delivered to acceptable quality and quantity.
	Uninterrupted Service	Service is reliable and subject to infrequent interruption.
Regulatory	Safety	Services meet safety requirements, as regulated by legislation and/or operating licenses or agreements.
	Environment	Services meet environmental requirements, as regulated by legislation and/or operating licenses or agreements.
Customer Service	Responsive	Customer issues are captured and acted upon in an efficient and timely manner.
	Accurate	Customer response is accurate and based on correct information.

Existing technical service measures have been mapped to this framework to identify Level of Service trends for each service area. While several gaps exist, based on available data Water and Wastewater service appears to be relatively stable overall, whereas Stormwater and Roads & Bridges service appears to be degrading. The following table highlights level of service trends based on available measures which are increasing or decreasing.

Table 4 - LOS Trend Summary

Dimension	Service Goal	Water		Wastewater		Transportation	
		Treatment	Distribution	Treatment	Collection	Roads	Bridges
Accessible	Affordable	↘	↘	→	↗	↘	↘
	Accommodate Growth	→	-	→	-	→	→
Safe	Keep employees safe	-	-	-	-	→	→
	Protect the Public	→	→	→	↗	→	→
Reliable	Sufficient Quality /Quantity	↗	↗	→	↗	↘	→
	Uninterrupted Service	-	↘	-	↘	↘	→
Regulatory	Safety	→	-	→	-	→	→
	Environment	-	-	-	-	-	-
Customer Service	Responsive	-	-	-	-	-	-
	Accurate	-	-	-	-	-	-

Legend: "-" = Not currently tracked; Measure under development.

Regardless of the types of indicator or the purpose of tracking, there are always external factors that are beyond the control of the organization that influence the trend. It is important to understand these trends so that performance targets are well-aligned to the realities under which the City operates.

Examples of trends that will continue to have an impact on water, wastewater, and roadway operations within the City are discussed in the table below.

Table 5 - Known LOS Influencers

Climate Change	While the full impacts of climate change will not be fully understood in the near future, the City is currently experiencing issues that can be directly attributed to climate change. Examples include 1) increase in the presence of certain types of algae in Lake Ontario and its impact on the water treatment process and drinking water taste/odor; 2) severe rainfall events and their associated impact on the effectiveness of the Stormwater system; and 3) flooding of roads and challenges in meeting winter control requirements
Aging Infrastructure	The City has a relatively old water and wastewater infrastructure which will continue to burden the City and impact its ability to provide high levels of service. The City's roads and bridges also continue to deteriorate and will require increasing levels of funding to ensure that they continue to offer safe and reliable transportation. The relatively early adoption of asset management practices by the City has helped to reduce costs by improving the cost effectiveness of maintenance and rehabilitation. The continued advancement of these practices, and support technologies will allow for timely and effective decisions to be made and further reduce the total cost of ownership for these assets.
Active Transportation	The growth in the use of alternative transportation options such as cycling and pedestrians has seen an increase in the pressure on the City to provide safe environments for these new road users. This will continue to increase and as a results the City will have to respond by improving the cycling and pedestrian facilities across the network,
Underfunded Transportation Network	An underfunded network of roads and bridges will lead to a poor transportation network. Higher taxes will need to be levied to improve the transportation network, which may result in people/businesses moving elsewhere, and could eventually lead to loss of revenue and jobs as industries move to more vibrant communities. If people move away, then the population will decrease and the City will see a reduction in residential taxes. Similarly, if businesses leave, the City will see a decrease in the Commercial/Industrial taxes.
Uncertainty in Growth Forecasts	According to analysis of the latest data, actual growth in the City has fallen short of 75% of that expected by the Province in its "Places to Grow" forecasts. This means that the City is falling behind in development activity and related revenues needed to support the debt required for the Places to Grow infrastructure. This uncertainty is not entirely within the City's control and will continue to impact several financial and operational performance indicators.
Declines in water consumption	Ongoing conservation efforts have led to declines in average household water consumption. This has an impact on revenue generation from rates. In addition, a similar decline has been witnessed in the large commercial and industrial sector that represent 40% of the City's water consumption. With the expected annual 4.25% increase in water rates, ICI customers can be expected to continue their conservation efforts. Economic uncertainty and its impact on large ICI customers is another concern as loss of any of the top ICI customers is equivalent to 4,500 new residential accounts.
Socio-Political expectations	Societal and political influences will continue to shape the City's strategy and priorities. The fluid and rapidly changing nature of socio-political concerns, expectations and requirements will continue to influence the City's targets and priorities for service delivery. Examples of such expectations include aspects like enhanced environmental stewardship and more cost-effective delivery of services.
Shifts in funding priority	Traditionally, the City has relied heavily on Federal and Provincial funding to address its road and bridge renewal requirements and meet service expectations. Changes in grant programs have made it difficult to maintain service, forcing it to juggle priorities, and target where and how it invests. Continued vigilance in asset management and adoption of new pavement technologies have allowed it to extend asset life and reduce the total cost of ownership, but current spending is insufficient to maintain service at current levels over the long-term.

1.4 Asset Management Strategy

Though it has yet to adopt a formal Asset Management Policy, the City of Hamilton actively supports asset management and the use of levels of service, risk management and lifecycle principals in the planning and delivery of infrastructure works. To support these priorities, the Public Works Department has embedded key language within its strategic plan and operating policies, and developed and/or adopted a number of standards, practices and tools to operationalize and support asset management thinking throughout the organization. The following table highlights major practices and tools used for asset management activities within each service area.

Table 6 - Summary of Current AM Practices and Tools

AM Activity	Water	Wastewater	Roads & Bridges
Inventory	• ROW asset data managed within HANSEN • Vertical asset data stored in various locations – being revisited in 2014	• ROW asset data managed within HANSEN • Vertical asset data stored in various locations – being revisited in 2014	• ROW asset data managed within HANSEN • Bridge data managed within BMS
Performance Assessment	• Break-frequency analysis for non-critical and advanced condition assessment for critical mains (Linear) • High level condition audits for all assets; targeted detailed assessment (Facilities)	• CCTV assessment (zoom and conventional) for all sewer infrastructure; targeted advanced assessment for critical assets (Linear) • High level condition audits for all assets; targeted detailed assessment (Facilities)	• Pavement rating based on visual assessment and automated data collection. • Manual bridge assessment driven by regulation
Performance Forecasting	• Break-rate deterioration model under refinement (Linear) • Estimated useful life based on observation and manufacturer recommendations (Facilities) • Some trending/forecasting of non-condition performance measures	• Condition deterioration model under refinement (Linear) • Estimated useful life based on observation and manufacturer recommendations (Facilities) • Some trending/forecasting of non-condition performance measures	• Mature pavement deterioration models in place • Mature bridge degradation models in place • Some trending/forecasting of non-condition performance measures
Demand Planning	• Water Master Plan • Water Treatment Master Plan	• Wastewater Master Plan • Treatment Master Plan	• Transportation Master Plan
Risk Assessment	• DWQMS • Criticality-driven management plans (Linear) • High-level model for all assets; detailed assessment for some facilities (Facilities)	• DWQMS • Criticality-driven management plans (Linear) • High-level model for all assets; detailed assessment for some facilities (Facilities)	• Driven by road classification and major bus / truck routes (all assets) • Criticality-driven management plans (Bridges)
Options Analysis	• Lifecycle cost-benefit supported treatment selection	• Lifecycle cost-benefit supported treatment selection	• Lifecycle cost-benefit supported treatment selection
Coordinated Decision Making	• Multi-Criteria coordination / prioritization of works within service area • IRISS System coordination within ROW (Linear)	• Multi-Criteria coordination / prioritization of works within service area • IRISS System coordination within ROW (Linear)	• Multi-Criteria coordination / prioritization of works within service area • IRISS System coordination within ROW (Linear)
Investment Planning	• Budgeting is historical-based or constrained by Regulation • Consultation-based works coordination across asset types and between asset groups • ROW plan coordinated by AM branch	• Budgeting is historical-based or constrained by Regulation • Consultation-based works coordination across asset types and between asset groups • ROW plan coordinated by AM branch	• Budgeting is historical-based or constrained by policy • Consultation-based works coordination across functional groups • ROW plan coordinated by AM branch
Lifecycle Management	• Operational, Maintenance and Financial/Funding strategies are generally in place	• Operational, Maintenance and Financial/Funding strategies are generally in place	• Operational, Maintenance and Financial/Funding strategies are generally in place

The City runs several key programs to extend asset life and reduce the lifecycle cost of ownership. The following examples highlight the benefit realized through two of these initiatives.

- *Sewer Main Lining Program* – For over a decade the City has been using trenchless technologies to renew deteriorated sewer pipes. Less costly and invasive than traditional construction techniques, lining restores sewer infrastructure to near new condition with limited need for excavation or prolonged street closure. This program has renewed over 250 km of sewers since 2005, resulting in a cost avoidance of over $100 Million.

- *Neighborhood Road Program* – The City has seen significant benefits from implementing an innovative procurement strategy for the annual Neighborhood Road Program. Under these contracts the contractors are allowed the flexibility to complete the work during the construction season at a time that fits with their overall schedule. Since 2009, 157 lane-km of roads in 17 neighborhoods have been renewed using this approach, resulting in a cost avoidance of $29 Million.

Lifecycle Management Plan

Lifecycle management plans provide a comprehensive view of investment needed to:

- Sustain Service through the operation, maintenance and renewal of existing infrastructure, and
- Enhance Service to address growth, and changing service requirements through the upgrading and expansion of existing infrastructure

While current budgets and spending don't clearly align with this model, based on available information operating budgets are generally focused on Sustaining Service, and capital budgets are split between sustaining and enhancing service.

Water, Wastewater and Stormwater

Within Hamilton Water, operating programs and budgets are split between water, wastewater, and stormwater service delivery. The 2014 Hamilton Water operating budget is $77.1 million, and is expected to grow by 3 to 5% annually, largely due to inflation. On the capital side, water, wastewater and stormwater spending is broken out in to the following nine program areas.

Table 7 - Relationship between Capital Investment Program and LOS

System Type	Sustain Service	Enhance Service
Linear	• Rehabilitation, Replacement & Upgrade Programs • Projects Coordinated with Roads program	• SERG Projects • Development/Extension Projects • Master Plan - Horizontal Assets
Facilities	• Plants/Outstation Projects (SAM)	• Plants/Outstation Projects (WQI) • Plants/Outstation Projects (WINS) • Master Plan - Vertical Assets

Based on this assessment, Hamilton Water's planned spending can be broken down as follows.

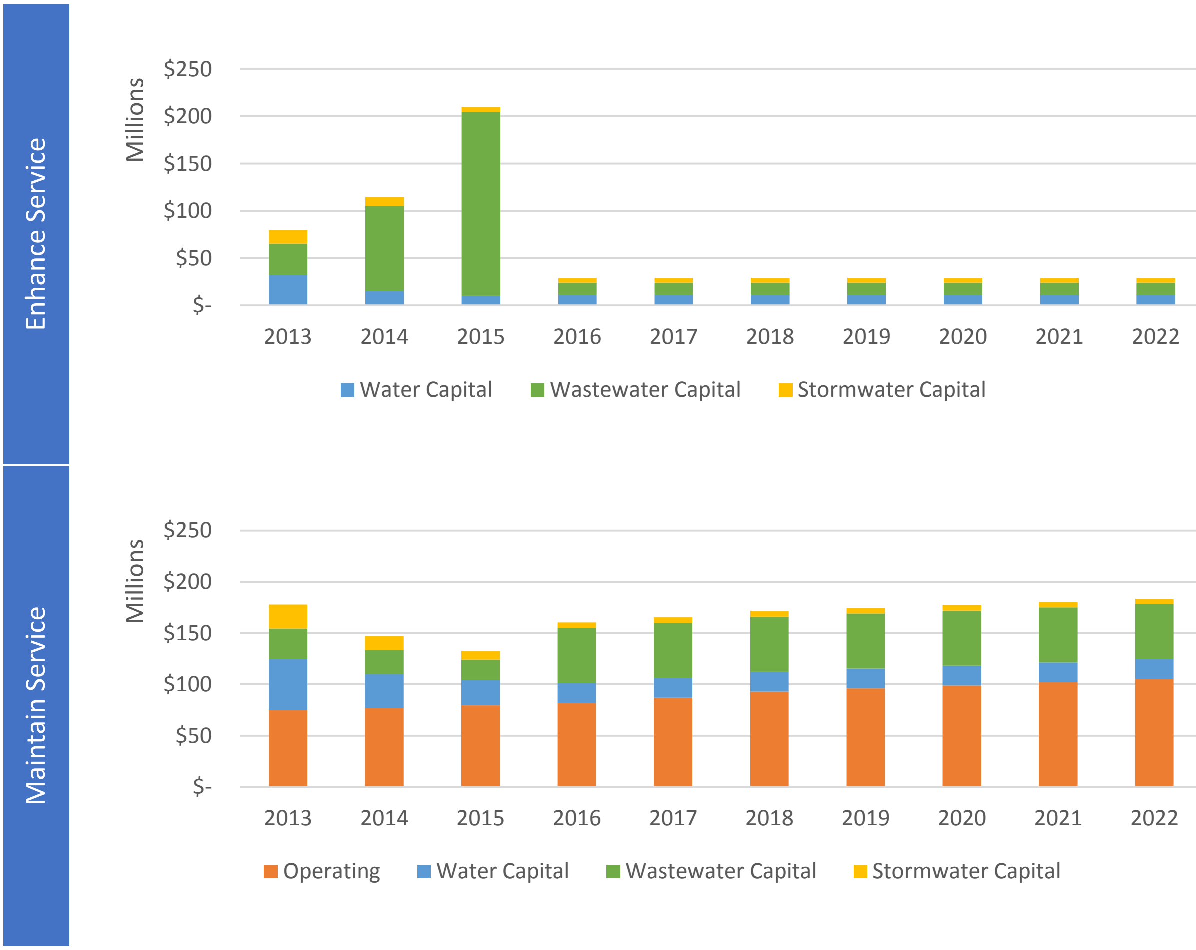


Figure 1 - Planned Investment by Service Focus – Water, Wastewater and Stormwater

Roads and Bridges

Roads and bridges spending can also be broken down based on service objective. As with Hamilton Water, roadway operations and maintenance spending can be aligned with maintaining current service, as supported by the impacted infrastructure. Capital spending on the other hand is split between maintaining and enhancing service. Road, Bridge and Other capital programs are focused on maintaining service through the preservation and renewal of existing assets. Council Priorities are split between maintaining and enhancing service through the acceleration of existing projects or introducing new investments. Growth activities are driven by the City's Transportation Master Plan and enhance service by improving amenities or extending service to accommodate more users.

Based on this assessment, planned Roads and Bridges spending can be broken down as follows.

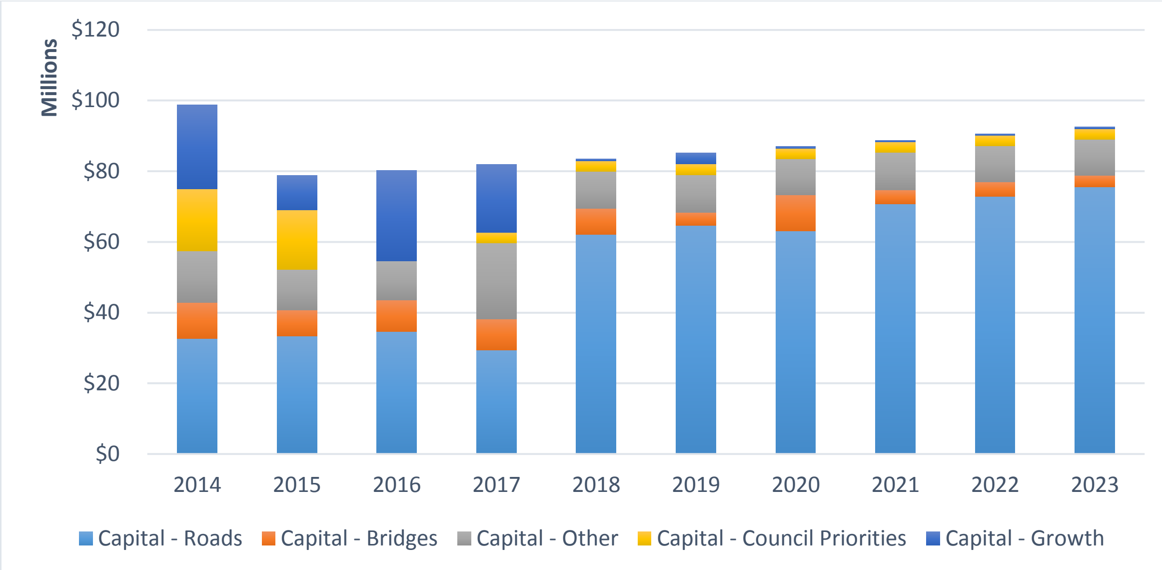


Figure 2 - Planned Investment by Service Focus - Roads and Bridges

1.5 Financing Strategy

The Public Works financing strategy identifies and allocates funding sources to needed operating and capital investment. Hamilton Water operates as a utility and therefore maintains a budgeting process that is distinctly separate from Roads and Bridges and other Public Works assets, which are primarily funded through taxes.

Water, Wastewater and Stormwater

Utility revenues come from billed charges which are based on water consumed and services rendered. Water consumption is based on metered consumption; meters are read with ratepayers billed by the City's billing agent, Horizon Utilities Corporation. Both Operating and Capital costs for the water, wastewater and storm programs are funded without the use of municipal property taxes. In addition to utility rates, Hamilton Water taps in to several alternative funding sources including development charges, reserves and other internal sources, external debt, and grants, subsidies and other external sources to pay for required works.

The following investment strategy highlights how planned Hamilton Water spending will be addressed. While review of available funding vs. planned investment shows a balanced capital budget, increased spending on expansion and upgrading of the Woodward Wastewater Treatment Plant will place significant financial pressure on the City, increasing reliance on Grant Programs and forcing the deferral of linear and facility works, risking system reliability and customer service impacts.

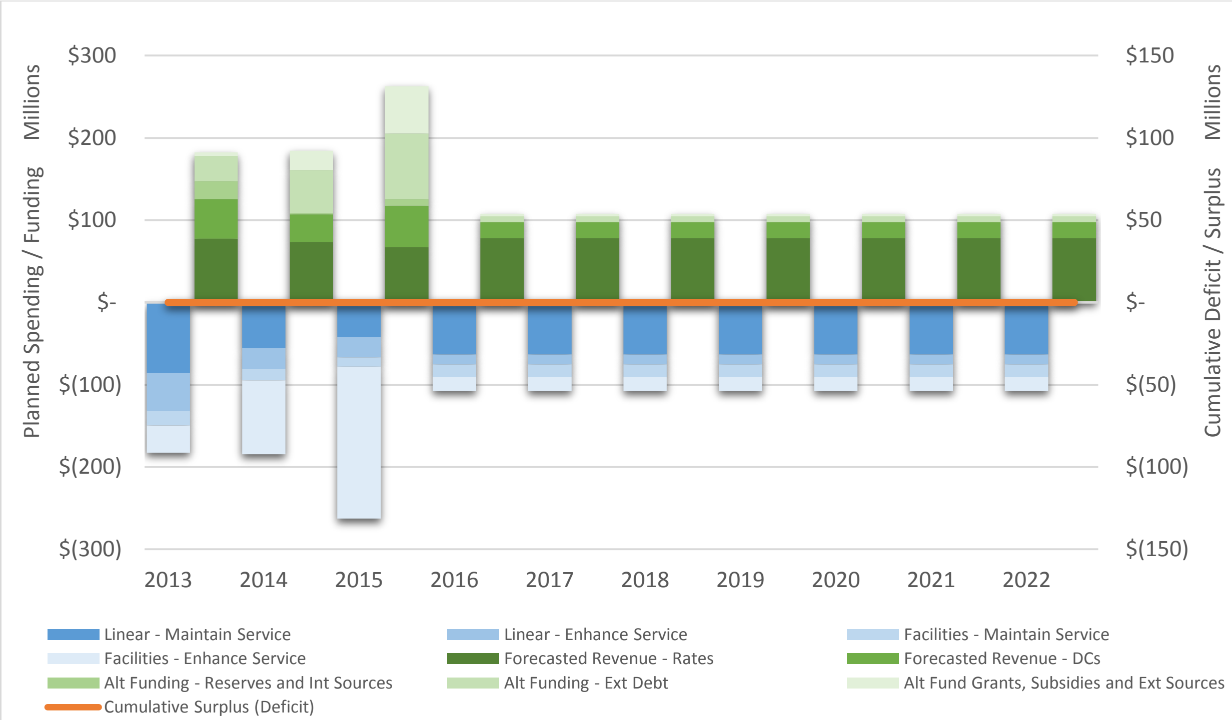


Figure 3 - Investment Strategy - Water, Wastewater and Stormwater

Roads and Bridges

The following investment strategy highlights how planned Roads & Bridges spending will be addressed. Based on pavement models maintaining current level of service will require sustained annual investment of approximately $50 Million, which is roughly $10 million above budgeted roads funding. As a result, roadway level of service will actually degrade over time.

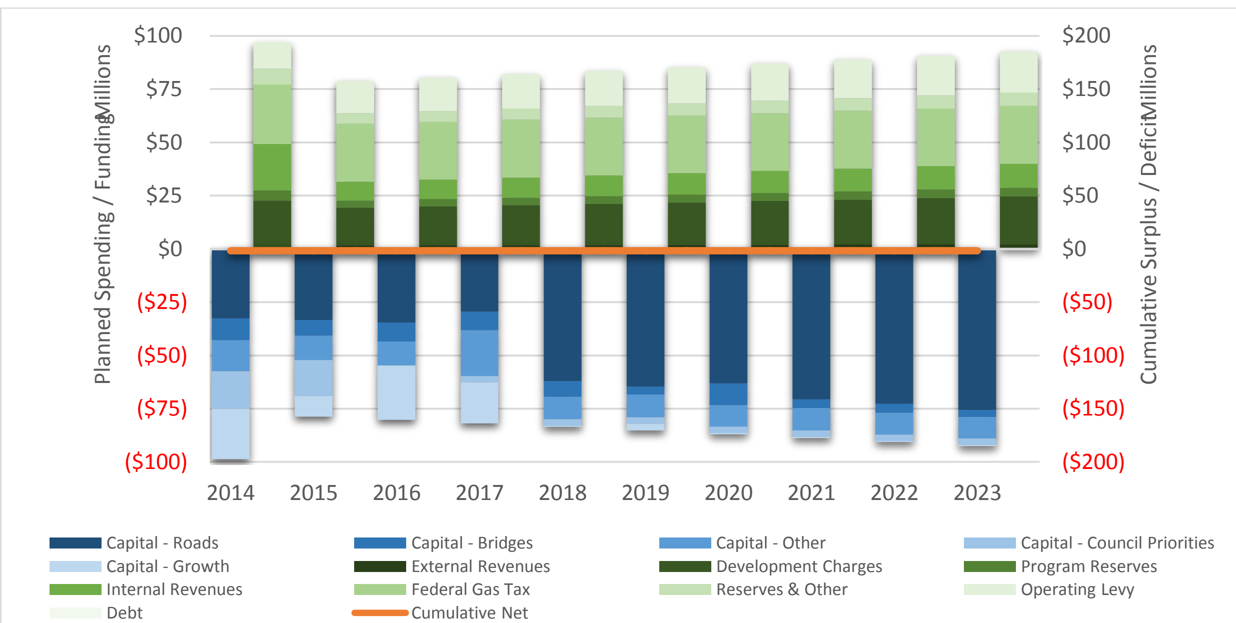


Figure 4 - Investment Strategy - Roads and Bridges

1.6 Improvement Plan

As indicated above, in addition to meeting Provincial AMP reporting requirements, this Asset Management Plan sets out a strategic framework for managing the City's Water, Wastewater, Stormwater, Road and Bridge infrastructure. As asset management practices continue to evolve, so too will the completeness and value of this report in guiding investment in these assets. The following planned improvements highlight City's continued commitment to the sustainable management of its core infrastructure to support the delivery of safe, reliable and effective municipal services to Hamiltonians.

- *Development of a Level of Service (LOS) framework* - Although the city is currently tracking a large number of performance indicators for benchmarking and operational performance measurement, there is a need to develop a more comprehensive framework that tracks customer and corporate indicators to facilitate the transition to a more service-oriented approach to asset management planning.
- *Continual development of long-term right-of-way (ROW) coordination using IRISS* - The City has recently deployed a state-of-the-art system that allows improved coordination of asset intervention decisions across its road, water and sewer system. The continued development and enhancement of this system is required to facilitate more comprehensive asset management planning at the tactical levels.
- *Rolling out the City's Water and Wastewater Facilities Asset Management Program* over the next few years will standardize practices related to data management, asset condition rating, performance management and investment planning for the City's vertical water and wastewater infrastructure.
- *Improve alignment between AMP and financial plans* - Continuous improvement is sought to enable the asset management planning process to better inform the City's budget preparation process and facilitate an evidence-based discussion around service levels, funding and affordability of service.
- *Expanding the scope to other asset classes* - Although not explicitly required by the Ministry of Infrastructure yet, the scope of the asset management plan is expected to increase to include other asset classes. Several municipalities have voluntarily produced an asset management plan that exceeds the scope of assets required by the Ministry.

1.7 Conclusions

Recent changes to Province of Ontario legislation require municipal governments to produce detailed Asset Management Plans, in order to qualify for Provincial grant funding. This AMP satisfies these requirements and provides a structured, high-level assessment of the City of Hamilton's Water, Wastewater, Stormwater, Roads and Bridges assets, and their respective service contributions, asset management practices, and investment strategies. This is the first Asset Management Plan developed by the City, and will serve as a benchmark for service delivery and foundation on which future program enhancements will be built. Future iterations of this plan will be used to communicate progress in asset management effectiveness and the City's performance in meeting its service commitments and goals.

The City of Hamilton's water infrastructure currently has a stable B- rating, however the cost of service delivery is increasing and the reliability is falling within the distribution system. Wastewater and Stormwater assets have declining C and D ratings, respectively, and like Water costs of service delivery are increasing, and conveyance system service reliability is falling. While funding availability is adequate to satisfy current investment plans, it is known that system performance and level of service will degrade if spending in key areas is not increased. Significant planned spending on Wastewater treatment upgrades is placing stress on other areas, forcing the delay of needed works in other areas. Further investment is needed in order to stabilize service delivery.

City Road and Bridge infrastructure has a declining C- rating, and is seeing growing costs of service delivery, and reductions to road quality and reliability. The review of available funding vs. planned investment shows a balanced capital, however, this is due to the many priorities that remain unfunded outside of the financing plan. While bridge performance will remain relatively stable, planned spending is insufficient to maintain current roadway service levels, and will lead to further deteriorations of pavement quality and reliability. Further investment is needed in order to stabilize service delivery.

Section 2 – Introduction and Plan Overview

2.1 Asset Management in the City of Hamilton

The City of Hamilton Public Works owns and operates over $14.4 billion in core infrastructure which services the needs of residents, local businesses and visitors to the City. These water, wastewater, stormwater, road and bridge assets contribute to community health, welfare and satisfaction, and long-term prosperity and growth. Management of this tremendous resource cannot be undertaken in a haphazard fashion. Steadfast commitment, coupled with effective asset management practices and tools are essential in ensuring that these assets are properly maintained and service the needs of current and future generations. The efficient management of urban infrastructure is predicated on effective planning, supported by sound data, and an understanding of asset risk and service delivery.

The City of Hamilton has pioneered the use of asset management amongst Canadian municipalities. As part of its amalgamation with surrounding municipalities in 2001, the City established an asset management section within its Public Works Department supporting infrastructure stewardship within the organization. The group is tasked with leading the development of Asset Management initiatives, strategic infrastructure programs, and the coordination of those programs, through the capital budget process. Key responsibilities include:

- The development of strategic infrastructure programs for roads, bridges, water, waste water, storm, facilities and parks;
- City-wide condition assessment of surface and subsurface assets;
- Monitoring life cycle trends and deterioration models;
- Identifying and monitoring the operational, economic, risk and financial impacts of various program methodologies.
- Forecasting and scheduling of rehabilitation and reconstruction activities;
- Developing an integrated 3 year detailed budget for roads, bridges, water, waste water, storm, facilities and parks;
- Developing a 10 - 20 year long range projected budget for roads, bridges, water, waste water, storm, facilities and parks;
- Coordinating capital budget submissions from all other divisions of Public Works including Water and Waste Water Plants, Transit, Fleet, Facilities, Waste, Parks and Open Spaces;
- Delivering a complete Public Works capital budget submission to Finance on an annual basis;
- Developing strategic reporting and communication of infrastructure issues through the State of the Infrastructure reports and the Asset Report Card.

Each of the business units compliment this centralized asset management function by taking on responsibility for various aspects of infrastructure operations, planning and renewal, and contributing to the corporate budgeting process.

Within Public Works, asset management responsibility is split between the Engineering Services Asset Management section and the Hamilton Water Sustainable Initiatives section. Conveyance infrastructure, such as sewer and water mains, manholes, hydrants, and service connections, is managed centrally to streamline and support the coordination of buried and surface work within the road right-of-way. Combining responsibility for inspection, condition assessment, and renewal planning for right-of-way assets within a single group provides the City with a holistic view of renewal requirements, allowing it to make coordinated renewal decisions that manage risk and maximize benefits. Asset management for water and wastewater facilities is the responsibility of Hamilton Water's Sustainable Initiatives section. As the operator and steward of the City's water and wastewater treatment, pumping and storage infrastructure, the division provides hands-on insight into the needs and priorities of these facilities. In addition to inspections, risk and financial analysis and capital planning, the Sustainable Initiatives section is responsible for the conceptualization and roll-out of strategic initiatives impacting the utility, including conceptual studies, funding coordination, and government and public liaison.

2.2 The Asset Management Plan

This Asset Management Plan summarizes current infrastructure planning and decision making practices within the City of Hamilton, and identifies the actions needed to meet current and future service delivery goals. This is a "living document", which will be regularly updated and built upon to track the evolution of asset management within the City, and guide the ongoing refinement of practices, strategies, and tools.

This Asset Management Plan follows the Ministry of Infrastructure's 'Guide for Municipal Asset Management Plans' contributing to making good asset management planning universal. The plan sets out a strategic framework that will guide future investments in ways that support economic growth, are fiscally responsible, and respond to changing needs. This Plan will move Hamilton towards making the best possible decisions regarding the building, operating, maintaining, renewing, replacing and disposing of infrastructure assets. The objective is to maximize benefits, manage risk, and provide satisfactory levels of service to the public in a sustainable manner.

This Plan:

1. Complies with the requirements as defined within the Ministry of Infrastructure's 'Guide for Municipal Asset Management Plans.
2. Demonstrates that Levels of Service are being met in an effective and efficient manner.
3. Demonstrates that due regard is being given to the long-term stewardship and sustainability of the asset base.
4. Demonstrates responsible management of the asset portfolio.
5. Communicates and justifies funding requirements.
6. Demonstrates the commitment that assets will be maintained in compliance with regulations.

By following the Asset Management Plan, the City will demonstrate how the municipal infrastructure will be managed to ensure that it is capable of providing the levels of service needed to support our municipal goals.

2.3 Relationship to Other Strategies, Plans and Finance Documents

As one of several business processes that take place within the City, the goals of this Asset Management Plan are clearly aligned with the City of Hamilton's strategic priorities. The table below highlights how the AMP aligns with visions and strategic objectives outlined in the City's 2012-2015 strategic plan.

Table 8 - Alignment of asset management with strategic planning statements

Strategic Plan Statement	AMP Alignment
Corporate Vision: To be the best place in Canada to raise a child, promote innovation, engage citizens and provide diverse economic opportunities.	Reliable high quality infrastructure services are required to attract residents and new businesses. The AMP aligns capital spending with needs based on target level of service standards across various service areas
Strategic Objective 1.2: Continue to prioritize capital infrastructure projects to support managed growth and optimize community benefit	AMP provides procedures and tools to allow for optimal allocation of capital infrastructure spending
Strategic Objective 1.3: Promote economic opportunities with a focus on Hamilton's downtown core, all downtown areas and waterfronts	AM data provides a better understanding of older infrastructure and provides decision-makers with tools to allow for optimal selection of asset intervention options
Strategic Objective 1.6: Enhance Overall Sustainability (financial, economic, social and environmental)	AMP provides a level of service framework that captures financial, social and environmental objectives and helps align decisions with these objectives
Strategic Objective 2.2: Improve the City's approach to engaging and informing citizens and stakeholders.	AMP provides transparency in communicating priorities and outlining how capital spending decisions are made across various service areas

This work is also intended to align with and support the City's existing municipal foundation documents. These relationships are highlighted in the following table; links to each of these documents are available on the City of Hamilton's website. Further integrations are planned as part of the City's long-term asset management strategy and will be reflected in future iterations of this document.

Table 9 - The Asset Management Plan's Relationship with Existing Municipal Foundation Documents

2013 Capital and Operating Budgets	The budgets present the current year committed funding, a 5 year projection for operating budgets and a 10 year projection of funding for capital projects. This first Plan focuses on the 10 year capital project list extracted from the budgets with the intent to evolve in the direction of lifecycle management introducing operational budget impacts as well. The budgets are critical to the implementation of the plan because they include the funding approval. Without funding, the plan is not implemented.
Corporate Strategic Plan	This document sets the target or key results expected from the Plan. The Corporate Strategic Plan frames the direction of the Corporate Asset Management Plan. The Plan is at a more granular level than the Corporate Strategic Plan. The Plan even speaks to the feasibility of whether the strategic plan can be achieved and/or sustained.
Official Plan	The Official Plan sets the criteria for the City in a regulatory format and provides parameters surrounding asset decision-making practices.
By-laws, policies, master plans, area plans, plans of subdivision, business plans	Generally these more detailed documents provide the information required to draft the Plan. In the future, service area asset management plans will be added to provide better information, thus leading to more effective planning and decision-making.

GRIDS (Growth Related Integrated Development Strategy)	The City has recently completed a planning process that integrates land use, transportation, water, waste water and stormwater planning into one project.

2.4 Development Methodology

This Asset Management Plan employed an inclusive development approach, gathering information and input from the various asset management stakeholders within the City. The methodology selected was structured around the primary AMP sections, as defined in the Ministry of Infrastructure framework.

Table 10 - Asset Management Plan Content

Section		Approach
0	Glossary	Highlight AMP-specific terminology used within the Plan.
1	Executive Summary	Summarize Plan content, highlighting specific findings, trends and implications.
2	Introduction	Provide an overview of asset management within the City and set overall context and expectation for the report.
3	State of Local Infrastructure	Present an overview of the asset portfolio, including information on inventory, condition, cost, etc., accompanied by information on supporting data.
4	Desired Levels of Service	Describe how service links to infrastructure investment and define how performance is measured and goals and expectations are identified and set.
5	Asset Management Strategy	Define planned actions that will enable the assets to provide the desired LOS in a sustainable way, while managing risk, at the lowest lifecycle cost (e.g. through preventative action).
6	Financing Strategy	Identify lifecycle investment requirements and identify appropriate funding strategies.
7	Improvement and Monitoring Plan	Describe how Asset Management will be monitored and improved across the City over time.

The AMP development process was split into two key phases:

1. Asset Management Plan Scoping and Strategy: This step identified a roadmap for AMP development, developed consensus around a detailed AMP structure, highlighted key AM practices, and identified data gaps and potential data sources for populating the document.
2. Asset Management Plan Development: This step utilized a series of workshops with stakeholder groups within the City to obtain input relating to the AMP components.

Being the first version of the AMP, several limitations are known to exist and will help inform the continuous improvement process for future versions of the report.

Table 11 - Limitations of First Asset Management Plan

1	The scope of this report covers only five service areas delivered by the City of Hamilton. It is expected that other services will be included in future plans. This incremental approach is similar to the approach adopted by the City in issuing its State-of-the-Infrastructure Report (SOTI).
2	There are currently several groups with asset management responsibility within the City. This means different areas have different practices thereby limiting the ability to compare projects across areas. This limitation can be addressed by adopting a corporate asset management approach within the City.
3	The City does not have a Level of Service registry and no system to track levels of service beyond the annual budget process. The indicators used in the budget process can be improved for asset management purposes to guide future investment planning.
4	An important factor in lifecycle management is the condition of the asset. The City addresses this information in three ways. Condition may be technically assessed and reported on in a quantifiable technique. Condition may be assumed based on age and estimated useful life. Finally, condition may be based on the expert opinion of staff using the asset. The City generally uses quantifiable techniques that are a more accurate and expensive approach in one-time reporting situations using consultants to analyze and prepare reports. Examples of assets with reliable condition information include roads, facilities, and sewers. These assets represent the majority of assets by replacement value. However several asset classes do not have this level of rigor to accumulate condition assessment information.
5	There is a need to improve the alignment between financial planning and asset management planning. Continuous improvement is sought to enable the asset management planning process to better inform the City's budget preparation process and facilitate an evidence-based discussion around service levels, funding and affordability of service.

2.5 Plan Scope and Timeframe

This first version of the Asset Management Plan focuses on high level planning for the services under the direct control of the City and excludes indirect service administered by Boards and Agencies. The Plan addresses four core service areas, as detailed in the Ministry of Infrastructure's 'Guide for Municipal Asset Management Plans':

- Roads & Bridges
- Water
- Sanitary
- Stormwater

By exception, this Plan does not cover Social Housing which was included as a core area in the Ministry of Infrastructure's 'Guide for Municipal Asset Management Plans'. In the City of Hamilton, Social Housing is owned by CityHousing Hamilton; they will be preparing a separate report.

The AMP forecasting timeframe utilizes both a short-term tactical planning window (10 years) and a long-term strategic planning window (100 years). The 100 year planning window is intended to better understand the needs of some asset classes that have exceptionally long service lives like buried water, wastewater, and stormwater infrastructure. The accuracy of the data used for each planning horizon needs to be considered as long-term strategic planning forecasts are heavily impacted by any changes in assumptions like inflation, asset useful life, community growth, changes in technology, changes in legislation, etc… In spite of its reduced accuracy, long-term strategic plans allow decision-makers to better assess existing asset needs and the adequacy of funding levels.

The City intends to update the AMP on a 5-year cycle and align any future editions of the State-of-the-Infrastructure (SOTI) Report with the AMP as the SOTI is a major input into section 3 of the AMP.

2.6 Improvement Plan

This first iteration of the Asset Management Plan was completed at a high-level, focusing on meeting the minimum requirements defined by Province of Ontario in its Guide for Municipal Asset Management Plans. Development of this first plan, has provided a better understanding of the requirements for future AMP versions, and has helped to identify data/knowledge gaps.

Going forward, the Public Works Asset Management section will coordinate and support asset management planning City-wide. Key improvement initiatives and plans for how the AMP is to be monitored, improved and reviewed are detailed in Section 7 - Plan Improvement and Monitoring.

The Plan will initiate a cyclical approach as shown between the service areas, developing a standardized framework for AMP reporting. Subsequent iterations will be aimed at the range of business units that are responsible for the majority of the City's asset base, providing a robust framework supporting the analysis, planning and reporting of asset management practices and business and financial needs. Outcomes and learnings from these business unit plans will then be captured and used to update this corporate level plan covering the City's overall asset base.

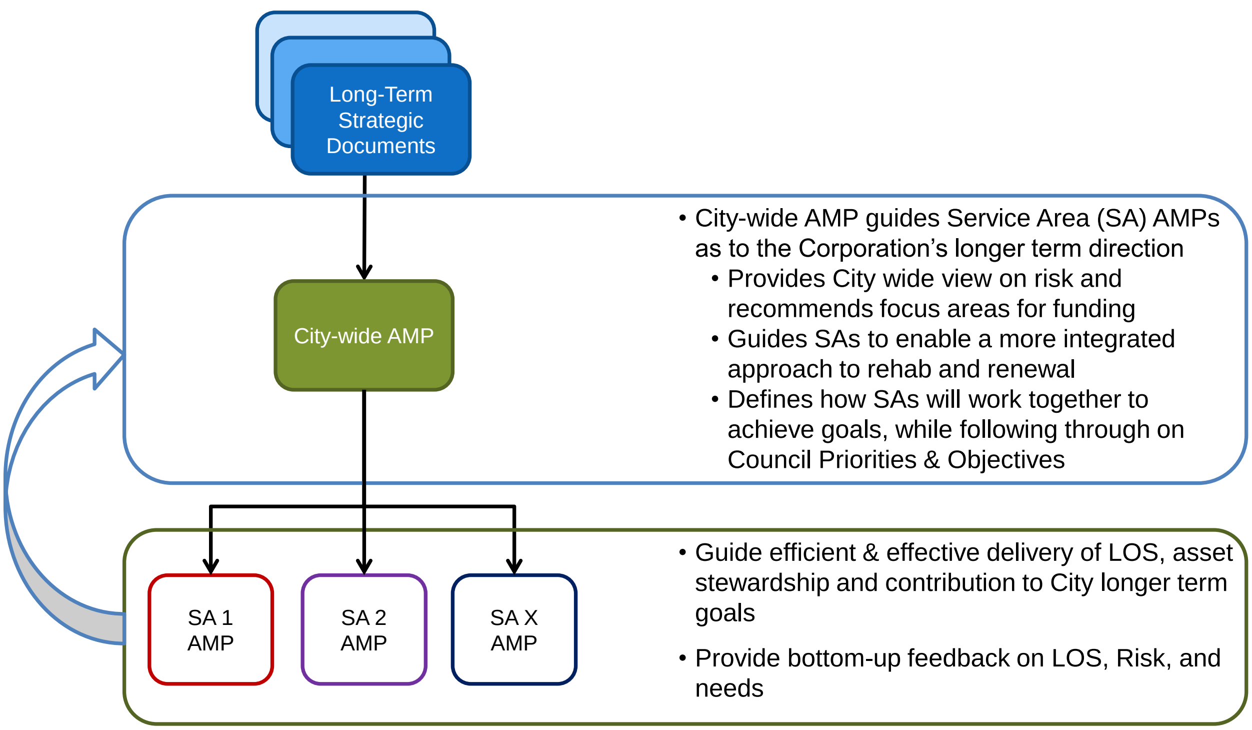


Figure 5 Methodology for AMP development

Section 3 – State of Local Infrastructure

3.1 Asset Inventory

The asset inventory is made up of three major categories; water, wastewater and stormwater assets. Tables showing the breakdown by asset type are shown below. A comparison is made between the inventory that was reported in the 2009 State of the Infrastructure Report (SOTI) and the 2013 inventory.

Table 12 - Asset Inventory - Water

Asset Type: Water		2009 Inventory*	2013 Inventory**	Change	% Change
Linear	Mains	1,946,968m	2,013,661m	66,693m	3.43%
	Hydrants	12,118			
	Valves	16,655	19,855	3,200	19.21%
	Services	132,988	143,826	10,838	8.15%
	Meters	132,988	143,826	10,838	8.15%
Facilities	Water Treatment Plant	1	1	0	0.00%
	Pumping Station	24	25	1	4.17%
	Storage	18	21	3	16.67%
	Wells	8	8	0	0.00%
	Surge Tanks	1	2	1	100.00%

Table 13 - Asset Inventory - Wastewater

Asset Type: Wastewater		2009 Inventory*	2013 Inventory**	Change	% Change
Linear	Interceptor + Trunk (>= 450)	470,586m	488,928m	18,342m	3.90%
	Local -Combined Sewer (<450)	1,200,132m	1,270,273m	70,141m	5.84%
	Maintenance Holes	20,537	22,177	1,640	7.99%
	Sewer Laterals	132,988	139,588	6,600	4.96%
Facilities	WW Treatment Plant	3	2	-1	-33.33%
	CSO Tanks	8	9	1	12.50%
	Pumping Stations	73	72	-1	-1.37%
	WW Control Gates	20	20	0	0.00%

Table 14 - Asset Inventory - Stormwater

Asset Type: Stormwater		2009 Inventory*	2013 Inventory**	Increase	% increase
Linear	Storm Sewers	1,009,569	1,113,315	103,746	10.28%
	Manholes	14,105	16665	2,560	18.15%
Stormwater Structures	Storm Ponds	76	185	109	143%
	Inlet & Outfall Structures	845	910	65	7.7%

Table 15 - Asset Inventory - Roads & Bridges

Asset Type: Roads & Bridges		2009 Inventory*	2013 Inventory**	Change	% Change
Roads	Lincoln Alexander Parkway (LINC)	81 km	85 km	4 km	5%
	Red Hill Valley Parkway (RHVP)				
	Urban Network	2,864 km	1,830 km	103 km	4%
	Rural Network		1,137 km		
Bridges	Bridges	271	296	25	8%
	Culverts (> 3m)	118	95	- 23	- 19.5%

**Based on the 2009 State of the Infrastructure Report*

*** Based on a capture of the asset inventory database in October 2013*

Based on a comparison of the 2009 and 2013 inventory the following can be noticed:

Water, Wastewater and Stormwater

- On the linear side, most asset classes experienced a minor inventory increase (3-5%) that can be explained by typical increase due to growth. Examples of these asset classes include water mains, sewer mains, water services, water meters, and sewer laterals.
- Water valves experienced significant increase in inventory (19%) from 2009 to 2013. This is mainly due to the improved capture of asset inventory information during this time. A large number of air valves and release valves were originally grouped with line valves in the past and now are being recorded as separate assets in the inventory database.
- Stormwater linear infrastructure experienced a relatively large increase (10%) which is a direct reflection of the City's effort to enhance its storm water collection system in the light of increased pressures due to intense rainfall events.
- Storm ponds experienced significant increase in inventory (143%) from 2009 to 2013. This is mainly due to the improved capture of asset inventory information during this time.
- For water facilities, changes in inventory are due to the following:
    - The Stelco Pumping Station (HWSTL) was not included as a separate asset in the 2009 SOTI report, but rather grouped as a sub-asset for the treatment plant. It will be tracked as a separate asset in the inventory.
    - In 2010 a new elevated tank was commissioned in Waterdown (HDT16). In addition, two Clear Wells at the Woodward WTP were originally tracked as a sub-asset of the treatment plant in the 2009 SOTI report. They will be tracked as a separate asset in the inventory.
- For wastewater facilities, changes in inventory are due to the following:
    - Waterdown WWTP has been decommissioned since 2009 leaving in service only 2 treatment plants: Woodward WWTP and Dundas WWTP.
    - A new CSO tank, McMaster CSO Tank (HCS09), was commissioned in 2009/2010.
    - One pumping station, Harmony Hall WWPS (HC008), was decommissioned.

Roads and Bridges

- The City's road network has increased by 107km or 4% since 2009 with much of that increase occurring within the urban/rural network.
- The bridge and culvert inventory has increased by a total of 2 structures. Differences in numbers of bridges and culvers over this period is due to reclassification of structures and updates in asset inventory and ownership information.

3.2 Asset Valuation

The 2013 replacement cost for the City's water, wastewater, stormwater, road and bridge assets is estimated at $14.37 Billion. This is a 19% increase from the value reported in the 2009 SOTI and reflects both inflationary increases and growth in the asset inventory itself. The tables below summarize the replacement cost values (in millions) for each asset group.

Table 16 - Replacement Value - Water

Asset Type: Water		2009 Replacement Cost	2013 Replacement Cost
Linear	Mains	$1,489	$1,874
	Hydrants, Valves, Services	Included in cost of mains	
	Meters	$48	$57
Facilities	Water Treatment Plant	$409	$450
	Pumping Station	$144	$158
	Storage	$195	$226
	Wells	$3	$3
	Surge Tanks	$1	$2
Sum		**$2,289**	**$2,771**

Table 17 - Replacement Value - Wastewater

Asset Type: Wastewater		2009 Replacement Cost	2013 Replacement Cost
Linear	Interceptor + Trunk (>= 450)	$723	$826
	Local -Combined Sewer (<450)	$571	$665
	Maintenance Holes	$697	$828
	Sewer Laterals	$689	$795
Facilities	WW Treatment Plant	$835	$918
	CSO Tanks	$135	$167
	Pumping Stations	$187	$203
	WW Control Gates	$16	$18
Sum		**$3,853**	**$4,419**

Table 18 - Replacement Value - Stormwater

Asset Type: Stormwater		2009 Replacement Cost	2013 Replacement Cost
Linear	Storm Sewers	$1,512	$1,833
	Manholes	Included in cost of mains	
Stormwater Structures	Storm Ponds	$47	$126
	Inlet Outfall Structures	$6	$7
Sum		**$1,565**	**$1,966**

Table 19 - Replacement Value - Roads & Bridges

Asset Type: Roads & Bridges		2009 Replacement Cost	2013 Replacement Cost[1]
Roads	Lincoln Alexander Parkway (LINC)	$192	$218
	Red Hill Valley Parkway (RHVP)		
	Urban Network	$3,760	$3,970
	Rural Network		$490
Bridges	Bridges	$446	$533
	Culverts (> 3m)		
Sum		**$4,398**	**$5,211**

[1] Roads values include replacement costs for sidewalks, signs & supports, Streetlights, Signals – Traffic/Pedestrian, Pavement Markings and the Communication System

3.2.1 Historical Cost Valuation

As part of its Tangible Capital Asset (TCA) reporting requirements, the City is required to undertake historical cost valuation of its assets and account for amortization, write-downs and betterments within its Financial Information Report. It should be noted that historical cost valuation will tend to underestimate asset value when compared to replacement cost valuation. For historical cost valuation, asset value must be recorded at the time of acquisition which in cases of infrastructure assets with long useful lives may translate into minuscule values for assets that acquired a long time ago. As such, historical cost valuation can be considered more of a "backward looking" view on asset value whereas replacement cost valuation is more of a “forward-looking” view. From an asset management perspective, replacement cost valuation is more useful in long-term decision making and promotes a better understanding future financial needs of the infrastructure. Historical cost values are included in this report to acknowledge that other asset valuation methodologies are being used to fulfill other reporting purposes within the City.

According the City’s 2012 Consolidated Financial Statement the book value of its Tangible Capital Asset base for water, wastewater and stormwater assets on December 31st 2012 is estimated at $1.87 billion. For roads and bridges it is estimated at $1.37 billion.

Table 20 - Asset Book Value by Category

Asset Class	Cost December 31, 2012	Accumulated Amortization	Book Value December 31, 2012
W/WW Facilities	613,353	289,850	323,503
W/WW/SW Linear Network	2,001,437	456,894	1,544,543
Roads	2,079,803	877,960	1,201,843
Bridges and other structures	214,694	44,753	169,941

3.3 Asset Useful Life

The estimated remaining useful life of a physical asset, based on the age of the asset, is considered a good starting point to estimate the overall well-being of an asset pool, however in many cases the percentage of useful life consumed may not be the most suitable indicator of current asset condition. Infrastructure assets in particular undergo a continual process of repair, rehabilitation and refurbishment in order to maintain their intended purpose. For example roads, bridges and facilities usually undergo continual maintenance and rehabilitation and hence age may not be the most suitable indicator to use for asset management planning. As such in many cases asset useful life needs to be augmented with other information such as condition rating, history of upgrades, and expert judgment.

It should be noted that estimated useful lives, based purely on age, can sometimes provide a misleading view on the replacement timing for the assets. In many cases assets that are properly constructed and maintained may outlive their estimated useful life and continue providing service. In other cases, due to poor workmanship and lack of proactive maintenance, asset may fail before they fulfill their anticipated useful life.

3.3.1 Water, wastewater and storm water assets

The City of Hamilton has utilized a hybrid approach that relies on asset age, assumed useful life, actual asset condition rating where available and expert judgment to evaluate the condition state of the various asset types.

Assumptions for asset useful life were based on the on those that were developed as part of the 2009 State of the Infrastructure Report. These estimates were based on as more detailed assessment of theoretical expected useful lives based on expert judgment and knowledge of City staff. These are the same values that are used for Tangible Capital Asset reporting. Values for asset useful life are shown below.

This section provides a high-level overview for the major asset classes where asset age and condition has been used to estimate the remaining useful life. Pie charts show the distribution across various age categories by length of pipe.

Table 21 - Estimated useful life – Water Assets

Asset Type	Asset Component		Useful Life (years)
Linear	Mains- Trunk Mains - Local	Rehabilitated	30
		Existing	75
		New	100
	Appurtenances	Included with mains	
	Meters	Industrial	5
		Residential	18
Facilities – All Types	Site Civil		25
	Process, Piping and Equipment		30
	Instrumentation and Control		15
	Process Structural		80
	Building Mechanical		25
	Building Electrical		25
	Building Structural		50
	Building Architectural		20

Table 22 - Estimated useful life – Wastewater Assets

Asset Type	Asset Component		Useful Life (years)
Linear	Interceptors, trunks, and local sewers	Lined sewers[1]	50
		Unlined Sewers	100
	Appurtenances	Included with sewers	
Facilities – All Types	Site Civil		25
	Process, Piping and Equipment		30
	Instrumentation and Control		15
	Process Structural		80
	Building Mechanical		25
	Building Electrical		25
	Building Structural		50
	Building Architectural		20

Table 23 - Estimated useful life – Stormwater Assets

Asset Type	Asset Component		Useful Life (years)
Linear	Sewers	Lined sewers	50
		Unlined Sewers	100
	Appurtenances	Included with sewers	
Facilities – All Types	Storm Ponds		100
	Inlet / Outfall Structures		100

[1] Based on design life not actual life of the liner. Once more performance data becomes available, estimates can be adjusted accordingly

Asset Type: Linear Water
Replacement Value: $1.87 Billion
Estimated Useful Life: 75 years
Percentage of assets exceeding useful life: 20%
Comment: Lack of available widespread condition assessment of water pipes make age a relevant indicator of condition. Overall the City's water network is evenly spread out over the past 100 years, implying that long-term capital spending on network replacement is not expected to encounter sudden spikes. The City does own a sizable inventory of water mains that are older than 100 years (7% by length). In the short-term these are expected to require immediate attention

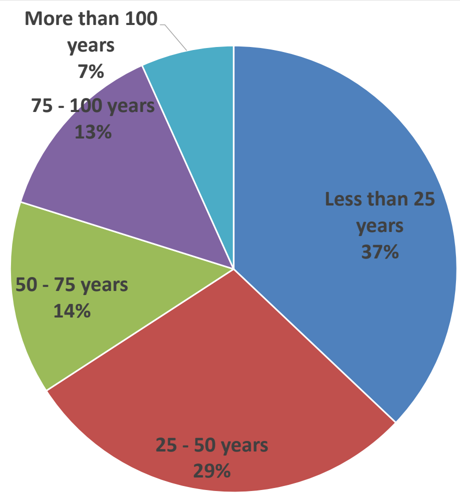


Figure 6 - Asset Age Distribution - Water Linear

Asset Type: Linear Wastewater
Replacement Value: $1.49 Billion
Estimated Useful Life: 100 years
Percentage of assets exceeded useful life: 12%
Comment: Compared to the linear water asset category, sanitary sewers are generally older with 21% of assets older than 80 years old. Overall the City's sanitary sewer network is evenly spread out over the past 60 years, implying that long-term capital spending on network replacement is not expected to encounter sudden spikes. It should be noted that the City regularly performs televised inspections of its sewer pipes to determine its actual condition grade.

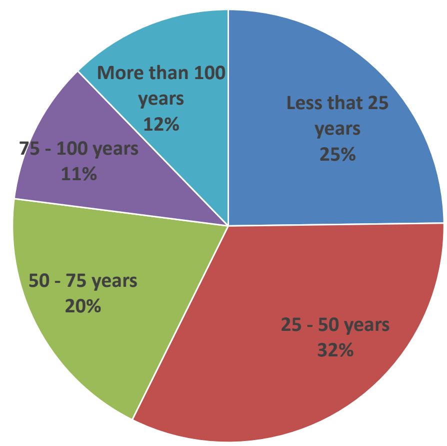


Figure 7 - Asset Age Distribution - Wastewater Linear

Asset Type: Linear Storm
Replacement Value: $0.88 Billion
Estimated Useful Life: 100 years
Percentage of assets exceeded useful life: 6%
Comment: The City's Stormwater linear infrastructure has the smallest percentage of assets that have exceeded their estimated useful life compared to all buried infrastructure classes. The vast majority (80%) of the 1,113 km is less than 50 years old. Capital investment needs for this asset class are expected to significantly increase compared to current levels as this cohort ages and reaches the end of its service life.

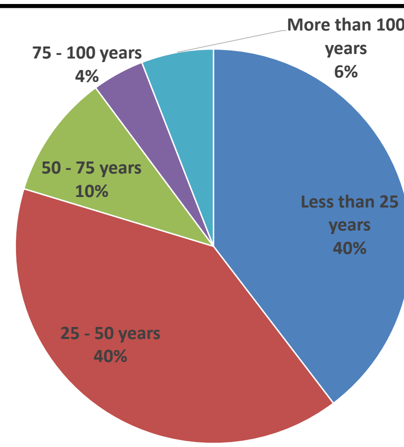


Figure 8 - Asset Age Distribution - Stormwater Linear

3.3.1 Roads

The City utilizes a pavement management system to calculate pavement age and remaining service life for each pavement segment, within the City's entire pavement network. Each road segment's age is determined using current pavement conditions, and back-calculated for when the pavement's condition value (the OCI – Overall Condition Index) would have been a perfect score of 100. The back-calculation uses pavement deterioration curves (Figure 2 - page 9), the shape/length of which, are determined by each road segment's pavement type, traffic volume, pavement thickness, and subgrade strength. The back-calculated field ("Construction Year") allows the City to estimate each road segment's effective age.

As part of the SOTI Roads Network and Traffic System Review project which was completed in 2013 initial prediction models were developed based on input from City staff on expected service lives for different functional classes as noted in the following table.

Table 24 - Estimated useful life – Roads

Class	Type of Work	Service Life (Years)
Urban Collectors/Locals	Reconstruction	35
Rural Collectors/Locals	Reconstruction	30
Urban/Rural Arterials	Reconstruction	28

The service life is an estimate, measured in years, of how long a given road section will last until it reaches a given trigger or service level. In this case, the service life shown above is measured based on the reconstruction trigger. In addition, these models have been compiled from a review of deterioration of roads in several cities, within southern Ontario.

The following graph illustrates the initial prediction models that were developed as part of the previous study. The rehabilitation trigger identifies when a pavement should be considered for a rehabilitation or resurfacing treatment; whereas a reconstruction trigger indicates when a pavement may qualify for major rehabilitation or full reconstruction.

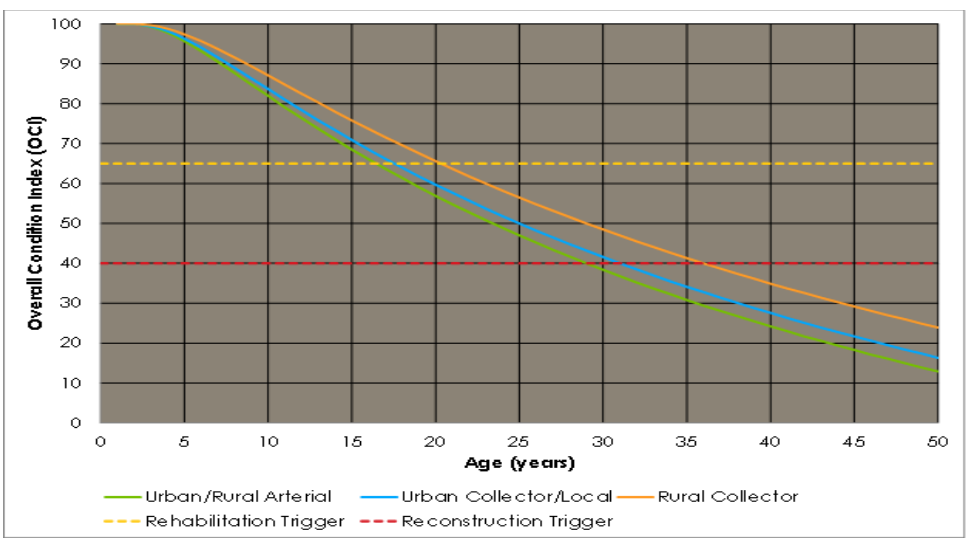


Figure 9 - Road Deterioration Curves

Asset Type: Roads
Replacement Value: $4.7 Billion
Estimated Useful Life: 28 – 40 years
Percentage of assets exceeded useful life: N/A
Comment: The City's Road network represents one of the most significant asset portfolios owned and operated by the City. Maintenance and rehabilitation of the road assets are funded from the levy, therefore, there are significant challenges associated with ensuring that this funding is sustainable in the long-term. The road network is inspected on a five-year cycle and an Overall Condition Index (OCI) is calculated for each road segment. Based on the most recent condition assessment which was completed in 2011/12 the average network OCI is 63 (on a scale of 0-100 where 100 would represent a new road).

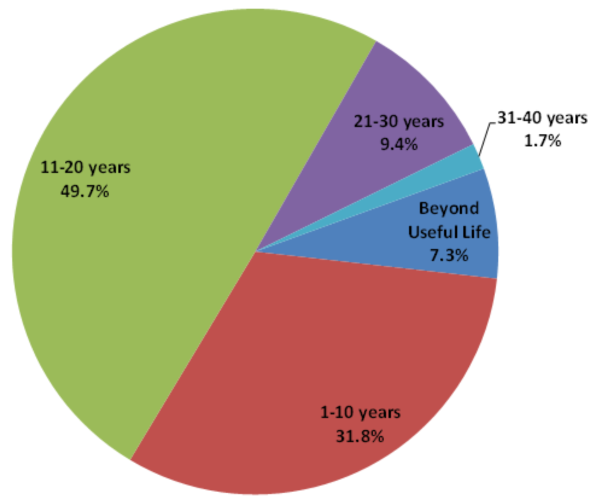


Figure 10 - Asset Age Distribution - Roads

3.3.2 Bridges & Culverts

A useful life span can be assigned to bridges and culverts. However, there are many conditions that can affect the true life of an asset, such as: design, construction, and manufacture quality, maintenance standards, quantity of use, surrounding environment, construction material, and so forth.

The level of intervention on infrastructure will vary significantly over the life cycle of an asset. The process of maintenance, rehabilitation, and failure is a very dynamic system. Therefore, it is essential that we take a life cycle approach to assessing the financial needs for the future.

This dynamic process of asset aging has a significant financial impact attached to it that can be quantified. Therefore, our financial analysis is based upon a life cycle model that identifies upcoming trends in asset replacement and, hence, funding needs.

The following diagram illustrates the age distribution of the County's bridge and culvert asset portfolio based on an estimated useful life of 75 years for bridges and culverts with the exception of corrugated steel culverts where 40 years was assumed[2].

Asset Type: Bridges and Culverts
Replacement Value: $0.53 Billion
Estimated Useful Life: 40 - 75 years
Percentage of assets exceeded useful life: 12%
Comment: Although approximately 12% of the City's Bridge and Culvert assets appear to be beyond their anticipated service life it should be noted that these assets are inspected every two years and all critical repairs are completed as required. The Bridge Condition Index (BCI) is the measure of the condition of the bridges and culverts. Based on the most recent OSIM inspections approximately 13 bridges and culverts have been identified as having a BCI <60, which means that some form of rehabilitation is required.

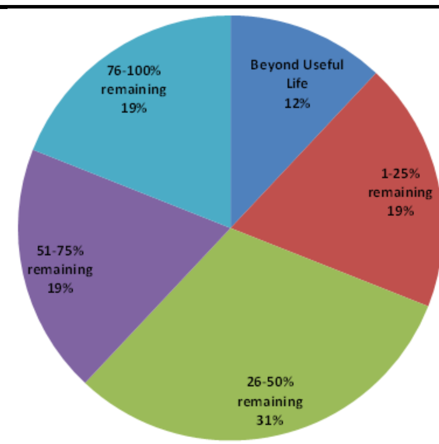


Figure 11 - Asset Age Distribution - Bridges and Culverts

[2] City of Hamilton, 2012 Tangible Capital Asset Report – Bridges and Culverts (October 2013)

3.4 Asset Condition

The condition of each asset group was evaluated to represent the current 'health' of the City's infrastructure. In the future the AMP will expand this assessment to include other service measures such as adequacy and reliability, to better reflect the ability of assets to service the needs of the community.

3.4.1 Overall Asset Rating

The City of Hamilton has developed two State of the Infrastructure (SOTI) reports for water and wastewater infrastructure, in 2005 and 2009. The methodology for overall condition rating used in these reports relies on three metrics:

- Condition / performance
- Capacity
- Needed versus available funding

The 2013 values reported in this section are the result of workshops conducted with City staff to update the 2009 ratings to reflect any significant changes in any of the aforementioned metrics.

Water infrastructure generally fared the best with a condition rating ranging from C to B+. This can be attributed to the large investments that were completed by the City on water infrastructure. Wastewater infrastructure fared worse than water with a condition rating ranging between C and B. Sewer laterals are of specific concern due age, unavailability of reliable condition data and the lack of funding source. Stormwater infrastructure generally received the worst overall condition grade due to the overall lack of a dedicated funding source to support capital investment needs. Of specific concern are stormwater ponds and outfall structures. The lack of comprehensive maintenance plans, incomplete inventories, capacity that limits growth in some areas and unreliable information on condition state are all reported issues for these assets.

Table 25 - SOTI Asset Rating - Water

Asset Type: Water		Rating	Trend
Linear	Mains – Trunk (> 450 mm)	C+	↓
	Mains – local (< 450mm)	C	↓
	Large Valve Chambers	C+	↓
	Services	B-	→
	Meters	B -	→
Facilities	Treatment Plant	B+	→
	Booster Station	B-	→
	Storage Reservoirs	B-	→
	Wells Systems	B-	→
	SCADA	B	↑
Combined		**B -**	**→**

Table 26 - SOTI Asset Rating - Wastewater

Asset Type: Wastewater		Rating	Trend
Linear	Interceptors	C-	↓
	Trunk Sewers (≥ 450mm)	C	↓
	Local Sewers and Manholes (<450 mm)	C	→
	Sewer Laterals	C-	→
Facilities	WW Treatment Plant	C+	↑
	CSO Tanks	B	→
	Pumping Stations	B-	→
	WW Control Gates	C+	↑
Combined		**C**	**→**

Table 27 - SOTI Asset Rating - Stormwater

Asset Type: Stormwater		Rating	Trend
Linear	Storm sewers & manholes	C	↓
	Engineered Channels	D+	↓
	Natural Channels	D-	↓
	Rear Yard Catchbasins	D-	↓
	Culverts	C	→
	Ditches	C	→
Structures	Storm Ponds	D	↑
	Inlet & Outfall Structures	D	↓
Combined		**D**	**↓**

Table 28 - SOTI Asset Rating - Roads & Bridges

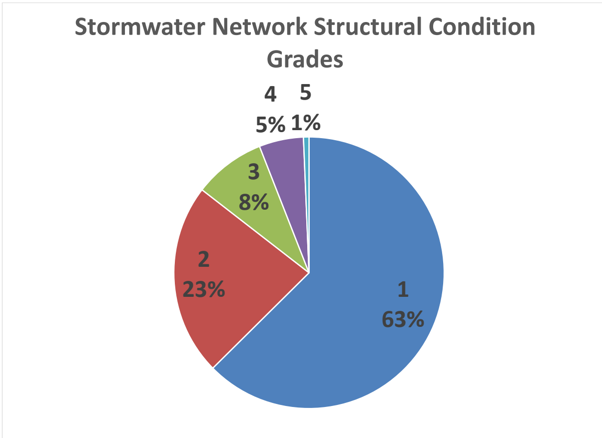
Asset Type: Roads & Bridges		Rating	Trend
Roads	Lincoln Alexander Pkwy (LINC)	C	↓
	Red Hill Valley Pkwy (RHVP)	C	↓
	Urban Network	D+	↓
	Rural Network	C-	↓
Bridges	Bridges	C	→
	Culverts (> 3m)	C-	→
Combined		**C-**	**↓**

3.4.2 Specific Asset Condition Assessment

The City of Hamilton undertakes a variety of formal and informal condition assessments on its water, wastewater and stormwater infrastructure annually. The following summaries highlight the outcomes of key procedures, and provides a benchmark which can be tracked over time.

Gravity Sewers (Wastewater and Storm)

The City of Hamilton undertakes annual inspections of its sanitary and storm networks using both movable and stationary (zoom) televised inspection. In total, 1,597 km of the City's sanitary network and 1,008 km of the City's storm networks have a structural condition grade either from zoom or movable CCTV. This represents 94% and 90% of the total sanitary and storm networks respectively. The City uses zoom inspections first to identify sewers that need more detailed inspection with movable CCTV. The condition grade is on a 1-5 scale with 1 representing an asset with minimal structural deficiencies and 5 representing assets that are on the verge of failure. Sewers that are in a condition state of 3 or worse are flagged for further inspection using movable CCTV to identify the exact location and severity of the sewer defects and guide the selection the most suitable treatment. In total 55% and 41% of the sanitary and storm sewer system have condition grades identified using movable CCTV technology.



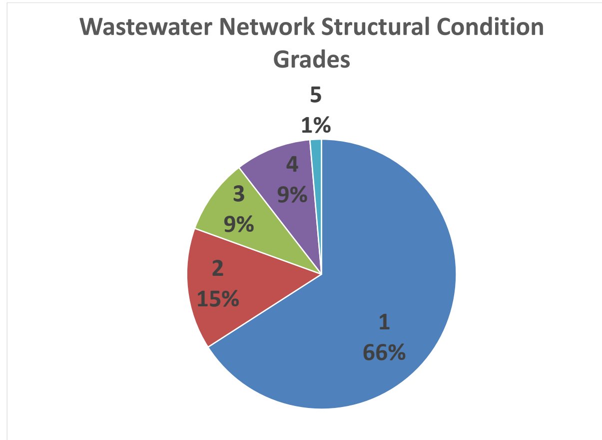


Figure 12 - Structural condition grades for stormwater and sanitary networks

Results of the condition assessment reveal that in spite of the age of buried sewer infrastructure, the actual condition of these assets does not necessarily correlate with its percentage of consumed actual life. The City is actively investing in condition assessment programs that allow capital improvements to target those assets that are in actual need of intervention rather than basing the intervention on age only.

Water Mains

The lack of available technologies to undertake wide-spread cost-effective condition assessments for water networks makes the process for water network condition rating more difficult compared to sewer networks. The City has developed a theoretical watermain condition index (TWCI) to be used as a proxy for condition data. The index relies on the number of pipe breaks, soil type, pipe material type and pipe age to forecast the expected condition of each asset. The TWCI is on a 0-100 scale with smaller values indicating a worse condition. Figure 4 (page 10) shows the distribution of pipe network by length in various condition grades. Only 6% of the City's network has a TWCI less than 40. These results reconfirm the previous observation regarding sewer networks regarding the inability of age to be a perfect predictor of condition grade for network infrastructure.

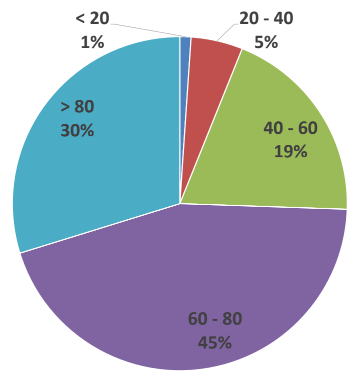


Figure 13 - Theoretical Water Main Condition Rating

Roads (pavements)

The City conducts a network-wide pavement condition assessment on a five-year cycle, with the most recent completed in the fall of 2011, and previously in 2006 and 2001. The methodology of the pavement survey, which included the collection of roughness and surface distress data. The 2006 and 2011 pavement condition surveys have utilised specialist equipment which is called the "Laser Road Surface Tester" or Laser-RST.

The main components of the Laser-RST include:

- Laser-Camera Array (LCA) system with integrated lasers, cameras, rate gyroscopes, inclinometers and accelerometers to automatically and continuously measure pavement cracking, texture, roughness, rutting, and geometrics.
- Digital Condition Rating System (DCRS) that may be customized to collect user defined severity/extent based pavement distresses and a variety of roadway attributes.

Using the pavement condition data collected as part of the roughness and surface distress surveys, the present status of the network is determined during the RoadMatrix analysis, and is summarized using the following Performance Indicators:

- **Roughness Index (RI) -** which represents the surface roughness on a scale of zero (0) to 100, where 100 indicates a very smooth surface.
- **Surface Condition Index (SCI) -** which represents the presence, severity, and extent of various surface defects on a scale of zero (0) to 100, where 100 indicates a pavement with no distress.
- **Overall Condition Index (OCI) –** is developed by combining the RI and SCI values to represents the overall condition of the pavement. This index is also evaluated on a scale of zero (0) to 100, where 100 represent a new road. A value of 20 or less represents a failed pavement requiring replacement.

The City's current average network OCI value is approximately 63. This is considered to be a "Good" condition. The average OCI values for each functional class are summarized below.

Table 29 - Pavement Conditions by Functional Class (by lane-km)

Functional Class	No. Sections	Lane-Length (km)	2011 OCI Average
Expressway Network	213	137	84
Urban Network	12,602	4,007	59
Rural Network	1,694	2,099	68
Entire Network	14,509	6,243	63

The current OCI distribution chart is shown in the following figure.

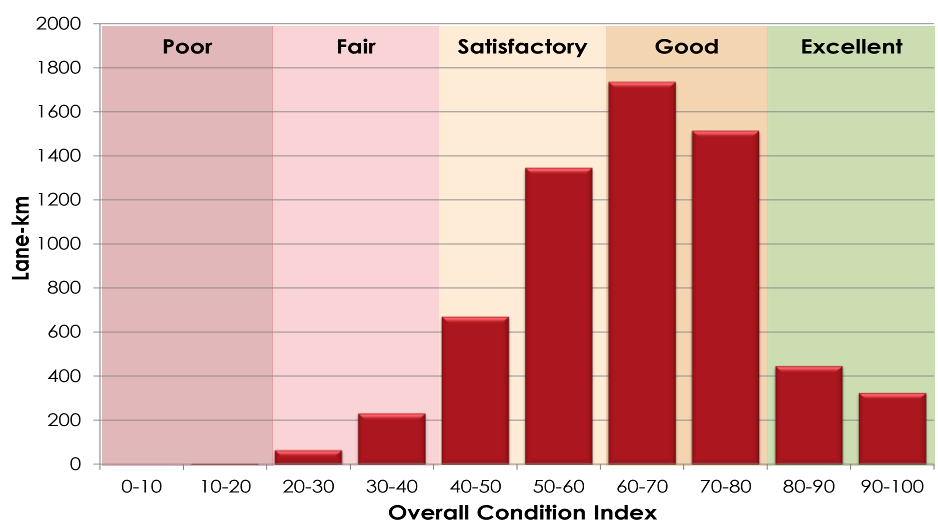


Figure 14 - Overall Condition Index (OCI) Distribution for City's Road Network

The treatment options available for use on the individual road segments are dependent upon the OCI value, these are summarized below:

OCI	Treatment
Poor	Reconstruction
Fair	Reconstruction or resurfacing
Satisfactory	Resurfacing
Good	Preventative maintenance
Excellent	Preventative maintenance as required

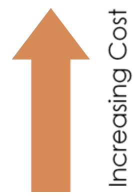


Figure 15 - Intervention Strategy by OCI

The City's objective is to maintain the overall network OCI within the "Good" range, although it should be noted that individual sections may fall below this level. However, by programming the section rehabilitation before it falls below an OCI of 40 the costs associated with the treatment options can be minimized.

Bridges and Culverts

The City's has implemented a Bridge Management System (BMS) which is used to hold the inventory and condition data which is available for the City's 391 bridges and culverts. The BMS can also be used to predict future bridge and culvert performance, and allows for various types of analyses, including recommendations of maintenance and rehabilitation programs based on needs, budgetary limits, or desired levels of service.

Bridge conditions are assessed through inspection, this inspection involves the use of various techniques to assess the physical condition of bridges. Bridge inspection procedures and guidelines are documented in well-developed bridge inspection manuals such as the Ontario Structure Inspection Manual (OSIM 1989) published by the Ontario Ministry of Transportation. The City currently contracts with structural engineering firms to undertake condition assessments on half of the bridges and culverts annually in accordance with Provincial requirements.

Condition is reported in terms of the BCI. The BCI is calculated in the BMS as a weighted average of the condition states for each of the elements making up the structure. Since elements are not of equal importance to the structure, the index is weighted according to the relative value or importance of each element in the total. BCI ranges from 100 (new) to 0 (all elements poor condition), and although primarily a representation of the overall condition of the structure, BCI is also representative of the remaining economic worth of the structure.

The Ministry of Transportation of Ontario (MTO) uses the BCI as a performance measure when reporting BCI results for individual bridges and for the network. BCI ranges have been defined as follows:

- **Good** (**G**) – BCI ≥ 70
- **Fair** (**F**) – 60 ≤ BCI < 70
- **Poor** (**P**) – BCI < 60

The distribution of BCI of the bridges and culverts based on the inspections in the database is given in the BCI histogram shown below. The 'current' average for all structures is 71.3, it should be noted that this is based on 2012 and 2013 inspections.

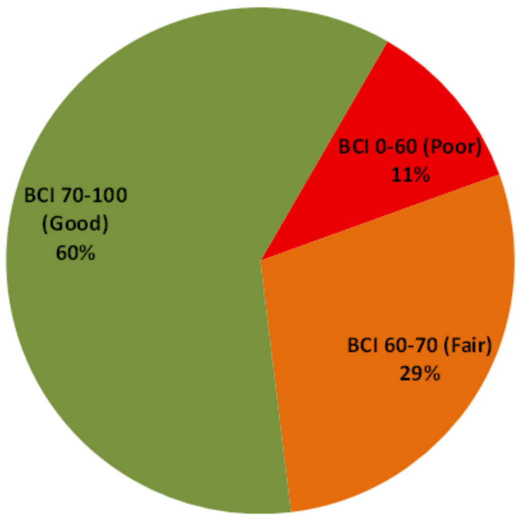


Figure 16 - Distribution of BCI (all structures)

It can be seen from Figure 16 that 40%, or 113 bridges and culverts, are in Fair or Poor condition. For proactive management of the asset, all of the structures in Poor or Fair should be addressed now, or within the short term (typically next 5 years), and plans should be made to address other structures as they reach Fair within 10 years. Deferring work will lead to further deterioration and larger proportions of the inventory in Poor and Fair condition requiring increasingly more costly repair and rehabilitation.

A closer look at the distribution of the BCI for all structures (Figure 17), reveals that although the average BCI for the City's bridges and culverts is in the lower 'Good' range, a large percentage of the inventory currently have BCI values between 60 and 80. Therefore, within a few years of continued deterioration, the largest percentage of the inventory will require work now, or in near future.

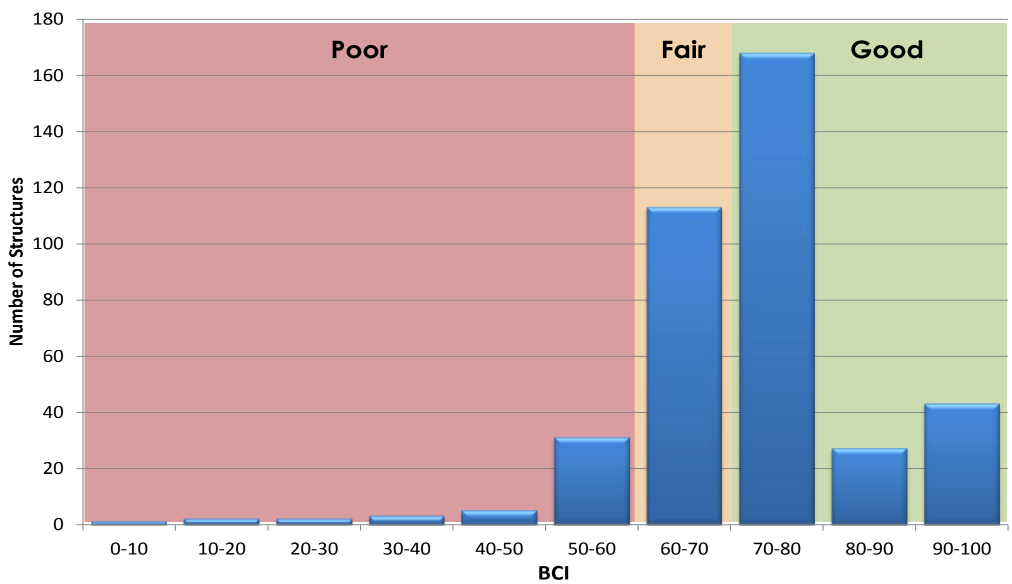


Figure 17 - BCI Distribution (all structures)

Section 4 – Levels of Service

4.1 Level of Service Context

The management of assets needs to consider the affordability of assets against customer needs and expectations. Level of Service is the means to measure this aspect of asset management. Decisions are made based on their impact on customers, the community, and the environment. Using levels of service links day-to-day asset management decision making with the strategic goals of the City.

A key objective of Asset Management is to optimize the balance between the competing objectives of Levels of Service, risk and cost with the aim of meeting customer service levels at the lowest lifecycle costs. This will include better understanding customer expectations, but considering these expectations whilst taking into account the affordability of services. It is therefore important to define and quantify the levels of service (LOS) within each Service Area, as these become the driver for the identification of asset needs and the basis for investment decisions. LOS are linked at three levels within the City – Corporate, Customer and Asset (or Technical) and the setting of these LOS measures needs to define reasonable expectations taking into consideration present and future needs over the life cycle of the assets, affordability and risk.

LOS can be measured at three levels within the City:

- *Corporate* – sets the corporate objective (e.g., providing safe drinking water)
- *Customer* – defines the service that the Asset Manager/City provides to the Customer (e.g., # of properties without water greater than x hours
- *Asset (or Technical)* – defines the technical requirements to achieve the service objectives (e.g., watermain break rates)

Currently the vast majority of performance indicators used to measure and track performance are asset/technical indicators. This traditional view of "asset stewardship" drives asset interventions based on age and condition rather than comprehensively link daily activities to meet desired customer or corporate objectives. Although the asset stewardship approach provides a reasonably sound engineering assessment of the state of the asset base, the approach has a number of weaknesses:

- The grades assigned for condition and performance are subjective and the approach to grading may vary between departments and/or individuals;
- The information which underpins the grades and the assessment of remaining life may be of varying age and quality; and
- There is no assessment of the level of service that the asset provides to customers.

In addition, the approach tends to overestimate the requirement for capital maintenance. This is because it overlooks the operator's capacity to:

- Rationalize the assets (by assessing whether or not it is still required);
- Adopt strategic solutions, by reorganizing the network to reduce or remove the asset;
- Use new technology; and
- Implement cost-effective operational solutions to defer replacement.

The City aims to transition into a more serviceability approach that fosters a more customer centric view of asset management. The City has already built many of the necessary building blocks to support this transition that include asset criticality frameworks, customer outreach initiatives, and performance tracking systems.

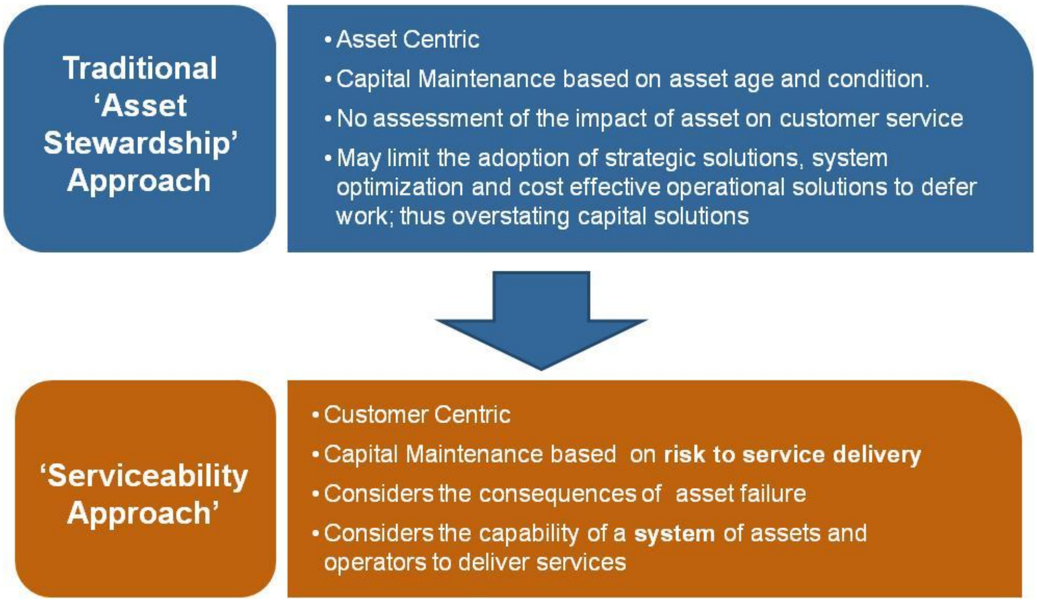


Figure 18 - LOS and approach to asset management

As the City moves towards this approach, alignment between service, service delivery goals, and technical performance indicators will need to be established. The following section presents a preliminary alignment model and discusses existing trends across various performance indicators. Future work will develop clearly defined customer performance indicators that link technical indicators with service delivery goals.

4.2 Performance Measures

Examples of performance measures related to water and wastewater services that are currently tracked by the City include those that are reported to the Ontario Municipal Benchmarking Initiative (OMBI) and the National Water and Wastewater Benchmarking Initiative (NWWBI). The majority of these indicators are considered technical indicators. The following sections discuss how these indicators are aligned to service delivery goals.

LOS indicators are aligned to 9 key service goals that are to be met by water treatment, water distribution, wastewater collection and wastewater treatment services.

- Providing affordable service to customers
- Providing accessible services through the accommodation of growth needs
- Ensuring the safety of utility employees
- Ensuring the safety of the public
- Providing reliable services by ensuring sufficient quality and quantity of service
- Providing reliable services by ensuring uninterrupted service delivery

- Ensuring regulatory requirements by meeting license requirements
- Maintaining a responsive customer service
- Maintaining an accurate customer service

Values and trends for the technical LOS indicators are presented in section 4.5

4.2.1 Water Services

Table 30 - Technical service alignment for water treatment service

Service	Service Goal	Technical Level of Service
Accessible	Affordable	O&M Cost / ML Treated
		Chemical Cost / ML Treated
	Accommodate Growth	Average Day Demand / Existing Water License Capacity
Safe	Keep employees safe	Not currently tracked; Measure under development
	Protect the Public	# of Occurrences of Total Coliforms
Reliable	Sufficient Quality /Quantity	Average Day Demand / Existing Water License Capacity
		Average Value for Turbidity (NTU)
		Median Value for Nitrates (mg/L)
	Uninterrupted Service	Not currently tracked; Measure under development
Regulatory	Meet License - Safety	# of Occurrences of Total Coliforms
	Meet License - Environment	Not currently tracked; Measure under development
Customer Service	Responsive	Not currently tracked; Measure under development
	Accurate	Not currently tracked; Measure under development

Table 31 - Technical service alignment for water distribution service

Service	Service Goal	Technical Level of Service
Accessible	Affordable	Non-Revenue Water (L/connection/day)
		Cost of Customer Billing / Service Connection
		O&M Cost ('000) / km Length
	Accommodate Growth	*Not currently tracked; measure under development*
Safe	Keep employees safe	*Not currently tracked; measure under development*
	Protect the Public	% of Inoperable or Leaking Hydrants
Reliable	Sufficient quality / quantity	# of Water Pressure Complaints by Customers / 1,000 Served
		# of Water Quality Customer Complaints / 1,000 Served
	Uninterrupted Service	# of Main Breaks / 100 km Length
		# of Unplanned System Interruptions / 100 km Length
		% of Valves Cycled
		% of Inoperable or Leaking Valves
Regulatory	Meet License - Safety	*Not currently tracked; measure under development*
	Meet License - Environment	*Not currently tracked; measure under development*
Customer Service	Responsive	*Not currently tracked; measure under development*
	Accurate	*Not currently tracked; measure under development*

4.2.2 Wastewater Services

Table 32 - Technical service alignment for wastewater treatment

Service	Service Goal	Technical Level of Service
Accessible	Affordable	O&M Cost / ML Treated
		Not currently tracked; measure under development
	Accommodate Growth	% of Design AAF Capacity Utilized
Safe	Keep employees safe	*Not currently tracked; measure under development*
	Protect the Public	kg of BOD Discharged to the Environment per Capita
Reliable	Sufficient Quality /Quantity	% of Design AAF Capacity Utilized
		# of odor complaints / 1000 people served

		Not currently tracked; measure under development
	Uninterrupted Service	*Not currently tracked; measure under development*
Regulatory	Meet License - Safety	*Not currently tracked; measure under development*
	Meet License - Environment	*Not currently tracked; measure under development*
Customer Service	Responsive	*Not currently tracked; measure under development*
	Accurate	*Not currently tracked; measure under development*

Table 33 - Technical service alignment for wastewater collection service

Service	Service Goal	Technical Level of Service
Accessible	Affordable	O&M Cost ('000) / km Length
	Accommodate Growth	*Not currently tracked; measure under development*
Safe	Keep employees safe	*Not currently tracked; measure under development*
	Protect the Public	5 Year Average Emergency Sewer Repairs / 100 km Length
Reliable	Sufficient quality / quantity	# of Wastewater Related Customer Complaints / 1,000 Served
		# of Blocked Sewers / 100 km Length
		% of Length Cleaned
	Uninterrupted Service	% of Length CCTV Inspected
		5 Year Average Emergency Sewer Repairs / 100 km Length
		# of Blocked Sewers / 100 km Length
Regulatory	Meet License - Safety	*Not currently tracked; measure under development*
	Meet License - Environment	*Not currently tracked; measure under development*
Customer Service	Responsive	*Not currently tracked; measure under development*
	Accurate	*Not currently tracked; measure under development*

4.2.3 Roads and Bridges

Table 34 - Technical service alignment for transportation (roads and bridges) service

Service	Service Goal	Technical Level of Service
Accessible	Affordable	Cost of maintaining and rehabilitating roads and bridges (% of capital project completed on schedule and within budget)
	Meets the needs of all users	Community believes that the transportation system is sufficient to meet their needs (# of roads or bridges have posted load/width restrictions)
Safe	The network is safe to use	Signs and pavement markings comply with MUTCD standards (x%) Number of pedestrian and cycle accidents involving vehicles /lane-km
Reliable	The network is reliable and predictable	Average travel speed for urban and rural networks (x km/hr)
Regulatory	Comply with Minimum Maintenance Standards	Track road patrols to ensure compliance with requirements (% of patrols not meeting standard)
Customer Service	Responsive	Track customer satisfaction with staff responsive to enquiries (%)

4.3 Goals & Objectives

In June, 2011, Council directed staff to proceed with a Service Delivery Review (SDR). The objective of the review was to analyze all the services delivered by the City, evaluate service delivery, and identify opportunities to make improvements. The SDR developed individual service profiles on all of the services that the City of Hamilton currently delivers to citizens. Profile information includes a detailed profile of every citizen facing and internal service delivered by the City including the cost, service levels, existing performance measures and benchmarking information. The evaluation mapped out how specific activities undertaken by the City are used to deliver services to accomplish programs and strategic goals as shown in the figure.

The City has defined several high-level strategic objectives as part of it strategic plan. As part of the City's transition to a service-centric approach to asset management and budgeting, the development of more well-defined service goals for each asset class will become better defined.

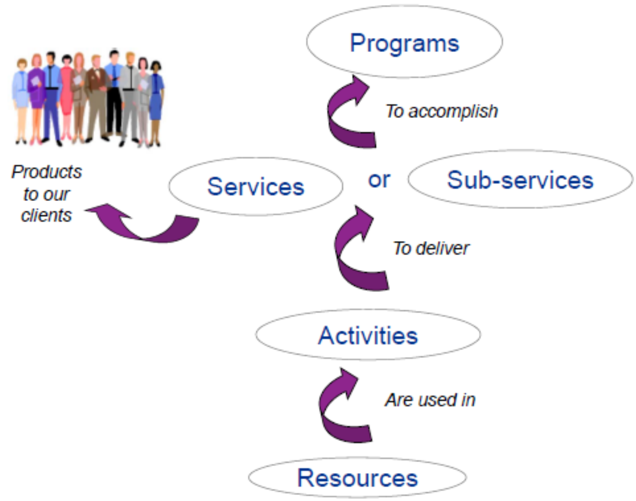


Figure 19 Service delivery model

4.4 Trends

Generally speaking, the tracking of performance indicators serves two key purposes; internal and external comparison. Internal tracking allows the City to evaluate performance over time in response to internal and external pressures. External tracking allows the City to benchmark its performance against similar organizations to help identify best practices and position itself amongst its peers.

Regardless of the types of indicator or the purpose of tracking, there are always external factors that are beyond the control of the organization that influence the trend. It is important to understand these trends so that performance targets are well-aligned to the realities under which the City operates.

Examples of trends that will continue to have an impact on water and wastewater operations within the City are discussed in the table below.

Table 35 - Known Level of Service Influencers

Climate Change	While the full impacts of climate change will not be fully understood in the near future, the City is currently experiencing issues that can be directly attributed to climate change. Examples include 1) increase in the presence of certain types of algae in Lake Ontario and its impact on the water treatment process and drinking water taste/odor and, 2) severe rainfall events and its impact on the service level provided by the City's Stormwater system. Similar impacts have been witnessed for the City's transportation network. Recent unusual weather events including summer and winter storms have resulted in flooding of roads and challenges in meeting winter control requirements respectively. It is likely that these events can be attributed to climate change and will require ongoing assessment of the performance measures used to assess the City's effectiveness in dealing with them.

Aging Infrastructure	The City has a relatively old water and wastewater system (average age of buried infrastructure is around 45 years). This is a known trend that will continue to burden the City and impact its ability to provide high levels of service. The relatively early adoption of asset management practices by the City has allowed maintenance and rehabilitation to be undertaken in a cost-effective manner during the last decade. The continued advancement of these practices will be imperative to address this challenge. The City's roads and bridges continue to deteriorate and will require increasing levels of funding to ensure that they continue to offer the travelling public with a safe and reliable transportation system. Many recent initiatives have explored the use of innovative road rehabilitation techniques to reduce the cost of meeting increasing rehabilitation needs. Continued deterioration of the roads and bridges will ultimately lead to increased budgets to fix the roads and bridges in poor condition. Use of an asset management for the roads and the BMS for bridges will allow effective decisions to be made that will allow the City to maximise the life of these assets.
Active Transportation	The growth in the use of alternative transportation options such as cycling and pedestrians has seen an increase in the pressure on the City to provide safe environments for these new road users. This will continue to increase and as a results the City will have to respond by improving the cycling and pedestrian facilities across the network.
Shifts in funding priority	Traditionally, the City has relied heavily on Federal and Provincial funding to address its road and bridge renewal requirements and meet service expectations. Changes in grant programs have made it difficult to maintain service, forcing it to juggle priorities, and target where and how it invests. Continued vigilance in asset management and adoption of new pavement technologies have allowed it to extend asset life and reduce the total cost of ownership, but current spending is insufficient to maintain service at current levels over the long-term.
Uncertainty in Growth Forecasts	According to analysis of the latest data, actual growth in the City has fallen short of 75% of that expected by the Province in its "Places to Grow" forecasts. This means that the City is falling behind in development activity and related revenues needed to support the debt required for the Places to Grow infrastructure. This uncertainty is not entirely within the City's control and will continue to impact several financial and operational performance indicators.
Declines in water consumption	Ongoing conservation efforts have led to declines in average household water consumption. This has an impact on revenue generation from rates. In addition, a similar decline has been witnessed in the large commercial and industrial sector that represent 40% of the City's water consumption. With the expected annual 4.25% increase in water rates, ICI customers can be expected to continue their conservation efforts. Economic uncertainty and its impact on large ICI customers is another concern as loss of any of the top ICI customers is equivalent to 4,500 new residential accounts.
Socio-Political expectations	Societal and political influences will continue to shape the City's strategy and priorities. The fluid and rapidly changing nature of socio-political concerns, expectations and requirements will continue to influence the City's targets and priorities for service delivery. Examples of such expectations include aspects like enhanced environmental stewardship and more cost-effective delivery of services.

4.5 Current Performance

4.5.1 Water Services

Technical LOS indicators for water services are presented in Table 36 and Table 37 . Affordability indicators for water treatment show a steady increasing trend for O&M costs that can be explained by typical inflationary increases. With regards to spending on chemicals for water treatment, a significant increase in costs during 2008-2010 occurred that was partly caused by inflation and increase in system size. Indicators relating to reliability and measured by reported complaints witnessed a tremendous improvement with water quality complaints dropping four-fold and pressure complaints dropping five-fold from 2007-2011. Other indicators like water main breaks and unplanned system interruption witnessed less improvement.

Table 36 - Technical LOS 2007-2011: Water Treatment (Woodward Ave, WTP)

Service Goal	TLOS	2007	2008	2009	2010	2011	Trend
Affordable	O&M Cost / ML Treated	$124	$117	$125	$127	$133	↘
	Chemical Cost / ML Treated	$4.7	$10.0	$9.7	$11.1	$5.0	→
Accommodate Growth	Average Day Demand / Existing License Capacity	0.28	0.26	0.27	0.26	0.25	→
Protect the Public	# of Occurrences of Total Coliforms	3	1	7	6	N/A	↘
Sufficient Quality /Quantity	Average Day Demand / Existing License Capacity	0.28	0.26	0.27	0.26	0.25	→
	Average Value for Turbidity (NTU)	0.06	0.06	0.05	0.04	0.03	↗
	Median Value for Nitrates (mg/L)	0.44	0.46	0.44	0.37	0.39	↗
Meet License	# of Occurrences of Total Coliforms	3	1	7	6	N/A	↘

Table 37 - Technical LOS 2007-2011: Water Distribution

Service Goal	TLOS	2007	2008	2009	2010	2011	Trend
Affordable	Non-Revenue Water (L/connection/day)	487	450	493	N/A	N/A	?
	Cost of Customer Billing / Service Connection	$11.3	$11.1	$12.8	$12.4	$13.6	↘
	O&M Cost ('000) / km Length	$4.6	$6.3	$6.9	$7.7	$7.3	↘
Protect the Public	% of Inoperable or Leaking Hydrants		1.43%	2.91%	5.65%	5.33%	↘
Sufficient quality / quantity	# of Water Pressure Complaints by Customers / 1,000 People Served	1.44	0.71	0.33	0.24	0.28	↗
	# of Water Quality Customer Complaints / 1,000 People Served	2	1.2	1	0.5	0.5	↗
Uninterrupted Service	# of Main Breaks / 100 km Length	19.1	12.9	14.8	13.6	17.2	↘
	# of Unplanned System Interruptions / 100 km Length	67.1	16.6	25.1	N/A	N/A	?
	% of Valves Cycled	34%	37%	32%	36%	35%	→
	% of Inoperable or Leaking Valves		0.60%	0.60%	0.60%	0.70%	→

4.5.2 Wastewater Services

Technical LOS indicators for wastewater services are presented in Table 38 and Table 39. Affordability indicators for wastewater treatment have fluctuated year-over-year. On the wastewater collection side, emergency sewer repairs dropped four-fold from 2007-2011 due the accumulation of sewer condition assessment information from CCTV inspections and the use of targeted capital renewal programs.

Reported wastewater complaints have remained steady in spite a significant increase in 2009 due to extreme rainfall events witnessed that year. Sewer blockages have started to creep up in 2011 after falling in 2008 and 2009. This can be partly explained by the introduction of more blockage-inducing material into the sewer system (e.g. grease and flushable wipes).

Table 38 - Technical LOS 2007-2011: Wastewater Treatment (Woodward WWTP)

Service Goal	TLOS	2007	2008	2009	2010	2011	Trend
Affordable	O&M Cost / ML Treated	$138	$118	$140	$152	$139	→
Accommodate Growth	% of Design AAF Capacity Utilized	82%	86%	78%	72%	79%	→
Protect the Public	kg of BOD Discharged to the Environment per Capita	4.96	5.57	2.87	3.23	2.71	→
Sufficient Quality /Quantity	% of Design AAF Capacity Utilized	82%	86%	78%	72%	79%	→
	# of odor complaints / 1000 people served	0.037	0.008	0.006	0.013	0.004	→

Table 39 - Technical LOS 2007-2011: Wastewater Collection

Service Goal	TLOS	2007	2008	2009	2010	2011	Trend
Affordable	O&M Cost ('000) / km Length	$2.8	$3.1	$3.1	$2.5	$2.4	↗
Protect the Public	5 Year Average Emergency Sewer Repairs / 100 km Length	2.5	2.2	1.7	1.2	0.7	↗
Sufficient quality / quantity	# of Wastewater Related Customer Complaints / 1,000 People Served	5.5	1.72	12.58	3.31	2.92	↗
	# of Blocked Sewers / 100 km Length	4.5	1.3	0.9	4.1	6.8	↘
	% of Length Cleaned	8.0%	3.0%	4.0%	3.0%	4.0%	→
Uninterrupted Service	% of Length CCTV Inspected	12.10%	6.90%	6.00%	6.90%	6.00%	→
	5 Year Average Emergency Sewer Repairs / 100 km Length	2.5	2.2	1.7	1.2	0.7	↗
	# of Blocked Sewers / 100 km Length	4.5	1.3	0.9	4.1	6.8	↘

4.5.2 Wastewater Services

The performance measure identified within Section 3.2 have not yet been developed for the City's transportation system therefore, they prove some examples of what might be included as the City begins the process of community engagement and hence the development of customer focused performance measures.

The options currently available of measuring the performance of the City in operating and maintaining these important transportation asset are generally external and include and the Municipal Performance Measurement Program. Internal measures that are used by the City are the OCI for roads and BCI for bridges described previously.

Roads

A recent review of the performance of the City's road network considered the overall asset condition while excluding the roads that were added to the network as a result of growth. This analysis showed that while the City saw a decline in the overall network condition from 2001 to 2006, significant improvements were achieved in improving the network performance in the years prior to the 2011 condition assessment (Figure 20).

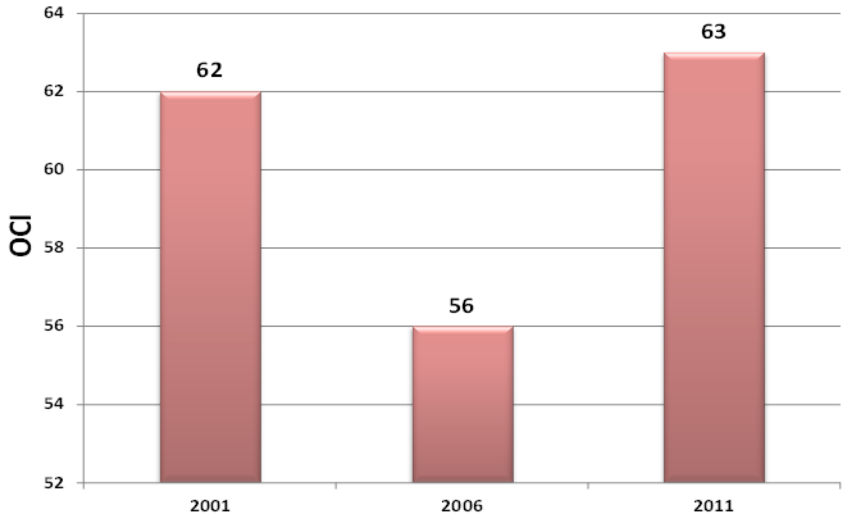


Figure 20 - 2001-2011 Historical Performance – Citywide Results

The network-level performance dropped from 2001 to 2006, but then improved from 2006 to 2011 which resulted from the fact that the emphasis in the first few years was to address the roads in very poor condition and resulted in the majority of the funding being spent on major rehabilitation and/or reconstruction projects which are very costly and only provide minor improvements to the overall network condition, as they tend to impact only a very small portion of the network.

On the other hand, minor rehabilitation projects tend to cover a larger portion of the network as they do not require the same level of effort or cost as major rehabilitation projects. In the period from 2006 to 2011 the emphasis changed to the use of pavement preservation and minor rehabilitation strategies which when combined with increases in roads capital funding resulted in the City being able to halt the slide in road network condition and even to return the condition to 2001 levels. It should be noted that there were significant injections in capital funding for roads in 2010 and 2011 as a result of Provincial initiatives. These allowed the City to investment more in the preservation and rehabilitation of the road network, however, these one-time funding initiatives cannot be relied upon to provide long-term sustainable funding of the road network.

It is difficult to provide the same historical comparison for the City's bridges and culverts as the same level of historical data is not available as was for the roads. However, a review of previous reports on bridge condition including the "State of the Infrastructure Review – Road Network and Traffic Systems" (2011) shows that the BCI for all bridges included in the database at that time was 73.7 (based on 2006 and 2008 inspections). Based on the 2012 and 2013 bridge inspections the overall BCI for all bridges and culverts is 71.3, however, it is important to note that there are 33 bridges and culverts that have been added to asset portfolio. If these newer structures are removed from the calculation of the average BCI the actual value for the older remaining asset portfolio the BCI for the bridges and culverts will be 67.2.

While the BCI for these older assets is still within the "Good" range it is clear that the funding requirements for the City's structures needs to be reviewed to ensure that it is at a sufficient level to avoid further deterioration. This BCI is consistent with the results of the bridge funding analysis which was completed for the "State of the Infrastructure Review – Road Network and Traffic Systems" (2011) that modelled the impact of a scenario that projected no funding of bridge repairs.

Section 5 – Asset Management Strategy

5.1 Asset Management activities, procedures and corporate policies

The City of Hamilton has developed a large number of procedures, practices and tools that are used to drive its asset management business processes. The City has many well established practices surrounding the planning and management of public infrastructure, and has pioneered the use of Asset Management amongst Canadian municipalities. A summary of these strategies and practices is shown in Table 40. Details on many of these tools and practices follow.

Table 40 - Summary of various asset management strategies used throughout the City

AM Activity	Water	Sanitary	Roads & Bridges
Inventory	• ROW asset data managed within HANSEN • Vertical asset data stored in various locations – 2014 update	• ROW asset data managed within HANSEN • Vertical asset data stored in various locations –2014 update	• ROW asset data managed within HANSEN • Bridge data managed within BMS
Performance Assessment	• Break-frequency analysis for non-critical and advanced assessment for critical mains (Linear) • High level condition audits for all assets; targeted detailed assessment (Facilities)	• CCTV assessment for all sewers; targeted advanced assessment for critical assets (Linear) • High level condition audits for all assets; targeted detailed assessment (Facilities)	• Pavement rating based on visual assessment and automated data collection. • Manual bridge assessment driven by regulation
Performance Forecasting	• Break-rate deterioration model under refinement (Linear) • Estimated useful life based on observation and manufacturer recommendations (Facilities) • Some trending/forecasting of non-condition performance	• Condition deterioration model under refinement (Linear) • Estimated useful life based on observation and manufacturer recommendations (Facilities) • Some trending/forecasting of non-condition performance	• Mature pavement deterioration models in place • Mature bridge degradation models in place • Some trending/forecasting of non-condition performance measures
Demand Planning	• Water Master Plan • Water Treatment Master Plan	• Wastewater Master Plan • Treatment Master Plan	• Transportation Master Plan
Risk Assessment	• DWQMS • Criticality-driven management plans (Linear) • High-level model for all assets; detailed assessment for some facilities (Facilities)	• DWQMS • Criticality-driven management plans (Linear) • High-level model for all assets; detailed assessment for some facilities (Facilities)	• Driven by road classification and major bus / truck routes (all assets) • Criticality-driven management plans (Bridges)
Options Analysis	• Lifecycle cost-benefit supported treatment selection	• Lifecycle cost-benefit supported treatment selection	• Lifecycle cost-benefit supported treatment selection
Coordinated Decision Making	• Multi-Criteria prioritization of works within service area • IRISS System coordination within ROW (Linear)	• Multi-Criteria prioritization of works within service area • IRISS System coordination within ROW (Linear)	• Multi-Criteria prioritization of works within service area • IRISS System coordination within ROW (Linear)
Investment Planning	• Budgeting is historical-based or constrained by Regulation • Consultation-based works coordination across asset types and between asset groups • Coordinated ROW plan by AM branch	• Budgeting is historical-based or constrained by Regulation • Consultation-based works coordination across asset types and between asset groups • Coordinated ROW plan by AM branch	• Budgeting is historical-based or constrained by policy • Consultation-based works coordination across functional groups • Coordinated ROW plan by AM branch
Lifecycle	• Operational, Maintenance and	• Operational, Maintenance and	• Operational, Maintenance and

Management	Financial/Funding strategies are generally in place	Financial/Funding strategies are generally in place	Financial/Funding strategies are generally in place

5.1.1 Asset Inventory

Hansen has been in use across the City beginning in Water and Wastewater Operations Division since the late 1980's. Since that time, the program has evolved and currently supports a number of business units across the Corporation. These include Water and Wastewater Operations for Water Distribution, Wastewater Collection, Community Outreach and Water Meters, Engineering Services for Asset Management, Operations for Roads, Parks, Forestry, Traffic and Cemeteries, Environmental Services for Waste Management, Planning and Economic Development for Animal Control and Parking Enforcement and Corporate Services for the Customer Contact Centre and Municipal Service Centres. Although not officially designated as the corporate "standard" for asset and operations management by Council, HANSEN can be considered as such by practice and adoption throughout the corporation. Asset Inventory data for linear water, wastewater and stormwater is stored in HANSEN. Related information for these assets like work order records, maintenance history, and condition rating are also available.

For water and wastewater facilities the City has been relying on DataStream (Infor EAM) as the main source for asset inventory and maintenance management data. The City is currently overhauling its asset management program for water and wastewater facilities to better align work practices and information with operational and reporting requirements. It is expected that a new / modified system will be in place within two years.

5.1.2 Asset Condition Assessment

Condition assessment is the process of determining the physical state of an asset. Systematic condition assessments allow the City to understand the existing needs of its infrastructure and hence identify the most effective asset intervention to undertake. By utilizing a consistent approach to asset condition rating, the City is able to track the status of its inventory over time and assess the effectiveness of its capital renewal, maintenance, and repair programs. Examples of condition assessments that are being regularly undertaken by the City include:

Sewer and Storm Pipe Assessments: Utilizing both stationary (zoom) and movable Closed Circuit Television (CCTV) equipment pipes and manholes are regularly inspected. Images of the pipe and manhole are transmitted to a trained inspector who identifies known defects (cracks, fractures, displaced pipe, etc…) and assigns them to each asset. An overall pipe condition grade (1-5) is assigned using standardized sewer condition assessment standards. Results of the assessment are fed into the City's corporate asset management system. As of October 2013 the City has inspected 94% and 90% of the total sanitary and storm networks respectively.

Water Pipe Assessments: Due to the lack of a widely-accepted and cost-effective technologies to undertake pipe condition assessments the City utilizes a tailored approach to undertake water pipe condition rating. For low criticality (consequence of failure) assets, pipe breaks are used a proxy for asset condition. Pipe breaks are used to rationalize the decision to replace or continue to repair based on a combination of life-cycle costs and minimum acceptable level of service standards. For high criticality (consequence of failure) assets where breaks cannot be tolerated, a combination of direct and indirect assessments are undertaken. Direct assessment utilize various high-end technologies based on acoustics and electromagnetics to determine actual pipe distresses like corrosion, pipe leaks and broken steel wires. These approaches are costly and are used for assets that exhibit the highest risk of failure. Indirect assessments rely on obtaining or measuring factors that are known to contribute to pipe deterioration (e.g. soil type, water level, soil pH, etc…) This approach is less accurate as it does not directly discern if a pipe is distressed or not but is less costly compared to direct assessment.

Water and Wastewater Facility Assessments: The City of Hamilton undertakes assessments of its water and wastewater facilities using Facility Condition Audits which are high level cursory inspections of the overall facility as well Condition Assessments that are more detailed evaluation of individual assemblies and components within each facility. This information is subsequently used to identify and prioritize capital improvement needs within and across each facilities. A condition audit was completed in 2011 for water stations. The audit includes a condition score, risk score (probability and consequence) and operational score (at 10 category level) to be able to produce a more thorough prioritization. Condition assessments are contracted out for the stations that rank worst in the audits. The condition assessment for each location is currently carried out at the component level of detail (and rolled up to the 10 category level) in order to support the detailed scoping of required operations and capital works. The City is in the process of developing a more comprehensive program for asset management across its water and wastewater facilities that will be reflected in subsequent versions of the AMP.

5.1.3 Risk Assessment

Asset management involves understanding and balancing levels of service, cost and risk. The City has undertaken several initiatives aimed at developing a clear picture of the risk profile of the asset base in order to better understand which assets are in most need of assistance. These initiatives have been predominantly asset-focused but lack consistency across asset groups thus limiting their ability to globally drive investments across asset categories. A consistent risk-based approach is needed to assess the relative priorities of individual assets. This applies not only to the allocation of capital budgets but also to operating and maintenance budgets. Risk management should be viewed as an integral part of managing the life cycle of assets. The simplest description of a risk assessment framework is based on the following formula:

Risk = Probability of Asset Failure X Consequence of Asset Failure

The probability of asset failure and consequence of asset failure allow for quantification of risk. The above formula can be made more sophisticated as needed. An example of probability and consequence of asset failure scoring categories are shown below.

Table 41 - Asset Consequence of Failure

Severity/Consequence Score Categories		Severity / Consequence Description: Legal & Regulatory
Minimal	1	Low level legal issue; technical non-compliance; legal and/or regulatory actions unlikely; limited regulatory scrutiny.
Marginal	2	Regulatory non-compliance; increased direct regulatory scrutiny.
Serious	3	Regulatory non-compliance with expected regulatory prosecution; possible fines; possible civil action.
Critical	4	Multi-jurisdictional regulatory non-compliance with prosecution and fines; civil action by third party
Catastrophic	5	Class action law suit

Table 42 - Asset Probability of Failure

Probability/Likelihood Score Categories		How Frequently Does the Event Occur?	Probability/Likelihood of Recurrence
Improbable	1	Hasn't happened before anywhere	Very Low
Remote	2	Has happened somewhere before	Low
Occasional	3	Can / could happen here	Medium
Probable	4	Has happened here before	High
Frequent	5	Happens often	Very High

In its most basic format, the risk management framework utilizes a probability/consequence matrix, e.g. 5 x 5, to rank probability and consequence of failure.

As an example for the application of this generic approach, this framework was tailored to better understand the consequence of failure for the City's 2,000km water distribution network. Factors like pipe diameter, pipe material type, road type, surrounding land use and type of customer served were combined to calculate the social, economic, environmental and operational consequence of failure. The City's network is currently categorized into three levels of criticality (A, B, and C) as shown in the figure below. As discussed later this criticality level is subsequently used to select the most suitable management policy as shown in Figure 21.

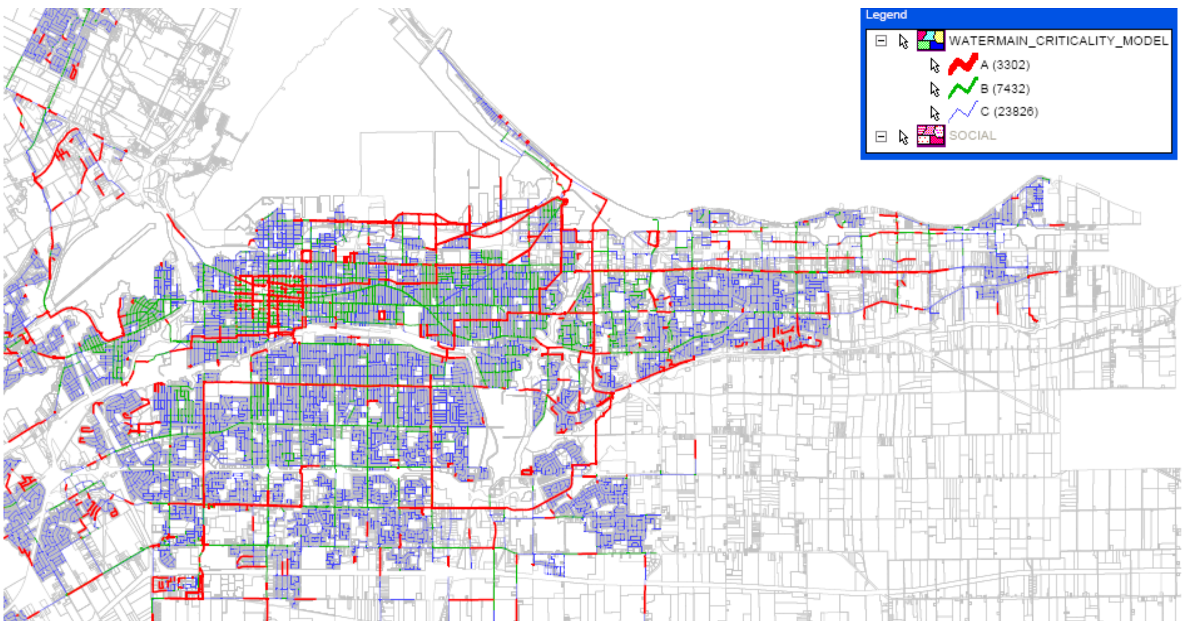


Figure 21 - Consequence of failure mapping for the City's water distribution network

5.1.4 Asset Deterioration Modeling

A deterioration model is an asset-specific forecasting tool that is used to predict the future condition of the asset based on its current condition. In many cases as was shown in section 3 of the AMP, age is not the only predictor of asset condition. As such, using straight line deterioration based on an assumed useful life can lead to sub-optimal replacement/rehabilitation decisions and in some cases unplanned failures. Deterioration models are primarily developed based on the analysis of historical condition trends. This analysis allows a better understanding of the factors, patterns and root causes of asset deterioration. This knowledge is subsequently used to forecast future asset condition with an increased accuracy. The sustained collection of asset condition data will support the continuous improvement of asset deterioration models and improve their accuracy over time. The City has developed deterioration models for its roads, bridge, sewer and water assets.

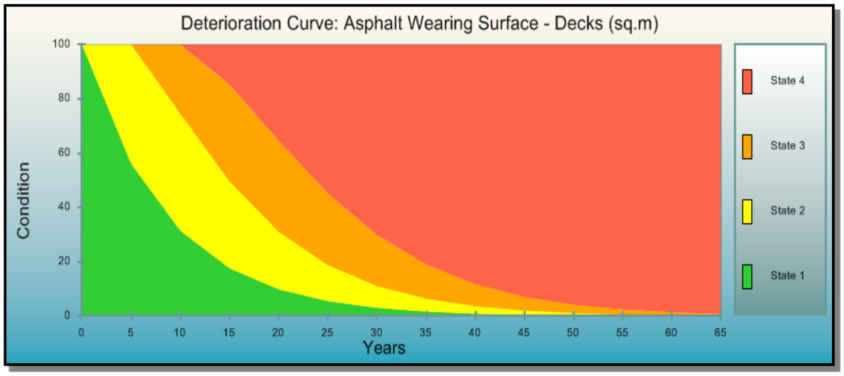
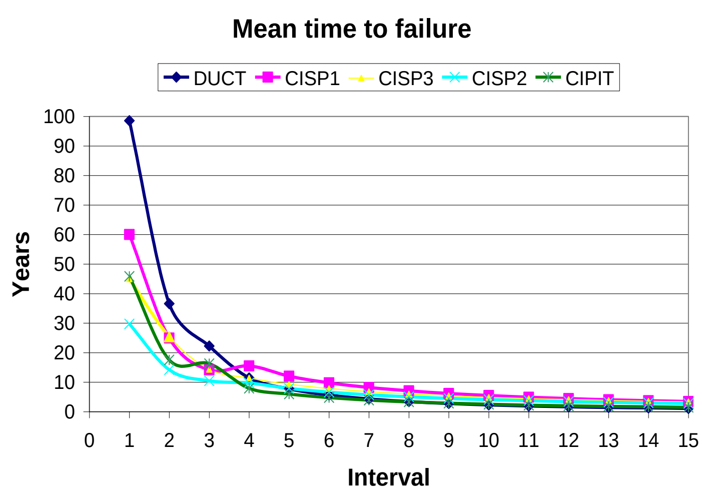


Figure 22 - Bridge Deterioration Curves

Bridge deterioration models are used in the BMS, to forecast future bridge condition and condition following different treatments when applied to various elements and combinations of elements. The deterioration models are also necessary to predict the treatment quantities required at the time the work is carried out on a given element.

The BMS includes deterioration models for each type of OSIM element and material, and for each of the possible OSIM environments. Models were calibrated for bridges in Southern Ontario. Over 200 deterioration models are contained in the BMS. A typical deterioration model used within the BMS ii shown below.

In order to better estimate the rate of watermain breaks, historical break trends were analyzed across cast and ductile iron pipes. This analysis revealed a phenomena that is widely observed across water utilities; decreasing failures times. Watermains that were analyzed experienced, on average, a relatively long time to encounter their first break. Once the first break occurs subsequent breaks occur at a much more accelerated rate as shown in the figure. This decreasing time between failures had some significant implications on setting water main replacement strategies and undertaking trade-offs between repair/replacement decisions. The model also allows an estimation of the probability of encountering a pipe break for any specific pipe segment, thus enabling coordinated infrastructure renewal (roads, water, and sewer) decision to be made based on more reliable information.



Fiaure 23 - Water Main Deterioration Curves

For sewer mains the City has developed both a Markov model and a transition state model based on the principles of survival analysis for its VT pipe. Both models were calibrated based on historical records of pipe condition grade as revealed through CCTV inspections. The models allow the future condition grade of sewers to be estimated based on baseline condition data. The City is currently using these models to forecast long-term capital expenditures needed to maintain a certain overall condition rating for its sewer network.

5.1.5 Coordinated Decision Making

The City's asset management practices have traditionally managed individual infrastructure networks, (i.e. water, wastewater, storm sewer, and road networks) in isolation from one another. Co-ordination of projects was done manually through high-level meetings amongst the management groups. Considering the close proximity and high level of interaction between infrastructure networks, asset management best practices recommend an integrated approach in order to make the most cost-effective decisions regarding rehabilitation and construction of infrastructure assets. The key factors used to assess individual infrastructure networks (water, wastewater, storm sewer, and roads) such as acceptable level of risk, minimum level of service, optimal scheduling, best technology, and financial constraints, can also be used collectively to assess a ROW to produce the most cost-effective program across all infrastructure networks. The City has been following a coordinated decision-making approach for its ROW infrastructure through holding a series of coordination meetings that aggregate the needs of water, sewer and road infrastructure. The City is currently deploying advanced technologies to streamline and optimize the coordination process.

For its linear systems, the City is currently deploying an integrated approach and decision-support tool: ***Integrated Right-of-Way Infrastructure Support System (IRISS)***. By using deterioration models and decision trees, an IRISS provides the ability to simulate any number of scenarios (using the Monte Carlo technique) in order to identify the most economical opportunities to achieve the desired level of service. The array of available actions (e.g. repair, rehabilitation, replacement, etc.) is geared not only towards getting the most out of available resources (both human and financial), but also towards ensuring that the quality and safety threshold is maintained in the long-term for asset sustainability. Optimizing decision making in the context of aging infrastructures and restrained budgets is the key to asset management success in the coming decades!

The model reviews all intervention options for every year and for each asset under management. Using simulation (up to billions of calculations), the model assesses risk and optimizes each investment in the short-term for immediate needs as well as in the long-term for strategic planning. The model also provides the impact of the current maintenance and investment policies on the actual and future LOS for each asset, for a group of asset or for the entire inventory. This conceptual model through the IRISS system demonstrates how risk management and financial analysis can be applied to integrated asset management planning. It provides a means for short-term and long-term planning – one asset at a time.

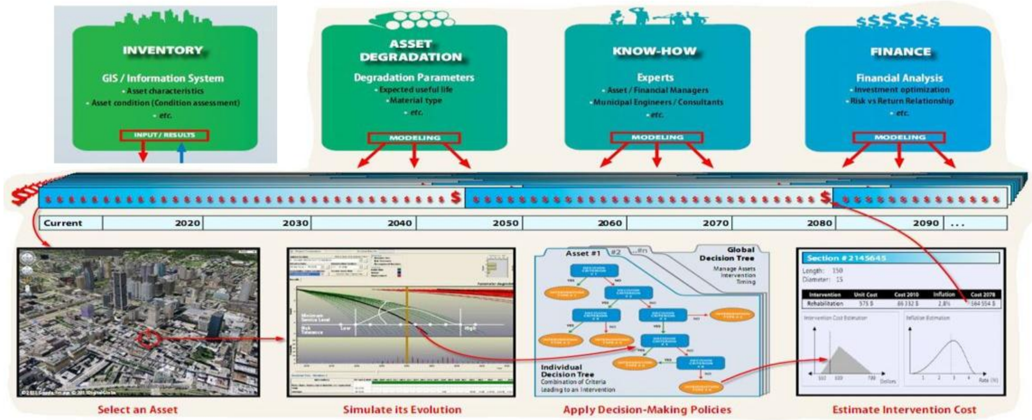


Figure 24 - Integrated Right-of-Way Infrastructure Support System

5.1.6 Asset Life Cycle Management

A comprehensive approach to asset management involves processes for managing and maximizing the performance of an asset while minimizing its costs throughout the course of its lifecycle as shown in below, enabling The City to make better asset investment decisions. This approach considers a range of parameters, for example, age, condition, historic performance, current capacity etc.

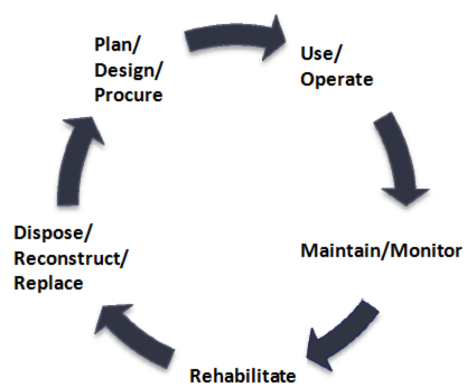


Figure 25 - Asset Lifecycle Activity

Key components of a Lifecycle Management Framework include:

1. Operational Strategies – including mitigating risks, deferring the need for upgrades/renewals, Asset Utilization & Demand and Emergency Response Planning
2. Maintenance Strategies – Including approaches for determining the optimal mix of planned and unplanned Maintenance and for carrying out Maintenance Performance Assessments & Reviews
3. Financial/funding Strategies – including valuation approaches, long term financial forecasts and funding plans
4. Optimized Decision Making Techniques – including risk based approaches, multi criteria analysis approaches along with approaches to optimizing investment across Service Areas
5. Investment Planning – including the identification and scoping of projects, to address Capital Maintenance, Enhanced LOS, Legislative, Growth (including development) or Efficiency needs.

Strategies covering 1) Operational Strategies, 2) Maintenance Strategies and 3) Financial/funding Strategies are generally in place or are under refinement within for roads, water, wastewater and stormwater assets.

5.1.7 Investment Planning

Hamilton's current investment planning process is developed around three distinct windows.

- The Strategic Planning Window (life cycle timeframe, 50 yr., 100+ yr. outlook)
- The Tactical Planning Window (3 – 10 yr. outlook)
- The Project Planning Window (1 – 3 yr. outlook)

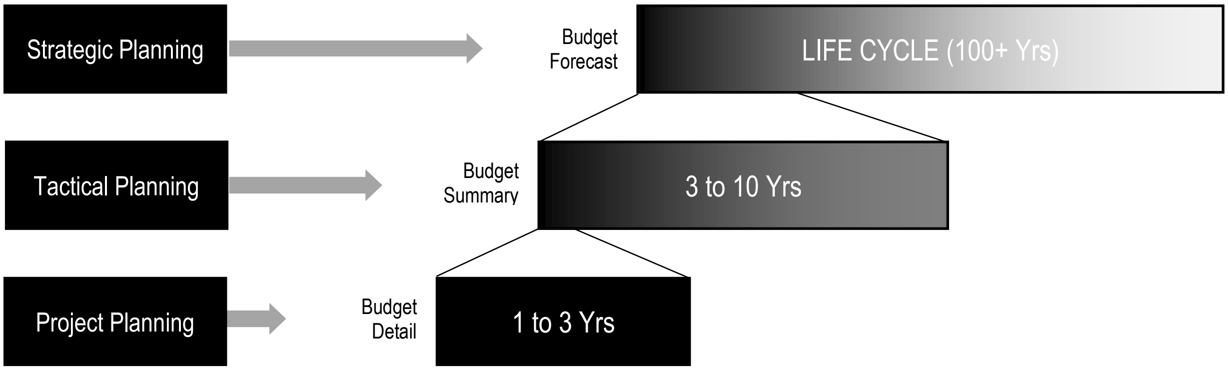


Figure 26 - Investment planning windows

The Strategic Planning Window includes a high-level analysis of the life cycle requirements of infrastructure assets, the creation of revenue plans for future renewal, rehabilitation and sustainable projections and ultimately, communication tools and reports to deliver the information forward to senior management and Council.

The Tactical Planning Window included the development of capital programs to ensure the best health of the infrastructure over the long term (3 – 10 yr.), and includes such items as infrastructure management systems, capital program development and prioritization, asset risk and criticality analysis, detailed sustainability plans, long term project listings and Council-approved methodologies.

The Project Planning Window is where the detailed capital budget is delivered by the Asset Management Section to the Design and Construction sections. This is delivered and approved through Council's capital budget deliberation sessions on an annual basis. The individual projects listed within Council's budget books are derived from processes and decisions from the Tactical Planning Window, which, in turn, is influenced by decisions and policies from the Strategic Planning Window.

The budget preparation process for water, wastewater and stormwater assets is shown in Figure 27. Project needs are identified from various groups within the Public Works department. On the linear water and wastewater side these groups includes 1) Asset Management, 2) Operations, 3) Master Planning, 4) Capacity and 5) Strategic. Input is also received from any downtown renewal projects driven by parks, street-scaping needs or waterfront project requirements. The results are subsequently coordinated on a monthly basis via coordination committee that utilizes risk-based prioritization techniques to prepare 10-year, 5-year and detailed 3-year project lists. Funding for linear water, wastewater and stormwater assets is both rate supported and levy supported. The levy supported budget goes through a subsequent review phase considering needs of other Public Works business units (transit, waste, facilities, etc…).

On the vertical side needs are consolidated from four main groups: 1) Asset Management, 2) Facility Operating Needs, 3) Planning & Development, and 4) Compliance. These represent needs driven by condition, immediate operating and maintenance needs, growth and regulatory compliance. A budget coordination meeting produces project lists that will be funded by the rate budget and are augmented to needs on the linear side. A final coordination of the rate-supported and levy-supported budget takes place to ensure that projects are aligned, followed by a final review and budget submission.

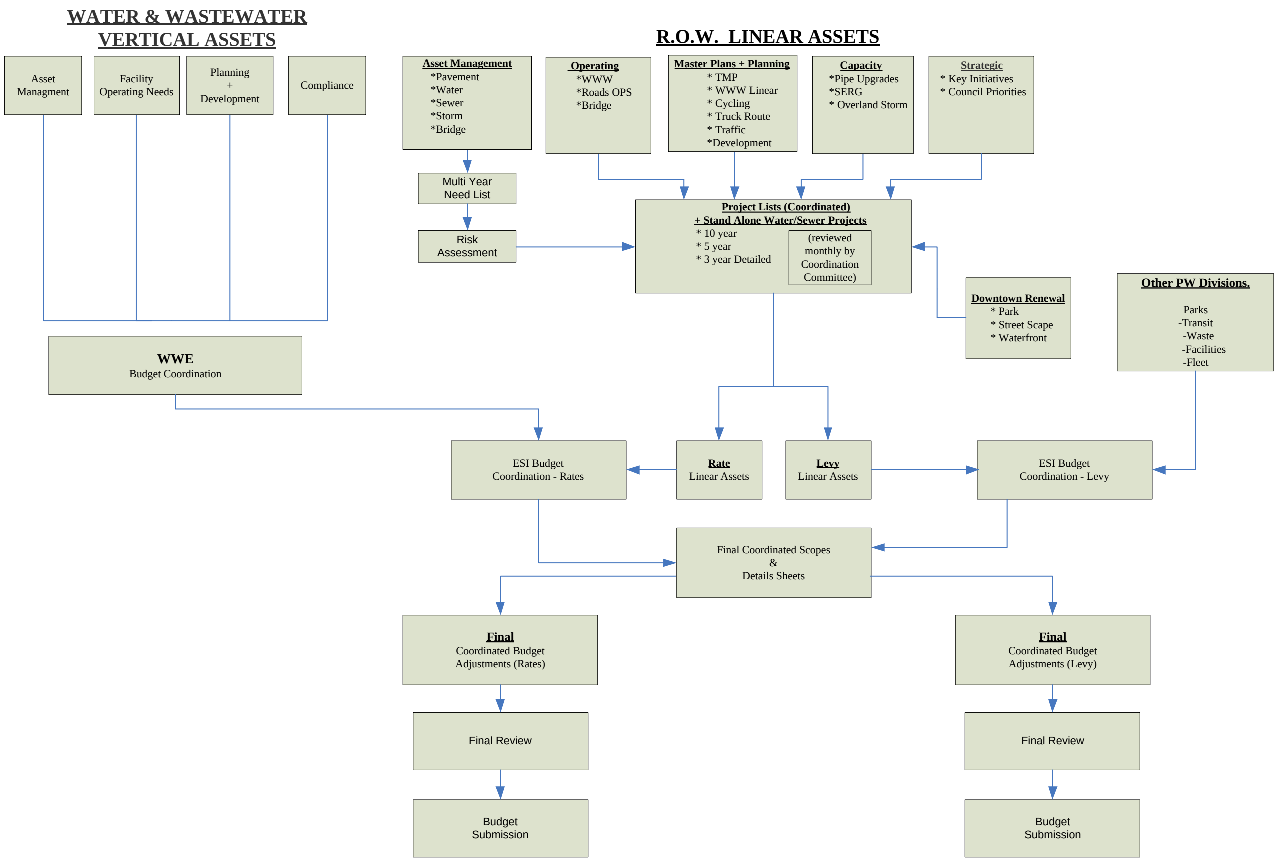


Figure 27 - Budget coordination process for public works assets

5.2 Approach for Option Analysis

Asset management decisions inherently involve the analysis of various options for asset intervention throughout the asset's life cycle. Options are typically analyzed at two distinct levels:

1. Network-level Asset Management: A global overview of assets within or across service areas with the goal of prioritizing assets and identifying immediate needs across the corporation.

2. Project-level Asset Management: Typically follows the network level analysis and is more asset-centric. Aims to identify the most suitable intervention to take for an asset or asset component.

Regardless of the analysis being conducted, the City of Hamilton has identified several approaches to support optimal decision making:

- Risk based framework
- Cost- Benefit Analysis (CBA)
- Multi Criteria Analysis (MCA)

Currently these techniques are not consistently used to undertake tradeoffs among all options being put forward by the City but have been used on an ad-hoc basis in the past. Moving forward, the City aims to incorporate these techniques in varying level of detail to support a more consistent and rigorous approach to decision-making

Risk Based Framework Technique

Decision techniques may focus on maximizing risk reduction for minimum cost. The corporation quantifies the risk, identifies mitigation measures and then sets out to reduce the risks in the most cost effective manner. Details of the approach to addressing risk are covered in the City of London CAM Risk Management Strategy. Risk as a parameter needs to be considered in all aspects of optimized decision making.

Cost-Benefit Analysis (CBA) Technique

BCA involves identifying the financial impacts of various alternatives within a business case. This includes both benefits and costs over the entire analysis period. The goal is to assess which alternative presents the greatest value of benefits compared to costs. With regard to selecting an alternative there are a range of approaches for assessing the relative costs and benefits within a Business Case. They are as follows:

- Capital costs only + descriptive text on other benefits
- Net present Values (NPV) + descriptive text on other benefits
- NPV + full criteria (not costed) as used in the Capital Project Multi Criteria Analysis model
- NPV + specific criteria quantified but not costed (e.g., TBL + other criteria that are specific to the need)
- NPV + costed TBL using a City wide library of typical TBL impacts, but TBL costs not included in the NPV
- NPV + fully costed benefits, benefit costs to be included in the NPV
- NPV + fully costed risks, which are included in the NPV (i.e., similar to 6 but the costs of the benefits/risks have been factored for likelihood)

Multi-Criteria Analysis (MCA) Technique

The MCA approach typically utilizes a set of benefit criteria which reflect the strategic objectives of the City as a whole.

These will form the basis for the benefit criteria which would typically include: Risk Reduction Improved Capacity (Growth), Regulatory Compliance (Legislative) etc. This approach provides an objective guide to help determine which combination of projects represent the best value capital program based on the current level of benefits they provide to the community and or other stakeholders.

The MCA approach takes into account the overall benefits of any particular project and considers the Triple Bottom Line (Social, Environmental and Economic) factors. Calibration of any multi criteria analysis approach is an iterative process that requires feedback from experienced staff to test the validity of outputs.

In setting up the MCA model particular attention needs to be taken to ensure that the selected scoring bands and weightings provide a true representation of priorities. It is therefore vital that stakeholders are engaged in the development of the criteria and their relative priorities. Weightings can be developed in a number of ways including a workshop setting. A structured and auditable approach – such as pair wise comparison – would utilized so that the prioritization and subsequent investment program is fully transparent, easily understood and defendable.

Appropriate weightings, that are consistent for all Service Areas, are applied to each benefit criteria to reflect their relative overall value or priority to the City. Each of these criteria is then broken down into an appropriate number of scoring bands. For each project, a score is attributed to each criteria which best reflects the value provided by the project under consideration. The collective scores and weightings for the project are then combined to determine its total benefit value.

The respective value for money of each candidate project that is calculated enables decision makers to prioritize projects and determine the best value capital investment program over the forthcoming budgetary periods. Since the relative weightings and associated scores are pre-defined to already reflect the value the projects deliver, it becomes possible to conduct a 'what- if' analysis. For example, what if available funding is reduced or there is a political desire to expedite a specific infrastructure project, the effects of this decision upon the remainder of the investment program can be easily determined and objectively analyzed and communicated so that appropriate and defendable investment decisions can be made.

There are two key outputs from a MCA approach. The first is a total benefit value for each candidate project which may be broken down to show the overall contribution from each benefit criteria. Projects can therefore be ranked in descending order of total benefit value.

The second output involves establishing the cost/benefit ratio of each project .This can then be used to plot a cumulative cost/benefit curve. Projects with low cost/benefit ratio represents higher value for money or more efficient use of money.

By reviewing both the project's total benefit value added and the relative efficiency as compared with other projects, it becomes possible to allocate projects into appropriate implementation timescales.

Grouping projects into these categories and totaling their costs provides a robust, defendable and staged approach to capital program delivery which will allows staff to demonstrate that they are making the best use of their available funding allocations over specific budgetary periods.

These practices are used in a variety of ways across water, wastewater and road assets as shown in Table 40.

5.3 Future Demand

The City of Hamilton initiated the Growth Related Integrated Development Strategy (GRIDS) as a planning process that helps to determine where the future growth of the City will take place over the next 30. This unique planning tool integrates land use, transportation, water, wastewater and stormwater planning into one project.

The purpose of GRIDS was to identify the most ideal places for growth and the type of growth based on environmental priorities, social issues, economic opportunities and population studies as well as to identify strategies to fund the servicing of these areas. The GRIDS recommended a strategy to accommodate a projected population of 660,000 and 80,000 additional households by 2031. To provide for balanced population, household and employment growth, a minimum of 2,500 acres (more than 1000 hectares) of additional employment lands are required to accommodate projected employment growth including 400 – 800 hectares of employment lands are required to facilitate the development of the Hamilton International Airport as an economic growth node within the City of Hamilton and Golden Horseshoe area.

The growth concepts and options were evaluated using a Triple Bottom Line (TBL) evaluation technique. TBL is a strategic planning tool that links current decisions to long term desired results, legislative requirements, and detailed strategic goals. City staff from a number of departments and those involved in the three comprehensive infrastructure Master Plans (transportation, water/wastewater and stormwater) participated in the TBL evaluation of alternatives.

The Provincial Places to Grow Plan growth forecasts are the starting point for GRIDS projections. The original growth options targeted the City of Hamilton with new 100,000 residential units by 2031. This was later updated to reflect the final Places to Grow Plan which targets the City of Hamilton with 80,000 new units by 2031.

Table 43 - Population and employment forecasts (Places to Grow)

Year	Population	Households	Employment
2001	510,000	190,000	210,000
2011	540,000	210,000	230,000
2021	590,000	240,000	270,000
2031	660,000	270,000	300,000
Change (2001-2031)	150,000	80,000	90,000

Table 44 – Forecast for household type (GRIDS compact scenario)

Year	Singles	Semis	Row	Apartments	Total
2001	113,000	6,000	16,000	54,000	189,000
2011	125,000	6,000	20,000	58,000	209,000
2021	136,000	10,000	26,000	67,000	239,000
2031	146,000	13,000	33,000	77,000	269,000
Change (2001-2031)	33,000	7,000	17,000	23,000	80,000

Population projections were subsequently used to forecast water consumption. Based on the review of residential consumption patterns, residential consumption, on average, has been declining over the past decade. The declining consumption reflects ongoing conservation efforts associated with fixture/appliance obsolescence such as the installation of water efficient toilets and washer machines. For 2013, staff is recommending that the forecast for average residential consumption remain at 220m3 to reflect consumption trends observed in 2008 – 2012. It is not clear how much further average residential consumption can decline, but there exists the potential for further declines, principally due to conservation efforts and the associated regulations. The Water Opportunities and Water Conservation Act, passed by the Ontario government in November 2010, includes measures to mandate specific water efficiency standards for consumer products such as toilets whereby only toilets of 6L per flush or less will be allowed for retail sale.

Analysis of the past 8 years of consumption data shows and average annual decline of 3% in the ICI and multi-residential sector as shown in Figure 28. This decline was encountered in spite a steady number of accounts (~10,000) during this period. On the residential side, an average annual decline of 1.3% was encountered despite a 12% growth in residential accounts as shown in Figure 29. Average actual household consumption declined from 281m3 in 2003 to 202 m3 in 2013.

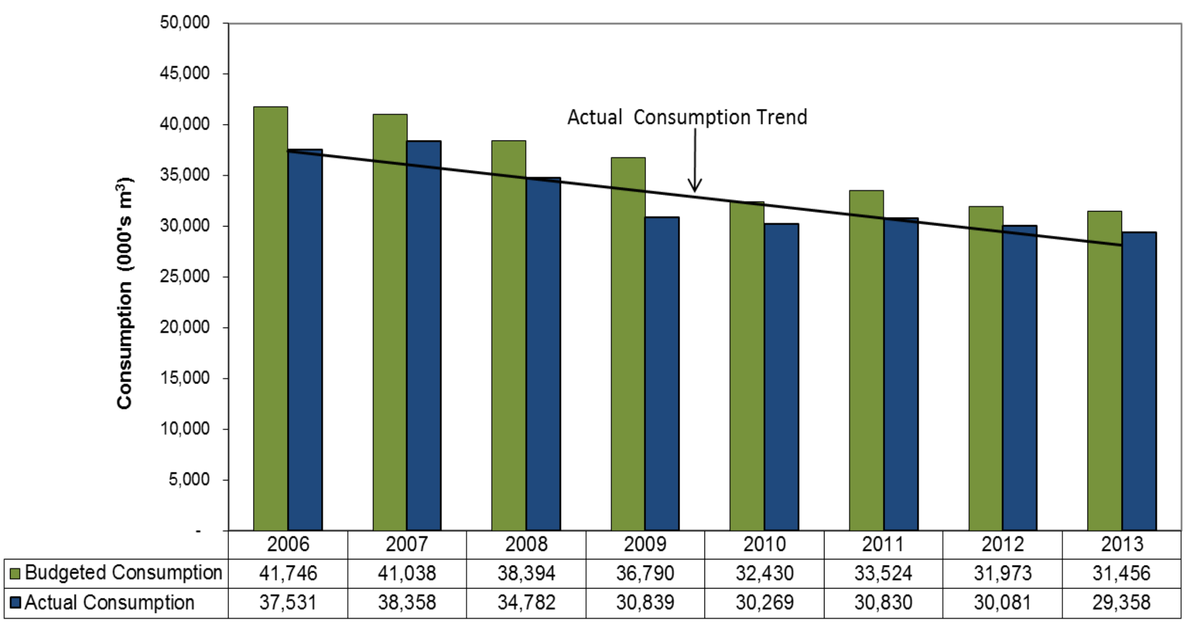
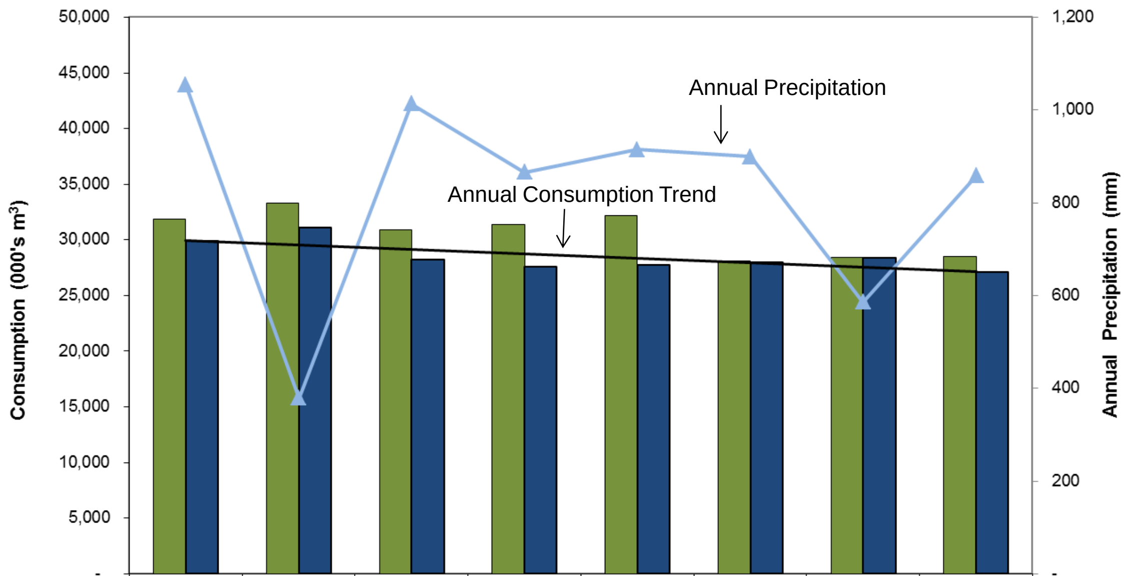


Figure 28 - ICI and multi-residential water consumption trends (2006-2013)



	2006	2007	2008	2009	2010	2011	2012	2013
Bud Consumption	31,856	33,318	30,907	31,369	32,219	28,127	28,457	28,485
Act Consumption	29,904	31,116	28,223	27,572	27,776	28,025	28,384	27,136
Precipitation (mm)	1,054	378	1,014	866	915	900	586	858
# of Accounts @ Y/E	119,322	122,468	124,292	126,135	127,866	129,027	130,919	133,082

Figure 29 Residential water consumption (2006-2013)

Total water consumption over the 10-year forecast is projected to increase by approximately 3% (or average 0.3% annually). This reflects an actual decline in average household and industrial consumption and is consistent with declines that were witnessed over the past 8 years. This relatively conservative forecast reflects the following:

- uncertainty surrounding growth/decline of consumption in the ICI sector loss of one of the top ICI users is equivalent to approximately 4,500 new residential accounts
- price elasticity in the ICI sector (small increases in rates can translate in reductions in consumption)
- conservation impacts (e.g. residential toilet consumption = 30% of indoor consumption low-flow toilets use 1/3 of conventional toilet 5% reduction in residential use = reduction of 1.6M m3
- energy conservation initiatives in the ICI sector usually include water impacts

For roads and bridges, future demand in addressed as part of the City's transportation master plan as part of the demand modeling exercise. The last master plan was undertaken in 2007. An update of the master plan is currently underway.

5.4 Lifecycle Management

The City has a number of strategies and processes in place to assist in the decision making process for the selection of appropriate asset interventions (maintenance, repair, rehabilitation, reconstruction, replacement) for its water, wastewater, stormwater, road and bridge infrastructure These are outlined in the sections below.

5.4.1 Non-Infrastructure Solutions

Dealing with Growth

Accurate and reasonable population/traffic growth forecasting allows the City to adequately plan road expansion activities, and ensure that infrastructure is built only to meet reasonable demands.

On a project-by-project basis, Environmental Assessment studies will explore various options, including alternatives to building new infrastructure, for any major developments being considered in the City.

Source Control Program

Over the last several years, staff in our Compliance and Regulations section have worked with our largest industries to assist them in moving toward full compliance with the City's Sewer Use By-law. Three of our largest consumers have spent a combined total of over $40 million commissioning wastewater treatment facilities of their own. We are already seeing vast improvements in influent quality at the Woodward WWTP with regards to parameters such as Polycyclic Aromatic Hydrocarbons (PAH), cyanide, phenol, benzene and toluene. Influent has already shown a 20 to 30% reduction in some of these non-treatable parameters, during the first half of 2012, and staff remain hopeful that even further improvements will be realized.

Through our Fats, Oils and Grease (FOG) Management Program, staff were able to educate food service owners on how to better handle and dispose of their cooking grease, thereby diverting grease from the drain. This has resulted in a 44% reduction in Oil and Grease (animal/vegetable) in the Woodward WWTP influent since 2008. It has also led to many restaurant owners saving money and, in some cases, making a profit by selling their used grease to recycling companies.

Leak Detection Program

In August of 2012, staff conducted temporary District Metering & Leak Detection Studies in pressure District 5 which initially began in 2010. The District 5 water distribution system is located between the Lincoln M. Alexander Parkway (LINC) at the south, the Niagara Escarpment at the north, from the east leg of Mountain Brow Blvd in the east, to Scenic Drive in Ancaster to the west. The study is being conducted to identify leaks in the water distribution system that are not evident due to geological or structural conditions. Repairing these unidentified leaks has had a significant impact on reducing the City's water loss. Staff are working toward repairing these leaks which are believed to account for 2.2 MLD of lost water every day.

Protective Plumbing Program

On July 7, 2011, Hamilton City Council approved amendments to the Protective Plumbing Program (3P) guidelines. One of the main changes to this program was to make it available for all owners of single family homes within the City of Hamilton who are connected to the wastewater collection system and have not previously experienced basement flooding. During the first two years of this program, the focus was on property owners who had previously experienced basement flooding during the various designated storm events where the compassionate grant had been utilized. With these new changes, property owners who wish to proactively protect their property from the effects of sewer surcharging during storm events would now be eligible to participate in the program. Since the new guidelines came into effect, the program has seen a dramatic increase in uptake. Throughout 2012, it is expected that approximately $5.8 million in grants will be provided. Staff will be reporting back to council on the sustainability of the program and potential delivery options.

Urbanization of Rural Cross Sections within Urban Boundaries

Within the urban boundaries of the City, there are two general classifications of roads: urban and rural. Urban roads have cross sections that typically include curbs, gutters, catch basins, underground storm water services, and sidewalks. Meanwhile, rural roads may be lacking some or all of these components and are more likely to include culverts and ditches for storm water management. The reconstruction of a rural road section to urban specifications is referred to as urbanization.

The decision to urbanize a rural cross-section brings with it significant additional life-cycle costs associated with the maintenance of the new additional assets that are added to the City's asset inventory, these are curbs, gutters, catch basins, underground storm water services, and sidewalks. The City has developed a decision making framework that allows staff to prioritise which roads are candidates for urbanization, thereby, reducing the pressure to add new infrastructure.

The framework considers the following factors:

- Traffic Data
- Road Condition
- Curbs Present?
- Sewers Present?
- Adjacent Land Use
- Bus Route
- Population Density
- Proximity to:
  - Arenas
  - Hospitals
  - Schools
  - Existing Sidewalks

Each of these factors were assessed and weighted to determine where the urbanization of rural cross sections would be most beneficial and economical to the city's residents. Each road section is assigned a Grade and priority as shown below:

Table 45 - Grades of Road Sections

Grade	Description	Number of Segments	Length of Segments
A	High Priority	451	71.1 km
B	Low Priority	457	115.5 km
C	No Added value	51	12.5 km

This decision making framework allows City staff to assess the most appropriate option for urbanization of rural cross sections within the urban area to ensure that the life cycle costs are minimised.

Framework for Selecting Upgrades of Surface Treated Roads

The City's network includes approximately 575 km of surface treated roads. There is often pressure to upgrade these sections to asphalt (AC) sections, however, this decision can have significant impact on the life cycle costs associated with maintaining the upgraded section. The City has developed a decision making framework to assist in determining the sections where an upgrade would be optimal.

The following are factors that were considered in the analysis:

- Current and anticipated traffic volumes on surface treated sections
- Pavement types
- Proximity to paved surface types including asphalt, concrete and composite)
- Current condition of surface treated section
- Life cycle costs associated with maintaining a typical surface treated section
- Life cycle costs associated with constructing and maintaining an asphalt upgrade

This decision making framework allows City staff to assess the most appropriate option for rehabilitation of surface treated roads to ensure that the life cycle costs are minimised.

Framework for Selecting Rehabilitation Treatments for Urban Arterial and Collector Streets

The City's urban network accounts for approximately 60% of the road lane-km network. These roads are vital to the long-term viability of the City, as they form the backbone of the City's transportation network and must continue to provide efficient routes for personal and commercial traffic.

By their very nature, many of these roads will carry large volumes of traffic and, as a result, any pavement rehabilitation strategy chosen will need to ensure that the implementation will not result in excessive disruption. In addition, there are different pressures on the urban network, resulting from the fact that the sewer and water infrastructure is either constructed within the roadway, or in close proximity, which will often drive pavement rehabilitation as a result of deterioration or even failure of these underground assets.

The City has developed a decision making framework for the selection of appropriate pavement rehabilitation treatments for the urban arterial and collector network. The framework considers the following factors in selecting the appropriate treatment:

- Current and anticipated traffic volumes,
- Current condition of roads,
- Life cycle costs associated with maintaining roads, and
- Life cycle costs associated with constructing and maintaining roads rehabilitation options.

This decision making framework allows City staff to assess the most appropriate option for rehabilitation of the urban arterial and collector network to ensure that the life cycle costs are minimised.

Pavement Management System

By implementing a pavement management system being committed to the regular update of the condition data for the road network the City is in a position to monitor the condition of network and to optimize the timing of treatments to ensure that the philosophy of "Doing the right treatment to the right asset at the right time" is followed.

In addition building a database of historical condition for each of the road sections has allowed City to assess the effectiveness of the treatments used in the past as well as the accuracy of the deterioration models used to determine the timing of rehabilitation needs.

This information provides important context for staff when deciding what treatments to apply to the specific road sections since using treatments that are not appropriate for the conditions that exist can lead to increased life cycle costs as a result of roads failing prematurely and requiring additional work to maintain their functionality.

Innovative Pavement Management Solutions

City staff implemented a number of innovative solutions to reduce the life cycle costs associated with maintaining the road network. These have included:

i. *Asphalt Joint Heating* – a critical component of any asphalt resurfacing project is the integrity of the joint that is formed between the cold edge of previously laid asphalt and new warm asphalt; this joint is often considered to be an area of weakness that can lead to water. The use of an infrared (or similar) joint heater allows the "cold" edge of the previously laid asphalt to be heated which means that the joint can be more effectively compacted minimizing the opportunity for water penetrating. The City now specifies the use of joint heating when laying asphalt pavements.

ii. *Road Diets* – this technique also known as “lane reduction” involves the reduction of the number of travel lanes on a road. This technique is often used to provide the opportunity to add sidewalks to increase pedestrian safety or cycle ways to encourage active transportation. An additional benefit recognised by the City is the reduction of the life cycle costs associated with the road section as these lanes are no longer used by vehicles and will require less frequent rehabilitation as a result of the reduced loading.

Bridge Management System

A highway bridge is a very expensive, complex structure where the elements of the structure must interact with each other in a unique and efficient way. The operational efficiency of the entire structure can be greatly affected by the malfunction of one element; thus, systematic and continuous maintenance of a bridge will extend its service life as well as reduce its operating expense. Sudden, catastrophic events can be avoided if good systematic, preventive maintenance is practiced. It is also important to carefully and systematically inspect all components of the structure periodically, in order to identify areas that require attention, before they require major repairs.

By implementing a bridge management system (BMS) and being committed to the regular update of the condition data through biennial OSIM inspections for the bridges and culverts the City is in a position to monitor the condition of these assets and to optimize the timing of treatments to ensure that the philosophy of “Doing the right treatment to the right asset at the right time” is followed.

The implementation of the BMS is still in the early stages with much of the additional data required to allow the City to fully benefit from the planning and prioritisation capabilities of the system still being collected through the OSIM inspections to be completed in 2014. As this data becomes available it will be possible for staff to develop the Bridge Condition and Urgency index which can be used to prioritise future rehabilitation needs.

In addition as the City builds a database of historical condition for each of the structures the City will be able to assess the effectiveness of the treatments used as well as the accuracy of the deterioration models used to determine the timing of rehabilitation needs.

This information will provide important context for staff when deciding what treatments to apply to the specific structures since using treatments that are not appropriate for the conditions that exist can lead to increased life cycle costs as a result of these assets failing prematurely and requiring additional work to maintain their functionality.

Cross Asset Optimisation

As with many communities various infrastructure assets have been managed separately with some interaction between the various departments responsible for each of the asset groups later in the process of programming and scheduling the work. Shortly after amalgamation the City formed an Asset Management group within the Public Works division to oversee the programming projects within the right of way. The objective of this coordination process was to ensure that efficiencies were achieved by coordinating road projects with repairs and replacement of underground infrastructure. This also assists in avoiding situations where roads were resurfaced and then were dug up to replace water and sewer pipes.

Using this approach the rehabilitation needs for each of the assets were assessed separately and then the coordination with other work was completed manually. Recently, however, the City has implemented a software tool that facilitates the use an integrated approach to project planning much earlier in the process. This tool is called IRISS or **I**ntegrated **R**ight-of-Way **I**nfrastructure **S**upport **S**ystem.

The IRISS builds upon the work that the City has done in the past in the development of the various decision making frameworks described above by incorporating these into the system.

By incorporating these decision making frameworks and the deterioration models that the City has developed for its various infrastructure components the as well as the IRISS is able to project the assets that require rehabilitation.

The IRISS implementation is nearing completion and as it becomes fully integrated into the budgeting and decision making process the City anticipates that significant benefits will be achieved in the optimization of projects across the various asset portfolios within the right-of-way. These benefits will include cost savings from

- bundling of projects
- selection of appropriate treatments at the right time in the asset life cycle
- minimizing the life cycle costs associated with maintaining the infrastructure.

5.4.2 Maintenance Activities

The City abides by the Ministry's minimum maintenance standards (Ontario Regulation 239/02), which specifies the frequency that roads need to be patrolled, and issues, including potholes, cracking, winter maintenance, and so forth, be addressed, based on road classification.

In addition to routine maintenance activities, based on requirements and/or operations guidelines, the City has implemented a pavement management system to determine optimal timing for preventive maintenance and rehabilitation work.

A well-implemented pavement management system allows the City to realize the benefits of lower-cost treatments such as preventive maintenance and light rehabilitation activities, by targeting interventions within the network, before more costly treatments, or full replacement, become necessary. The management philosophy applied within the City, with respect to the road network, is to "Apply the right treatment to the right asset at the right time".

5.4.3 Rehabilitation Activities

Sewer Main Lining Program

For over a decade the City has been using trenchless technologies to renew deteriorated sewer pipes. Less costly and invasive than traditional construction techniques, lining restores sewer infrastructure to near new condition with limited need for excavation or prolonged street closure. This program has renewed over 250 km of sewers since 2005, resulting in a cost avoidance of over $100 Million.

Sewer Lateral Management Program

The Sewer Lateral Management Program (SLMP) provides guidance and grants to property owners experiencing sewer related problems. For the last three years, there has been a decline in the number of sewer lateral investigations conducted. Since 2009, investigations have declined by approximately 12% annually to a total of 848 investigations in 2012. From September 1, 2011 to August 31, 2012, 963 sewer laterals were repaired or replaced under this program.

Pavement Maintenance and Rehabilitation

For the purposes of developing this AMP a pavement management system was used determine most cost-beneficial pavement maintenance and rehabilitation strategies to be applied to the road network at the most optimal time.

The system uses the results of the pavement condition survey, coupled with predictive pavement deterioration curves and decision tree models, to determine appropriate Maintenance and Rehabilitation (M&R) treatments for each pavement segment in the City's road network.

Decision trees allow the City to identify maintenance and light rehabilitation treatments early in a pavement's life, when surface conditions are good and the pavement has not begun to experience more rapid deterioration due to weather, traffic loadings, and age. Applying early intervention strategies extends the life of the pavement significantly at a low cost; therefore, the cost-benefit of these types of interventions is typically high.

Using a combination of appropriate decision trees and cost-benefit analyses is an optimal approach for identifying maintenance and light rehabilitation work, minimizing the need for costly reconstruction activity.

Allowing pavements to deteriorate further, triggers the need for heavier rehabilitation strategies. Although heavy rehabilitation is typically less cost-effective than maintenance and light rehabilitation, it is still preferable to apply this type of treatment, instead of the more costly full reconstruction of a road section.

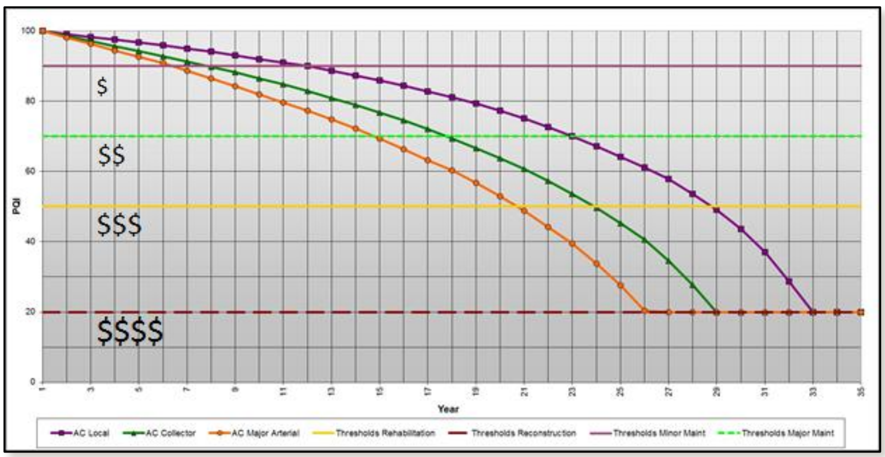


Figure 30 - Conceptual Representation of Trigger Points for M&R Activities, and their Relative Costs

The City has taken a proactive approach in implementing its pavement maintenance and rehabilitation program. Following its most recent pavement condition survey in 2011/2012, the City reviewed and refined its pavement management system parameters, including deterioration curves, decision trees, and treatment benefits. These improvements allow for a more comprehensive cost-benefit analysis of the network.

The following treatments are considered within the rehabilitation program:

Table 46 - Treatment List Considered for each Pavement Type

Surface Treated	Asphalt Concrete	Composite
AC Overlay	OGCM (not on Arterials)	Mill & AC Overlay
AC Reconstruction	Tar & Chip (not on Arterials)	Strip & AC Overlay (strip all asphalt)
Open Graded Cold Mix Reconstruction	Mill & AC Overlay	Strip & Concrete Base Repair & AC Overlay
Pulverise and AC Overlay	Strip & AC Overlay (strip all asphalt)	Full Reconstruction - AC
Surface Treatment Reconstruction	Cold-in-Place Recycling	Full Reconstruction PCC
	Pulverize & AC Overlay	Mill AC, Rubbleize & AC Overlay
	Full Reconstruction - AC	

Within the pavement management system each of these treatments are assessed for their suitability and prioritized based on their benefits to users versus the life cycle costs associated with them. Once the appropriate treatments are identified a review is completed to consider additional criteria including coordination with other work such as the replacement of sewer and water infrastructure before making the final recommendation.

5.4.4 Replacement Activities

Lead Service Replacement

Since 2007, the issue of lead in drinking water has become a concern in Ontario. Education and outreach programs related to lead in drinking water has increased response to the City of Hamilton's Lead Service Replacement Program. Under the Lead Service Replacement Program, the first step is the inspection of the existing water service line to confirm if it is constructed of lead or lead alloy. Since 2007, the number of service line inspections increased considerably in response to the awareness to outreach respecting lead and its adverse health effects. As a result, the numbers of water services replaced annually continues at an increased rate. By 2012, the number of water service line inspections has stabilized to approximately 870 per year and the City is currently completing approximately 700 water services per year with no appreciable backlog.

Pavement Reconstruction

A pavement with an OCI value of 20 (or below) is considered to have failed, and is no longer salvageable. It may also indicate that the road is under-designed for its current traffic loading; therefore, it will be necessary to reconstruct a failed pavement.

Currently, the City owns approximately 8 lane-km of roads whose OCI values are below 20.

Any pavement reconstruction activities will be coordinated with other pending and/or desirable projects at the same location, such as sewer or watermain replacement, in order to minimize disruption to the Community, and minimize overall project costs.

5.4.5 Expansion Activities

The City of Hamilton expects modest growth in the foreseeable future. Expansion activities are reflected in the City's Water and Wastewater, Stormwater and Transportation Master Plans. All major expansion projects are subject to Environmental Assessment studies, which evaluate the necessity of expansion of the asset portfolio and assess overall impact on the Community, environment, and so forth, for the various options available.

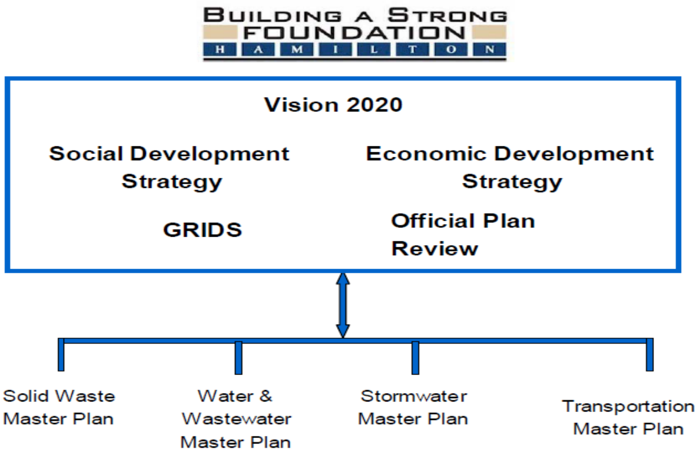


Figure 31 - Relationship between various master planning initiatives

5.4.6 Procurement Methods

The City has seen significant benefits from implementing an innovative procurement strategy for the annual Neighbourhood Road Program. Under these contracts the contractors are allowed the flexibility to complete the work during the construction season at a time that fits with their overall schedule. This approach has seen contract values that are often 50% lower than traditional contractual terms that typically mandate that work is done to a clearly defined schedule.

To ensure the most efficient allocation of resources and funds, the City will consider bundling projects when issuing tenders, to realize cost-benefits of economy of scale.

5.4.7 Risks

There are several risks that could prevent the City from reaching/maintaining its target level of service for water, wastewater, stormwater, roads and bridges:

Table 47 - Risks to reaching / maintaining target Level of Service

Potential Risk	Potential Impact
Required Funding Not Secured	• Assets deteriorate further • Network average condition grade decreases • Assets deteriorate beyond current need level (i.e., a maintenance need becomes a rehabilitation need) • Backlog of work increases • More costly treatments are required
Substantial Increase in M&R Unit Costs in Future	• Inability to complete all planned projects with allotted budget levels • Assets deteriorate further • Assets deteriorate beyond current need level (i.e., a maintenance need becomes a rehabilitation need) • Backlog of work increases • More costly treatments are required
Underestimated Asset Deterioration Models	• More rapid asset deterioration • Underestimated funding needs • More costly treatments are required
Environment Change (e.g., severe weather, high population/traffic growth)	• More rapid asset deterioration • Underestimated funding needs • More costly treatments are required • New or expanded assets are required

Section 6 – Financing Strategy

The water, wastewater and stormwater budgeting process is a distinctly separate from other Public Works assets. Utility revenues come from billed charges which are based on water consumed[1].Water consumption is based on metered consumption; meters are read with ratepayers billed by the City's billing agent, Horizon Utilities Corporation. Both Operating and Capital costs for the water, wastewater and storm programs are fully funded from rates and therefore, do not affect municipal property taxes.

6.1 Expenditure History and Forecasts

6.1.1 Expenditure History

Table 48 shown the expenditure history over the past 4 years as stated in the "restated budget" column of the 2010-2013 water, wastewater and stormwater budgets. Total expenditures have undergone a 3.5-4% annual increase during this period.

*Table 48 - Expenditure History Water, wastewater, and stormwater (2009 – 2012) – Millions**

Component	2009	2010	2011	2012
Operating Expenditures	$67.177	$68.831	$69.444	$72.186
Contributions to Capital	$77.613	$82.329	$77.460	$73.646
Contributions for DC Exemptions	$6.090	$6.294	$9.000	$9.000
Debt Charges	$9.931	$6.188	$6.572	$10,367
Transfer to Reserves	$(328)	$2.389	$(3.208)	$(487)
Total Expenditures	**$160.483**	**$166.031**	**$159.268**	**$164.712**

* Excludes amortization expense & interest on long term debt

*Table 49 - Expenditure Roads and Bridges (2009 – 2012) – Millions**

Component	2009	2010	2011	2012
Roads - Paved	$23.237	$24.829	$22.160	$26.286
Roads - Unpaved	$0.946	$0.974	$0.830	$0.579
Roads - Traffic Operations & Roadside	$30.425	$25.836	$24.726	$25.129
Roads – Bridges & Culverts	$2.333	$2.479	$1.646	$2.873
Total Expenditures	**$56.941**	**$54.118**	**$49.362**	**$54.867**

* Excludes amortization expense & interest on long term debt

6.1.2 Expenditure Forecast – Water, Wastewater & Stormwater

Expenditure forecast are based on the 2013 Water and Wastewater Budget. The 10-year operating budget highlights the commitment of a rate strategy as a means of achieving sustainable water and wastewater systems. Beyond 2013, program expenditures, exclusive of costs associated with addition of tertiary treatment of the wastewater treatment plant, are forecast to increase on average by approximately 3% annually, reflecting a continued commitment to try to identify additional savings and efficiencies. Also, over the next 10 years, the financing for the capital program will increase on average by approximately 5% per annum. Over the period 2013 to 2022, total expenditures are forecast to increase from $172 million to $256 million, an increase of nearly 50%, or 5% annually. The need for sustainable pricing as a method of providing sustainable infrastructure means that, over the period 2013 to 2022, the typical residential annual metered bill.

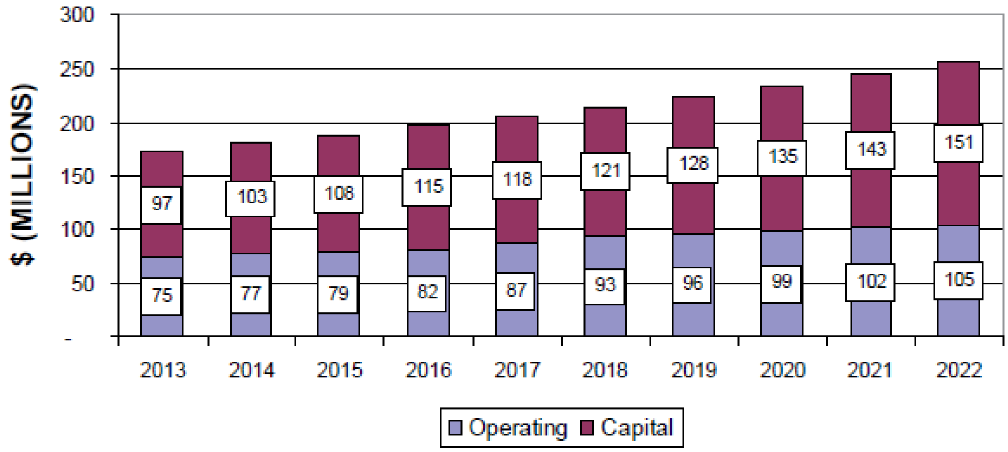


Figure 32 - Breakdown of rate-supported capital expenditures

The Utility capital forecast is heavily influenced by the Woodward Ave Wastewater Treatment Plant upgrade, which requires nearly $750 Million of investment over the next twenty years. The development plan for this project has been recently updated to accommodate a phased implementation approach. Phase 1 is for effluent quality treatment improvements and is expected to be completed by 2017. Phase 2 will involve the expansion of the treatment plant to accommodate growth. The majority of the growth component costs ($248.5 million) are now forecast beyond the 10 year period (2013 – 2022).

This revised implementation plan was necessitated as a result of changes in the overall program planning conditions including significant reduction in water consumption and subsequent flows to the WWTP resulting from a combination of the effects of the past recession as well as conservation regulations and a decline in overall water consumption across all sectors and a loss of Institutional, Commercial, and Industrial (ICI) customer base. A revised implementation plan was also pursued due to continuing concerns for the overall program affordability and the timing and pace of debt financing. The basis for the revised implementation plan is to postpone the expansion elements of the WWTP Program while supporting the short-term delivery of water quality improvements needed to support the City's commitment to the Hamilton Harbour Remedial Action Plan (HHRAP) for the de-listing of Hamilton Harbour as an International Joint Commission designated Area-of-Concern.

Table 50 - Capital expenditure forecasts for the Woodward Ave. WWTP upgrade project

	Total	Pre 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Post 2022
Phase 1 – Clean Water	479.7	149.2	14.9	82.8	180.0	52.8							
Phase 2 – Expansion	262.1										6.8	6.8	248.5
Total WWTP	741.8	149.2	14.9	82.8	180.0	52.8					6.8	6.8	248.5

The 10-year capital program for water and wastewater services is forecasted at $1.384 Billion and is detailed in Figure 33. Wastewater infrastructure is expected to consume 858 million (62% of total expenditures) due to a forecasted $500 million investment in the Woodward Ave WWTP over this period.

Total investment in stormwater infrastructure is expected to consume only 10% of the budget in-spite of the Stormwater infrastructure base representing roughly 20% of the overall value of the water, wastewater and stormwater infrastructure base. This can be partially explained by the relatively long useful life of stormwater infrastructure that is primarily comprised of underground infrastructure compared to water and wastewater systems that have a significant portion of facility infrastructure that required more frequent capital investments throughout its lifecycle.

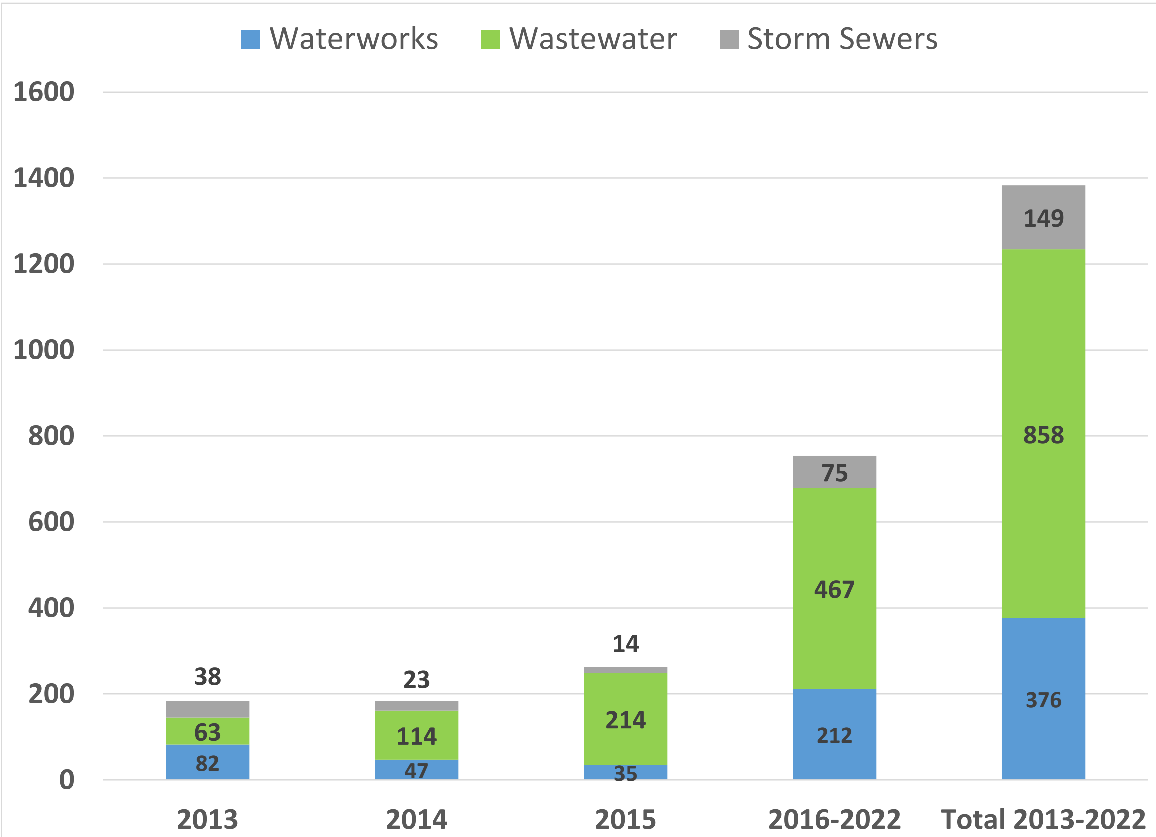


Figure 33 - 10-year capital program for water, wastewater and Stormwater services

In order to provide a longer-term forecast of capital investment needs, a 100-year planning horizon was used to match the lifecycle of some buried infrastructure assets. Although 100-year planning models tend to be less accurate, they provide decision-makers with a strategic outlook on the viability of their infrastructure. The 100-year planning model was based on the analysis completed in the 2009 State of the Infrastructure Report and adjusted for inflation to facilitate comparison with the 2013 budget figures. A comparison of the two models is shown in Table 51.

Overall, total capital investment needs for water, wastewater and stormwater are relatively similar but differences in capital spending exist across each area. Based on the 10-year model, the majority of investments will be focused on wastewater infrastructure due to the Woodward Ave. WWTP upgrade project. This focus on wastewater has reduced the amount of capital dollars available for water infrastructure. This trend will smooth out over the 100-year planning horizon. As will be discussed in the following sections, the financial viability of the 10-year model is based on $200 million in grants for the Woodward Ave. WWTP that was received from the Provincial and Federal governments. As such the long-term financial viability based on the 100-year model will either have to continue to rely on similar grants or rely on alternative sources of funding.

Table 51 - Average annual capital investment levels - Millions

	Waterworks	Wastewater	Storm Sewers	Total
Average Annual Capital Investment (2010-2100)	49.0	70.6	16.2	135.9
Average Annual Capital Investment (2013-2022)	37.6	85.8	14.9	138.8

6.1.3 Expenditure Forecast – Roads and Bridges

Managing the road network requires the City to balance the rehabilitation needs with the funding that is available, therefore, an important component of any asset management strategy will be defining a level of service for the network that will be used as the benchmark for where the network condition should be maintained. The City has completed an analysis to identify the level of funding required to meet the desired level of service which has been identified as maintaining the network level OCI of 63. Over the 10-year planning period the total investment required has been estimated to be $513,000,000 or $51.3 million annually.

The City's Tax Supported Capital budget shows that from a total combined roads budget of $98.75 million the total capital investment allocated for replacement and rehabilitation of the City's roads and bridges is as follows:

- Roads - $33.8 million (excluding Council Priority Projects)
- Bridges - $11.1 million

The projected Tax Supported Capital budget for the roads is shown in the following figure.

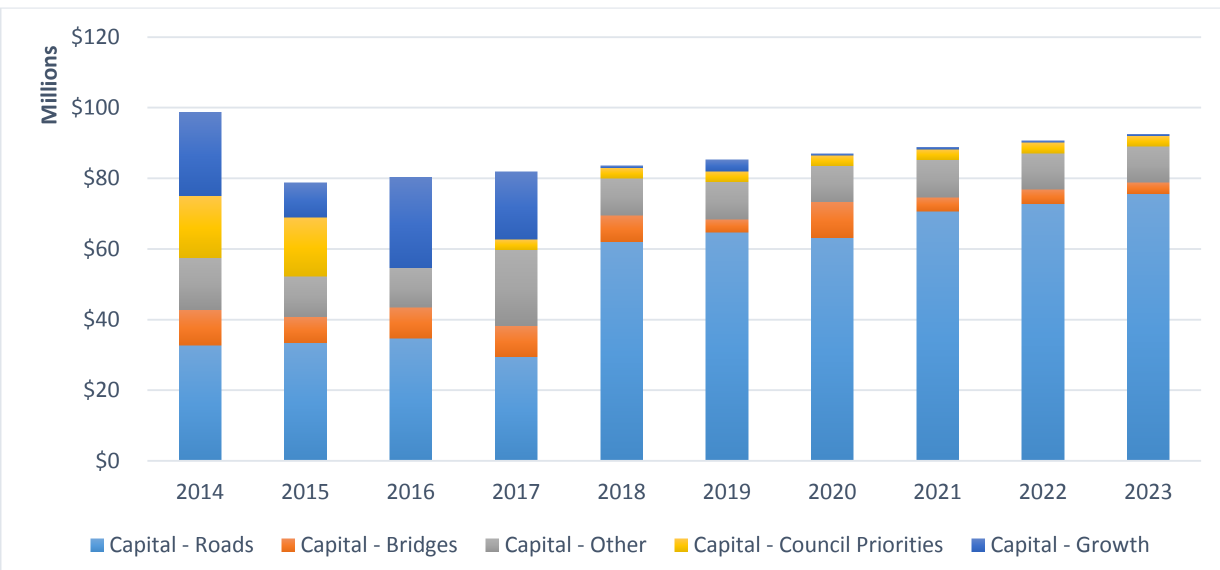


Figure 34 - Projected Capital Expenditure for Roads & Bridges (2014 – 2023)

Over the 10-year planning period shown in Figure 34 it can be seen that the funding for roads fall short of the $53.1 million required to maintain the network at its current average OCI of 63. Although the investment in roads in 2021 and 2022 are projected to approximately $50 million annually the average investment over the 10-year period is approximately $40 million. This shortfall will lead to the continued deterioration of the City's road network.

6.2 Yearly Revenues – Water & Wastewater

Total annual revenue in 2013 is expected to reach $171 million and is forecasted to increase by 4 - 4.5% annually over the next 10 years as shown in Table 50. Currently, the City of Hamilton has approximately 142,000 metered water accounts, approximately 92.3% of which are residential accounts. While industrial/institutional accounts make up less than 0.5% of total metered accounts, industrial/institutional water consumption accounts for 25% of total consumption. In 2012 (year to date), residential users account for 46% of total water consumption, the balance 54% is attributed to commercial demand.

Forecasts shown in the table below are based on a planned 4.25% annual increase in water rates over the next 10 years. Other trends that will continue to have an effect on actual revenues are the decline in water consumption by the ICI and residential sectors due to an increase in water conservation initiatives. In the ICI sector, historical trends have seen an average 3% decline in average consumption in the large ICI sector.

Table 52 Forecasted annual revenue sources

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Residential	77,367	81,237	85,289	89,529	93,968	98,614	103,474	108,561	113,882	119,449
ICI	82,941	86,466	90,140	93,970	97,962	102,125	106,464	110,990	115,707	120,625
Haldmand / Halton	2,644	2,756	2,873	2,996	3,123	3,256	3,394	3,538	3,689	3,845
Non-metered	594	594	594	693	693	693	792	792	792	792
Private Fire Lines	400	412	424	437	450	464	478	492	507	522
Hauler / 3rd Party Sales	1,041	1,072	1,104	1,137	1,171	1,206	1,242	1,280	1,318	1,358
Wastewater Abatement Program	(440)	(453)	(467)	(481)	(495)	(510)	(525)	(541)	(557)	(574)
Overstrength Agreements	1,600	1,648	1,697	1,748	1,801	1,855	1,910	1,968	2,027	2,088
Sewer Surcharge Agreements	3,200	3,296	3,395	3,497	3,602	3,710	3,821	3,936	4,054	4,175
Non-Rate Revenues	2,626	2,692	2,761	2,844	2,929	3,017	3,108	3,201	3,297	3,396
Total Revenues	171,973	179,720	187,810	196,370	205,204	214,430	224,158	234,217	244,716	255,676

Examining consumption patterns, residential consumption, on average, has been declining over the past decade. The declining consumption reflects ongoing conservation efforts associated with fixture/appliance obsolescence such as the installation of water efficient toilets and washing machines. For 2013, staff is recommending that the forecast for average residential consumption remain at 220m3 to reflect consumption trends observed in 2008 – 2012. It is not clear how much further average residential consumption can decline, but there exists the potential for further reductions, principally due to conservation efforts and the associated regulations. The Water Opportunities and Water Conservation Act, passed by the Ontario government in November 2010, includes measures to mandate specific water efficiency standards for consumer products such as toilets whereby only toilets of 6L per flush or less will be allowed for retail sale.

Total water consumption over the 10-year forecast is projected to increase by approximately 3%. This relatively conservative forecast reflects the following:

- uncertainty surrounding growth/decline of consumption in the ICI sector loss of one of the top ICI users is equivalent to approximately 4,500 new residential accounts

- price elasticity in the ICI sector (small increases in rates can translate in reductions in consumption)
- conservation impacts (e.g. residential toilet consumption = 30% of indoor consumption low-flow toilets use 1/3 of conventional toilet 5% reduction in residential use = reduction of 1.6M m3
- energy conservation initiatives in the ICI sector usually include water impacts

6.3 Funding Strategies

6.3.1 Funding Strategy – Water, Wastewater & Stormwater

Five major funding sources are applied, as reflected in the City's Water and Wastewater 2013 rate budget; contribution from operating (water rates), development charges, external debt, subsidies, and reserves. The vast majority of capital spending (55%) will be directly supported from water rates. The second largest source of funding is development charges (20%) followed by external debt (15%). Taking a closer look at the breakdown and implications moving forward the following can be concluded:

- Relatively significant reliance on two funding sources that are characterized by uncertainty (water rates and development charges) – this amounts to 75% of expected funding sources.
- Relatively low reliance on reserves.
- Out of the $105 million expected from subsidies, $100 million will be allocated to wastewater, specifically to the Woodward WWTP expansion.

Recent trends in water consumption and the pace of development activity have not kept up with previous forecasts. Contribution from operating (water rates) is impacted by 1) Water Consumption and 2) Water Rates. The City is planning to maintain a 4.25% annual increase in water rates to keep up with inflation and required capital funding. Decline in average household consumption and decrease in ICI consumption will effectively mean that rate revenue will not keep up with water rate hikes.

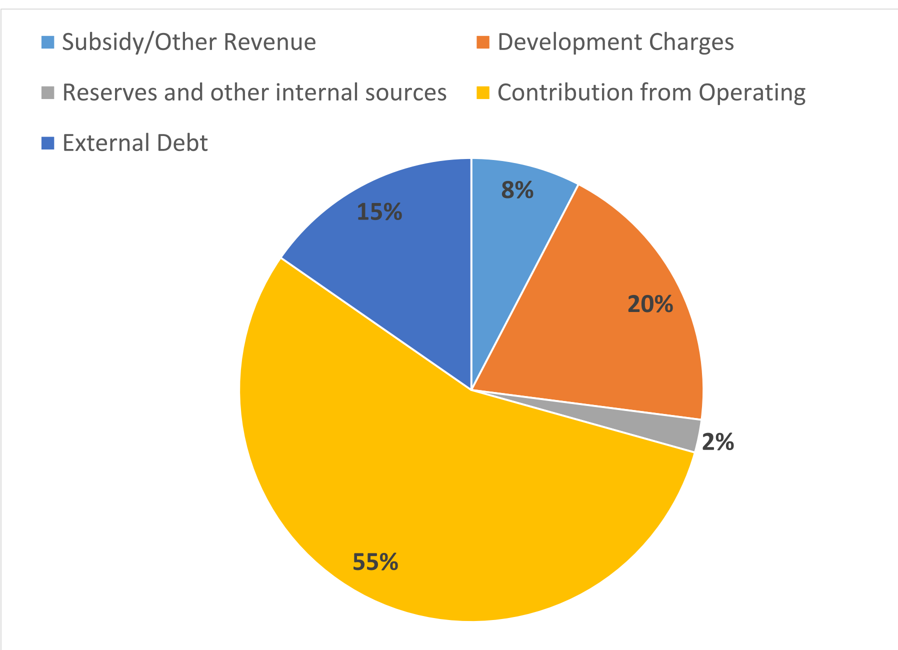


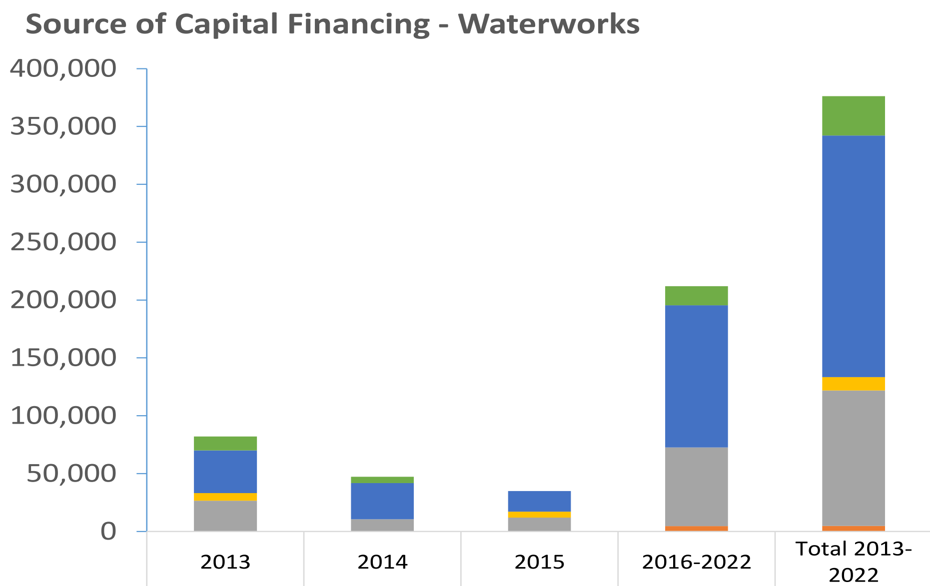
Figure 35 Breakdown of sources of financing for water and wastewater capital (2013-2022)

Table 53 shows the relative breakdown of the capital spending from 2013-2022 across water, wastewater and stormwater by funding source. A comparison reveals the following trends:

- The need to fund the Woodward Ave. WWTP upgrade project requires a relatively higher reliance on subsidies, as compared to water and storm services.
- The split of the Woodward Ave. WWTP project into two phases (phase 1 – upgrade and phase 2 – expansion) translated into a decreased reliance on development charges for wastewater, as compared to water and storm. Once phase 2 starts-up as planned in 2021, there will be an increased reliance on development charges for funding wastewater
- The lack of a dedicated funding source for stormwater has led to an increased reliance on reserves to fund capital projects, as compared to water and wastewater
- The surge of capital projects in water over the past 5 years has translated into decreased reliance on external debt as a main funding source for water, as compared to wastewater and storm.

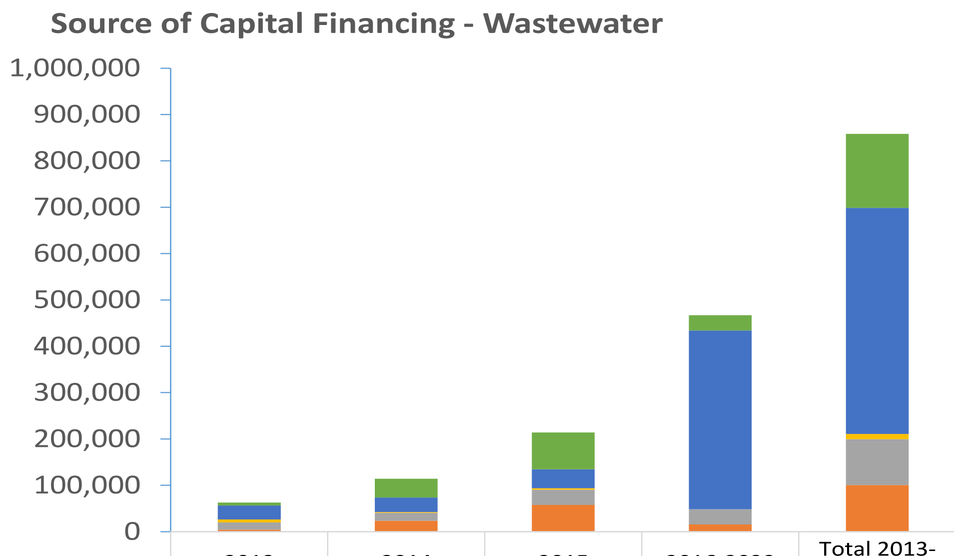
Table 53 Sources of funding for various programs (2013-2022)

	Waterworks	Wastewater	Storm Sewers
Subsidy/Other Revenue	1.3%	11.7%	0.5%
Development Charges	31.1%	11.5%	35.1%
Reserves and other internal sources	3.1%	1.3%	5.9%
Contribution from Operating	55.5%	56.8%	46.1%
External Debt	9.1%	18.6%	12.4%



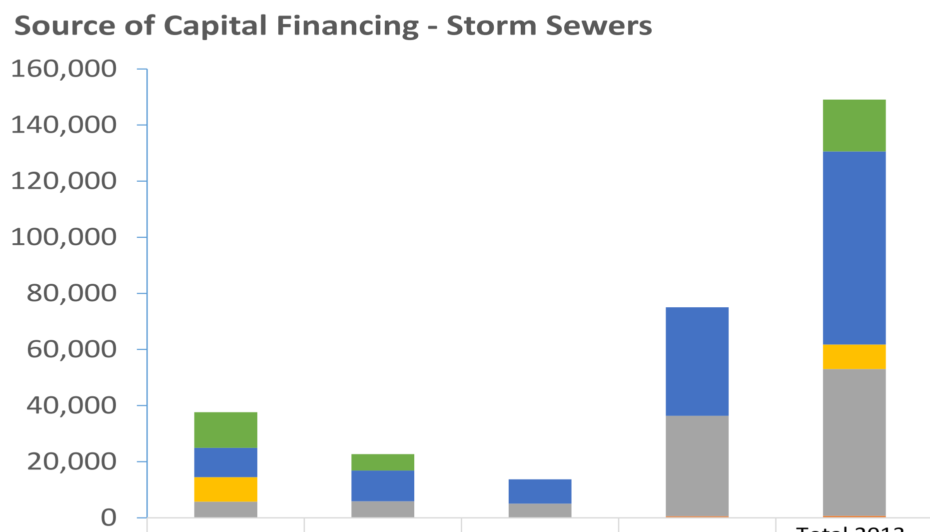
	2013	2014	2015	2016-2022	Total 2013-2022
External Debt	11930	5550		16640	34120
Contribution from Operating	36930	31210	17870	122800	208810
Reserves and other internal sources	6520		5000		11520
Development Charges	26520	10570	12040	67986	117116
Subsidy/Other Revenue	100			4614	4714

Figure 36 Sources of funding for waterworks capital projects



	2013	2014	2015	2016-2022	Total 2013-2022
External Debt	6310	40837	79495	32901	159543
Contribution from Operating	30110	31280	40910	385480	487780
Reserves and other internal sources	6454	1580	3420		11454
Development Charges	15781	17181	32905	33214	99081
Subsidy/Other Revenue	4158	23432	57400	15335	100325

Figure 37 Sources of funding for wastewater capital projects

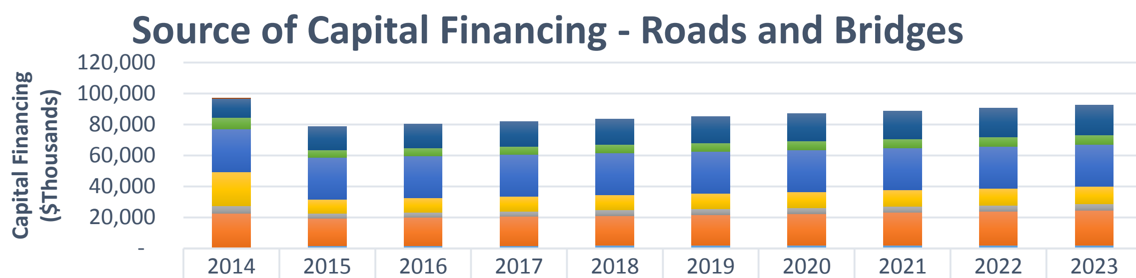


	2013	2014	2015	2016-2022	Total 2013-2022
External Debt	12670	5850			18520
Contribution from Operating	10460	10965	8665	38695	68785
Reserves and other internal sources	8750				8750
Development Charges	5750	5810	4950	35850	52360
Subsidy/Other Revenue		75	75	525	675

Figure 38 Sources of funding for stormwater capital projects

6.3.2 Funding Strategy – Roads & Bridges

The projected investment and associated funding sources for the investment in the road network is summarized in Figure 39. The values shown for represent the approved budget for 2014 and forecasts for the period 2015-2023.



	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Debt	200									
Operating Levy	12,346	15,127	15,580	16,048	16,529	17,025	17,536	18,062	18,604	19,162
Reserves & Other	7,229	4,990	5,139	5,294	5,452	5,616	5,784	5,958	6,137	6,321
Federal Gas Tax	27,950	27,110	27,110	27,110	27,110	27,110	27,110	27,110	27,110	27,110
Internal Revenues	21,780	8,906	9,173	9,448	9,732	10,023	10,324	10,634	10,953	11,282
Program Reserves	4,920	3,286	3,384	3,486	3,590	3,698	3,809	3,923	4,041	4,162
DC's	22,300	17,689	18,220	18,766	19,329	19,909	20,506	21,121	21,755	22,408
External Revenues	250	1,655	1,705	1,756	1,809	1,863	1,919	1,976	2,036	2,097

Figure 39 Summary of Funding Sources

6.3.3 Alternative Funding Strategies

In addition to the five core funding sources identified above, the City is actively considering a variety of alternative funding sources in order to close their funding gap. This report discusses two sources that have been investigated.

Stormwater Rates

The City of Hamilton owns and operates one of the largest, oldest, and most complex stormwater drainage systems within the Great Lakes basin. The City's Stormwater Management (SWM) Services program is currently funded through the water and wastewater rate, property taxes, and development charges. The City has experienced financial challenges under the present funding system, particularly during wetter than average years. The cost to convey and treat Stormwater and combined sewage flows drastically increases during wet years (i.e., energy, chemical, operations and maintenance costs). Stormwater revenue drawn from these funds must compete with many other City services and is often inadequate to provide the level of service demanded by federal/provincial regulatory agencies, citizens, businesses, other community organization s, and a changing climate. Further, given the high treatment costs during wet periods, the City has a fundamental need for a stable and dedicated SWM funding mechanism; one that reduces or eliminates the current reliance on volatile metered water revenue.

A stormwater rate (also known as a stormwater utility in the U.S.) is an alternative financing mechanism to the City's existing processes that offers a fair and equitable method for allocating the costs of the SWM Services program. This rate would be administered as a user fee, in a similar fashion as the City's current water and wastewater rate, allocating SWM-related costs to property owners based on the measured area of impervious ground cover (e.g., rooftops, driveways, and parking lots). This approach quantifies the relative contribution of stormwater runoff from each property to the municipal SWM system, since runoff is a function of the land use practices and surface treatment decisions of property owners.

A 2010 study completed by the City recommended the use of the Tiered Single Family Unit billing unit method for storm water rates. According to the study, in order for the storm-water program to be fully sustained by stormwater rates, detached homes would be required to pay a monthly fee ranging from $8.10 – $30.70, depending on the impervious area of the home. Other types of residential dwellings (town homes, duplex, condominiums, etc…) would be charged anywhere from $3.13 – $10.86. Non-residential properties would be assessed based on actual measured impervious area on a parcel by parcel basis, at a rate of $18.40 per month per 301 m2 of impervious area.

The proposed stormwater rate would raise $66.4 million in annual revenue for the City and provide the following advantages: 1) Achievement of the shared City principles of fairness, equity and sustainability; 2) Provides a flexible mechanism to support the current and future needs of the SWM program; and 3) Offers financial incentives for property owners to provide on-site controls to reduce stormwater and pollutant loads to the municipal SWM system, through the adoption of a credit policy.

Plans to move forward with the stormwater rate have been put on hold, pending further public consultation. In the future, the use of this mechanism is considered a viable option that will be taken into consideration.

Public Private Partnership

The Federally funded Public-Private Partnership program, known as P3 Canada, was created to improve the delivery of public infrastructure and provide better value, timeliness and accountability by increasing the effective use of partnerships to deliver public infrastructure. The introduction of a private sector partner that is responsible to shoulder the design, construction, financing and operation of a portion of the City's infrastructure present an opportunity to redistribute risks and decrease the short-term burden of large up-front capital investments. The City will repay the operating and capital expenditures to the private sector partner throughout the concession period.

The City of Hamilton is seeking to procure a private sector partner who will provide biosolids management services based on a long-term Design-Build-Finance-Operate-Maintain (DBFOM) contract. A DBFOM contract is a form of public-private partnership that will allow the City to capitalize on the potential for PPP Canada to fund up to 25% of eligible Project costs. This Project involves the development of biosolids management infrastructure, as part of the City of Hamilton's wastewater treatment process. The City currently utilizes a Land Application process for management and disposal of biosolids. However, Land Application faces a variety of challenges which require the City to carefully consider whether a different approach to biosolids management will be more sustainable for the long-term. The business case concluded that Enhanced Treatment and Thermal Reduction are the most suitable technologies based on the City's triple bottom line evaluation criteria.

A Business Case for the project was approved by Council in 2012 and is currently under review by P3 Canada.

Energy Recovery

The City has recently completed an upgrade to its biosolids train of its Woodward Ave WWTP. The upgrade increased biogas generation resulting in energy recovery and an overall reduction in the greenhouse gas footprint required to fully process the biosolids. Benefits of the upgrade include a direct reduction in the ultimate volume of biosolids to be disposed and reduction in operating costs associated with the dewatering process. In addition, a portion of the biogas is purified in the new Biogas Purification Plant to natural gas pipeline quality and fed in the Union Gas utility distribution network. The volume of gas processed through the BPP is equivalent to that used by 1,500 homes annually. This plant is the first installation in a municipal system in North America and received the 2012 PJ Marshall Award - Certificate of Merit for Municipal Innovation from the Association of Municipalities of Ontario (AMO).