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City of Greater Sudbury

Stormwater Asset Management Plan

Final Report

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Project #: 60541343

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Mr. Paul Javor
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April 1, 2021

Project #
60541343

Dear Mr. Javor:

Subject: Stormwater Asset Management Plan
Final Report

Please find enclosed AECOM's final submission of the **City of Greater Sudbury's Stormwater Asset Management Plan Final Report**.

We trust the enclosed meets your approval. Should you have any questions or require further information about our submission, please do not hesitate to contact Nancy Hill at (604) 790-1637.

Sincerely,
AECOM Canada Ltd.

Nancy Hill

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NH
Encl.
cc:

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AECOM: 2015-04-13

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1. Introduction

1.1 Background

According to ISO 55000:2014, an asset is defined as an item, thing or entity that has potential or actual value to an organization. As such, the City of Greater Sudbury (hereinafter refer to as "the City") owns, operates and maintains a wide array of assets that include, but are not limited to, information technology systems, equipment, stormwater management ponds, vehicles and even natural systems. These assets are expected to function efficiently and effectively for many years and support the mission-critical functions of the organization. Actions such as planning, delivery of assets, operations, maintenance, and performance management, which are performed by various divisions within "the City", all contribute to effective asset management (AM) with support from finance and information systems. However, all these assets have a defined service life and, as they age and deteriorate, it is imperative for the City to understand how to manage them in such a way to ensure that their full-service life is reached, and to have in place a mechanism to enable their renewal or replacement whilst risks are managed.

The objective of this Asset Management Plan (AMP) is to deliver the context and the financial and technical road map for the management of the City's **stormwater infrastructure assets** and to provide the basis for decision making and budgeting for sustainable management of these assets and delivery of these assets over a 10-year planning period.

The City's goal in managing infrastructure assets is to meet their defined levels of service (as amended from time to time) in the most cost-effective manner for present and future consumers. Key elements of the City's approach to infrastructure asset management are:

- Providing a defined level of service and monitoring performance;
- Managing the impact of growth through demand management and infrastructure investment;
- Taking a lifecycle approach to developing cost-effective management strategies for the long-term that meet the defined level of service;
- Identifying, assessing and appropriately controlling risks; and
- Linking to a long-term financial plan which identifies required, affordable expenditures and how funding will be allocated.

1.2 Connectivity to Other Corporate Documents

This AMP supports the City of Greater Sudbury's Strategic Plan objective for Asset Management and Service Excellence which states "maximize value of investments in physical infrastructure and initiatives that enable reliable service delivery and promote economic competitiveness"[1]. It also serves to advance the City's strategic priorities; one of which is to continue to develop and implement asset management plans. Since AM affects a large portion of the City's activities, it is important that there is a line-of-sight between all AM documents. The City's recently updated AM Strategic Plan sets the vision and guiding principles for the corporate-wide management of the City's assets and articulates commitment to continuous improvement in AM.

[1] *City of Greater Sudbury, Strategic Plan, 2019 - 2027*

1.3 Key Steps Supporting this Asset Management Plan

The actual steps used to develop this AMP are listed below and were selected to ensure that reliable and robust useful information is provided with which the City can have confidence to make fact-based and defensible business decisions.

1. Reviewed and summarized existing inventory of the City's stormwater assets;
2. Improved the City's data through its GIS inventory where possible;
3. Established a Levels of Service framework with performance indicators;
4. Optimized and formalized stormwater operations and maintenance to match desired Levels of Service;
5. Determined criticality of system assets;
6. Assessed the City's stormwater asset life cycles and replacement costs, funding gaps, and capital investment requirements;
7. Provided a plan for capital improvement rationalized by asset life cycles, risk, and available funding;
8. Summarized findings of all tasks to provide the City with an overall stormwater asset management plan.

The following sections summarize the exploration and findings of the AM Planning process for the City's stormwater infrastructure assets.

1.4 Limitations of this Asset Management Plan

This plan is based on current assets and current conditions. It does not include analysis of future growth, regulatory changes, or changes in climate. The operations and maintenance plan is based on the current asset inventory and the capital investment plan is based on "like for like" replacement of the current asset inventory. The City is not expected to experience significant growth in the near future, but it is likely that when existing stormwater assets are replaced, they will need to be built larger to consider current design standards. It is possible that future environmental regulations will necessitate changes to the City's stormwater infrastructure (e.g. the provincial's proposed requirements for stormwater runoff volume control). The existing design storm is the "Timmins" storm which was an extreme "once in a century" rainfall event. Therefore, increases to the design storm are not expected in the near future. However, it is recommended that as the City periodically reviews and updates its stormwater asset management plan, considerations are integrated to include changes in demand stimulated by growth, regulatory requirements, and/or climate change projections as required by O. Reg 588/17.

2. State of the Infrastructure

2.1 Asset Summary

The City owns and operates approximately 540 kilometres of stormwater mains and approximately 277 kilometres of ditches alongside other stormwater management assets including manholes, catch basins, discharges/outlets, inlets, ponds (dry, wet & infiltration), and oil and grit separators (OGS). The complete engineered stormwater asset inventory is summarised in **Table 1**. Note that this inventory doesn't include the natural stormwater assets (e.g. creeks, lakes etc.) within the City, which also serve an important stormwater function.

Table 1: City of Greater Sudbury Asset Inventory Summary

Stormwater Assets	Quantity	Unit
Stormwater Mains (includes culverts)	537	km
Ditches*	277	km
Manholes	8,600	EA
Catch Basins	8,744	EA
Discharges / Outlets	2,751	EA
Inlets	3,372	EA
Ponds	15	EA
Oil Grit Separators	24	EA

*Note: * While ditches within urban areas were reviewed through this assignment, rural roadside ditches remain a key data gap. Rural roadside ditches are not digitized but could account for a significant portion of the drainage system (based on a cursory desktop review of rural roads not covered by the City's coverage of as-built drawings).*

2.2 Replacement Cost

To calculate replacement cost for the engineered stormwater asset inventory, a series of unit replacement costs were developed based on the combination of industry standard replacement values carried by AECOM during financial planning, and information gathered from AECOM's National Water and Wastewater Benchmarking Initiative. Several of the City's largest oil grit separators were valued individually using the City's records of design and construction costs.

Table 2 and **Figure 1** show the replacement costs for all engineered stormwater assets owned and operated by the City. The total replacement value for all the City's engineered stormwater assets is $520 M with 81% of the value associated with stormwater mains (and manholes).

Table 2: Summary of Asset Replacement Cost

Stormwater Assets	Quantity**	Unit	Replacement Value
Pond	15	count	**$1,500,000**
OGS	24	count	**$10,350,000**
Ditch	277	kilometres	**$13,836,000**
Discharge	2751	count	**$18,707,000**
Inlet	3372	count	**$22,930,000**
Catch Basin	8744	count	**$29,730,000**
Gravity Main (includes culverts) (Manholes)*	537 (8600)	Kilometres (count)	**$423,042,000 ($75,671,000)**
Total			**$520,095,000**

*Note: * The individual cost of manholes (~ $76 M) is included within the cost of gravity mains ($423 M). The cost of manholes has been itemized to demonstrate the relative contribution but is not included as an additional input into the valuation.*
*** based on GIS inventory – may need to update once GIS update assumptions are confirmed*

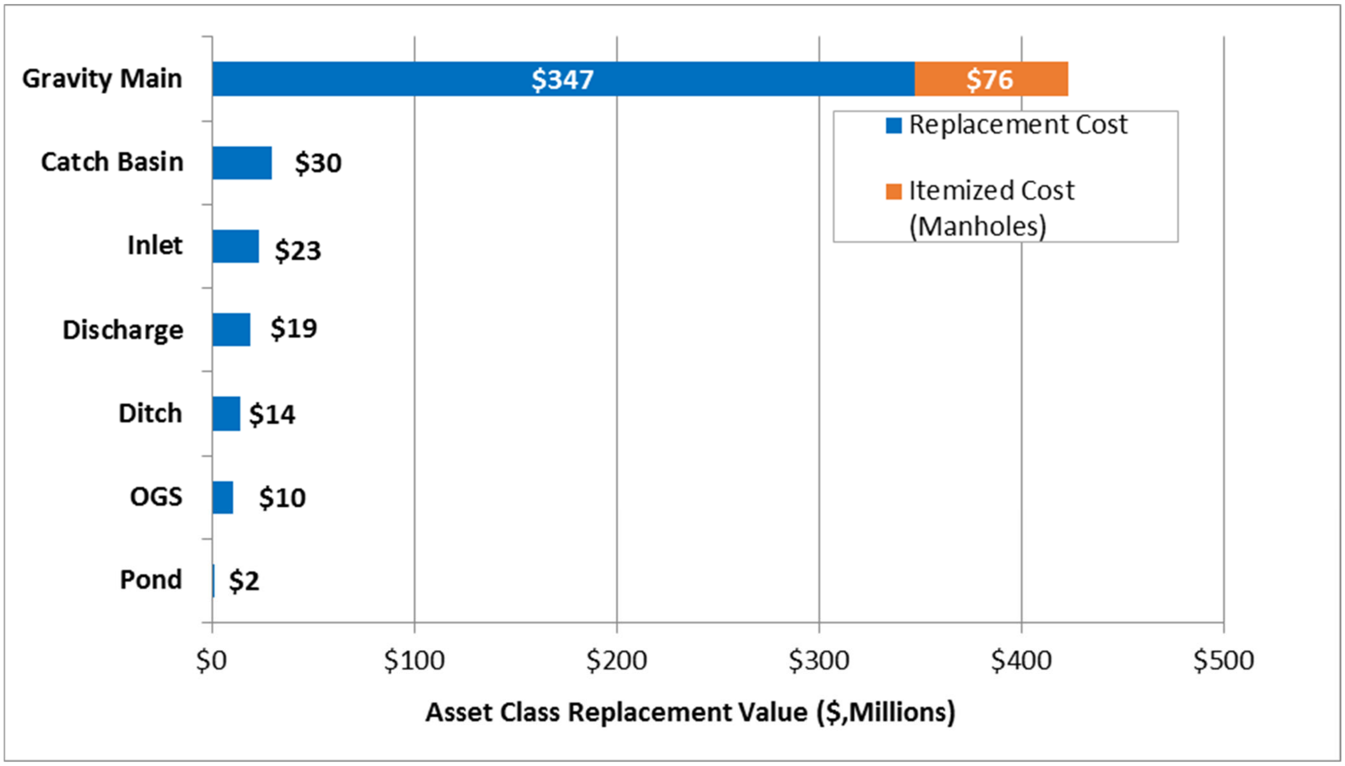

Figure 1: Replacement Value Breakdown by Asset Type

2.3 Supportive Drainage Assets

While the provided inventory serves as the basis for understanding investments and financial exposure for stormwater assets engineered by the City to convey stormwater, it is important to recognize the other natural features within the City that contribute to the management of stormwater. These assets provide value to the City by conveying or retaining stormwater, either as naturalized features or assets constructed by the City. The intrinsic value of these assets should be recognized by the City – if an asset was altered or removed, the support it provided could have to be supplemented elsewhere in the system to ensure drainage is adequate. Supportive drainage assets under consideration include waterbodies, wetlands, forests, municipal drains and road surfaces (act as overland flow routes). From an asset management perspective, preserving these features can play an important role in minimizing the cost of the City's drainage system (for example, allowing a resident to in-fill their ditch or municipal drain could lead to increased demands for infrastructure). See **Table 3**.

Table 3: Summary of Supportive Drainage Assets

Asset Class	Units	Amount	Data Source
Municipal Drains	km	179	City
Wetlands	km^2	336	City (Remote Sensing Analysis)
Waterbodies	km^2	442	City (Remote Sensing Analysis)
Water Courses	km	2,565.5	City (Remote Sensing Analysis of Rivers, Streams, and Creeks)
Forests	km^2	2,146	City
Roads	km	2,847	City

For this study, supportive drainage assets listed above were not considered except municipal drains which were included in the operation and maintenance plan.

2.4 Lifecycle Analysis

For developing a rate of sustainable funding for the City, medium to long term investment needs were determined by developing an investment profile for each of the primary stormwater asset groupings. 30-year and 100-year planning periods were chosen to represent the medium-and-long term cases respectively. Here, a 30-year planning period represents the investment profile most applicable to the needs of the City in the next planning cycle. The 100-year investment profile may appear abstract but gives the City additional foresight into long term asset renewal needs. For developing the investment profile, a combination of two approaches was taken. For linear assets a probability-based (Weibull-type) assessment was used, while for non-linear assets a straight-line approach using age and expected service life was used. Given the sensitivity of both approaches to expected service life, and in cases where in situ experiences differ from known expected service life behaviour, it is useful to calculate a range of options, thereby providing multiple scenarios that can support planning and high-level decision making.

Optimistic vs. Conservative Scenario:

To further aid the City's overall asset management plan, a scenario analysis was developed to quantify the effect of varying assumed ESLs for stormwater mains on capital expenditure over the next 30 years, comparing "optimistic" values (i.e. ESLs typically experienced by AECOM on past projects) and "conservative" values (i.e. ESLs typically experienced within the City's specific operating context) as provided within **Table 4**. These types of comparisons are valuable, given the sensitivity of a lifecycle analysis to the inputs for expected service life (limitations and recommendations previously provided). By comparing optimistic and conservative scenarios, the City gains a broader insight into the potential funding requirements over the next planning cycle.

Table 4: Expected Service Lives of Stormwater Mains by Material Type

Abbreviation	Material	ESL – Conservative	ESL – Optimistic
AC	Asbestos Cement	85	120
CI	Cast Iron	85	120
CL	Clay	85	120
CSP	Corrugated Steel Pipe	10-25*	15-30*
CON	Concrete	90	120
HDPE	High Density Polyethylene	85	120
LEAD	Lead	75	120
OTH	Other	75	120
PCCSP	Pre-stressed Corrugated Steel Pipe	90	120
PE	Polyethylene	85	120
PVC	Polyvinyl Chloride	75	120
RCON	Concrete, Reinforced	90	120
STL	Steel	85	120
UNK	Unknown	80	120
WD	Wood	75	120

Note: From discussions with the City, CSP pipes experienced premature degradation around **10-15 years when the pipe segment is open and exposed. For buried CSP pipes, the ESLs are closer to **25-30** years.*

Figure 2 shows the range or "band" of annual capital expenditures because of varying assumed ESLs (conservative vs. optimistic). The annual expenditure difference starts at $1.8 M/year in 2018 and reaches a high of $7.2M in 2041, with the end of analysis period being 2047. The reason for this increase in difference is the timing of the City's replacement "envelope". By taking the conservative approach, the replacement envelope when many assets will reach their ESL occurs earlier in the investment profile than what is forecasted under the optimistic approach. Recognizing the need to gather condition data to verify ESLs and that local site conditions will produce varying lifecycles for assets of similar design, it is likely that the City's recommended capital expenditure will fall between the "band" over the next 30 years.

Given the City's proposed asset management strategies (**Section 4.4**) , the 'optimistic' approach was carried through remaining lifecycle analysis calculations so that long term planning incorporated normalized expected service life behaviour.

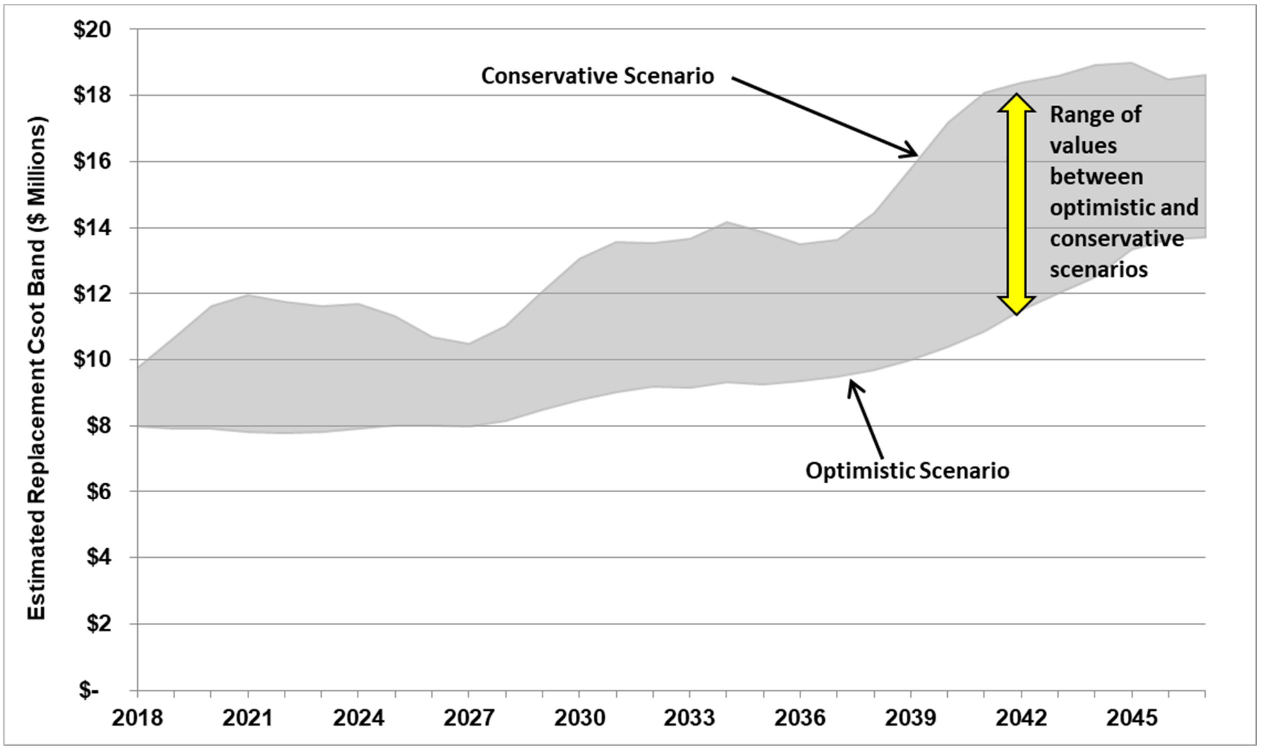

Figure 2: Optimistic vs. Conservative Budget Scenarios

Lifecycle Investment Profiles:

Figure 3 and **Figure 4** define the City's medium and long range investment profiles provided that an optimized approach to capital improvements is taken, namely by being proactive and addressing the existing investment backlog.

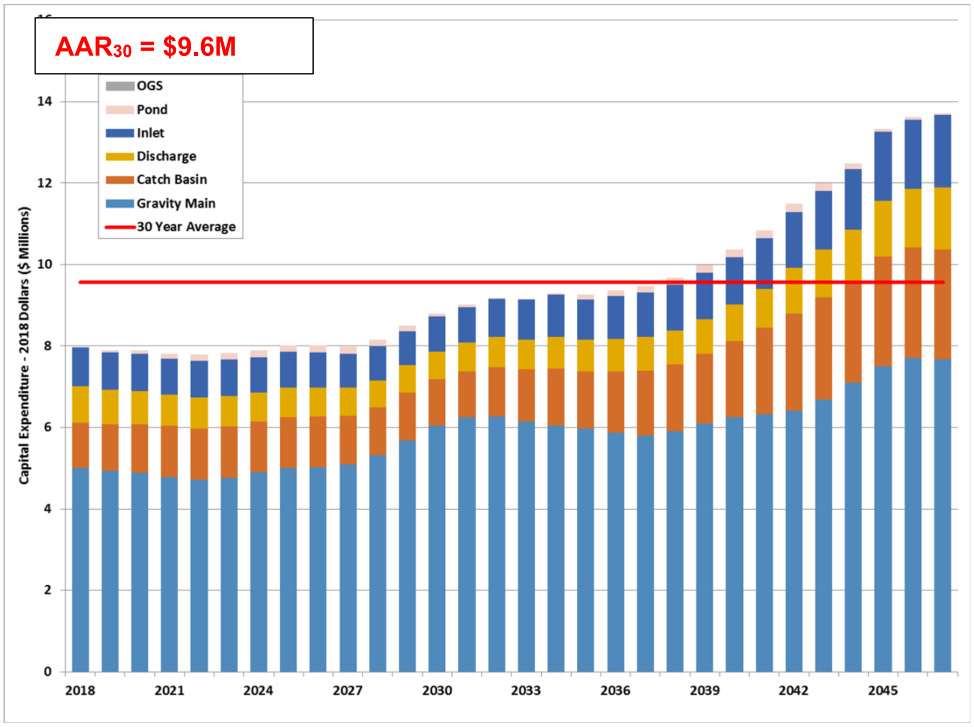

Figure 3: 30 Year Investment Profile for Stormwater Assets (Optimistic Scenario)

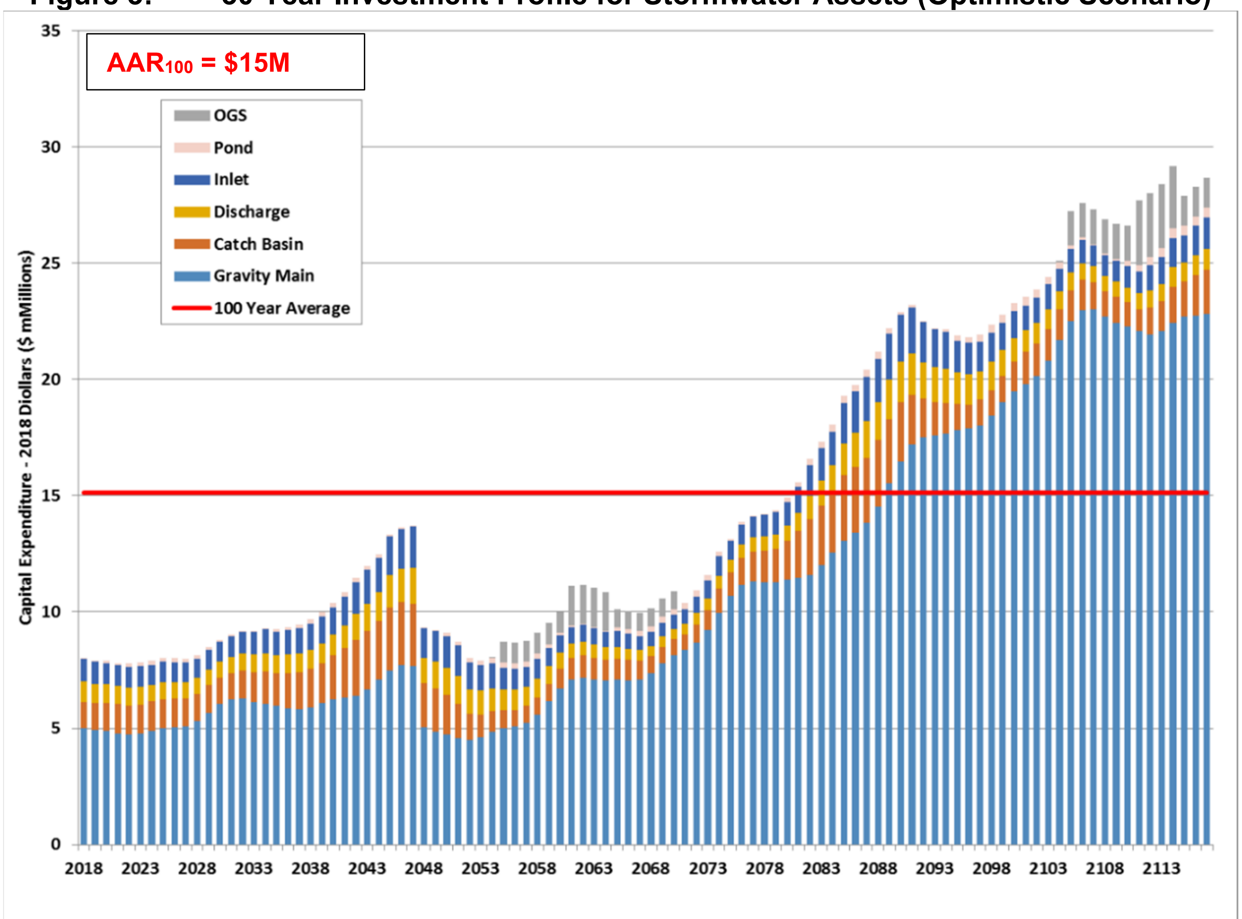

Figure 4: 100 Year Investment Profile for Stormwater Assets (Optimistic Scenario)

For each investment profile, an average annual reinvestment value, or “AAR”, is depicted. The average annual reinvestment rate represents the average value across the time scale of the presented scenario.

Funding Gap Analysis:

Using the calculated investment profiles (i.e. required capital expenditures for sustainable infrastructure capital funding) as well as an estimate of the City’s funds spent on capital improvement based on current levels, AECOM conducted a funding gap analysis to quantify the difference between the City’s current capital expenditures and the forecasted capital expenditures required. **Figure 5** shows the projection from 2018 to 2047. Over the entire 30-year period, the City could develop a significant funding shortfall. On average, the funding shortfall is approximately $6.7 M. When extrapolated over 30 years, the funding shortfall (ranging from $5.1 M to $10.3 M per year) reaches approximately $200 M in 2047. Asset management and replacement strategies (e.g. risk management) discussed later in this report were undertaken to improve on the City’s funding gap by incorporating risk-based and rehabilitation strategies.

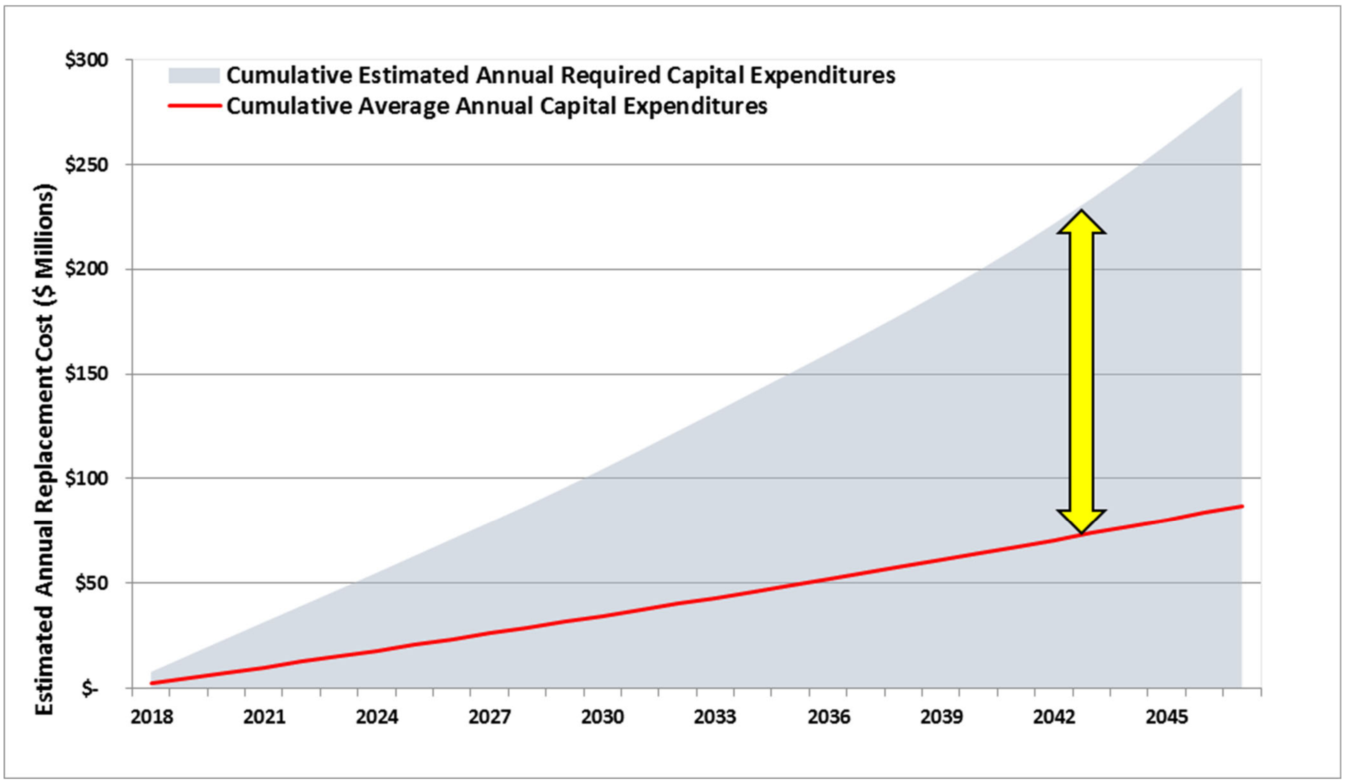

Figure 5: Cumulative Funding Gap

These results present the first step in developing an understanding of the total lifecycle cost of the assets, as well as the approach to a sustainable funding strategy.

Refer **Appendix C – Technical Memorandum #2: Asset Lifecycle Analysis & Financial Model** for additional information.

3. Levels of Service

Levels of Service (LoS) document the services provided by and performance of the City's stormwater system. By defining outcomes of the assets and the services they provide, links can then be made to the activities needed to own and maintain them. Based on the City's strategic goals, AECOM documented the City's desired LoS, and hence the required level of activities to achieve them. By rationalizing each goal to understand what actions should be taken by an organization to achieve the goal (for example using policy, planning, capital, or O&M), the linkage between the activities and the rationale for completing them (at a given cost) becomes clear.

LoS are generally separated into three levels, as presented in **Figure 6**. This aligns with *Ontario Regulation 588/17*, which establishes requirements for **Community LoS** and **Technical LoS**.

- **Corporate LoS** describe the organizational mission, vision and corporate goals and objectives, as reflected in the direction provided by elected officials and the municipal senior administration. The Corporate LoS should reflect the values of the stakeholders and their willingness to pay but may be directed by certain legislative / regulatory requirements.
- **Community LoS** describe the service that individual stakeholders and users can expect using plain language that is understandable by most stakeholders.
- **Technical LoS** describe parameters that must be achieved to deliver Customer LoS. Technical LoS may be described in more technical language.

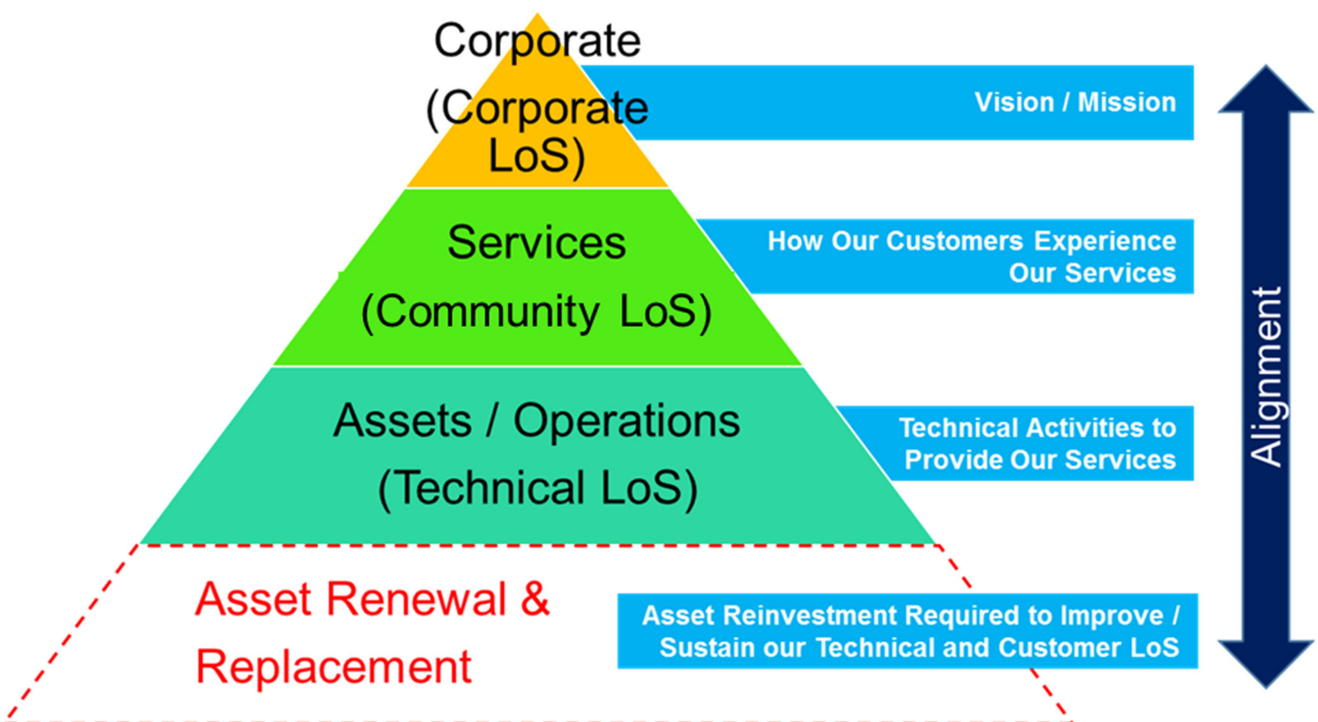

Figure 6: LoS Should Ensure Strategic Alignment of Activities throughout an Organization

To articulate the City's LoS, several overarching goals were defined. Each goal had several sub-goals that described in detail how the strategic outcome, or Corporate LoS, could be measured or achieved. When combined, they represent the overall strategic vision for the services provided by the stormwater system, and serve as the basis for determining what lifecycle activities and Technical LoS should be applied to the assets:

- Goal #1 – Protect the Environment
- Goal #2 – Obtain Adequate and Sustainable Funding
- Goal #3 – Ensure Adequate Capacity to Protect Life and Property
- Goal #4 – Provide a Safe and Productive Workplace
- Goal #5 – Have Satisfied and Informed Customers
- Goal #6 – Meet Service Requirements with Economic Efficiency

Evident from the goals listed above is that they are high level, and strategic in nature but can be further translated into tangible AM activities. With the overall goals established, the focus can then shift to where the City is currently as well as where it wants to be. Using the LoS goal model, the City's current and desired LoS were determined using the following definitions:

- Current Levels of Service: Describes the current performance of the assets and the actions taken by the City to maintain the assets or deliver services. It is based on current approaches, practices, and funding.
- Desired Levels of Service: Describes the desired performance of the assets, assuming the use of asset management practices and other enabling factors. It is based on the City's vision for what it wants to achieve with its stormwater program.

3.1 Current Technical Levels of Service

Aside from the overall level of drainage the system offers, there are several other services and activities associated with the stormwater system that are a technical LoS. Here, a detailed view of the activities establishes the performance of the stormwater system and the lifecycle activities needed to support current and desired LoS. Using the LoS Goal Model, the current Technical LoS can be summarized as well as supporting lifecycle activities.

Current Technical LoS are summarized in **Table 5**. For a full breakdown of the City's Technical LoS, see **Appendix D – Technical Memorandum #3: Levels of Service**.

Table 5: Summary of Current Technical LoS

Goal	Current Technical Levels of Service Highlights
Protect the Environment	• Source Protection Plans developed and maintained. • Source control program in place with a supporting By-Law • Riparian areas are maintained in a natural state or are being addressed by sub-watershed studies. • Flow rates are controlled within developments where design permits. • Discharge volumes are not limited. • Enhanced protection is provided by developments with stormwater management ponds. Additional quality measures will be identified by sub-watershed studies.
Adequate and Sustainable Funding	• Stormwater assets are funded through the general tax base. • The City will review funding requirements as per stormwater asset management plan, identify options and implement preferred funding option.

Table 5: Summary of Current Technical LoS

Goal	Current Technical Levels of Service Highlights
Capacity to Protect Life and Property	• A limited number of properties are impacted by minor storm events. • Existing developments are designed to various standards. • Design storms were last updated in 2003 but are based on an extreme event. • Very little damage to property is reported during minor storms. • Zero incidences resulting in injury or death. • Safe passage is maintained on arterial roads. • New developments are designed for a 100-year event (5 year in the minor system, 100 year in the major system). Existing developments are to be modified as funds are available. • Emergency response times range from 1 to 4 hours.
Safe and Productive Workplace	• Accidents are recorded and addressed in accordance with health and safety policies. • All regulatory requirements for workplace safety are achieved. • Current breakdown of field hours and productivity is unknown. • More maintenance work is preventative than corrective.
Satisfied and Informed Customers	• The City received a total of 969 stormwater related customer complaints in 2018. This includes all issues related to drainage and ponding – it does not necessarily reflect the number of unique incidents. • Stormwater educational information is provided on the City's website.
Meet Service Requirements with Economic Efficiency	• The final goal is to achieve the first five goals while doing it in the most cost-effective manner. Once the City can articulate all its targets with respect to the first five goals, it can then work towards accomplishing these goals in the most cost-effective manner possible.

3.1.1 Lifecycle Activities Supporting Current Level of Service

As demonstrated by **Figure 6**, maintaining current or desired LoS is incumbent upon operational and lifecycle activities that either deliver services or maintain the assets in the state necessary to provide the LoS. The links to activities allow the City to evaluate how any modifications will impact service outcomes. The activities carried out to provide the current LoS are summarized as follows (**Table 6**).

Table 6: Activities Supporting the Current Technical LoS

Capital Activities*	Operational Activities*
• Gravity sewers are replaced at the end of their life, typically during road corridor reconstructions. • Catch basin and manhole lids/chambers are reconstructed in advance of road overlay work. • The City maintains a culvert replacement program. • Support for driveway culvert replacements is provided by the City to homeowners.	• Storm sewers were flushed and inspected • Catch basin sumps are cleans and leads are flushed. • Ditches are regraded mechanically. • Culverts are inspected, cleaned, and repaired • Screens and inlets are inspected • Drainage maintenance is provided in the form of service requests, responses to flooding, etc.

*Note: * Activities are identified at a high-level only and do not indicate activity frequencies. Activity frequencies and the necessary adjustments are shown in **Appendix F**.*

3.2 Desired Technical Levels of Service

Building on current LoS, the City has identified desired LoS it can work towards through continual improvement, with the objective of providing a stormwater system that achieves all goals completely. A summary of the City's desired LoS is provided within **Table 7**. Desired LoS are included in the detailed breakdown in **Appendix D**.

Table 7: Summary of Desired Technical LoS

Goal	Desired Levels of Service Highlights
Protect the Environment	• Review and implement all quality, volume, and flow rate modifications and monitoring requirements based on sub-watershed studies. • Sewers, catch basins, OGS units, and stormwater management ponds are inspected and cleaned at an optimal frequency.
Adequate and Sustainable Funding	• Funding comes from a long-term, sustainable source that ensures resources, staff, and equipment necessary to deliver desired LoS.
Capacity to Protect Life and Property	• Design criteria for all developments are defined and achieved. • Modelling is used to review and update design criteria • Private damage caused by stormwater is limited to properties located within the flood plain. • Passage is maintained on arterial roads 100% of the time. • Existing developments are modified with available funds.
Safe and Productive Workplace	• Zero accidents. • Continue successful record of compliance with regulatory requirements. • Complete preventative maintenance program each year. • Define and track all stormwater O&M activities.
Satisfied and Informed Customers	• Review and track call center data. • Outreach during public facing projects, such as sub-watersheds studies.
Meet Service Requirements with Economic Efficiency	• Meet all service requirements. • Strive to improve the efficiency of how requirements are met.

3.2.1 Lifecycle Activities Supporting Desired Level of Service

Table 6 began the process of linking activities to the technical LoS the City provides for its stormwater assets. Many of the same activities apply to the desired level of service, but adjustments to the achievements of the activities are required. There are also new activities that need to be introduced to achieve desired Levels of Service. This is summarized in **Table 8**.

Table 8: Activities Supporting Desired Technical LoS

Lifecycle Activity	Activity Type	New Activity for Desired Level of Service	Adjustments from Current LoS Required
End of Life Replacements	**Capital**	-	✔
Storm Structure Reconstructions		-	✔
Culvert Replacement Program		-	✔
Homeowner Culvert Replacement Subsidy		-	-
Storm Sewer Lining and Trenchless Repairs		✔	-
Storm Pond Sediment Dredging		✔	-
Ditch Inspections	**Operational**	✔	-
Mechanical Ditching		-	✔
Screens and Inlet Inspections		-	✔
Culvert Inspections		-	✔
Culvert Maintenance		-	-
Culvert Resets		-	-
Culvert Cleaning		-	✔
Culvert Snow Removal		-	-
Storm Structure Cleaning		-	✔
OGS Maintenance (Inspect/Clean/Repair)		✔	-
Pond Maintenance		✔	-
Storm Sewer CCTV		-	✔
Storm Sewer Flushing		-	✔
Storm Sewer Repairs		-	✔

From **Table 8**, it is clear that moving towards the desired LoS means that changes to current capital and operational practices are required, with the overall goal of providing sustainable capital, operations and maintenance program that meet service requirements. To address these changes beyond the conceptual level, a detailed breakdown of the recommended O&M and capital improvement activities is discussed later.

Refer to **Appendix F – Technical Memorandum #3: Levels of Service** for additional information.

4. Asset Management Strategy

The primary purposes of the asset management strategy are to describe the organization's long-term requirements, provide a clear rationale for these objectives (explaining how they align with asset management policy and the strategic plan), and provide the framework for developing and prioritizing detailed asset management plans. For the Stormwater AMP, the methodology included the development of components that could be combined as a strategy to produce the AMP. The enabling components of the overall strategy were:

- Establishing asset data needs that will support planning, analysis, decision making, and performance measurement. Improving asset data is built into both capital and operational work streams.
- Using risk as the basis for tactical asset management and a driver for decision-making in the face of limited funds to create prioritized work program.
- Emphasizing the need for preventative operations and maintenance program that extend the life of the assets, maintain a state of good repair, improve Levels of Service, and create opportunities for field-based data collection.
- Carrying out a capital improvements program that uses condition data to renew the system at funding levels aligned with the rate at which the system is aging.

When combined, these components of the strategy allow for O&M and Capital Improvement Plans to be produced, which represent the total cost of maintaining the existing stormwater network while meeting service requirements. The Plans incorporate the AM strategy elements to ensure that they are technically sound, strategic, and aligned with core City values. See the O&M and Capital Plans in **Section 5** and **Section 6 r**espectively.

4.1 Asset Data

Data is the core of any asset management program. The City has made significant efforts to improve its data holdings, an effort that will continue going forward with the implementation of the stormwater AMP. Data will support all levels of asset management, including financial planning, defining and measuring Levels of Service, assessing and managing risk, programming and reviewing maintenance activities, and applying decision making in support of capital improvements. Technical Memorandum #1 (see **Appendix A**) summarizes the City's existing information databases and outlines recommendations for filling any notable gaps

The strategy for the stormwater AMP and the proposed O&M and capital improvement programs are underpinned by the assumption that the City will continue to improve its asset inventory, data capture, and use of data for asset management. A detailed asset information strategy was developed for the City that identified a series of measures that could be taken to improve on the current state. To summarize:

1. The City will work to expand the current asset inventory within GIS to include rural roadside ditches and driveway culverts. Within the overall inventory, it will define asset ownership (e.g. public versus private) and roles/responsibilities, with the goal of having an awareness of the entire AM system. The addendum to Technical Memorandum #1 (see **Appendix B**) provided the results of the GIS update that was completed as part of this asset management plan.
2. The City will continue other stormwater management efforts that produce data applicable to the AMP. This includes stormwater modeling and sub-watershed studies, which can be used to define Levels of Service, risk profiles, investment needs, etc.
3. The City will conduct asset inspections as part of its O&M and capital improvement plans to build condition information. Lifecycle activities related to condition (e.g. rehabilitation/replacement/failures)

and CCTV condition data will also be recorded. The information will be used to update long term investment profiles, which are currently based on installation date information only, and to update the current risk-based approach (which uses age only).

4. The City will improve the use of its existing CMMS to capture asset level activity data for all maintenance activities. It will categorize the maintenance activities as preventative or reactive and ensure that activities are quantified using asset-level units of attainment (e.g. metres or number of assets). The City will use maintenance data to update and improve the AMP and facilitate future maintenance planning.
5. The City will engage in larger efforts to share stormwater data with water, wastewater, and roads staff to facilitate integrated corridor decision making with the assistance of decision support software.

When combined, current data and future efforts will facilitate the use of asset data in all AM activities, while engaging in processes of continual improvement based on key performance indicators. Technical Memorandum #7 (see **Appendix H**) provides an overview of the role of asset management software, establishes the current state of how software is used to support asset management and data management at the City, and suggests ways to improve upon the current state of data management through a combination of technology and business processes.

4.2 Risk

Many municipalities, including the City, must work hard to balance priorities as demands increase and resources remain limited. This creates several strategic challenges when planning for asset replacement. Accounting for asset risk facilitates the development of management strategies and prioritized replacement schedules so that risks can be balanced against budget constraints while the most critical assets are still triggered for rehabilitation and/or replacement. In addition, understanding the risk exposure for a given set of assets allows the City to identify where the organization is most exposed, and to target strategies to most effectively reduce that exposure.

During the development of the AMP, risk or criticality was calculated for each asset in the City's inventory as a function of the asset's consequence of failure (CoF) and likelihood of failure (LoF); each of which were measured on a 1 - 100 rating scale. CoF scores were assigned in consultation with City staff using a blend of qualitative and quantitative frameworks. In both cases, the CoF score generated recognised the potential environmental, public safety, worker safety, equipment, and operational impacts, with severity of the criticality ranging from "Low" to "High". Conversely, LoF scores considered the asset's age, expected service life, and used Weibull Probability Distribution to act as a proxy to condition due to limited records of condition assessment data for linear stormwater assets.

The risk values defined for assets enable the City to identify management strategies for the different risk categories based on the City's risk tolerance. **Figure 7** shows a sample intervention plan in matrix form.

Likelihood of Failure		Consequence of Failure: Low	Consequence of Failure: Medium	Consequence of Failure: High
	High	Repair / Run-to-Failure	Programmed Rehabilitation	Urgent/ Corrective Rehabilitation
	Medium	Inspect, Monitor and Forceast	Proactive Assessment	Programmed Rehabilitation
	Low	Inspect, Monitor and Forceast	Inspect, Monitor and Forceast	Proactive Assessment

Figure 7: Risk Matrix Intervention Plan

4.3 Operations and Maintenance Strategy

4.3.1 Background

Operations and Maintenance (O&M) describe the principal activities taken by the City to control assets in a manner that allows them to deliver the necessary outputs to the City. How the City uses and maintains the assets can impact performance, reliability, and productive life. Effective asset management involves co-ordinating plans and activities across the life cycle of an asset to maximize value. The operations and maintenance of the asset will account for a significant amount of the cost during an asset's lifecycle. In the case of the City's stormwater assets which do not expend labour, energy or materials when in operations, most lifecycle activities will be attributed to inspections, cleaning, and maintenance. **Figure 8** demonstrates the different stages of an asset's life cycle.

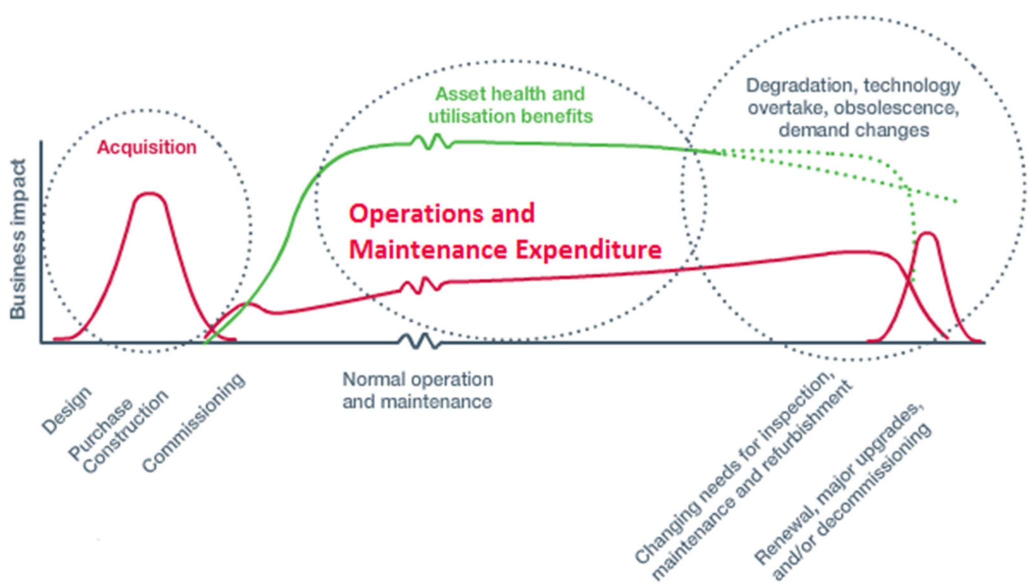

Figure 8: Capital and Maintenance Expenditure during an Asset Lifecycle

Every organisation has a variety of stakeholders, such as residents, businesses, staff, regulators, suppliers and the local environment. These groups have a variety of interests and priorities, so the organisation needs to find the best value compromise between conflicting interests. Realizing value, therefore, involves finding the optimal mix of factors such as costs, risks, and performance, while considering the longer-term consequences of a given approach. In the context of asset management, understanding and optimizing O&M serves as a critical component of managing the asset portfolio. Good maintenance planning and maintenance management is a vital component of asset management. Ultimately, a system of infrastructure such as the City's stormwater system requires O&M practices that achieve the following:

1. Maintains infrastructure in a state of good repair
2. Ensures the stormwater system performs as designed
3. Ensures public safety
4. Maintains high customer satisfaction
5. Protects the environment

Beyond these primary objectives, operations and maintenance should be executed in a cost-effective manner. Formalizing an optimal O&M program is the practice of analyzing, defining, and monetizing the O&M practices that will actualize these objectives. Completed successfully, annualized savings may accrue from some or all the following:

1. Reduced cost of individual work orders through better planning and execution
2. Reduced levels of overtime and premium pricing of equipment and materials
3. Extended useful life of assets, thereby reducing the need for replacements and capital reinvestments.
4. Better and more predictive O&M planning, as past year results feed directly into the forecasting of workloads and budgets for the future.

4.3.2 O&M Planning

One of the core objectives of this study is to develop an operations and maintenance (O&M) model for stormwater assets that will allow the City to identify best-practice maintenance activities and forecast the cost and resource impacts of various O&M strategies. For that purpose, AECOM has developed an O&M model that aligns the asset inventory with existing O&M activities categorized by the City's work management system and proposed new activities defines activity frequencies, and quantifies annual costs based on local context and best practices.

When planning for O&M, two types of work can be considered - preventative and reactive:

- <u>*Preventative Maintenance (PM):*</u>
  Preventative maintenance is regularly scheduled, periodic maintenance activities that are proven to prevent assets from failing or that result in timely defect identification. These activities are defined in advance through sources that include asset manufacturer recommendations, operator knowledge, and generally accepted best practices. PM work can be forecasted in advance, and the cost to complete PM work can also be forecasted and ideally budgeted in advance. The general assumption of PM work is that completing this volume of work reliably is the most cost-effective way to minimize the occurrence of unexpected asset failures that can result in loss of service, costly repair work, increased risk exposure and reduced service life. Failure to complete PM work exposes the utility to risk associated with asset failures and results in reduced efficiency as unanticipated corrective work volumes increase, further disrupting work schedules. One of the most important key performance indicators for utility maintenance is the attainment percentage of PM Work Orders over time. Low

levels of PM attainment could result in higher levels of service outage risk and is an indicator that the utility is operating in a more expensive, reactive manner.

- *Corrective Maintenance (CM):*
  Corrective maintenance is work that is required to respond to the failure of an asset or responding to a condition that has or will soon result in a loss of service. Corrective maintenance will always account for a portion of maintenance work. While the year to year volume of corrective work can be generally estimated (based on historical trends), it is not possible to predict when and where the work will be required. Corrective maintenance can be further broken down into emergency corrective maintenance and regular corrective maintenance. By making this distinction, the reactive impacts of corrective "break-down" work can be minimized, resulting in higher levels of maintenance efficiency.

The focus of this study was on the preventative maintenance, as it was assumed that corrective maintenance would be conducted on an ongoing basis, as required.

For each activity that was suggested (recall the activities linked to desired LoS), AECOM developed activity unit cost and resource requirements for each activity, which can then be used along with asset quantities and attainment levels to forecast costs of program adjustments. The activity costs were based upon existing information within CityWorks, and interpolation for the activities that are currently not tracked at a detailed level. It is recommended that the costs be refined based on actual costs in the future.

The activity and cost information was assembled while linking Levels of Service and consulting best practices (including the National Water Wastewater Benchmarking Initiative) to produce an O&M Plan (**Section 5**).

4.3.3 Implementation

The O&M planning process served as the basis for a new understanding of how stormwater O&M should be programmed and how it supports asset management and Levels of Service. The City already has a robust O&M program in place that will serve as a strong foundation for implementing the proposed improvements. A few key observations from the O&M planning process inform the suggested implementation:

1. In most cases, the City already conducts the prescribed stormwater O&M activities at some level of attainment: many proposed changes are changes in attainment levels or activity frequency only.
2. The City relies on a massive ditch network for drainage that is not fully inventoried or proactively maintained. The key gap in current practices is an awareness of the ditch network, which is serviced but only mostly in response to flooding issues.
3. Current practices and business processes associated with the City's use of CityWorks is not adequate for the envisioned O&M program, which assumes the use of computerized maintenance management to measure activities performed for each asset and track associated costs. Without this technological support, it is difficult to determine the status of individual assets or the achievements of the overall program.
4. Most O&M activities are driven by knowledgeable operators and City staff, but not all of this knowledge is documented. Documented known problem areas and risk-based approaches to maintenance are needed to optimize the assets that are proposed within attainment levels selected by AECOM.

Understanding these realities, implementation of the O&M strategy needs to provide a path from current to desired states of the program.

4.3.3.1 Adjusting Attainment Levels

The assumptions under the desired preventative maintenance program is that this level of preventative maintenance will help to minimize the City's risk exposure such that all catchment areas have a plan that meets required levels of service and ongoing regulatory requirements over the long term. It is recognized that enhancement to the current maintenance program will need to be incremental over time as it is not reasonable to modify the current preventative program so significantly in a short period of time. The preferred approach to enhancing the preventative maintenance program will be therefore to address the most critical assets / activities initially and expand to less critical assets / activities when possible. As such, **Figure 9** illustrates the proposed phased implementation which focuses on meeting the desired future targets on high priority preventative maintenance activities (for critical assets), along with the current preventative maintenance attainment levels for medium and low priority activities.

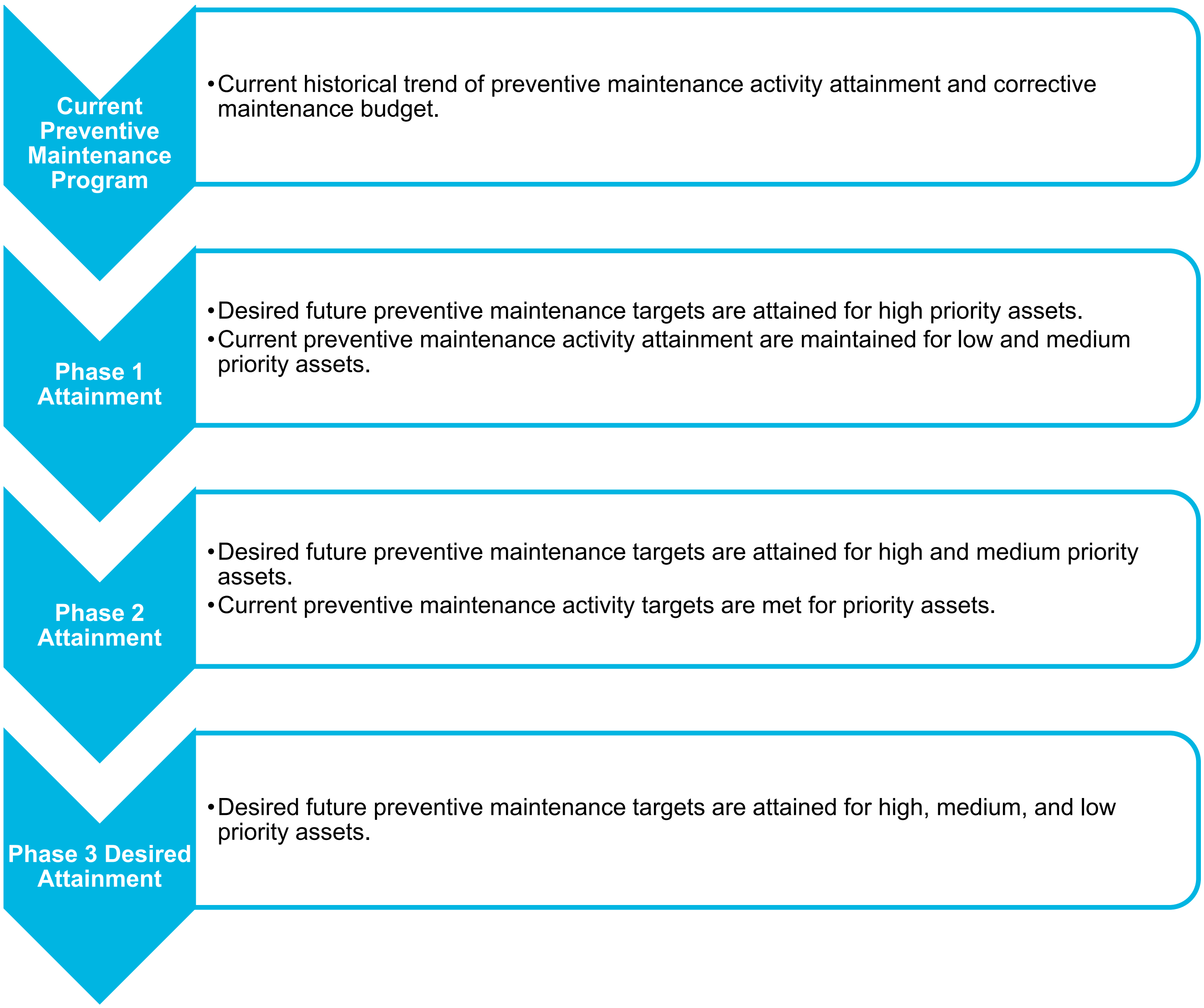

Figure 9: Recommended Phased Approach to Maintenance Funding

It is important to note that as additional activity-based data becomes available through implementation and tracking of various maintenance activities; the desired preventative maintenance targets should be reviewed. The O&M framework developed by AECOM did not optimize using criticality due to condition data being mostly unavailable. However, the City has tools to plan the O&M program as well as to employ risk-based decision making for both capital and O&M programs. It is envisioned that the City work to build a maintenance planning process that incorporates O&M data, failure histories, maintenance records, and risk profiles. At a high level, AECOM envisions a structured and risk-based maintenance management program as one of the outcomes of incorporating risk and failure data (**Figure 10**):

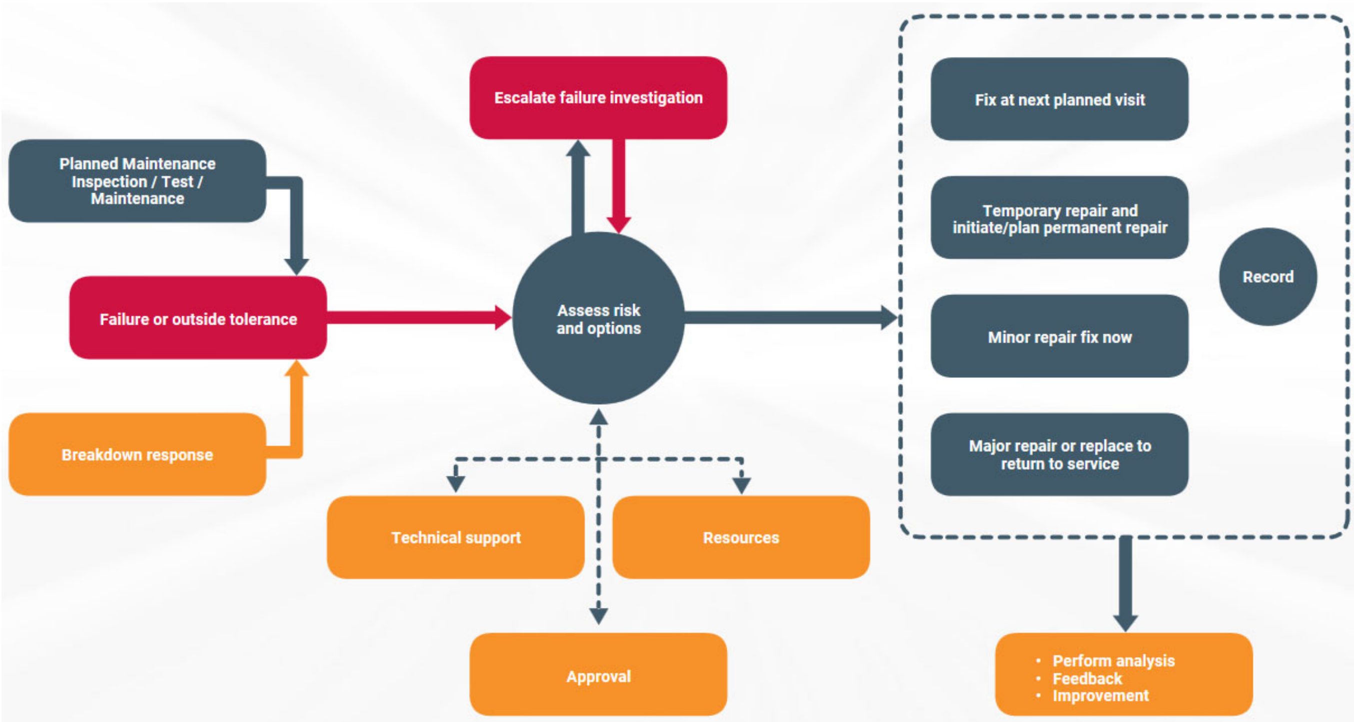

Figure 10: Incorporating Risk within the Maintenance Planning Cycle

4.3.3.2 Computerized Maintenance Management, Activity Tracking, and Performance Measurement

The current use of the City's CMMS (CityWorks) has the potential to limit the achievement of the O&M strategy. At present, work orders can be generated within GIS but activities for individual assets cannot be tracked. The City needs to deploy field-based data collection tools and procedures to record asset activities (preventative and reactive) for each asset. When the new O&M program is implemented, it is important that the City's CMMS and performance measuring are configured to track the attainment of O&M activities as measured by asset quantities and tracked back to the individual asset. To do this, the City also requires a complete asset inventory: the AMP identified that the ditch and culvert inventory is complete within the extent of the City's as-built drawings, but there are large rural areas serviced by ditches and culverts that are not in the inventory. These assets need to be accounted for so that O&M requirements can be accounted for and results measured.

4.4 Capital Improvements Strategy

4.4.1 Introduction

A capital improvement strategy sets out the approach to planning capital activities. Capital improvements describe major activities required to rehabilitate or replace existing assets in response to an asset failing to deliver on its service objectives. Improvements are typically required when there are deficiencies within the asset caused by age or operating conditions and should be managed through the risk assessment process. Other drivers of capital improvements could include inadequate performance by design, or regulatory related requirements. The City is currently undergoing a series of "sub-watershed studies" which examine the performance and capacity of the drainage system and will also address performance related issues and capital upgrade requirements.

The City's approach to capital improvements is guided by its Asset Management Policy. Here, it is stated that:

- Strategies should reflect levels of service expectations
- Rehabilitation and construction projects should be prioritized to support budget planning

This aligns with the approach taken for this Stormwater AMP.

4.4.2 Renewal Timing

When estimating the timing and scope of infrastructure renewal or replacement there are many factors to consider. The right time for asset replacement will depend on expected levels of service including reliability, the ability of an organization to adjust maintenance schedules for unplanned repairs, and capital budget. Each of the following criteria should be assessed when determining whether an asset should be replaced.

- **Criticality:**
  A highly critical asset should be replaced before failure, while some non-critical assets can be run to failure and replaced as required.
- **Condition:**
  What is the asset's current condition and what level of refurbishment can be achieved through maintenance.
- **Functionality:**
  Design and operating conditions. A bad design or poor material selection may reduce reliability or condition of an asset, triggering the need for premature asset replacement.
- **Budget:**
  Resources (funding and staffing) available to complete the project(s).

4.4.3 Strategies

For each stormwater asset class, a capital improvement strategy was devised that reflected the current state of asset data, the age and risk profile of the assets, and available options for renewal or replacement. This generally comprised of an Inspection Strategy and a Rehabilitation Strategy, that when combined would guide the City on how to complete capital improvements.

4.4.3.1 Inspection Strategies

All assets require inspection data that support the needs assessment and business case before carrying out any capital improvements. Within the assets that do have condition data, it is assumed that risk-based prioritizations will help to select the assets programmed for replacement. This identifies the need for data driven work streams supported by inspection program.

When considering storm sewers, structures, ditches, driveway culverts, road crossing culverts, and storm management ponds as a collection of assets, it is clear each will require a separate inspection strategy. This is summarized within **Table 9**.

Table 9: Summary of Inspection Strategies

Asset Class	Inspection Strategy	Link to Capital Improvements
Gravity Sewers	• Prioritize baseline inspections based on Consequence of Failure. This will typically begin with the City's main transportation corridors and the largest sewers. • Deploy CCTV to establish the types of defects and the overall condition. • Work to establish baseline conditions for the entire system. • Update risk profiles based on condition information. • Schedule subsequent inspections based on system risk (likelihood of failure can be determined by the previous inspection(s)).	• Age is not an indicator of replacement needs due to the deterioration mechanisms for sewers. • Defect codes can be translated to viable repair methods. • Condition data ensures the selected assets for replacement are appropriate. • Proactive inspections ensure sewers are repaired and failures are avoided.
Storm Structures	• Operators will visit the storm structures as part of annual cleaning program(proposed). Site visits should be leveraged as opportunities to record visual condition observations using field data collection tools. • O&M Plan includes some targeted inspections that assume the use of a risk-based methodology and greater inspection detail than regular O&M.	• Condition data allows for targeted repairs when need is identified by inspections. • Inspections are largely opportunistic but provide valuable information for capital improvements.
Culverts	• Meet legislative requirements for the City's largest culverts (>900 mm) based on OSIM protocols. • Apply same approach as storm structures for medium culverts (450-900 mm). • Use customer complaints about driveway and small culverts (<450 mm) to build on inspection data.	• Driveway or small culvert replacements are often managed operationally but are still a renewal of the asset lifecycle. The inspection information and the renewal information should be used to inform the state of the City's culverts and future renewal needs.
Ditches	• O&M program proposes proactive inspections of the ditch network, including completing the GIS inventory.	• Ditches do not need to be "replaced" but may need to be regraded and can typically be managed operationally. Inspection and condition information should still drive maintenance renewals.
Stormwater Management Ponds	• Stormwater Ponds will require renewal of the assets within the footprint (e.g. structures, vegetation, fencing etc.) as well as dredging of the storage basin. • Stormwater Pond condition assessments shall be used to document condition of facility assets. • Bathymetric surveys should be used to determine sediment accumulations.	• Bathymetric surveys and environmental monitoring can be used to trigger dredging projects that "reset" the capacity of the storage basin. • Multiple inspection data points can be used to calculate a time-based sedimentation rate, which will improve the accuracy of forecasting future dredging needs.

Over time, the City can use the outputs of the inspection strategy to improve and refine its approach to capital improvements. This is summarized within **Figure 11**, which shows the progression of approaches that can take place as the City builds on the Stormwater AMP.

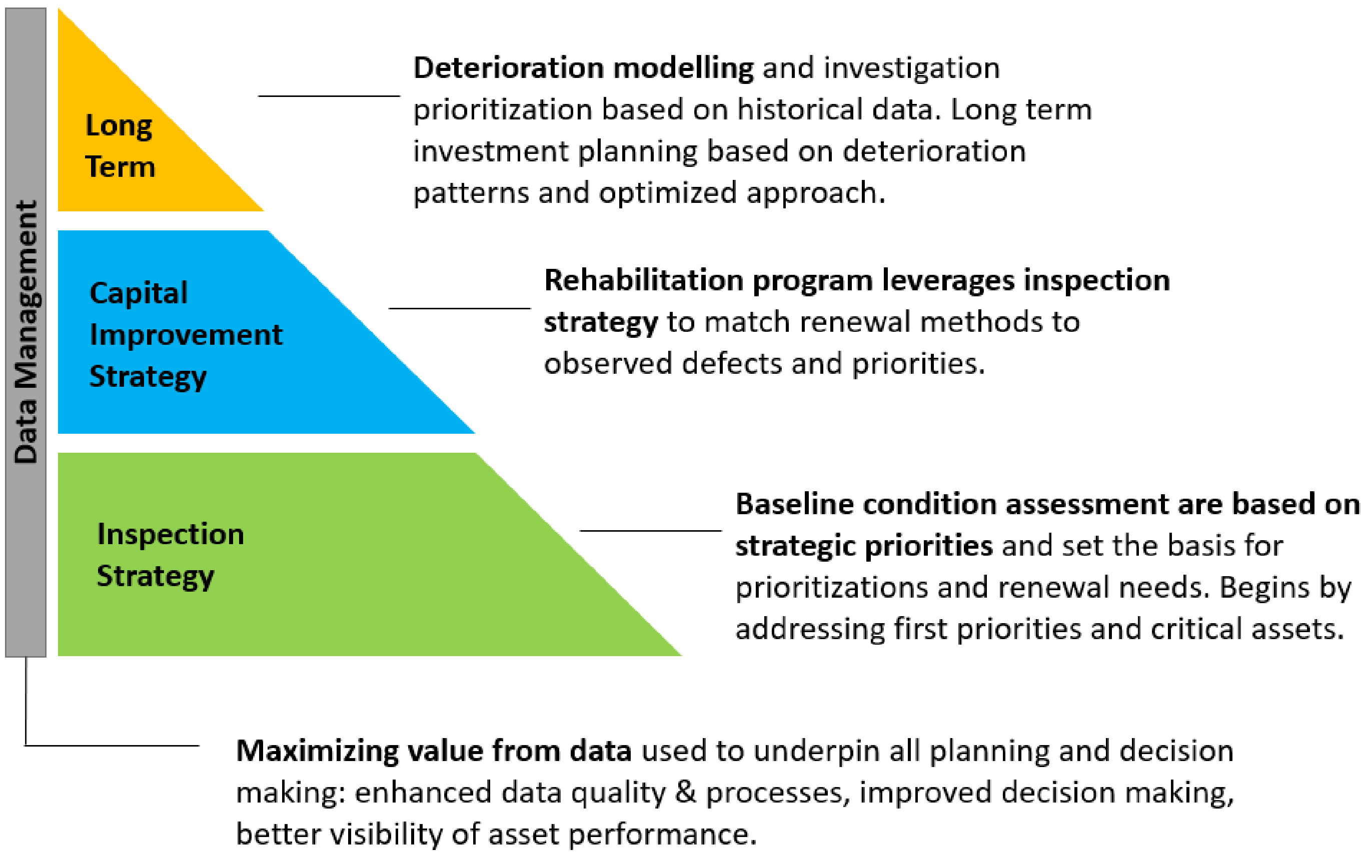

Figure 11: Advances in Capital Improvements are Dependent on Data Management and an Inspection Strategy

4.4.3.2 Rehabilitation Strategies

Rehabilitation strategies describe the decisions the City can make when selecting assets for renewal or replacement – while all assets will age and require renewal over time, the City can still make optimized decisions when presented with numerous defects and limited funds to address them.

- **All Assets**

  Focus should be made on proactively carrying out the rehabilitation of assets with a strong cost/benefit ratio or high strategic priority. Given a budget constraint, all actions should be ranked according to risk, and needs are funded in this order until the budget constraint is reached for given funding period. All unfunded needs would then roll into the set of needs for the next period, at which point the risk prioritization would be re-evaluated. This is illustrated in **Figure 12**.

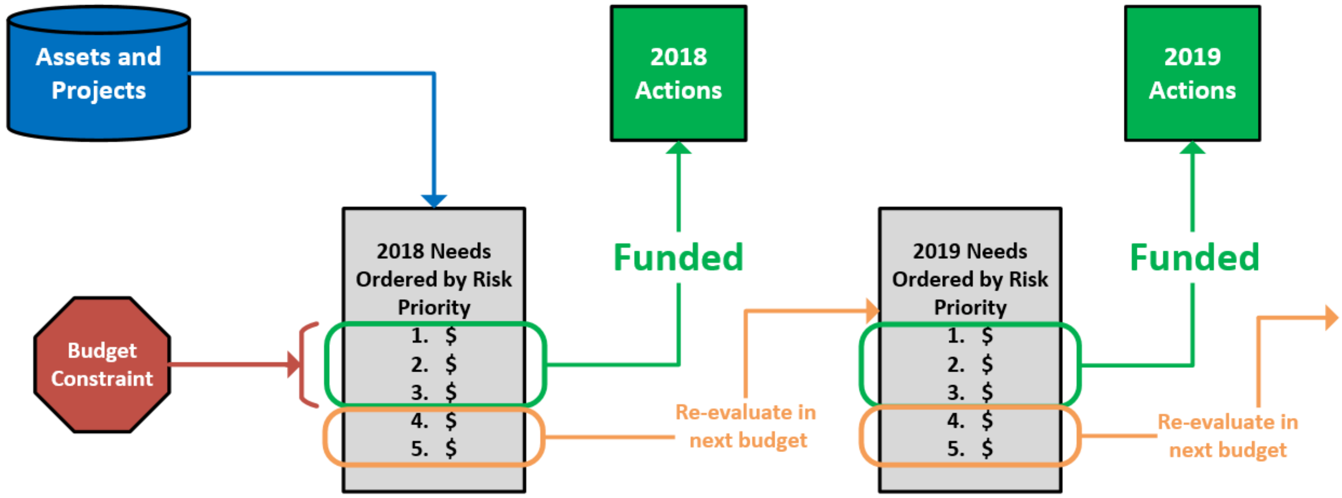

Figure 12: How Risk is Used to Prioritize Annual Asset Renewal and Replacement Spending

- **Gravity Sewers**

  To maximize the utility of the condition assessment process, the rehabilitation strategy recommends that the treatment of each sewer be matched to the type of defects that are observed. In this way, a wider range of repair techniques become available with a wider range of costs and levels of pavement disruption. Such a rehabilitation strategy will reduce the use of full segment replacements, thereby potentially extending useful life and reducing lifecycle cost. Rehabilitation techniques considered by the strategy included stabilization, lining, trenchless point repairs, external point repairs, augmented lining (point repairs followed by lining), and full segment replacements. The technique selected will also depend on co-ordination with other asset renewal projects (e.g. sanitary sewer replacements and road reconstruction works).

- **Storm Structures**

  The rehabilitation strategy for storm structures focuses on opportunities for rehabilitation that are opportunistic or driven by inspection data, while ensuring that the system is operating safely. Because portions of a storm structures are located at the road surface, surficial rehabilitation activities (e.g. manhole lid resets) may be carried out independent of a storm sewer rehabilitation work stream (which seeks to maximize the use of trenchless rehabilitations and minimize pavement disruption/full segment replacements). The State of the Infrastructure established that on the basis of age and expected service life, storm structures are predicted to account for a significant portion of the City's backlog (i.e. assets that are past their expected service life). As this is only based on age, this "backlog" would need to be confirmed through condition assessments. In addition, the estimated structures "backlog" his does not account for the City's ongoing roads operations, which often reinstate or replace storm structures through operations and road surfacing. These activities are logged within invoices and other methods of financial reporting but are not documented at the "asset level". It is recommended that the City begin to log these activities to ensure that investments in infrastructure are fully recognized and future forecasts can be improved.

- **Stormwater Ponds**

  Rehabilitation of stormwater management ponds requires planning for the dredging of sediment for quality and quantity control purposes and maintaining the appurtenances of the facility that provide conveyance or other supporting functions. Removing sediment from a stormwater facility can be a significant expense. Predicting when it needs to occur can be estimated through regular sediment measurements to determine an "average sedimentation rate" and then determining when the basin's capacity is reduced to the point that it can no longer provide sufficient detention to fulfill its regulatory requirements (or design standards). The cost of dredging will be dependent on the size of the basin, the amount of sediment to be removed, environmental considerations (i.e. the presence of aquatic life), the need for bypass pumping, the level of contamination within the sediment, and the distance required to travel to dispose of the sediment.

- **Ditches**

Ditches are open channels that convey stormwater. They are typically not "replaced" as a pipe would be replaced but will need to be cleaned out and regraded from time to time. The cost associated with maintaining ditches is an operational expense captured by the formalized O&M plan. However, the roadside culverts in line with ditches have a finite service life that should be managed by a replacement strategy.

- **Culverts**

Due to a short-estimated service life, corrugated steel pipe (CSP) culverts currently occupy a significant component of the City's current backlog. While the City has reported that CSP will be replaced with more durable materials within the sewer system, the use of CSP for culverts will continue due to its exposure to the environment and depth of cover. At present, the lifecycle analysis of culverts is based on a collection of original installation date information, which does not account for any repairs made by City roads operators (an active program) as well as those by homeowners along roadsides. Given the assumed age of the inventory and City observations about expected service life, it can be assumed that some culverts have already been replaced. If no action had been taken, the City would face a significant backlog as demonstrated by the State of the Infrastructure report. The inspection strategy is predicted to help address this issue by documenting the current condition of the assets.

The culvert replacement strategy is further complicated by the varying owners of culverts. The roadside culverts in the City's stormwater system are either owned by the City or by homeowners. Private culverts are the responsibility of the homeowner to replace, but the City offers two methods of assistance:

- The City can replace the culvert at cost to the homeowner. The City provides materials and schedules the work for the homeowner. The City will also replace the culvert free of charge if it heaves within one year of installation;
- The culvert can be replaced by a private contractor, and the work will be inspected by the City. The City will subsidize the cost of the culvert based on the User Fees By-Law.

While it is recognized that the cost of the City replacing private culverts can be recovered in part, the City still requires the resources to carry out replacement activities. Therefore, the capital improvement plan funding levels for culverts consider both City owned culverts and those in the inventory that are located underneath driveways. While the approach to replacing culverts and the cost incurred by the City may vary, it should be recognized that the private culverts are still part of the stormwater system and lifecycle activities need to be properly anticipated.

4.4.4 Decision Making

While the capital improvement strategies and plan can be considered the optimal approach for the Stormwater Asset Management Plan, this does not reflect the realities of most utility corridors within the city. Municipal rights-of-way are typically comprised of multiple systems of infrastructure assets including roadways, bridges, water, sanitary sewers and stormwater pipes, sidewalks, and chambers, to name but a few. This means having to manage a broad range of assets within a portfolio, with each asset deteriorating at a different rate and requiring interventions that often are not optimally coordinated to reduce cost and limit disruption to customers. When implementing the stormwater capital improvements strategy, the City will need to integrate the stormwater assets with the rest of its assets to perform integrated decision making. The capital improvement strategy emphasizes the need for trenchless and independent work streams for each asset class so the optimal interventions can be made, but the City will also need to consider the optimal solution when multiple interventions within the same corridor are plausible. The Stormwater Asset Management Plan recommends that the City adopt a decision support software tool to assist in this process.

Refer **Appendix E – Technical Memorandum #4: Risk & Criticality Assessment** for additional information.

5. Operations and Maintenance Plan

The City's approach to O&M is guided by its Asset Management Policy which states that maintenance practices should aim to "maximize asset lifecycle and reliability by carrying out interventions at the right place and the right time considering budgetary and resource constraints". The understanding of the City's O&M program and the overview of the O&M planning process used for the AMP shown in **Section 4** served as the basis for developing a full O&M Plan that shows the cost of the activities and proposed changes based on requirements for sustainability, industry best practice, or desired Levels of Service.

5.1 Current Practices

The City has Standard Operating Procedures (SOPs) for various maintenance activities for assets within it's existing O&M program. These SOPs provide a brief description of the objectives, step-by-step procedure, labour, equipment & material requirements along with quantities and operating procedure achievements. These SOPs can generally be categorized by asset class.

A line-by-line review of the City's SOPs was performed to identify existing activities that are applicable to stormwater assets. Refer to

Table 10 for a list of existing O&M activities that were included in the proposed O&M program. In some cases, the work order (WO) activity description titles were updated for the proposed O&M program for greater clarity.

Table 10: Existing Stormwater O&M Activities

Asset Class	Activity Code	WO Activity Title (Old)	O&M Activity Name
Roads	1941	Manual Sweeping	
	1942	Machine Sweeping - Summer	Machine Sweeping Summer - Arterial Roads
	1943	Intersection Sweeping	Cleaning Major Intersections Summer
	1945	Street Sweeping – Elephant Vac	
	1951	Street Flushing – Own Crews	Street Flushing Summer
	6141	Spring Cleanup - Manual	
	6142	Spring Clean Up-Catch basin	
	6143	Spring - Clean Up – Flusher & Sweeper	Spring Cleanup Machine Sweeping & Flushing - All Roads & Streets
	6144	Spring-Clean Up- Sidewalk Sweeping	Spring Cleanup - Sidewalk Sweeping
Ditches	4001	Mechanical Ditching - Spot (Own Crews) and Contract	Roadside Ditching - Rural
	4002	Roadside Ditching - Urban	
	4021	Manual Ditching - Backyards	
	4091	Other Ditching Maintenance	
	6041	Open Ditches & Catch Basins – Manually	Open Culverts - Manual
	6042	Steam Ditches & Catch Basins	Open Culverts - Steam
	6043	Opening Ditches - Mechanical	Open Ditches/Culverts - Mechanical
Culverts	4141	Bridge & Culvert Maintenance – Maintenance and Inspection	Culvert Inspection - Small < 400mm Culvert Inspection - Medium - 400 mm to 900 mm
	4311	Road Culvert Maintenance	
	4401	Culvert Maintenance – Roadway Culvert Cleaning	Culvert Cleaning
	4411	Entrance Culvert - Resets	
	4412	Culvert Maintenance – Entrance Replacement	
	4421	New Entrance Culverts	
	4591	Screens & Inlets Maintenance	Screens and Inlets Maintenance
Sewer	4501	Storm Drainage Repairs	Storm Sewer Repairs
	4521	Storm Drainage Clean and Inspect	Storm Sewer Flushing
Structures	4522	Storm Sceptor Cleaning	
	4551	Catch Basin / Manhole Cleaning	Catch Basin Cleaning Manhole Cleaning (2 separate activities)
	4561	Catch basin/Manhole Repairs<1FT	
	4562	Catch Basin/Manhole Repairs>1FT	

Not all activities within the City's stormwater SOPs are captured the same way in

Table 10. This is because existing O&M activities were slightly modified for the proposed O&M program. For instance, certain O&M activities specifying inspection and cleaning as a part of the same work order were split in to two different activities requiring separate work orders with specific achievements.

5.2 Proposed Program

In addition to activities defined by the City's SOPs, new activities were also developed for the recommended O&M program to meet the desired Levels of Service. **Table 11** lists recommended new O&M activities.

Table 11: List of New O&M Activities

Asset Class	WO Activity Title
Ditches	Ditch Inspection
Structures	Inspection (Catch Basins & Manholes)
	Open Catch Basins - Manual
	Leaf Pickup Program
Storm Sewers	Storm Sewer Inspection / Condition Assessment (CCTV)
OGS	Inspect Units (MH)
	Repair Units (MH)
	Inspect Units (Chamber)
	Repair Units (Chamber)
	Clean Units (Chamber)
Municipal Drains	Inspect Municipal Drains
	Other Maintenance – Beaver Trappings
	Mechanical Brushing
	Repair & Clean-Out
Facilities	Inspection
	Routine Maintenance
	Non-Routine Maintenance
	Stormwater Monitoring

The City's SOPs formed the basis to develop the proposed O&M framework for each stormwater asset class, with emphasis to labour, material and equipment requirements along with activity achievements defined in the SOPs for each activity and matching them with the standard rates provided by the City for developing activity cost estimates.

Activity 431-1 Road Culvert Maintenance

Description: Roadway Culvert Maintenance: This activity is used to repair road culverts including repairs to the road base when performed at the same time. It includes excavation, backfilling and repairing to the travelled surfaces. Any resurfacing with asphalt is to be carried out under the appropriate asphalt patching activity. Accomplishments are measured in linear metres.

Method: Roadway Culvert Replacement

Purpose: To maintain the flow of water in culverts by repairing defective culverts or by replacing culverts that are interfering with traffic such as when a broken, collapsed or heaved culvert is restricting the flow of water and causing damage to the roadway.

Procedure:

1. First generate and discuss traffic control and complete circle check. (15 minutes)
2. Break the surface with a backhoe and or hand tools to remove pipe and roll to one side.
3. Clean the excavation to allow new pipe to sit properly adding more bedding if required.
4. Place new pipe using any available stones to hold in place and backfill in and around the pipe with new granular material and compact in no more than six inch layers to the level of the remaining roadway.
5. Sweep excess to the roadside then load old pipe and any leftover material and then move to new site.
6. At the end of the shift, return to the yard and gas up and ensure all tools and equipment are cleaned.
7. Report any necessary repairs and hand in the complete crew card to the foreman.
8. At the back of the crew card, indicate where the work was completed by the street address or by some other reference point

Suggested Crew Size: LABOUR

1 Lead Hand	8 Hrs
2 Truck Driver	16 Hrs
1 Equipement Operator A	4 Hrs
2 Utilityperson	16 Hrs

Suggested Equipment: EQUIPMENT

1 ¾ Ton Truck	4 Hrs
2 Multi Function Tandems	16 Hrs
1 Backhoe/ Loader	4 Hrs
1 Utility Tandem Trailer	8 Hrs
1 Solartech Arrowboard	8 Hrs
1 Backhoe w/ Hoeram	6.04 Hrs
1 Bomag/ Trailer (Double Drum)	1 Hr

Materials: MATERIAL

Granular A	22 Tonnes
Galv. Lockseam Pipe	16 Metres
Couplers Corrigated	2

Achievements:
16 Linear Metres

Figure 13: Sample Work Order Activity Description (SOP)

To achieve the WO requirements, the City also contracts out certain O&M activities (**Table 12**). However, most of these activities do not cover the entire asset inventory. For instance, Spring Cleanup Machine Sweeping & Flushing - All Roads & Streets, 75% of the inventory is contracted while 25% is managed in-house.

Table 12: List of Contracted O&M Activities

Asset Class	Activity Code	Activity Name
Municipal Drains	409-1	Other Drainage Maintenance - Beaver Trappings
Sewers	450-1	Storm Sewer Repairs
Structures	455-1	Catch Basin Cleaning
Culverts	459-1	Screens & Inlets Maintenance
Structures	614-2	Spring Clean Up-Catchbasin
Roads	614-3	Spring Cleanup Machine Sweeping & Flushing - All Roads & Streets

Upon defining the proposed O&M framework, the desired frequencies of O&M activities were determined based on industry best management practices to maintain service levels and develop the program O&M budget.

Appendix F describes the process for developing the O&M framework inputs, including the creation of new activity costs, and a fully developed proposed O&M framework that combines inputs to present a budget. A summary of annual budget requirements and gap analysis is presented below.

5.3 Summary

Bringing together the results of the proposed O&M program, the various changes can be aggregated to assess the total change in the proposed budget. The total proposed budget for stormwater O&M activities is $8.9M, compared to $6.8M that is spent currently on the O&M activities that were examined. Here, it is understood that the total budget for operators is currently larger than $6.8M, but that this includes activities that are being addressed in the capital improvement plan or not classified as stormwater. The budget will increase from $8.9M to $9.5M in later years following the transfer of sewer management activities from the capital plan to the operational plan (e.g. inspection and cleaning).

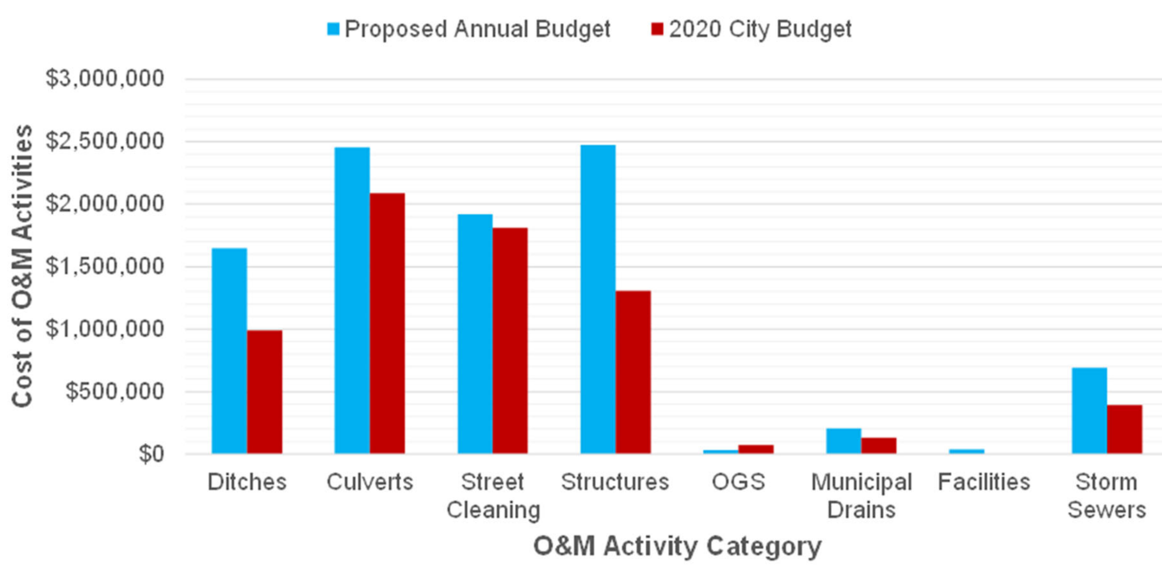

Figure 14: Existing and Proposed O&M Budget

As stated throughout the discussions of Levels of Service, O&M activities, and activity targets, the proposed budget represents the cost of maintaining a sustainable stormwater system. The major proposed changes to the budget include:

- Dedicated visual inspection program for ditches, culverts, and storm structures. These programs integrate the use of data gathering methodologies that can be used to determine maintenance planning.
- Improved sediment management through street cleaning, catch basin/manhole cleaning, and sewer flushing. The City does not currently perform sediment management at a level commensurate with the amount of road sand that is applied each year, leading to an accumulation within the system and the environment.
- Full consideration of assets not currently addressed by the O&M program, including ditches outside the GIS inventory and the introduction of new asset classes (oil grit separators, stormwater management ponds).
- Update to most activity frequencies to shift the outlook to a medium-long term, with an emphasis on the sustainability of the system and service levels.
- New structure of activities and breakdowns to facilitate modern maintenance management and analysis, as well as a shift from reactive to preventative works.

While capital forecasts can vary significantly from year to year, the O&M program is structured in a manner that allows funding to be predicted with relative certainty. Although requirements will vary from year to year, the use of activity frequencies to plan for medium to long term time horizons mean that expenses can be predicted with the proper planning. The O&M forecast is intended to align with the capital improvement plan, which covers the initial costs of sewer CCTV and flushing before shifting the expense to operations. This is summarized in **Figure 15**.

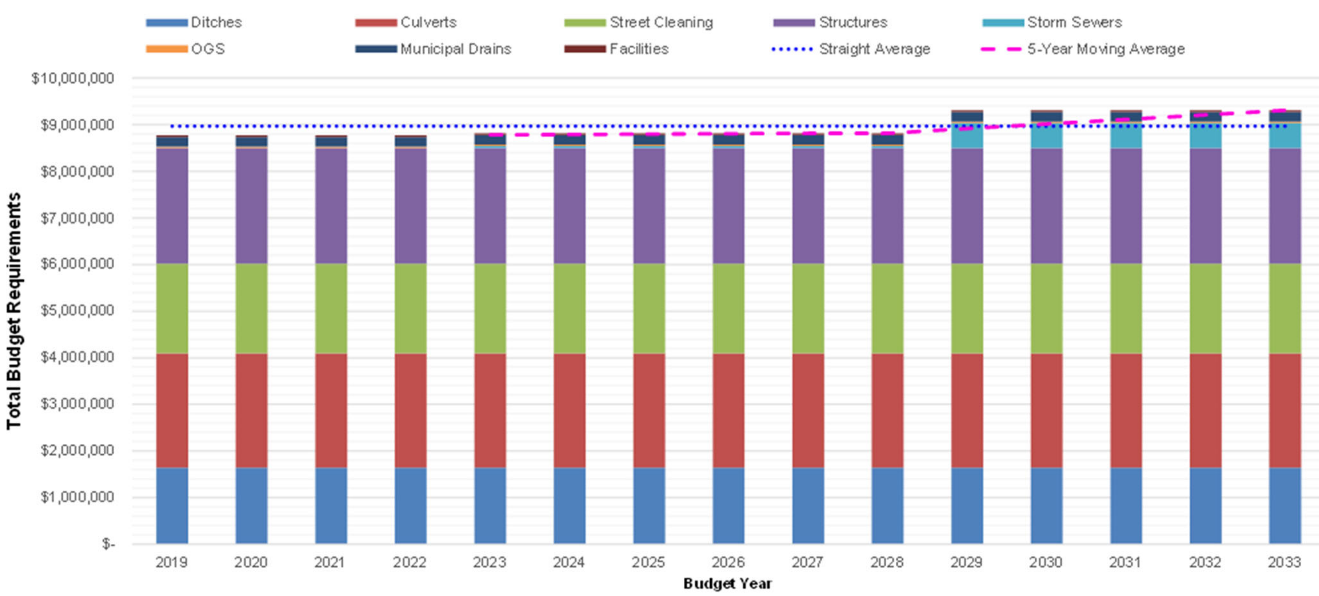

Figure 15: Annual Stormwater O&M Budget Forecast by Asset Class

Refer to **Appendix F – Technical Memorandum #5: Operation and Maintenance Plan** for additional information.

6. Capital Improvement Plan

Using strategies outlined in **Section 4**, the Capital Improvement Plan (CIP) provides the City with a series of asset-level plans that can be executed upon. Each plan, when paired with the underlying strategy, should provide key action items at the asset level with a scope, methodology, cost, and business case. Asset-level plans provide both items for immediate action and implementation, as well as longer termed insights into budget forecasting and plans for capital spending. Each asset-level plan highlights the proposed timescale. Many plans involve initial assessments that may lead to further activities. All plans provide the City with tools and the methodology to obtain the information required to take further actions in stormwater asset management.

6.1 Gravity Sewer CCTV Program

A CCTV program underpins the City's rehabilitation plans for gravity sewers and aims to first prioritize highly critical assets for inspection before working to establish baseline conditions for the entire system as prescribed by the inspection strategy. The timeline for establishing baseline conditions is suggested as 10 years. At a cost of $2.00 per meter (the City reported $1.54 per meter and a slight contingency was added), the cost of establishing baseline conditions can be summarized (**Table 13**):

Table 13: Summary of Camera Work Costs

Sewer Category	Total Length	Unit Cost	Total Cost
High Consequence of Failure	34.96 kilometres	$2.00 / meter	**$69,939**
Medium Consequence of Failure	75.92 kilometres	$2.00 / meter	**$151,853**
Low Consequence of Failure	347.75 kilometres	$2.00 / meter	**$695,501**

Flushing is a requirement for CCTV inspection when sediment and debris obstruct visual assessment of the pipe's internal wall for defects. The City uses a significant amount of road sand in the winter, which can impact the success of a CCTV inspection due to the accumulation in storm sewer pipes. At present, the City performs some sewer flushing through a combination of internal operations and contracted services. The City has reported that sewer flushing attainment levels do not always align with expectations as sewers are found to be heavily impacted with sand, which increases time needed for cleaning and reduces the overall quantity of cleaning that can be completed in a typical shift. In 2018, the City spent approximately $170,000 on storm sewer flushing.

Flushing is included in the CIP because of its alignment with the requirements for CCTV inspections. It is expected to be a significant expense that meets the definition of a capital activity. A larger level of effort will be required to flush all sewers prior to baseline inspections than what is required to maintain the sewers operationally. Once the buildup of sand associated with several years of limited/no flushing is removed, maintaining the "status-quo" on an on-going basis is expected to be less costly than what is proposed for determining the baseline condition over the next 10 years (back-log reduction). Based on historical costs reported by the City, sewer flushing is estimated to cost $30 per meter. This is much higher than what is observed in southern Ontario, where costs typically range from $10 to $20 per meter. The City reported contractors are currently paid by the hour rather than by the meter because of how long the flushing takes. **Table 14** summarizes the cost of flushing all City sewers, followed by a breakdown of proposed annual costs that combines camera work and flushing (**Table 15**).

Table 14: Breakdown of Flushing Costs for CCTV

Sewer Category	Length of Sewer	Unit Cost of Flushing	Estimated Fraction of Required Sewers	Total Cost
High Consequence of Failure	34.96 kilometers	$30 / meter	50%	**$524,541**
Medium Consequence of Failure	75.92 kilometers	$30 / meter	50%	**$1,138,900**
Low Consequence of Failure	347.75 kilometers	$30 / meter	50%	**$5,216,255**

Table 15: Proposed Timeline for CCTV Baseline Inspection

Year	2019	2020	2021	2022 – 2028
Program Cost	$628,000	$628,000	$628,000	$845,000 (annually)
Program Scope	**Baseline inspection – Priority Sewers (Medium + High CoF)**			**Baseline Inspection – Non-Priority Sewers (Low CoF)**

Upon completion of the CCTV inspection program, monitoring can be performed at a lower level of effort. As well, flushing becomes significantly less expensive due to backlog being addressed. For the remainder of the 30-year plan (2029 to 2047), these expenses become operational (*Refer **Appendix F – Technical Memorandum #5: Operation and Maintenance Plan** for additional details*).

6.2 Lining and Replacement Program

Using the proposed rehabilitation strategy, the City can begin to plan for rehabilitations and replacements using the outcomes of an inspection program. At present, the candidates for the program are only estimates based on age. In the future, using results of the CCTV inspection program, the actual condition of sewers can be used to further refine the capital improvements program.

Using available information, there are two main components of the capital improvements program:

- Replacing sewers that have reached the end of their service life. The State of the Infrastructure work suggests some sewers could be currently reaching the end of their service life. Until conditions can be verified with CCTV, the City should assume this is a replacement requirement. The lifecycle analysis can be used to suggest the required funding level. At a minimum, preparing for end of life replacements is a requirement for the City.
- Trenchless repairs are staged earlier in the asset lifecycle. By applying point repairs and linings, the structural integrity of the sewer can be maintained and the period where deterioration from infiltration and soil loss could be mitigated is maximized. This type of program is proactive based on CCTV inspection and is intended to minimize total lifecycle costs. Because data is not available to support the planning of this program at present, the cost of the program will be based on high-level assumptions.

The cost inputs for gravity sewer replacements are derived from the State of the Infrastructure work and are summarized in **Figure 16**. This serves as a high-level estimated forecast of replacement requirements in the absence of an understanding of the baseline condition of the storm sewer network.

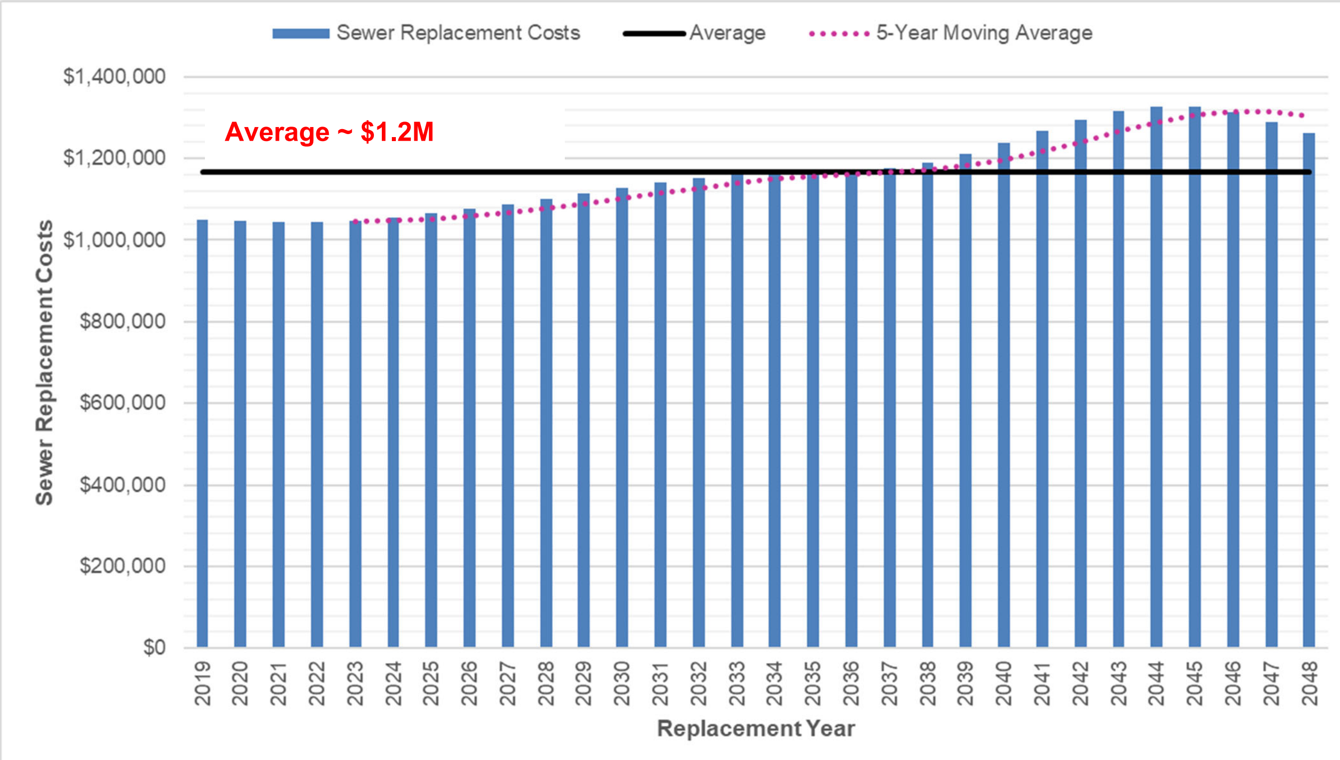

Figure 16: Sewer Replacement Costs from Lifecycle Analysis

As the City inspects sewers, it should have funds and resources ready to mobilize when defects are discovered. The discovery of defects is on-going as the CCTV program continues. To support budget planning, it is assumed that 5% of all inspected sewers will have defects eligible for trenchless repairs. It is further assumed that a lining will be used (as opposed to other trenchless technologies). Finally, it is assumed that the repairs for defects will be spread out over several years after the introduction of CCTV and continuing after baseline inspections are complete (approximately 10 years). These assumptions are significant and should not be relied upon once data becomes available but provides the City with a starting point. These assumed cost inputs are summarized in **Table 16**.

Table 16: Trenchless Repairs Budget, Inputs and Assumptions

Length of Sewer System	Assumed Quantity of Defects	Unit Cost of Lining	Total Cost of Defects	Years to Address Defects	Estimated Annual Funding Level
458,678 (m)	5% (22,934 m)	$450/m	$10,320,255	20	$516,012

Table 16 indicates that based on a series of assumptions, a lining program could cost $516,012 per year if the City were to address all eligible defects. This value has been rounded to $500,000 to avoid implying that estimates are precise or accurate, which they are not.

6.3 Storm Structure Replacement Program

Lifecycle analysis establishes the need to replace manholes and catch basins, which the State of the Infrastructure work estimated to have a shorter expected service life than gravity sewers. The State of the Infrastructure report notes that the cost of manholes was included within the cost of gravity sewer replacement candidates. Therefore, manhole replacements can be considered a part of the proposed budget for sewer replacements. While manholes were accounted for here, catch basins were not. The replacement of catch basins has historically been handled operationally by Roads operators, but it is proposed as having budget allocated through the CIP due to the scope and cost of the activity.

Using the results of lifecycle analysis, the proposed level of funding for catch basin replacements as a combination of backlog reduction (calculated as approximately $300,000 per year) and forecasted replacements was provided (**Figure 17**). The increase in cost by the end of the 30-year plan is attributable to a significant portion of the asset inventory reaching the end of their estimated service life based on age. Many catch basins were installed in the 1970s and 1980s and are estimated to have a 50-year service life.

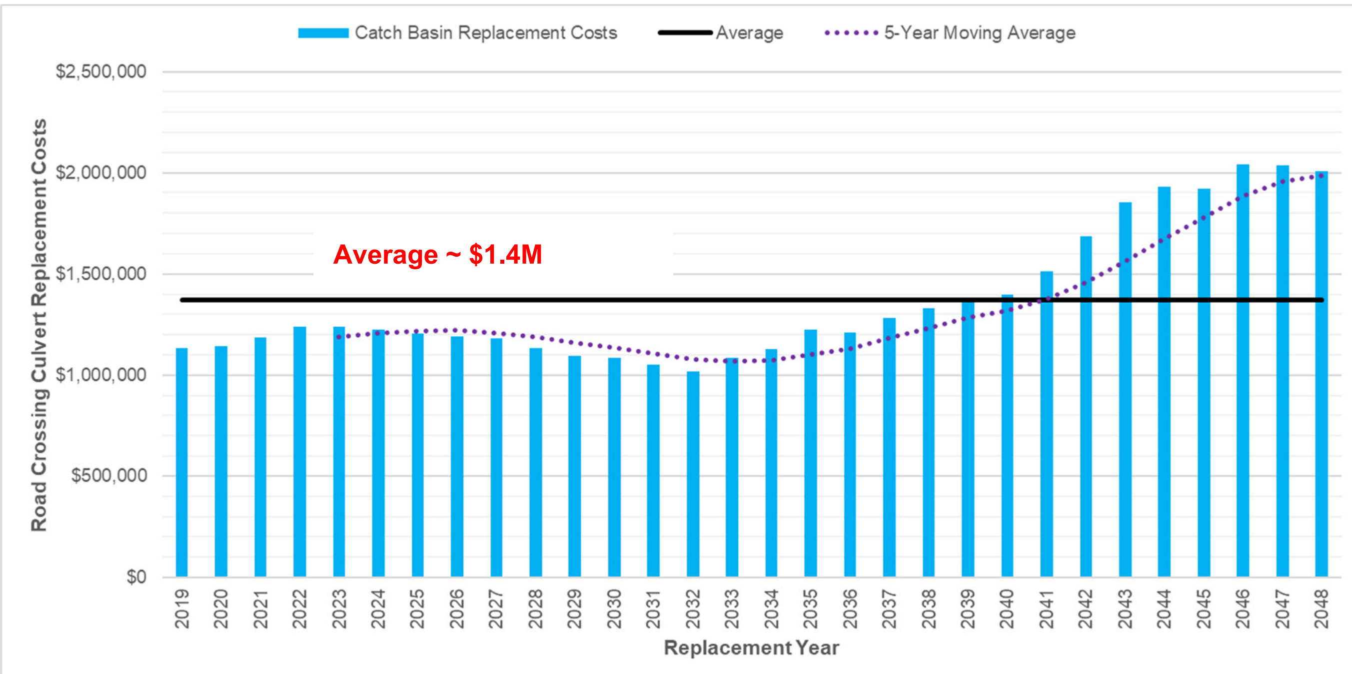

Figure 17: Catch Basin Replacement Costs for Lifecycle Analysis

6.4 Culvert Replacement Program

The combined observations about asset data (the culvert inventory within GIS is incomplete if you consider private driveway culverts) and the options for financing replacements (the City could replace its own culverts only, subsidize the cost and resources for private replacements, or assume the full cost of private replacements with the goal of full governance of the stormwater system) means that the funding levels for culvert replacements have a wide range of possibilities.

As a starting point, funding levels have been limited to culvert replacements for City-owned, road crossing culverts. The funding levels are based on an age-based assessment. It is assumed that all culverts (road crossing and driveway) will be inspected and condition will be documented as part of operations which could refine these estimates (**Figure 18**).

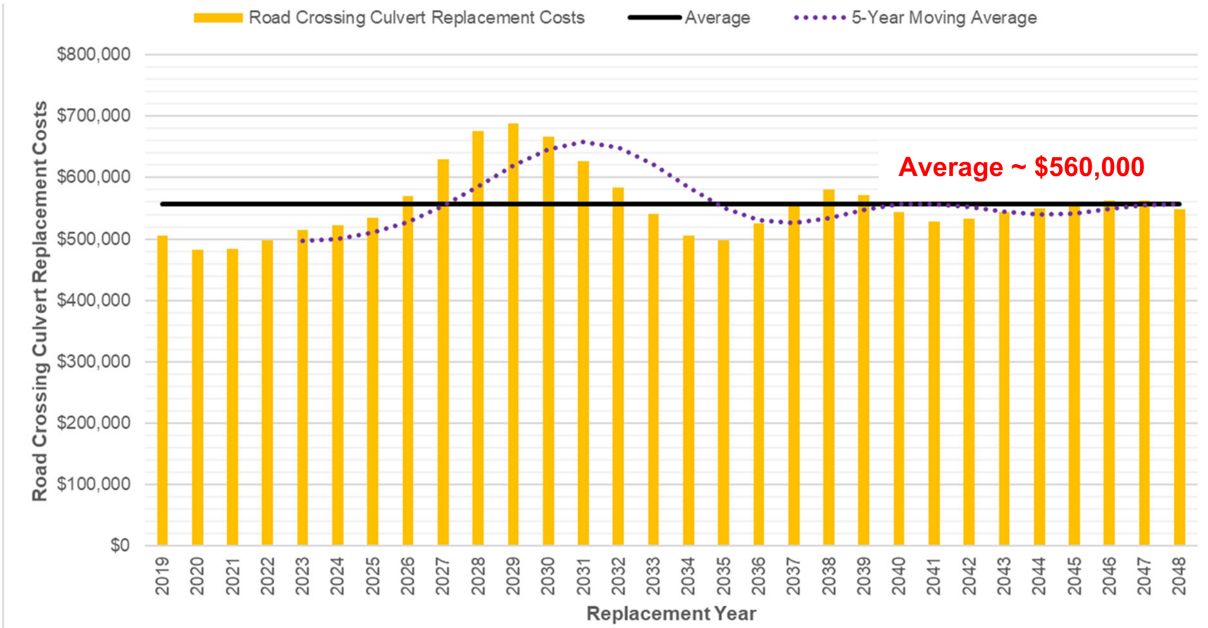

Figure 18: Road Crossing Culvert Replacement Costs

Roadside and driveway culverts occupy a significant component of the City's drainage system: the inventory is incomplete, and if private responsibilities are continued the City still needs to apply a governance framework and whole portfolio considerations. Given the size of the inventory, a full replacement program is estimated to cost millions of dollars per year. As a next step, the City should evaluate these financial implications as they apply to both the City and homeowners. Once some of the assumptions are verified, the City can select its desired approach to culvert management and budget the culvert improvement program accordingly.

6.5 Stormwater Management Pond Program

The Stormwater Management Pond program is a combination of detailed inspection and rehabilitation activities. They are periodic, which is why they are not covered operationally. Details about inspection and rehabilitation requirements are summarized in **Table 17** and **Table 18**.

Table 17: Summary of Detailed Stormwater Management Pond Inspections in the Capital Improvement Plan

	Stormwater Pond Condition Assessment	Bathymetric Survey
Description	A condition assessment is required once for each stormwater pond at a minimum. This process will inventory all assets within the stormwater pond site, establish their condition state, and identify any remedial actions. Since the City has limited knowledge of its ponds, this process is the starting point for stormwater pond management (at which point subsequent inspection/assessment activities can be handled operationally).	Bathymetric Surveys are an important part of the stormwater pond inspection strategy and involves monitoring accumulated sediment to plan for large sediment removal projects. Bathymetric surveys are intended as a periodic monitoring tool for wet ponds only. In addition to capital planning, they can support monitoring and reporting of regulatory requirements related to sediment removal.
Scope and Quantity	15 Stormwater Pond Sites	6 Wet Ponds
Frequency	Once	5 times over 10 years
Unit Cost	$1500*	$3600*
	Unit costs are slightly higher than what is observed in the Greater Toronto Area, as these activities may have a more limited pool of vendors in Sudbury.	

Using the results of inspections, the City will use the acquired data to plan for sediment removals and asset renewals. This CIP does not include the potential cost of renewing stormwater pond components (e.g. control structures, signs/fencing, conveyance assets, etc.) An update to the City's asset inventory through a stormwater pond condition assessment could add to or change the CIP forecast. Sediment removals are typically triggered using a combination of bathymetric survey results and environmental performance monitoring data. In the absence of this data, it was assumed that a pond will accumulate 2.5% each year from the time of construction, and that a cleanout would occur when the pond was 50% full. This was accomplished using basin volumes and "built-by" dates within the City's Environmental Compliance Approvals, as summarized in **Table 18**. The cost of sediment removals assumes a total cost of $150 per cubic meter for dewatering, storage, transportation, and disposal.

Table 18: Summary of Pond Dredging Costs

Facility	Environmental Compliance Approval	Built By	Basin Volume (m^3)	Dredging Cycle	Assumed Dredging Year	Assumed Sediment Volume (50% of Basin, m^3)	Dredging Cost
Hidden Ridge	0904-8GPJ6Q	2011	5320	25 Years	2036	2660	**$399,000**
Spruce Meadows Subdivision - Ph 2, 3 & 4	7400-7XFL3P	2009	1445		2034	722.5	**$108,375**
Lavallee Drain	0535-889KK4	2009	16683		2034	8341.5	**$1,251,225**
Royal Meadow Subdivision	0761-7XNTZT	2010*	4187		2035	2093.5	**$314,025**
Redwood Subdivision-Ph 2	2793-8LRHPH	2011	903		2036	451.5	**$67,725**
Second Ave.	5693-5RGJ2Z	2005*	10275**		2030	5137.76983	**$770,665**
Assumptions	**Two ponds did not have a "built-by" date recorded within the Environmental Compliance Approval. In absence of a date, the average of the City's 14 facilities with "built-by" information was taken (2015). The City has reported that "built-by" dates are conservative and that some ponds were constructed earlier. The first round of bathymetric surveys will help to address these gaps in data by establishing the potential timeline for dredging.* ***One pond did not have a basin volume available. To remediate this, permanent pool surface areas of the 5 wet ponds with volume information were used to obtain a very rough "height" dimension estimate, converted from volume. Values ranged from 0.5 m to 1.6 m for wet ponds. The average of these values (1.0 m) was used to estimate the basin volume of the pond with missing data. The design drawings for the pond should be reviewed to replace this assumed value given that this pond is the second largest*						

6.6 Summary

During the development of the Stormwater Asset Management Plan, several strategies were put forward that formulated the proposed Capital Improvement Plan. The overall asset management plan is intended to provide the City with a series of initial first steps that can be used to gather information and continuously improve capital forecasts over time. The 30-year forecast is intended to translate the results of lifecycle analysis into a costed stormwater capital plan that the City can expect in upcoming budget cycles. It is strongly recommended that the City update the capital plan with new data as it becomes available. The total cost of the proposed Capital Improvement Plan, which is based on available data, previously mentioned strategies and assumptions, and AECOM's recommendations, is shown in **Figure 19**.

Refer **Appendix G – Technical Memorandum #6: Capital Improvement Plan** for additional discussion regarding the capital improvement plan.

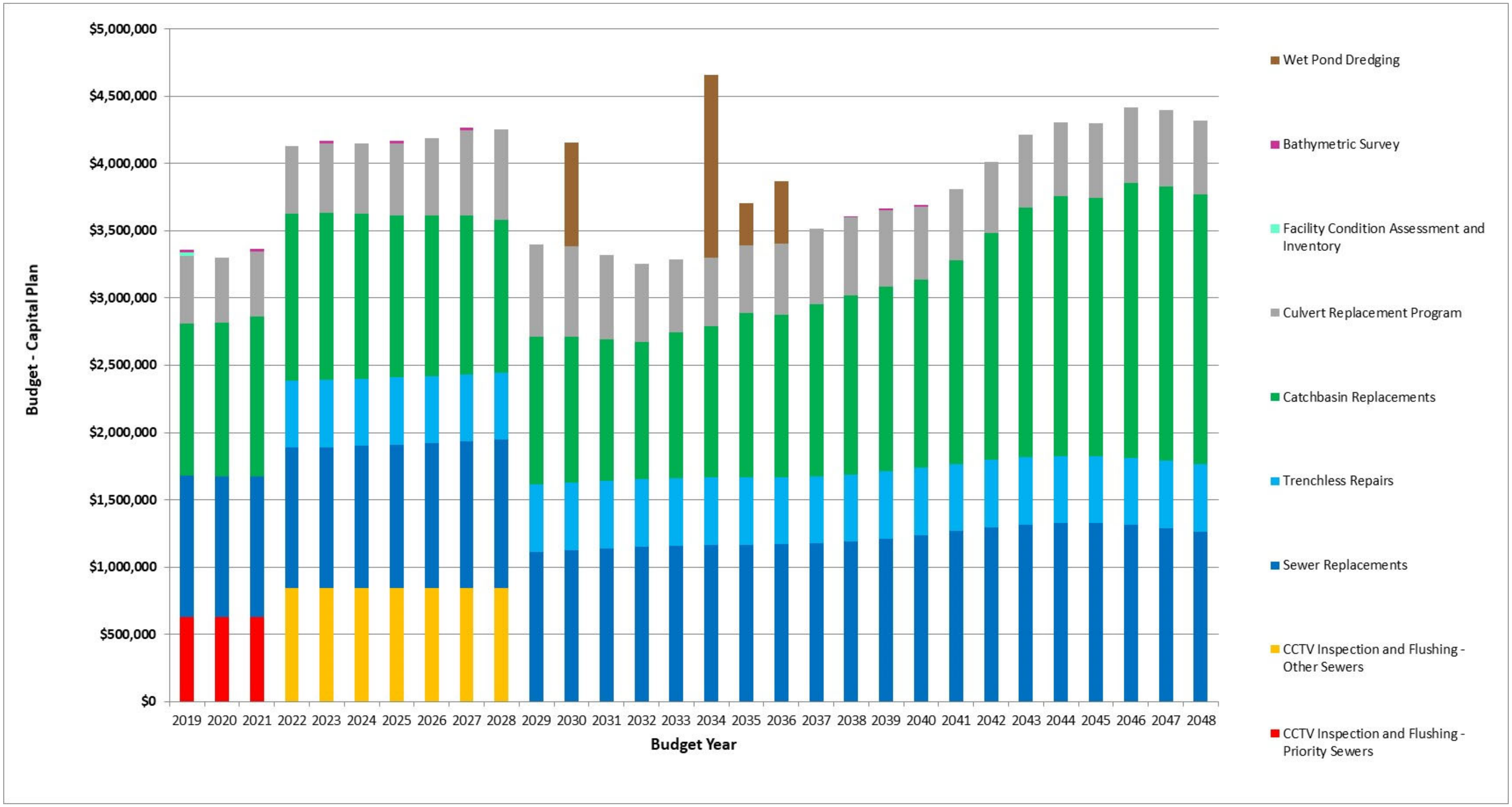

Figure 19: Budget Summary - 30 Year Stormwater Capital Improvement Plan

7. Financial Plan

The Financial Plan includes the total forecasted stormwater program cost, the underlying principles of the forecast, and the necessary contributions to infrastructure reserves. The goal of the Financial Plan is to provide a medium to long term horizon of expected investment needs, based on delivering the requirements for Levels of Service and a sustainable stormwater asset network. Recognizing that the proposed Financial Plan is a distinct shift from current practice, implementation is also discussed.

7.1 Program Costs

The results of **Section 5** and **Section 6** provide the City with a comprehensive view of potential funding requirements for stormwater assets based on the proposed O&M and Capital Improvement plans.

Figure 20 provides the results of integrating forecasted capital and operational expenses for City assets across a 30-year time horizon. The average cost of system requirements for the proposed program are approximately $13.3 M per year. In this figure, the O&M costs are fairly consistent due to their cyclical nature. The City should monitor the trend of O&M costs to determine if they are escalating over time, for example due to the inclusion of new assets.

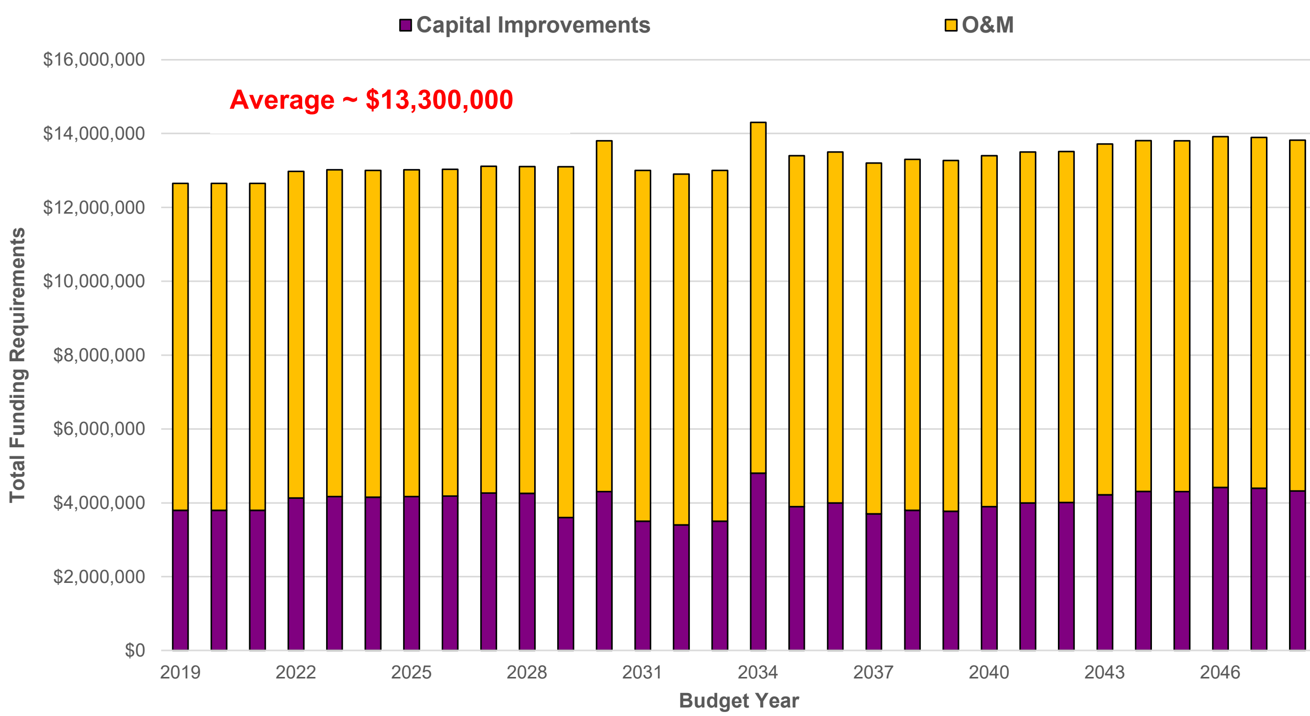

Figure 20: Summary Budget Forecast of Capital and Operational Plans

7.2 Program Cost Observations, Assumptions, and Recommendations

The total cost of the proposed stormwater asset management program is a combination of operational and capital plans that are both linked to Levels of Service and the need to ensure that the stormwater system is sustainable over the long term. At present, operational costs are greater than capital costs. This is shown in **Figure 21**, which warrants further discussion.

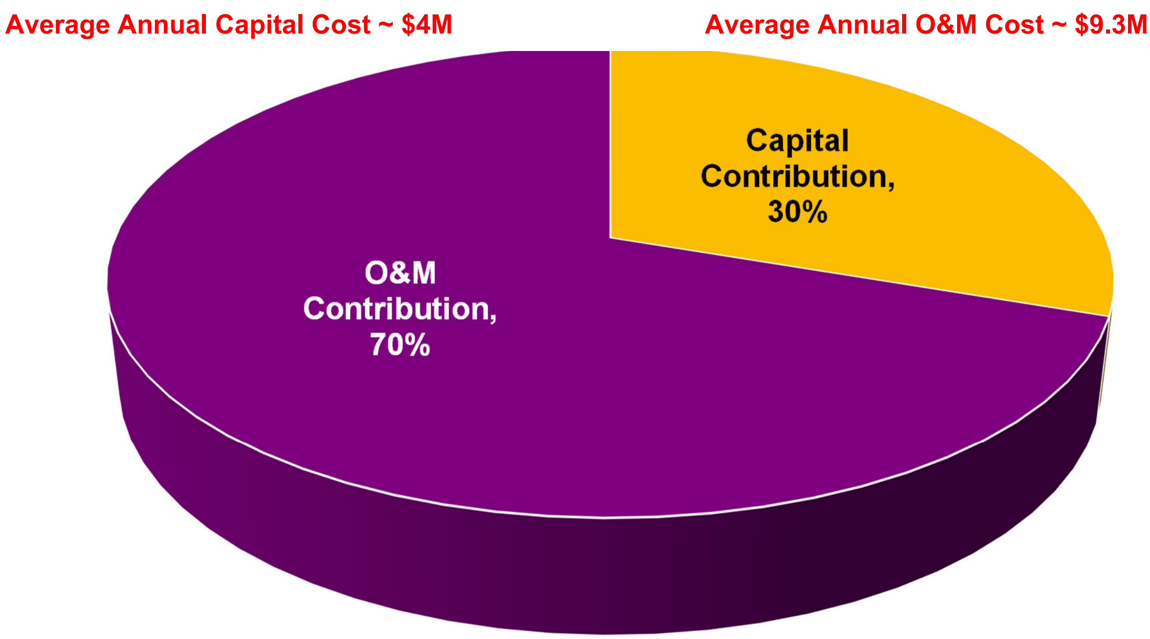

Figure 21: Summary of Program Cost Allocation Between Capital and Operational Expenses

The greater cost of the O&M program that is shown in **Figure 21** is based on several underlying principles within the AM Plan. Important points of discussion include the overall mix of capital and operational expenses, levels of capital improvement funding relative to the lifecycle analysis shown in the State of the Infrastructure and supporting inputs from the AM plan that justify overall funding levels.

- **Allocating Capital Improvement Costs**

  The capital improvement plan is partially based on the lifecycle analysis provided within the State of the Infrastructure; however, these are not the same thing. The lifecycle analysis is an age-based method of assessing the medium to long term implications and potential funding requirements for an aging network. It serves as the starting point for understanding future requirements before they are augmented by additional data or information. The lifecycle analysis demonstrates that, based on age, the City would be required to spend approximately $9.6M per year on capital replacements over the next 30 years (recall the limitations of age-based methods shown in **Section 3**). The proposed capital investment plan is forecasted to be less than the age-based projections of the lifecycle analysis. The proposed capital improvement plan assumes that a full O&M program will be one of the driving factors in reducing backlog and documenting asset conditions, which would refine future needs. As well, the funding levels proposed at the outset are meant to be achievable, meaning the program could be implemented. The City should still be monitoring its long-term spending against the lifecycle analysis while refining the State of the Infrastructure with new asset condition data.

- **Infrastructure Reserves**

  The lifecycle analysis demonstrates that in the medium to long term, the City must prepare for a wave of replacements as the system constructed in the 1960s and 1970s ages and reaches the need for renewal. To prepare for upcoming replacement requirements, the City will need to begin building stormwater infrastructure reserves now.

- **Balancing Capital and Operational Expenses**

  The initial emphasis on O&M in the total cost forecast is due to the ability of the proposed O&M program to extend the useful life of the assets and maximize the coverage of the asset management plan Whereas a capital-intensive program could fully replace some aging assets, many system needs would not be addressed, resulting in data gaps and potentially unforeseen asset failures etc. Conversely, a comprehensive O&M program allows for the inspection of all assets to gain condition data and the use of preventative and planned corrective maintenance to ensure system performance, and potentially to avoid asset failures. When taking this overall approach and integrating the capital and operational program, the O&M program can be used to inform and adjust the capital program over time. As more information about the system is gained, the program can become more capital intensive if inspection program identify or justify the need.

- **Asset Management Strategy**

  The proposed financial plan also assumes full use of the asset management strategy. So far, the use of asset data to refine the program as well as the underlying capital/O&M strategies were discussed. The funding levels are also assuming that the City will apply a risk-based approach to asset lifecycle activities. This is reflected within the capital improvement plan, which was developed largely based on reducing risk exposure. Here, it is assumed that low risk assets will have a greater emphasis on O&M, while higher risk assets will receive more in capital improvements. Moving forward, it is recommended that O&M planning also incorporate risk profiles once more information is gleaned from the condition assessment baseline.

7.3 Infrastructure Reserve for Sustainable Asset Management

Figure 20 provides the results of integrating forecasted capital and operational expenses for City assets across a 30-year time horizon. The cost of system requirements for the proposed program are approximately $13.3 M per year. Evident from **Figure 20** is that the City will require funding less than $13.3M until 2029, however, the funding needs will increase in 2030 and after 2033. This means that when the City does not spend the full $13.3M amount on stormwater assets, the unspent money still needs to be allocated to an infrastructure reserve so the City can properly prepare for the upcoming replacements. If the City did not contribute or waited to start contributing, the upcoming obligation would be the same, but the funding gap would become larger.

7.4 Next Steps – Funding Strategy

Evident from the results of analyzing total lifecycle cost is that a funding strategy is required to meet the current needs of the assets without compromising those of the future. With asset management planning in place, the focus of the City should shift towards the study of sustainable funding to evaluate options for funding the desired program. Given that there is no dedicated source of funds for stormwater projects as a utility (stormwater needs are currently funded from the tax base), this is a pivotal next step. **Figure 22** summarizes the work completed by the City to achieve sustainable stormwater management as well as the next steps.

Figure 22: Path to Sustainable Stormwater Management

Although municipal governments are responsible for managing almost all aspects of stormwater within their jurisdiction, they have limited flexibility and autonomy in generating dedicated revenue. Despite new regulations, there are limited federal or provincial funding sources to achieve these more stringent outcomes, thereby increasing budgetary pressures. With property tax funded SWM program, annual stormwater budgets must compete with other vital public services.

In cases where the resource requirements placed upon a community far exceed the available resources appropriated by elected officials, the implementation of capital projects or the extent/frequency of O&M activities becomes dependent on the availability of funds rather than based on need. This situation only contributes to the infrastructure funding gap. As a result, it is expected that competing demands for limited public funds will continue, forcing municipalities to pursue alternative financing mechanisms to provide a financially sustainable program.

Sustainable infrastructure funding is defined as the level of funding required to sustain assets in such a manner that meet present infrastructure needs without compromising the ability of future generations to meet their infrastructure needs. Reaching an understanding of what sustainable funding is required for the owner of an asset portfolio is a key outcome of the Stormwater Asset Management Plan.

7.4.1 Linking the Funding Strategy to Levels of Service

Evident from the dilemma outlined above is that the conventional method of financing stormwater assets limits the ability of the City to deliver the desired levels of service. To address this challenge, a paradigm shift in the funding for stormwater assets is required. At present, decision makers may not have the information required to make informed decisions about the funding requirements of existing stormwater assets. This project changes this reality by defining the objectives of the assets through Levels of Service (**Section 3**), and forecasting the cost associated with providing the Level of Service (through capital and O&M activities). If the funding requirements cannot be met, the City then must understand that the desired level of service cannot be delivered. Levels of Service can therefore be used as the mechanism to renegotiate funding, with all parties having a full understanding of what can be achieved with a given budget level and what the implications of increasing or decreasing funding will be. If activities are not funded, decision makers will also recognize the implications for regulatory requirements (e.g., failure to meet minimum requirements), customer service, and infrastructure sustainability. The links between Level of Service and funding stormwater asset management is shown in **Figure 23**.

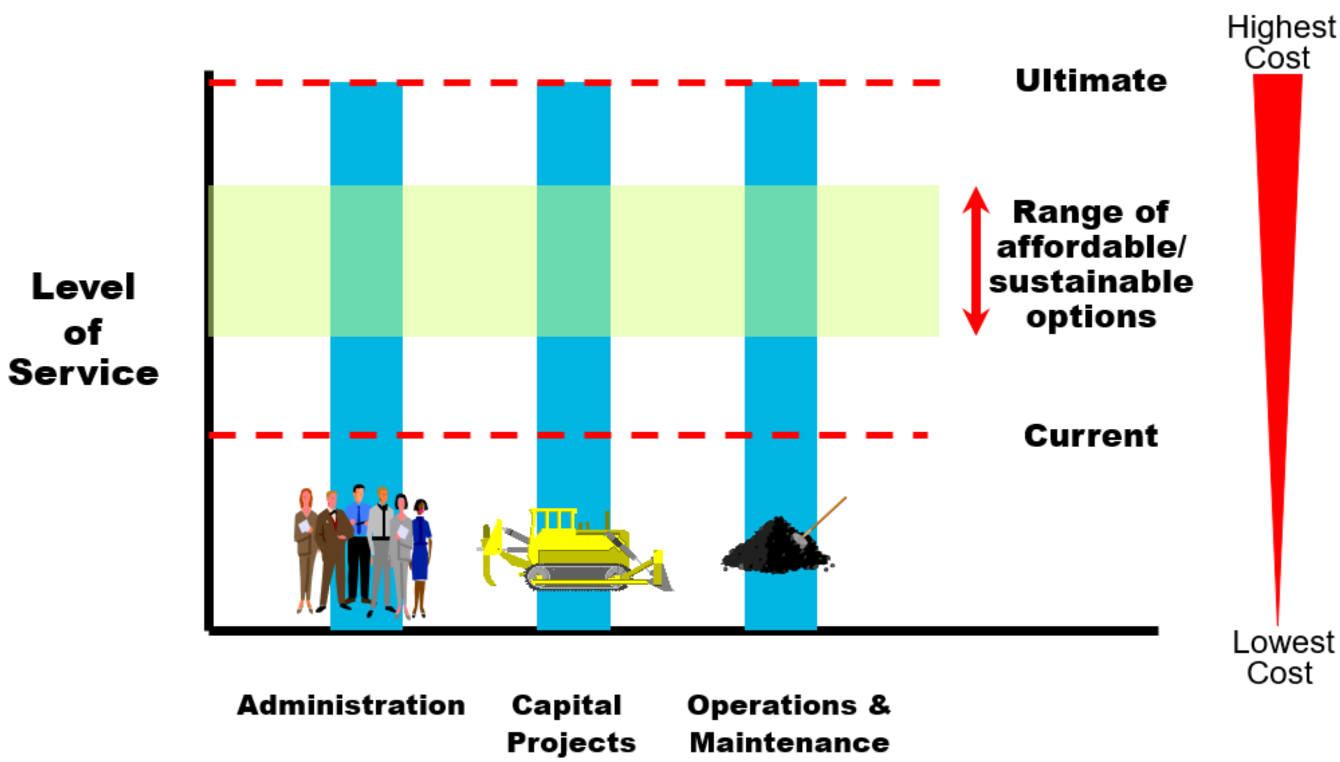

Figure 23: Levels of Service can be used to Determine Sustainable Options for Funding Existing Stormwater Assets

Given the impact Levels of Service will have on budget requirements, it is a good practice to have Levels of Service adopted by Council. This provides a formalized agreement to the asset objectives and gives the City a clear directive to complete the asset lifecycle activities. It will also establish the clear need for dedicated funding.

7.4.2 How Do You Pay for It?

The Asset Management Plan is an intermediate step in creating a framework for sustainable stormwater asset management. During this study, the total funding requirements for existing stormwater assets were established. With this understanding, the focus should now turn to how to pay for the necessary investments in infrastructure.

One way to accomplish this is through a Financing Study, the pivotal next step that is recommended given that the City does not currently fund the stormwater asset at the levels identified by the Asset Management Plan.

A Financing Study will analyze present and future program expenditures (capital projects, O&M, administration, growth, etc.) to assess funding options (taxes, fees, special levies, development, partnerships, debt financing, grant funding, or a combination of the above). A Financing Study would then use this information to evaluate the feasibility of different funding models for stormwater assets and the path forward for implementation. It can provide information and recommendations for decision makers who will determine the path forward for financing stormwater assets. It is strongly recommended that the City consider a Financing Study, given the magnitude of the necessary funding for stormwater assets.

8. Recommendations

To continue to improve the Asset Management Plan (AMP) AECOM recommends the following:

1. Develop new work order task codes and stormwater operating procedures for new activities identified in Operation and Maintenance Plan and modify the work order achievements for activities that do not measure the number of assets serviced.
2. Complete data collection activities for rural road ditches, screens, and sidewalks. These asset quantities could significantly impact potential budget requirements. The proposed data collection strategy for each asset class is as follows:
3. Ditches can be collected in GIS using ortho-imagery and street view imagery.
4. Sidewalks can be collected with collaboration from other engineering and roads departments.
5. Screens/grills should be collected using operator knowledge and a field tagging program.
6. Introduce a capital CCTV and flushing program to establish baseline conditions for the entire system.
7. Use updated condition data to revisit risk frameworks and develop a criticality profile for all stormwater assets.
8. Revise and update capital and operating plans (and financial forecasts) system criticality.

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