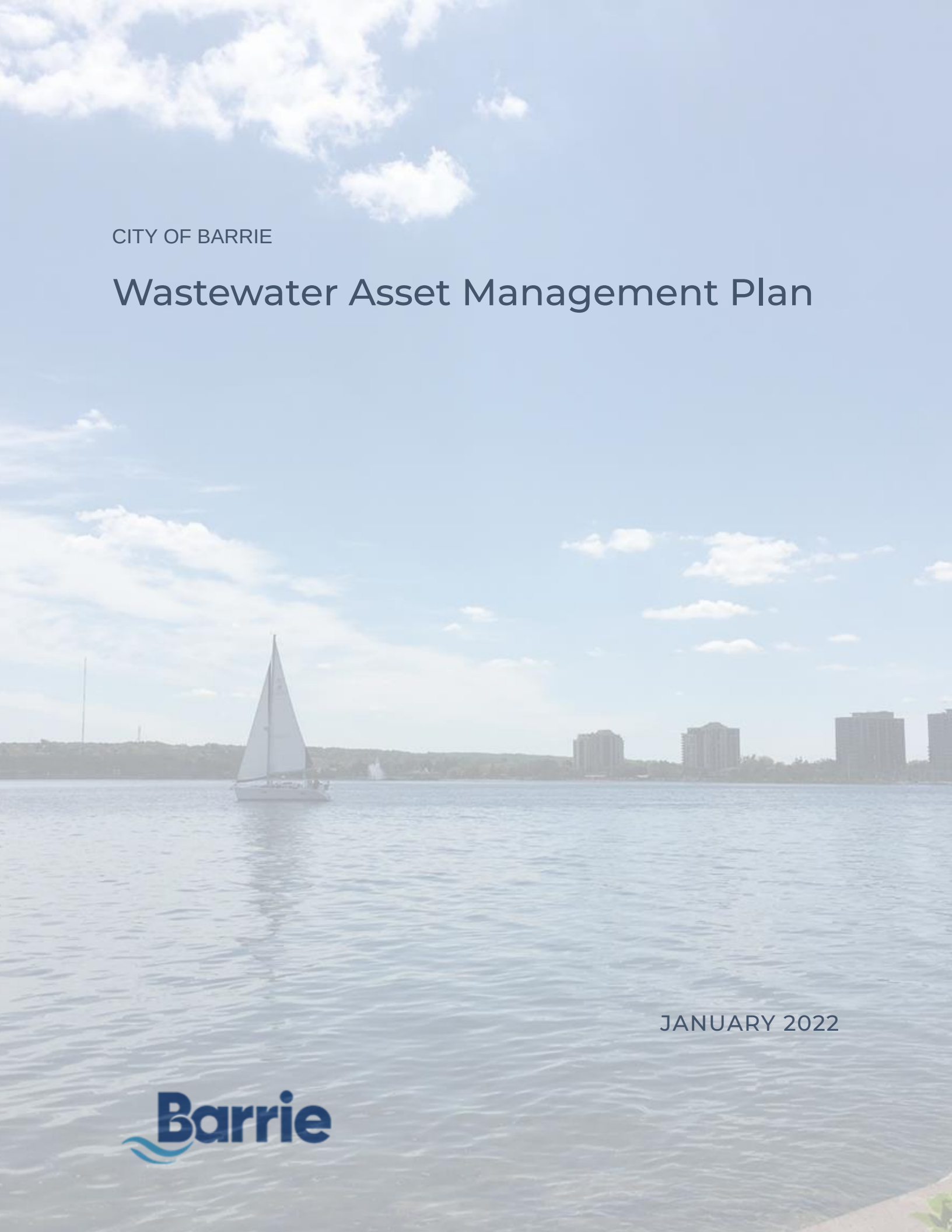

CITY OF BARRIE

Wastewater Asset Management Plan

JANUARY 2022

Wastewater Asset Management Plan

CITY OF BARRIE

FINAL (VERSION 3.0)

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Executive Summary

Introduction

The wastewater asset management plan (AMP) supports evidence-based decision making and development of strategies to extend the lifecycle of assets while meeting regulatory and customer service expectations. The wastewater AMP benefits the City by forecasting the investment needs of the wastewater assets and identifying how to prioritize allotment of the City's budget to provide the greatest value to the wastewater service users.

Asset management best practices require an understanding of what assets the City owns, what services the assets provide, and how services are delivered. To address these questions, the wastewater AMP reviewed the asset inventory to assess the state of the infrastructure, the current and proposed levels of service (LOS), strategies to maintain the assets, and the investment required to implement said strategies.

State of the Infrastructure Overview

The 2020 replacement value of the wastewater asset portfolio is approximately $1.35B (Table ES-1). This includes 549 km of pipes, worth approximately $331M, 7,890 maintenance holes worth $74M, and 13 pumping stations worth $30M. The estimated value of the Barrie WWTF and Oro-Medonte Biosolids Facility (BSF) are approximately $800M and $119M, respectively.

Condition ratings have been assigned to all wastewater assets using a scale of 1 (Very Good) to 5 (Very Poor). Where possible, these conditions were informed by a visual assessment of physical condition or performance testing (e.g., CCTV inspection for sanitary sewers, or visual inspection for pump stations). Age was used as a proxy where condition data was unavailable. Further details are provided in Section 3.2.

Table ES-1: Wastewater Asset Portfolio.

ASSETS	QUANTITY	UNIT	AVERAGE AGE IN 2020	AVERAGE EXPECTED LIFE	AVERAGE CONDITION	REPLACEMENT COST ($M 2020)
Sewer Mains	549	km	29	106	1.4 (Very Good to Good)	$ 331
Treatment Facility	1	ea.	25	64	2.4 (Good to Fair)	$ 798
Biosolids Facility	1	ea.	18	72	1.9 (Very Good to Good)	$ 119
Maintenance Holes	7,890	ea.	28	80	1.8 (Very Good to Good)	$ 74
Pumping Stations	13	ea.	22	43	1.9 (Good to Fair)	$ 30
NETWORK TOTAL			**25**	**75**	**2.0 (Good to Fair)**	**$ 1,353**

The earliest records of wastewater infrastructure in the City of Barrie include a sedimentation tank being built at the present site of the WWTF in 1911. The largest expansion period for both the linear and vertical wastewater assets occurred in the 1990s. Most of the wastewater assets are younger than 40 years (Figure ES-1). The average age of most wastewater assets has not yet surpassed the halfway point of their estimated service lives.

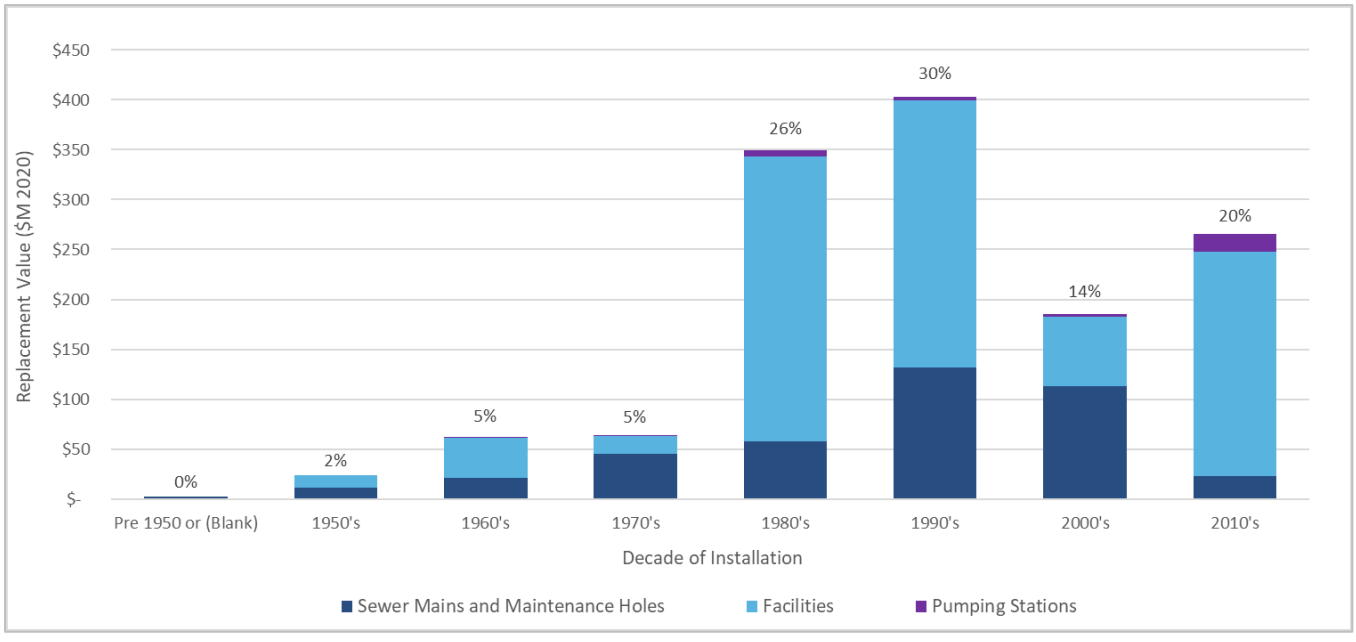

Figure ES-1: Wastewater Portfolio Replacement Value by Age Group.

The condition of all pump stations was determined through visual assessment. The remainder of the vertical assets' conditions was assumed based on age. From this analysis, 85.9% of vertical assets are considered to be in 'fair' to 'very good' condition.

The condition for linear assets was established using a combination of CCTV data and an age-based analysis. The condition analysis concluded that 99.1% of linear wastewater assets are in 'fair' to 'very good' condition.

Overall, approximately 83% of the City's wastewater assets are in 'good' or 'very good' condition (Figure ES-2).

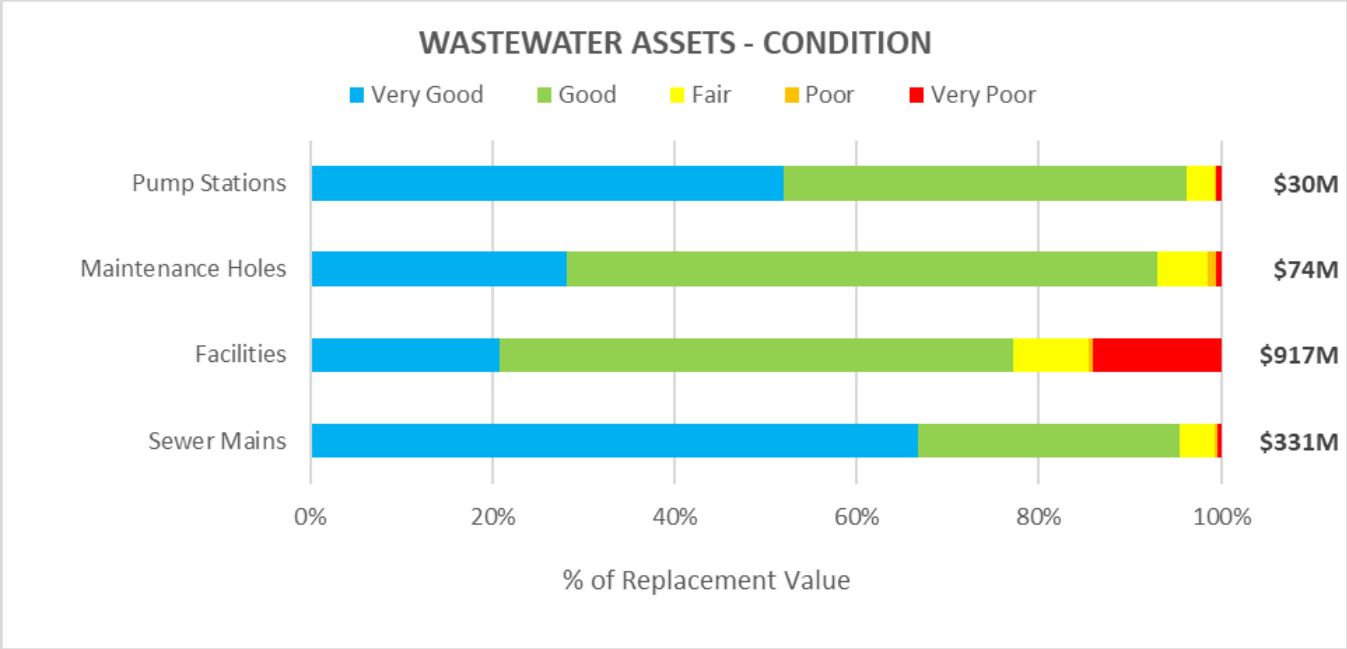

Figure ES-2: Wastewater Asset Condition Profile.

In order to prioritize assets for inspection, maintenance, or renewal activities, it is important to consider the overall risk of the asset failing. This is done be considering the probability that the asset will fail as well as the consequences if the asset fails. Probability of failure is estimated based on the condition, age, and sometimes other characteristics of the asset such as the material of construction; while the consequence of failure is evaluated based on factors such as the size or capacity, replacement value, and asset location (see Section 3). The risk assessment conducted for this AMP concluded that no assets are currently considered to be in the 'very high risk' category. However, approximately 8.8% of the assets in the City's wastewater portfolio ($119M) are considered 'high risk' assets (Figure ES-3). These high-risk assets are all components of the WWTF, many of which will be replaced or renewed as part of planned upgrades at the WWTF. The City should continue to monitor the condition of the remaining high-risk assets and implement renewal work as appropriate.

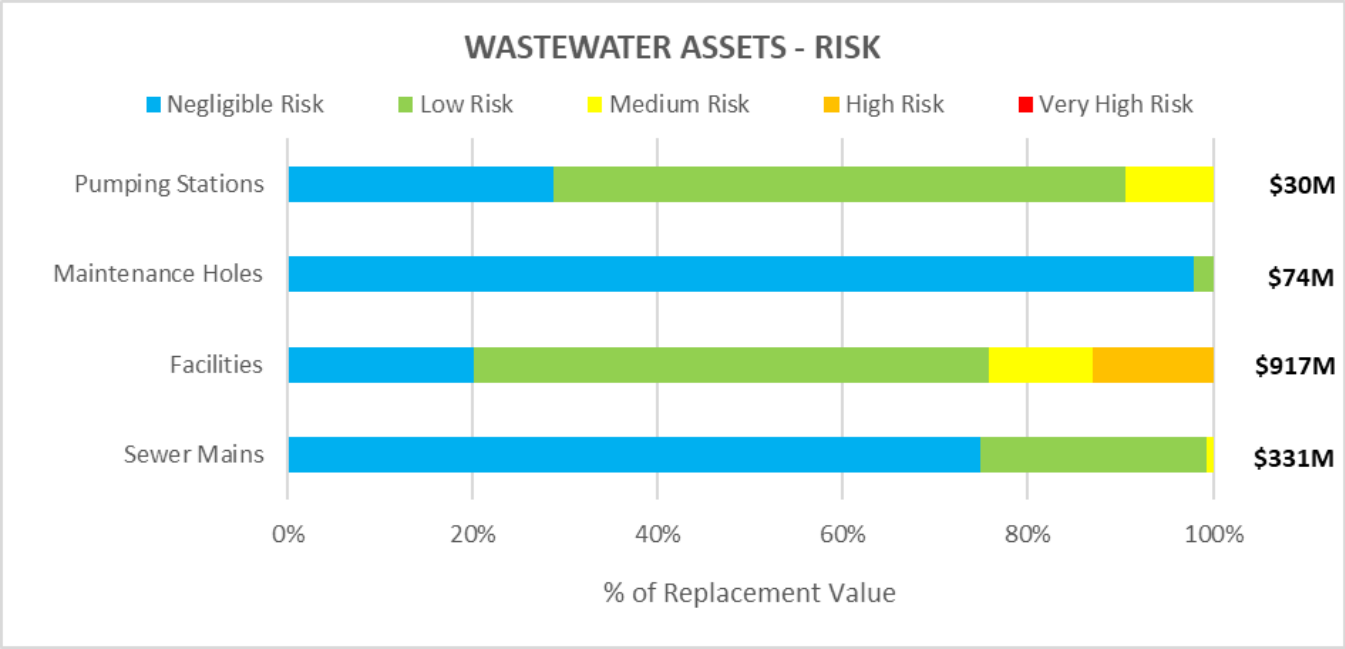

Figure ES-3: Wastewater Asset Risk Profile.

Levels of Service Overview

The LOS assessment describes the performance of the assets in relation to user and regulatory expectations. In general, the City aims to ensure that wastewater assets are in fair or better condition, of adequate capacity, and performing well at delivering expected service levels to the community.

The current performance has been documented based on the most recently available data. The performance targets for the LOS in this AMP are based on a combination of historical performance, where available, as well as City and stakeholder objectives.

Lifecycle Strategy Overview

The City's current practices for maintaining assets and meeting the service expectations of the community were documented in asset lifecycle strategies considering two general categories of activities: operation and maintenance (O&M), and renewal and replacement (R&R). The strategies were applied to individual assets to develop forecasts of estimated lifecycle needs and costs (see Section 4).

Growth and Demand

The City of Barrie continues to experience growth pressures requiring new and upgraded infrastructure to accommodate development in the secondary plan areas as well as intensification within the former built boundary of the City. The 2019 WWT and WWC Master Plans identified over $400 million in expansion and upgrade projects that would be needed to address growth projections for the City by 2031. Since growth has been proceeding more slowly than projected, the City has refined the identified needs and this is reflected in the City's 2021 Capital Plan and Outlook. The planned expenditures for expansion and upgrade of the City's wastewater assets in the City's 2021-2030 capital plan are $363 million. Approximately $9 million in expansion and upgrade projects from the WWC Master Plan have been deferred beyond 2030. This gap is not anticipated to result in impacts to levels of service over the 10-year planning period but the City will continue to monitor growth needs and adjust plans as appropriate.

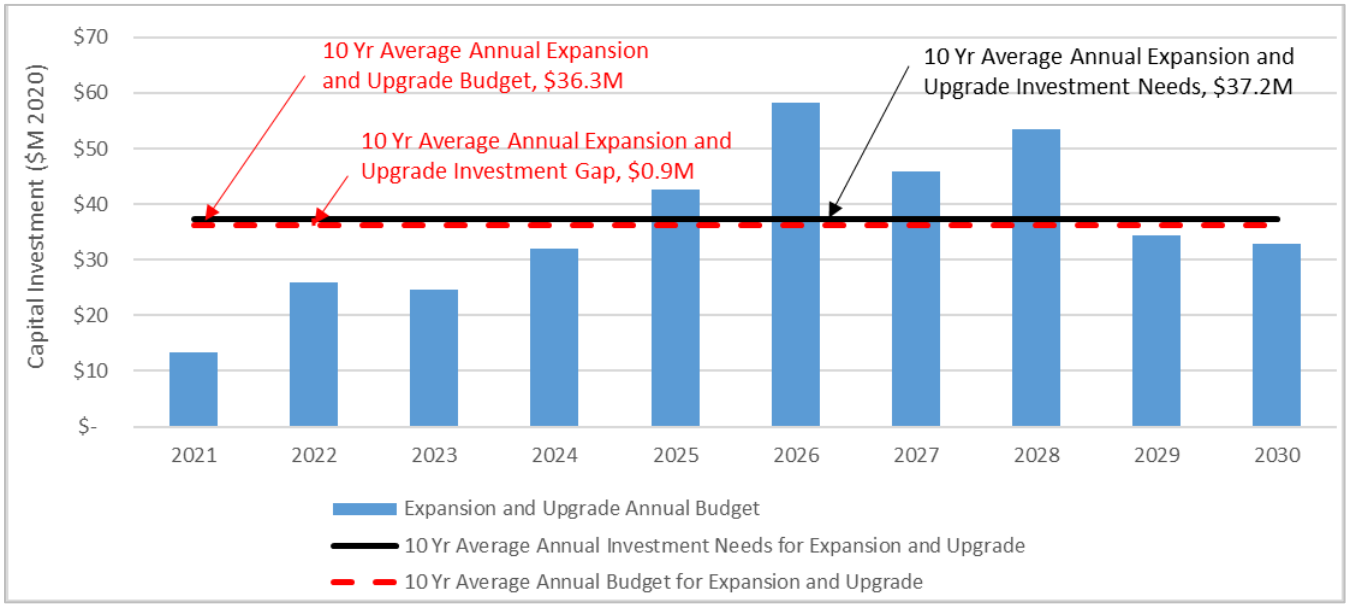

Figure ES-4: Comparison of Expansion and Upgrade Budget and Investment Needs.

Financial Strategy Overview

Paying for the Lifecycle Strategy requires careful consideration of the various sources of funding available. To avoid wide fluctuations in rates, best practices for financing rely minimally on short-term or reactive rate changes and instead optimizing the use of external sources of funding and strategic reserve funding approaches. Rate changes should be limited to regular annual adjustments rather than subjecting ratepayers to large swings or spikes in rates that are in response to infrastructure funding demand peaks.

This AMP does not present a specific strategy for funding the infrastructure needs but presents a long-term forecast to help inform financial planning. Capital renewal backlogs for existing infrastructure have been included in the forecasts to account for capital works that have been strategically delayed, many of which will be addressed in the expansion and upgrade activities that are planned to address growth.

Short-term Financial Strategy

The current infrastructure renewal backlog for wastewater assets, comprising assets that are currently past their theoretical service lives, is approximately $130M. This Includes approximately $1.5M worth of sewers and maintenance holes which are overdue for replacement, $0.1M of pumping station components, $0.2M for renewal of site works at the biosolids storage facility, and the remainder is made up of component assets at the wastewater treatment facility. Of the WWTF assets included in this backlog, approximately $91 million worth are scheduled to be replaced or renewed as part of planned upgrades to the WWTF within the 10-year planning period.

Based on findings from the short-term financial forecast (Figure ES-5), the annual investment shortfall is $7.6M on average over the 10-year period. This deficit includes capital renewal projects, operations, maintenance, and upgrade or expansion projects to address growth.

Infrastructure backlogs can have significant implications to the long-term financial sustainability of wastewater services. Many strategies exist to mitigate infrastructure backlogs, including investigating availability of external funding, reserve funding strategies, and prioritizing investments based on risk.

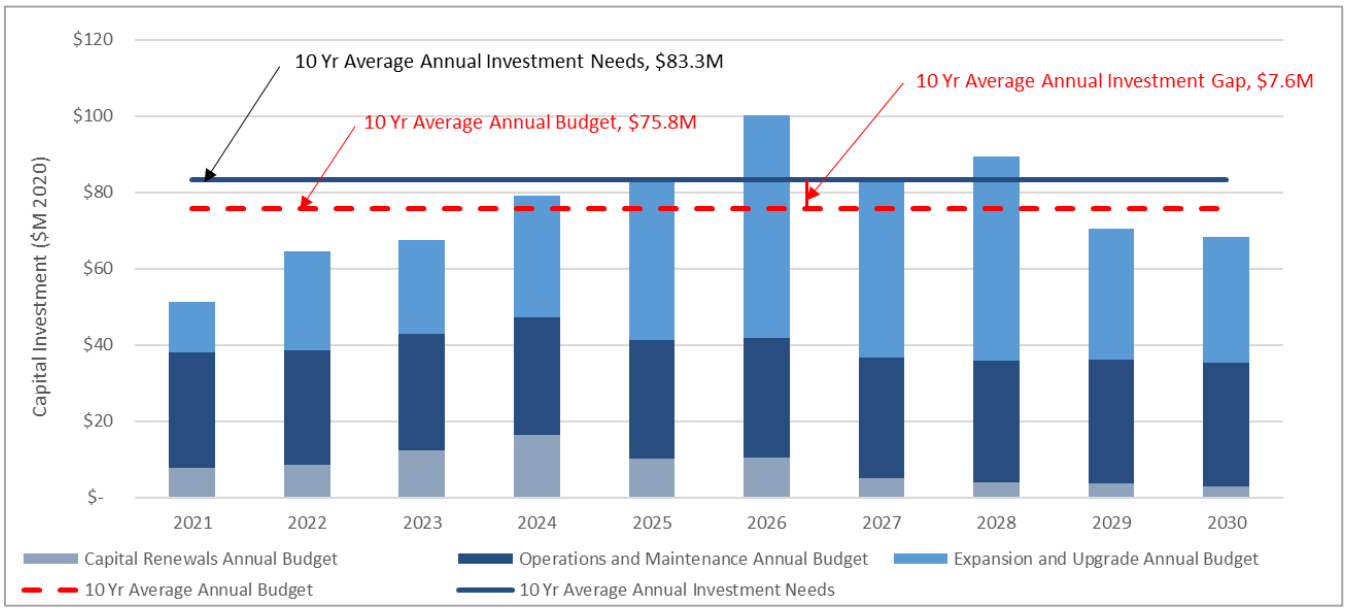

Figure ES-5: Short-Term Financial Needs Compared to the City's Budget.

Long-term Financial Strategy

Long-term reserve funding strategies are typically adopted to meet the long-term (i.e., 100 years) infrastructure needs. Considering only the existing asset portfolio over the next 100 years, the City will need to contribute an average of $26M dollars per year in capital renewal needs (Figure ES-6, see Section 6.2 for further details). This is approximately $12M dollars more per year than the average planned expenditures over the coming 10 years. The infrastructure needs forecast over the next 100 years shows several large peaks where many assets are expected to require renewal. Adequate funds must be available to manage these peaks and avoid undue financial burden to future generations, and work must be appropriately scheduled and phased to manage resourcing. Lifecycle needs associated with new assets constructed to service population growth have not been included in this forecast but will be integrated into future planning exercises as projects are realized.

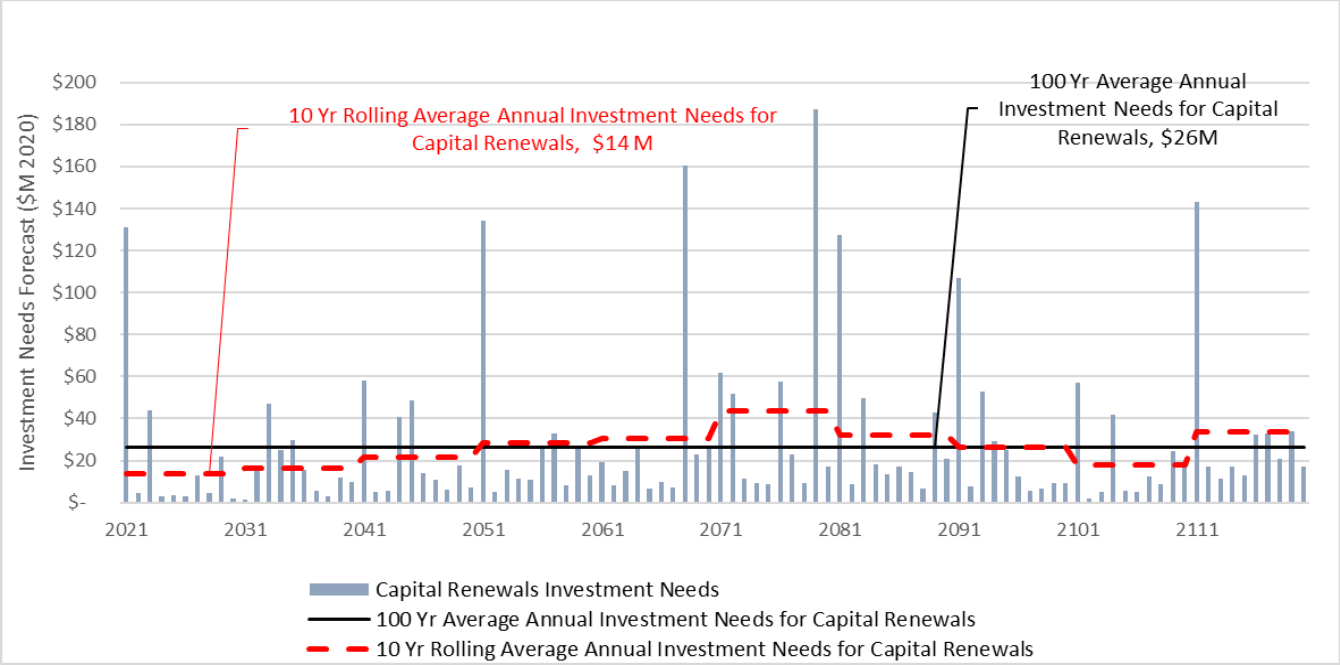

Figure ES-6: Long-Term Investment Needs for Wastewater Infrastructure.

Summary

The current wastewater asset portfolio has a replacement value of approximately $1.35B (2020). Most of the portfolio is younger than 40 years and has not yet surpassed the halfway point of their estimated service lives. Approximately 8.8% of assets in the portfolio can be considered ‘high risk’ assets that require condition monitoring and renewal prioritization. Over 83% of the City’s wastewater assets are in ‘good’ or ‘very good’ condition, and most of the assets are of adequate capacity and performing well.

There is currently a capital investment backlog, and the infrastructure gap is expected to continue to grow if existing levels of investment don't change. The financial forecasts developed in this AMP suggest an additional $7.6M of annual budget allocation would be needed over the next 10-year period to meet the needs identified in the lifecycle management strategy. However, thanks to the relatively young age of the City's wastewater assets, this investment gap is not expected to result in impacts to levels of service in the near term. For the long-term financial sustainability of the wastewater services, there is an anticipated renewal demand averaging $26M per year over the next 100 years for the existing asset portfolio. It should be noted that planned capital upgrades are already underway for certain assets that encompass some of the forecasted renewal needs and will therefore mitigate some of the infrastructure backlog and investment shortfall. Additional strategies, including investigating availability of external funding, reserve funding strategies, and prioritizing investments, are being considered to address the long-term investment needs. The City should continue to monitor the needs of the wastewater system and prioritize projects as appropriate, while also working toward ensuring adequate funding is available to meet the long-term financial needs.

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1 Introduction

Delivering wastewater services to the residents of the City of Barrie (the City) depends on effectively managing wastewater assets. Managing assets requires considering the full lifecycle of an asset from planning for new assets to the disposal of old assets. To continue delivering wastewater services that residents and businesses depend on, the City must make the right decisions at the right time to the right assets.

The City of Barrie developed a Strategic Asset Management Policy in 2019, outlining three guiding principles of the City's asset management strategy (Figure 1-1).

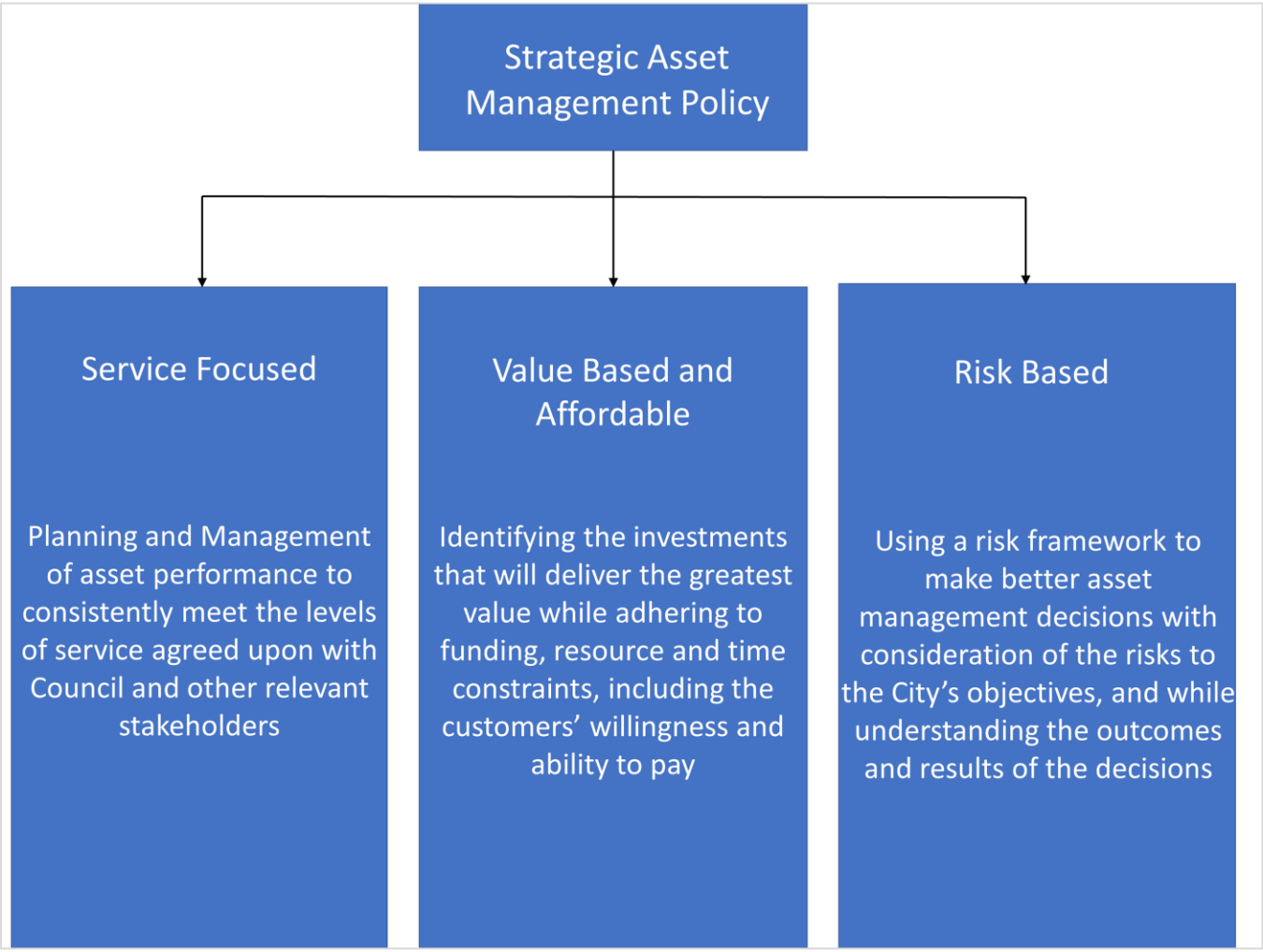

Figure 1-1: Guiding Principles for Asset Management[1].

[1] Adapted from the City's 2019 Strategic Asset Management Policy

1.1 Wastewater Goals

The Barrie City Council's strategic plan, approved by Council in 2019 and updated in 2020, highlights six key priorities.

- Growing our Economy
- Fostering a Safe and Healthy City
- Building Strong Neighbourhoods
- Supporting a Vibrant and Safe Downtown
- Offering Innovative and Citizen Driven Services
- Improving the Ability to Get Around

The City's goals for the wastewater asset portfolio are outlined in the Official Plan as follows:

- To cooperate with Conservation Authorities in the preparation of watershed plans for development decisions and water and wastewater servicing decisions
- The long-term protection of drinking water sources
- Maintaining high water quality in Kempenfelt Bay and the various watercourses within Barrie
- Providing clean, safe, and environmentally efficient methods of water treatment and distribution and sanitary sewage treatment and collection for industrial, commercial, institutional (ICI) and residential customers
- Encouraging measures that promote efficient and sustainable use of the City's water resources and conserving water through appropriate engineering and building requirements

1.2 Purpose

The Wastewater AMP reports on the health and sustainability of wastewater assets to the public and the City. The AMP also serves to meet the City's priority of "Offering Innovative and Citizen Driven Services" through providing the public information on service delivery and communicating Levels of Service (LOS).

This plan meets the 2022 and 2025 regulatory requirements of Ontario Regulation 588/17 (O.Reg.588/17) for the City's wastewater assets, which are defined as a core infrastructure asset in the regulation (Figure 1-2).

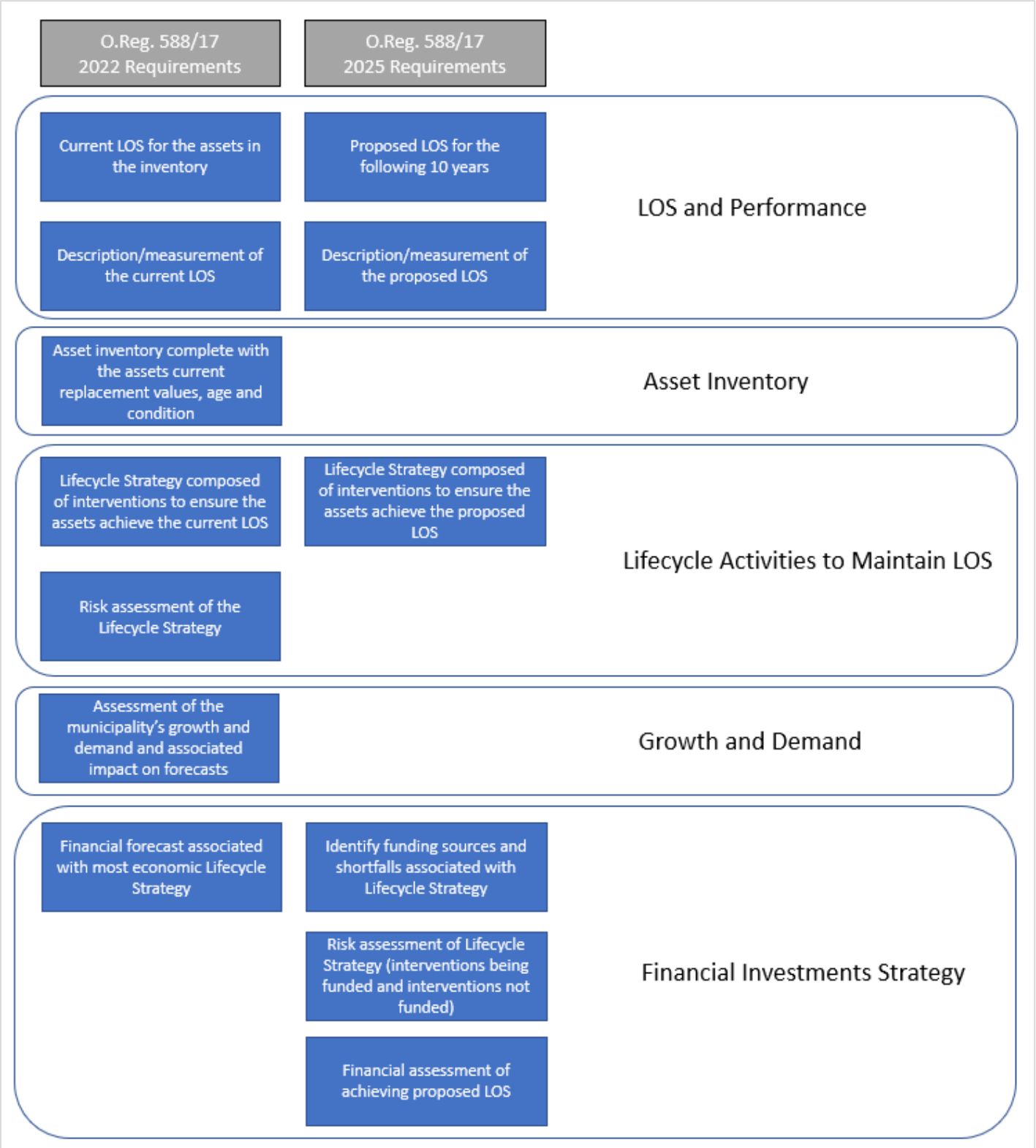

Figure 1-2: O.Reg. 588/17 Requirements.

1.3 Relationship with Other Planning Documents

This AMP is a planning document meant to support effective management of wastewater assets. Through effective management of the asset portfolio, proper resourcing of trained staff, and appropriate operation processes, high water quality can be maintained in Kempenfelt Bay and Lake Simcoe, and the City can continue to provide effective, safe, and environmentally-sound sewage collection, treatment, and effluent discharge. Achieving these goals will align with the Strategic Plan by contributing to a safe and healthy city, by contributing to growing Barrie's economy, and by helping to build strong neighbourhoods.

The Wastewater Treatment (WWT) and Wastewater Collection (WWC) Master Plans concluded that the City needs to increase its wastewater treatment capacity to accommodate the anticipated growth outlined in the City's Growth Scenarios Report (see Population and Economic Growth Plan), and that the current collection system needs expansion to continue to provide the same levels of service. The documents outlined several recommendations for upgrade and expansion projects for the wastewater portfolio to address additional future demands for wastewater servicing. The impact of these projects has been discussed in associated sections of the AMP.

The AMP has also considered several other additional planning documents, including:

- The Strategic Asset Management Policy,
- Official Plan,
- Council's Strategic Plan,
- Growth Scenarios Report,
- Growth Plan for the Greater Golden Horseshoe
- Long-Term Growth Scenarios Charges Background Study.

1.4 Scope of Plan

This AMP examines linear and vertical wastewater assets that are owned and operated by the City of Barrie, including:

Sewer Mains & Maintenance Holes

1 Barrie Wastewater Treatment Facility
1 Oro-Medonte Biosolids Facility

13 Sanitary Pumping Stations

The AMP has also incorporated future assets associated with the Secondary Planning Areas of Hewitt and Salem and other additional growth areas in the City.

1.5 Council Presentation and Approval

Council's involvement in asset management practices is outlined in the Strategic Asset Management Policy:

- Approval, by resolution, of the core infrastructure asset management plans by July 1, 2022 and any updates, at least every five years
- Approval, by resolution, of the annual reviews of asset management planning improvement on, or before July 1 of every year after the year in which the asset management plan is completed
- Support of the continuous effort to improve and implement this asset management plan

1.6 Process for Developing Plan

The AMP was developed following a six-phase process (Figure 1-3). Throughout the process, workshops were conducted to make decisions about key aspects of the plan including:

- Asset hierarchy workshop to confirm the level of detail in the hierarchy
- Risk workshop to discuss approach to development of the risk framework
- LOS workshop to develop LOS that will reflect the City's vision statement
- Lifecycle Strategies workshop to confirm current intervention strategies used by the City

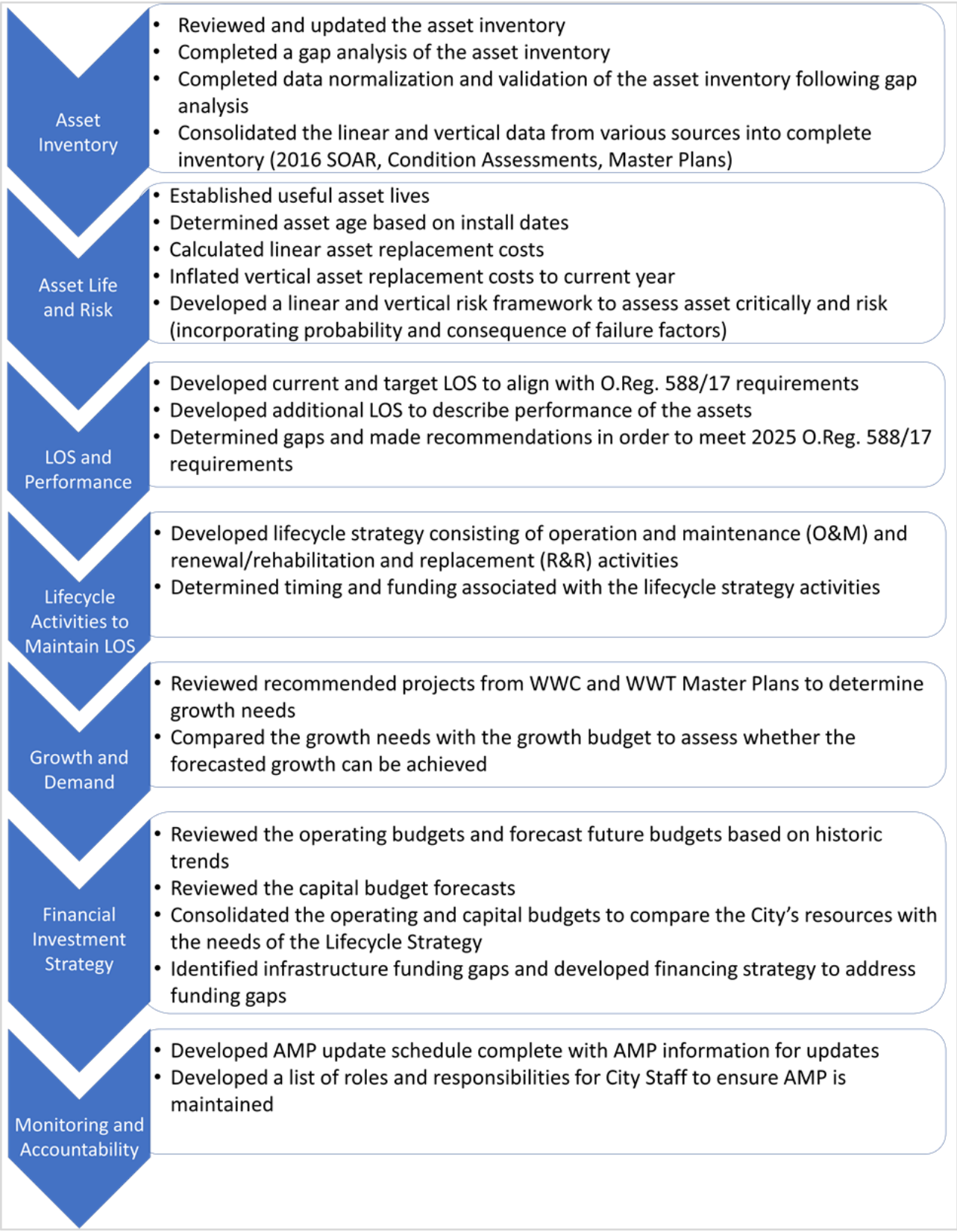

Figure 1-3: AMP Development Process.

2 Levels of Service and Performance

2.1 Introduction to Levels of Service and Performance

The LOS help define services offered, supporting decision-making regarding the level of investment and the types of activities required to maintain a service. Alignment between the services delivered and the investments made helps to meet or address stakeholder expectations. Effective LOS must balance needs, affordability, and risk tolerance.

Through consideration of wastewater service objectives and City Staff's understanding of stakeholders' expectations, a wastewater service outcome statement was adopted for this AMP to help document and guide the plan:

> "Public safety is our top priority, rooted in having available reliable and quality infrastructure in good condition that is managed to keep risk low and meet our compliance objectives."

2.2 Regulatory Requirements

O.Reg. 588/17 differentiates level of service between community LOS and technical LOS. To ensure the 'line of sight' with the City's vision statement is satisfied, additional LOS performance measures have been included as shown in Figure 2-1. These LOS include historical data, where available, to establish trends in the performance of the wastewater system.

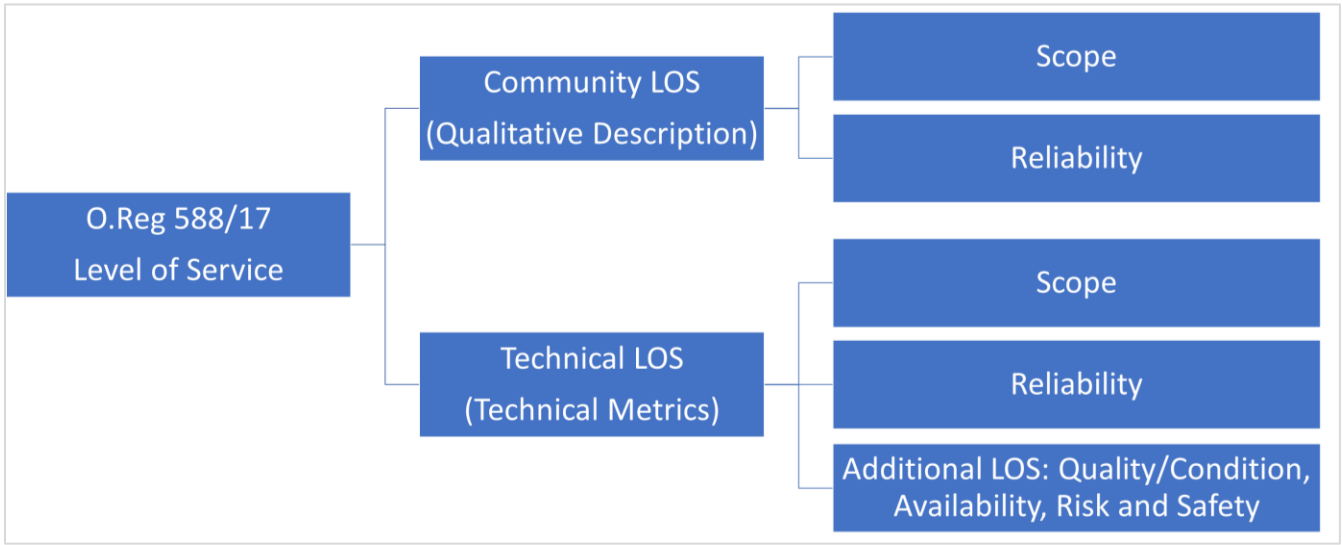

Figure 2-1. Level of Service Hierarchy per O.Reg. 588/17.

2.3 Levels of Service and Performance Measures

The discussion in this section will focus on the wastewater asset portfolio's performance in relation to the LOS measures required by O.Reg. 588/17 as well as additional performance measures chosen to support effective asset management. It should be noted that several of the LOS specified in O.Reg. 588/17 do not apply; for instance, O.Reg. 588/17 requires a description of the combined sewers in City's sanitary network for two separate Community LOS; these are not relevant because the City of Barrie is no longer serviced by combined sewers in the sanitary network.

Inflow and infiltration (I&I) can enter sanitary networks in a few ways, including cracks in pipes, and through illegal sump pump and downspout connections to the system. For this AMP, the prevalence of I&I has been estimated by comparing the volume of treated potable water produced with the volume of sewage treated at the Wastewater Treatment Facility (WWTF). Analysis revealed that the extent of I&I in the City's sanitary network ranges from 25% to 35%. In other words, the City currently treats more wastewater than water is produced. This analysis is an interim measure for I&I while more detailed studies examine the prevalence of I&I within the system. More detailed measurement and indicators of I&I are planned to be developed over the next few years.

Analysis of the linear wastewater assets shows that over 99% are currently in 'fair' to 'very good' condition, indicating that most of the sewer network is in a good state of repair. Forecasting the linear system's condition over the next 10 years (Figure 2-2) shows that the system is expected to be in fair to good condition, on average, in 2030.

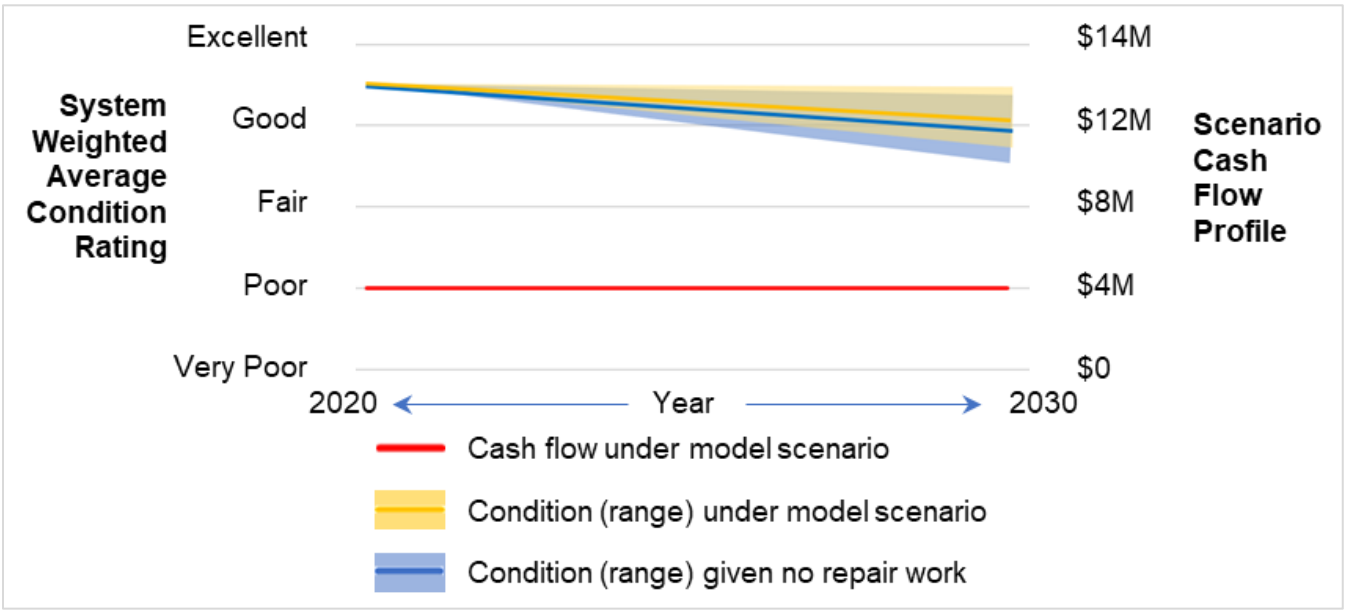

Figure 2-2. Linear Asset Lifecycle LOS Forecast under Current Investment Levels

A similar analysis of the vertical wastewater assets reveals that approximately 85.9% are currently in 'fair' to 'very good' condition. When the vertical asset condition is forecast over the next 10 years (Figure 2-3), the levels of services are shown to exceed targets. In 2030, for instance, the aggregate average condition is estimated to be 'fair'. Several components of vertical assets do fall under the target level of service: building architectural, building and process electrical, and building services.

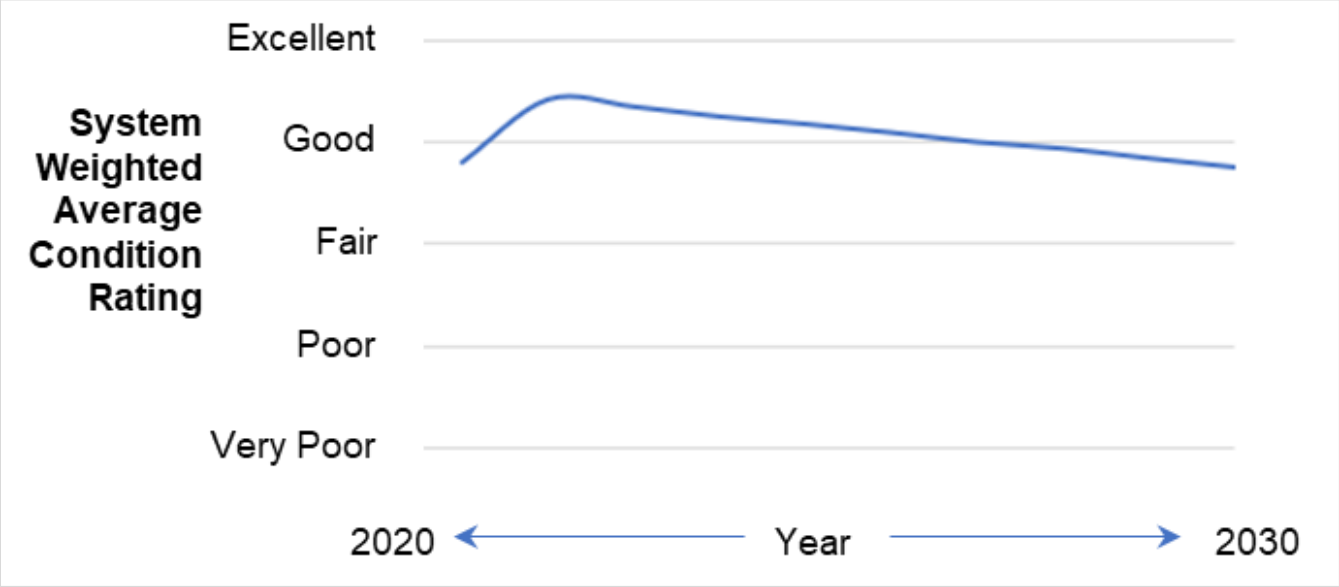

Figure 2-3. Vertical Asset Lifecycle LOS Forecast under Current Investment Levels

The anticipated upgrades to the WWTF are expected to positively influence the average condition rating of the vertical assets. It should be noted that the physical condition is not an evaluation of system capacity.

Historic data for the WWTF effluent reveals that discharged effluent is high quality treated water. In 2019, the WWTF only recorded 6 incidents (see Table 2-1) exceeding effluent objectives, and no instances of exceeding regulatory limits. The WWTF consistently produces effluent with a concentration that fully meets objectives and limits set out in the facility's environmental compliance approval (ECA) (see Appendix A: WWTF Performance), which reduces the human impact of our community on the health of Lake Simcoe and the natural environment.

Table 2-1 below summarizes the community and technical LOS required to be reported on for O.Reg. 588/17 compliance. The City is meeting or exceeding performance targets in most of the measures, indicating very good performance overall.

Table 2-1. LOS and Performance Measures.

LOS CATEGORY	SERVICE ATTRIBUTE	LEVELS OF SERVICE	PERFORMANCE	PERFORMANCE TARGET
COMMUNITY LEVELS OF SERVICE	Scope	Description, which may include maps, of the user groups or areas of the municipality that are connected to the municipal wastewater system. (O.Reg. 588/17).	99.5% of properties are connected to the municipal wastewater system.	Not applicable.
	Reliability	Description of how combined sewers in the municipal wastewater system are designed with overflow structures in place which allow overflow during storm events to prevent backups into homes. (O.Reg. 588/17).	The City is no longer serviced by combined sewers.	Not applicable.
		Description of the frequency and volume of overflows in combined sewers in the municipal wastewater system that occurs in habitable areas and beaches. (O.Reg. 588/17).	The City is no longer serviced by combined sewers.	Not applicable.
		Description of how stormwater can get into sanitary sewers in the municipal wastewater system, causing sewage to overflow into streets or backup into homes. (O.Reg. 588/17).	Infiltration and inflow into sanitary sewers during storm events may enter from a variety of sources such as cracks in the sanitary sewers and downspout/sump pump connections to the system.	Infiltration and inflow are less then 25% of dry weather flow.
		Description of how sanitary sewers in the municipal wastewater system are designed to be resilient to avoid overflow or backup events. (O.Reg. 588/17).	To mitigate sewage overflow or backup events into streets or homes, the City of Barrie has designed the sanitary sewers to accommodate flows so that infiltration is accounted for and these events are minimized.	ALL sewers are designed to meet the City's standards.

LOS CATEGORY	SERVICE ATTRIBUTE	LEVELS OF SERVICE	PERFORMANCE	PERFORMANCE TARGET
		Descriptions of the effluent that is discharged from the sewage treatment plants in the municipal wastewater system. (O.Reg. 588/17).	The effluent discharged from the WWTF is the treated sewage from ICI and residential users that flows into Lake Simcoe. The effluent from the Barrie WWTF has compliance limits and objectives outlined in its ECA (No. 0284-B2ML52) that it must meet. Appendix A summarize the WWTF's 2019 performance against these objectives and limits.	Not applicable.
TECHNICAL LEVELS OF SERVICE	Quality / Condition	Percentage of linear assets where the condition is rated as fair to very good (by current replacement value)	99.1%[1]	70%
		Percentage of vertical assets where the condition is rated as fair to very good (by current replacement value)	85.6%[1]	70%
	Scope	Percentage of properties connected to the wastewater system. (O.Reg. 588/17).	99.5%	99%
	Reliability	The number of events per year where combined sewer flow in the municipal wastewater system exceeds system capacity compared to the total number of properties connected to the municipal wastewater system. (O.Reg. 588/17).	The City is no longer serviced by combined sewers.	0
		The number of connection-days per year [that the properties connected to a municipal system are affected by a service issue] due to wastewater backups compared to the total number of properties connected to the municipal wastewater system. (O.Reg. 588/17).	35 connection-days[2] (45,009 properties connected to the municipal wastewater system)	30

LOS CATEGORY	SERVICE ATTRIBUTE	LEVELS OF SERVICE	PERFORMANCE	PERFORMANCE TARGET
		The number of effluent violations per year due to wastewater discharge compared to the total number of properties connected to the municipal wastewater system. (O.Reg. 588/17).	0[1] (45,009 properties connected to the municipal wastewater system)	0
	Availability / Reliability	Inflow and infiltration prevalence in the collection system (% of unaccounted water when comparing treated water divided by produced water)	27.6%[1]	25%
	Risk / Safety	No. of annual ECA effluent concentration limit exceedances	0[1]	0
		No. of annual ECA effluent concentration objective exceedances	6[1]	0
		No. of annual ECA effluent loading limit exceedances	0[1]	0
	Quality / Condition	% of City sewer length inspected annually	14.85%[1]	10.0%

[1:] Based on 2019 inspection program.
[2:] Estimated based on the number of incidents and the average duration of service disruption per incident.

3 Wastewater Asset Inventory

3.1 Summary of Assets

The City of Barrie operates and maintains a wastewater asset portfolio worth approximately $1,353M (Table 3-1). This includes approximately 549 km of sanitary sewers comprising 10 km of sanitary force mains, 419 km of local sewers, and 120 km of trunk sewers. The portfolio also includes approximately 7,890 maintenance holes, 2 major facilities (Barrie WWTF and Oro-Medonte Biosolids Facility) and 13 sanitary pumping stations.

Table 3-1: Summary of Wastewater Assets

ASSETS	QUANTITY	UNIT	CURRENT REPLACEMENT VALUE ($M 2020)
Sewer Mains	549	km	$331
Treatment Facility	1	ea.	$798
Biosolids Facility	1	ea.	$119
Maintenance Holes	7,890	ea.	$74
Pump Stations	13	ea.	$30
TOTAL			**$1,353**

The replacement values presented throughout this document differ from the book value of the assets. The replacement value considers the full cost of like-for-like replacement of assets. Replacement value accounts for the cost of replacing assets in the urban environment while maintaining the service, minimizing impacts to other operating assets, and replacement with modern equivalent assets. Many assets were acquired during large scale development or construction projects where installations are less costly due to the greenfield nature of construction or lack of previous development. Materials and methods of construction change over time and therefore the estimated cost of replacement reflects the current practices.

3.2 Asset Qualitative Analysis

3.2.1 Overview

The linear wastewater asset data was exported from the City's mapping (GIS) database. The condition of each pipe segment was determined based on CCTV inspections or, for those pipes that have not been inspected, based on age and service life. The vertical infrastructure asset inventory was based on previous work undertaken by the City, and updated with available information to reflect 2020 replacement cost estimates. In 2020 a visual condition assessment was conducted for the pumping stations, while the condition of most assets at the WWTF and the biosolids facility (BSF) was estimated based on asset age and expected service life. Wastewater Operations Branch (WWOB) staff are currently undertaking work to improve the vertical asset data.

3.2.2 Linear Infrastructure

The pipe materials used in the sanitary collection system include asbestos cement, concrete, ductile iron, high density polyethylene (HDPE), polyvinyl chloride (PVC), and vitrified clay. The most prevalent material in the collection system is PVC, while the least prevalent is ductile iron (Figure 3-1). Despite its strength, ductile iron is vulnerable to deterioration in corrosive environments. In contrast, PVC is a very corrosion-resistant material. Currently, PVC and concrete pipes are used for most installations across the City. Only approximately 53m of ductile iron pipes still exist in the City's sanitary collection system.

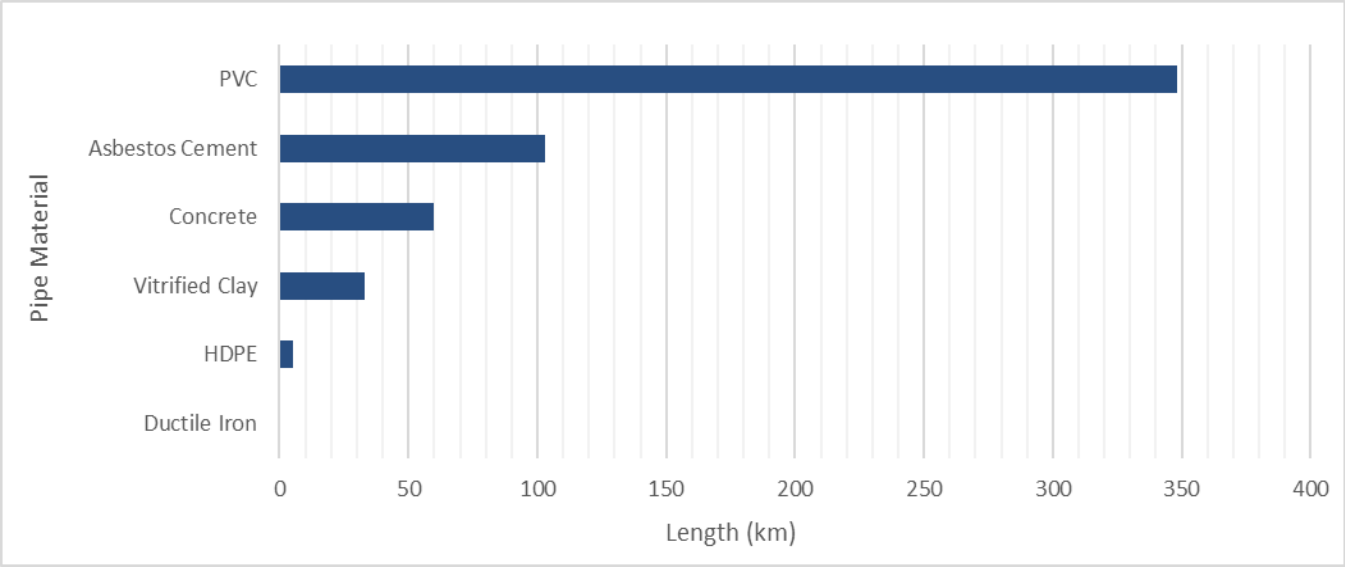

Figure 3-1. Sanitary Collection System by Material of Construction

3.2.3 Vertical Infrastructure

The vertical component of the wastewater asset portfolio comprises the Barrie Wastewater Treatment Facility (WWTF), a Biosolids Facility (BSF), and thirteen (13) sanitary pumping stations. The Barrie WWTF is the most valuable vertical wastewater asset at approximately $798M (2020), while the BSF is valued at approximately $119M (2020). Figure 3-2 and Figure 3-3 present the replacement value breakdown by asset lifecycle categories for these two facilities.

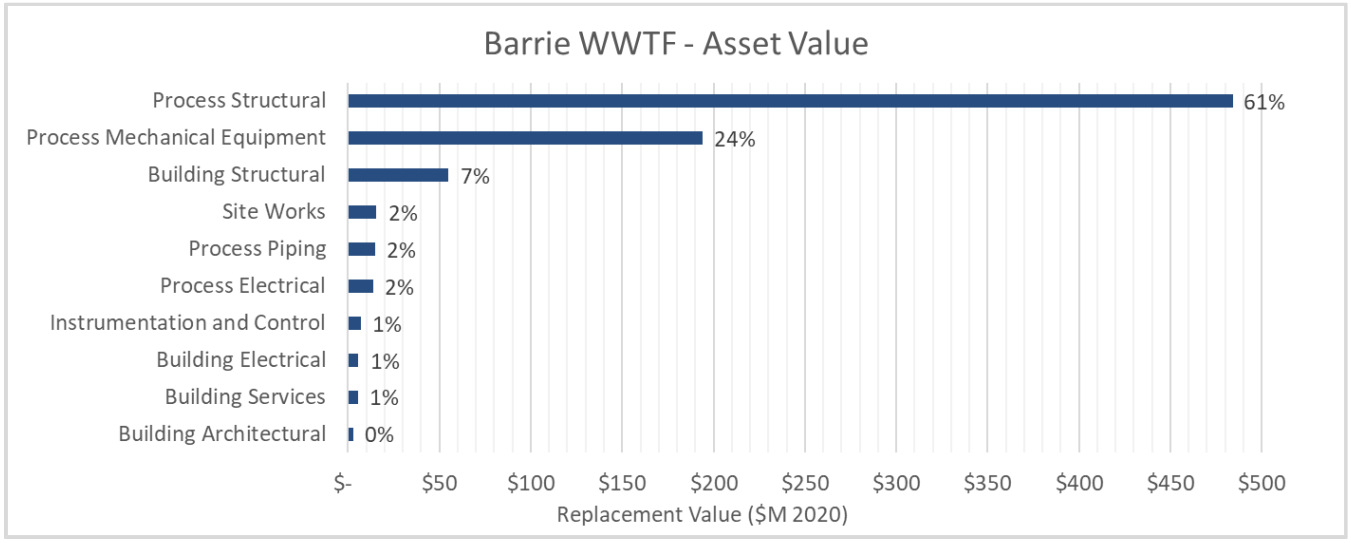

Figure 3-2: WWTF Asset Value by Category.

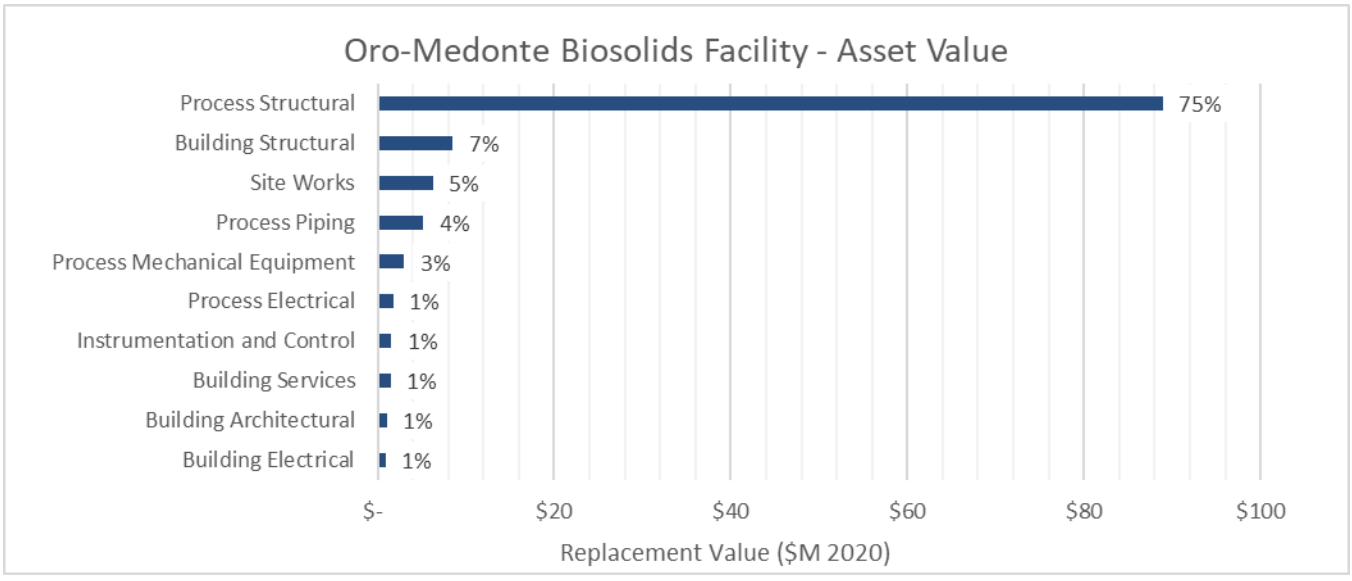

Figure 3-3: Oro-Medonte Biosolids Facility Asset Value by Category.

The Sanitary Pumping Stations (SPSs) account for approximately $30M (2020) of the vertical wastewater portfolio (Figure 3-4).

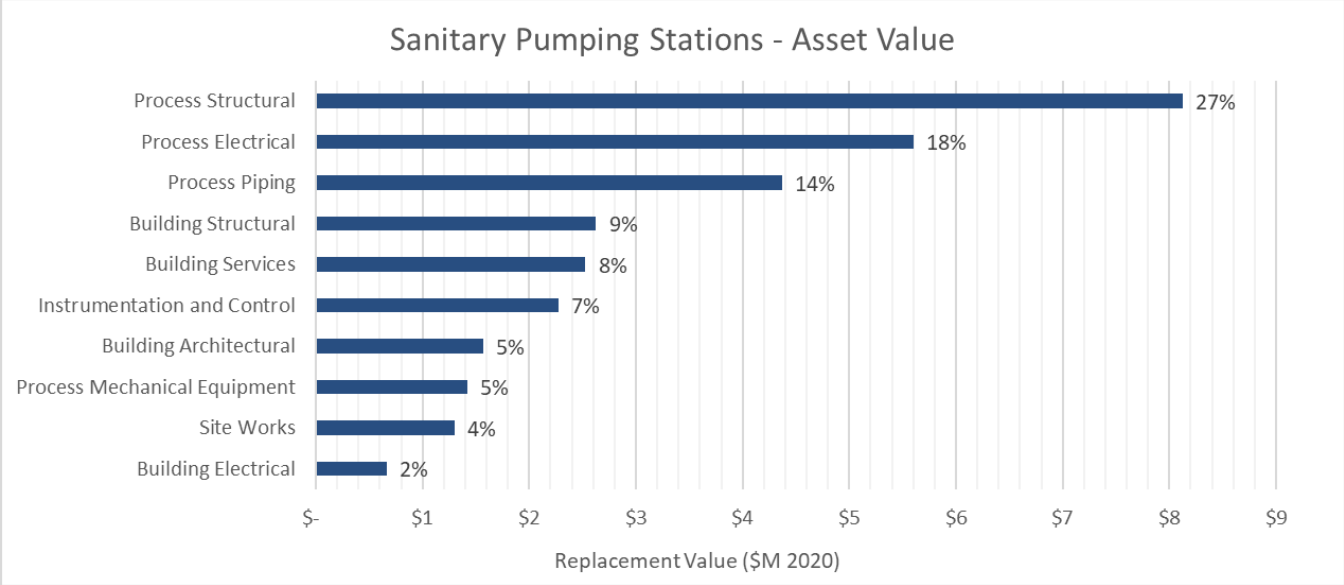

Figure 3-4: Sanitary Pumping Stations Asset Value by Category.

The estimated replacement value of each SPS provides us with a useful proxy of their relative size (Figure 3-5). The distribution shows that the largest SPS is Holly SPS, accounting for approximately 52% of the total SPS portfolio replacement cost. The smallest SPS is Innisfil Street SPS, accounting for only about 1% of the total SPS replacement costs.

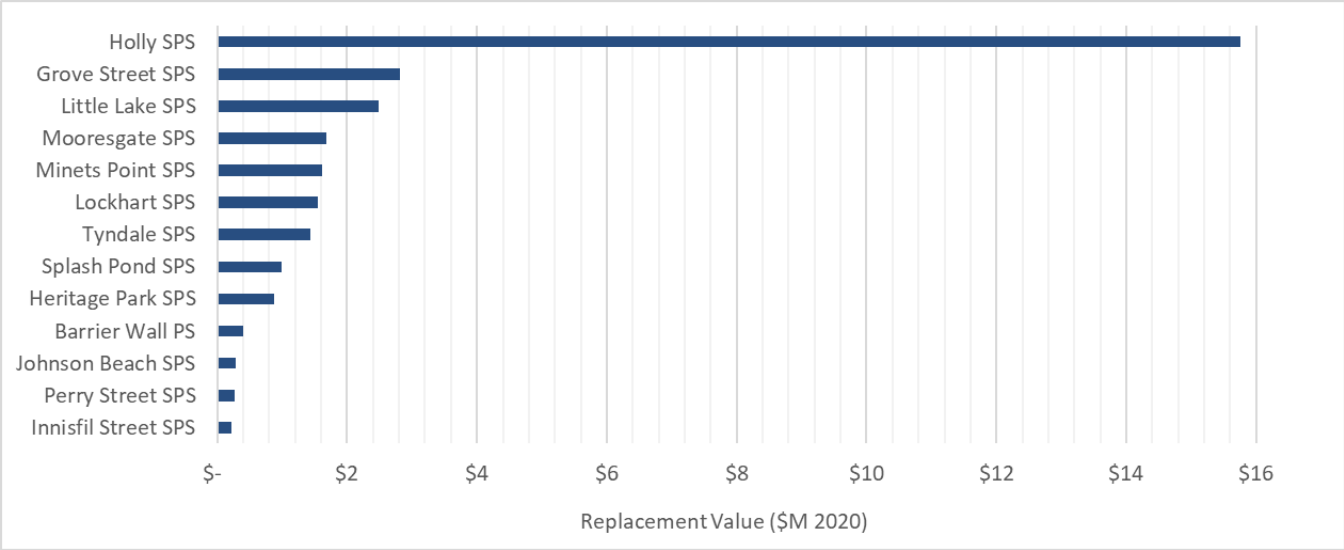

Figure 3-5: Sanitary Pumping Stations by Current Replacement Values.

3.2.4 Lateral Sewer Connections

While lateral connections in the City are owned by property owners, in some cases the City provides grants for renewal and replacement works. Considering the lateral connections alongside the City's wastewater system can support decision-making and understanding the size and probable condition of the portfolio helps facilitate better decisions related to laterals. There are over 45,000 billed sewer connections recorded, with a total length estimated between 400 and 500 km (Table 3-2). Of these 45,000 sewer connections, an estimated 1,780 are constructed of bituminous fibre – a material used primarily between 1940 and 1965, and which is more likely to fail due to use of hot water from washing machines and dishwashers.

Table 3-2. Lateral Sewer Connection Inventory (Not City Property)

INVENTORY INFORMATION	QUANTITY
Total number of lateral sewer connections (i.e., billed sewer connections)	45,009
Total number of bituminous fibre lateral sewer connections	1,780[1]
Total length of pipe and associated replacement cost[2]	Length: 450km – 500km Replacement cost: $450M- $500M

1: Based on the estimate from Staff Report RPF009-18, June 25, 2018

2: Costs have been adjusted based on 2020 values

3.3 State of Infrastructure

3.3.1 Wastewater Portfolio by Asset Age

Expected Service Lives

Estimated service lives (ESLs) were assigned to every asset in order to forecast future replacement needs, and to approximate asset condition for infrastructure that has not been inspected. The ESL for different materials of pipe was determined based on the industry best estimates and specific experience in the City (Table 3-3). Service life estimates were assigned to vertical assets based on the category of asset (Table 3-4).

Table 3-3. Linear Asset Estimated Service Life (Years).

MATERIAL	ESTIMATED SERVICE LIFE (YEARS)
Asbestos Cement	80
Concrete	80
Ductile Iron	80
High Density Polyethylene (HDPE)	80
Polyvinyl Chloride (PVC)	120
Vitrified Clay	100 (local sewers), 80 (trunk sewers)
Maintenance Holes	80

Table 3-4. Vertical Asset Expected Service Lives (Years).

CATEGORY	ESTIMATED SERVICE LIFE (YEARS)
Building Architectural	25
Building Electrical	30
Building Services	25
Building Structural	60
Instrumentation and Control	15
Process Electrical	30
Process Mechanical Equipment	30
Process Piping	60
Process Structural	60
Site Works	25

Age Profiles of the Linear Wastewater Assets

The average age of linear assets relative to their respective ESL shows that most of the assets are relatively new (Figure 3-6). The only two pipe materials for which the average age had exceeded half of the estimated service life were the asbestos cement and vitrified clay pipe segments, which is expected considering that these are obsolete materials that were used early in the system's development. The City's maintenance holes are also relatively new, matching the linear asset development, with an average age of 30 years.

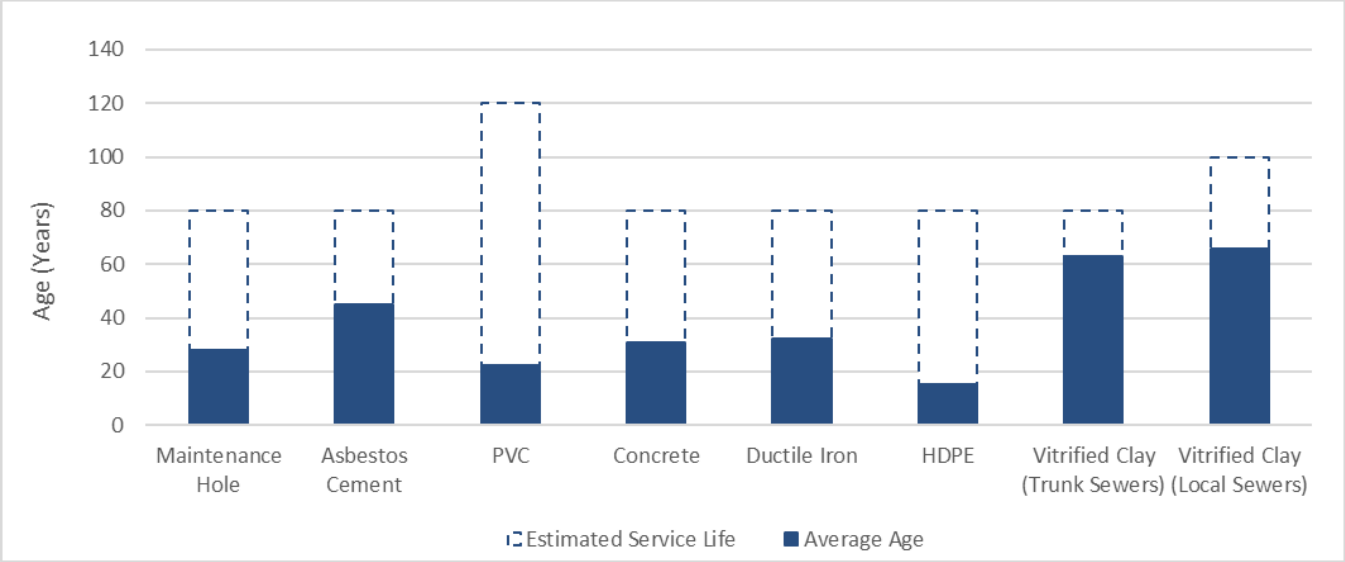

Figure 3-6: Average Age of Linear Wastewater Assets

Installation dates for the sanitary sewers and maintenance holes (Figure 3-7) were exported from GIS records. Over 60% of sewers and maintenance holes were installed in the past 30 years. The significant growth in linear wastewater assets was due to an increasing population and corresponding wastewater service demand. The trending growth in demand over the last 30 years aligns with population forecasts summarized in the City's Growth Scenarios Report (see Section 5.1).

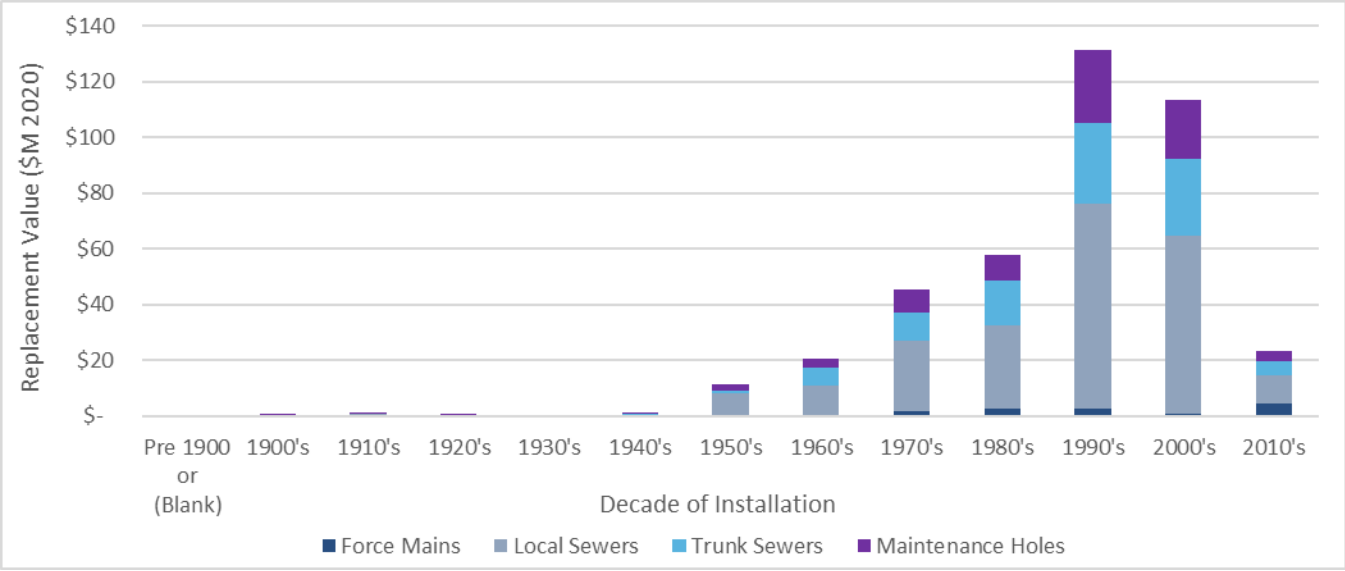

Figure 3-7: Age Profile of Linear Assets.

Over 80% of the linear assets have yet to pass the halfway point of their estimated service life as shown in Figure 3-8.

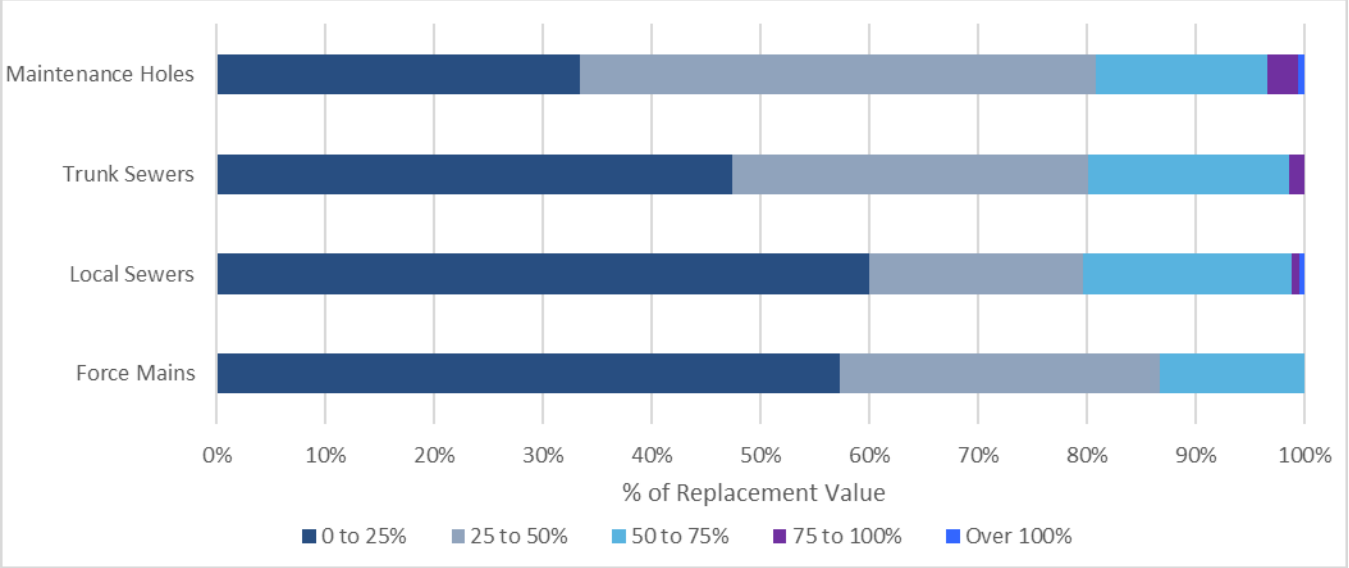

Figure 3-8: Age Profile of Linear Assets by Expended Lives.

Age Profiles of the Vertical Wastewater Assets

The average ages for vertical wastewater assets show a mixture of expended asset lives. The average age of instrumentation and control assets have nearly consumed their service lives (Figure 3-9). Instrumentation and control assets include items such as flow meters and programmable logic controller (PLC) panels which are critical for the process and monitoring of vertical wastewater facilities. Although the instrumentation and control assets are still in service, these assets should be prioritized for replacements to prevent further deterioration and unexpected failures.

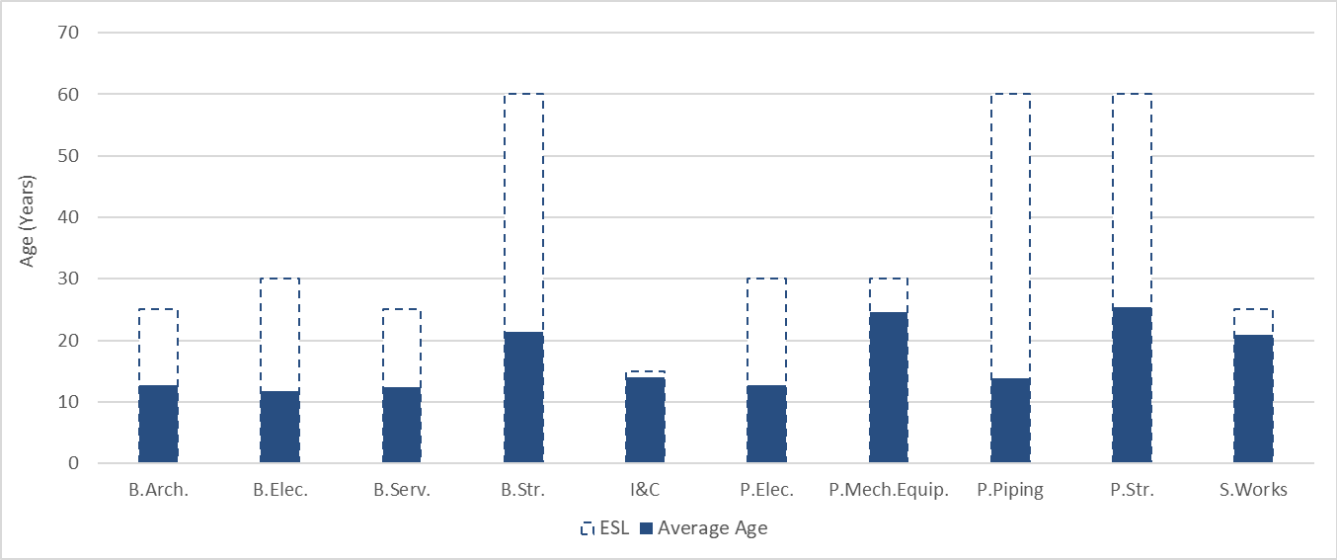

Figure 3-9: Average Age of Vertical Wastewater Assets.

Over 90% of vertical assets were constructed after the 1980's (Figure 3-10). The WWTF has the widest range of asset ages, which was expected because it is the City's oldest vertical wastewater asset. The significant planned expansion to the WWTF aligns with the population growth expected based on current forecasts.

Implementation of O&M activities are essential for maintaining the level of service of the City's wastewater assets. Regular maintenance and inspection can help detect issues and determine appropriate interventions early, extending asset life. Asset failure has the potential to directly or indirectly harm City Staff, the public, and/or the environment. Through implementing optimal lifecycle strategies, the City aims to maintain a sustainable level of service.

The needs forecast has highlighted a theoretical backlog of capital renewals. The backlog is sufficiently large that it will need to be prioritized based on risk, affordability, and available resources. This backlog could lead to increased risk of asset failure, unplanned maintenance and possibly not meeting level of service objectives if not addressed.

It is expected that the largest percentage of asset replacements will be required at the Barrie WWTF due to age. The City is in the process of upgrading and expanding the WWTF, and the average age of these assets will change significantly following the completion of these projects.

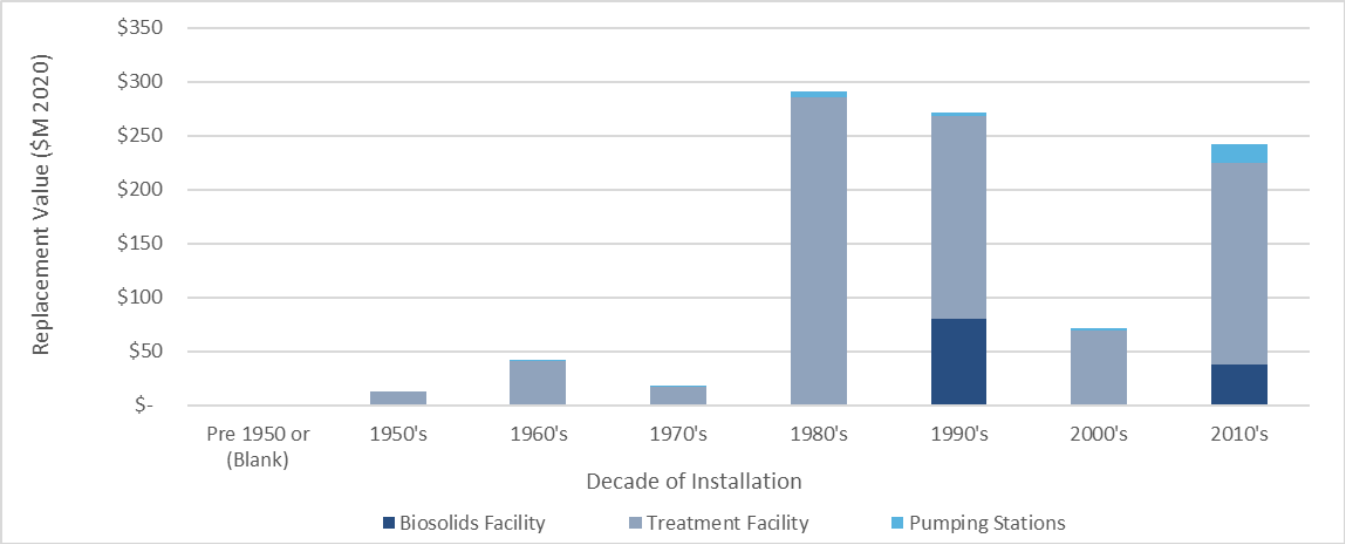

Figure 3-10: Age Profile of Vertical Assets.

The 1980s and 1990s were the decades with the largest acquisitions of vertical wastewater assets. Approximately 30% of the total vertical wastewater assets' value was acquired in each of these decades. Approximately 14% of the vertical wastewater portfolio (by replacement value) have exceeded their estimated service life. These assets need to be prioritized in future renewal projects. It should be noted that some of the replacement needs identified will be addressed in planned capital upgrades at the WWTF.

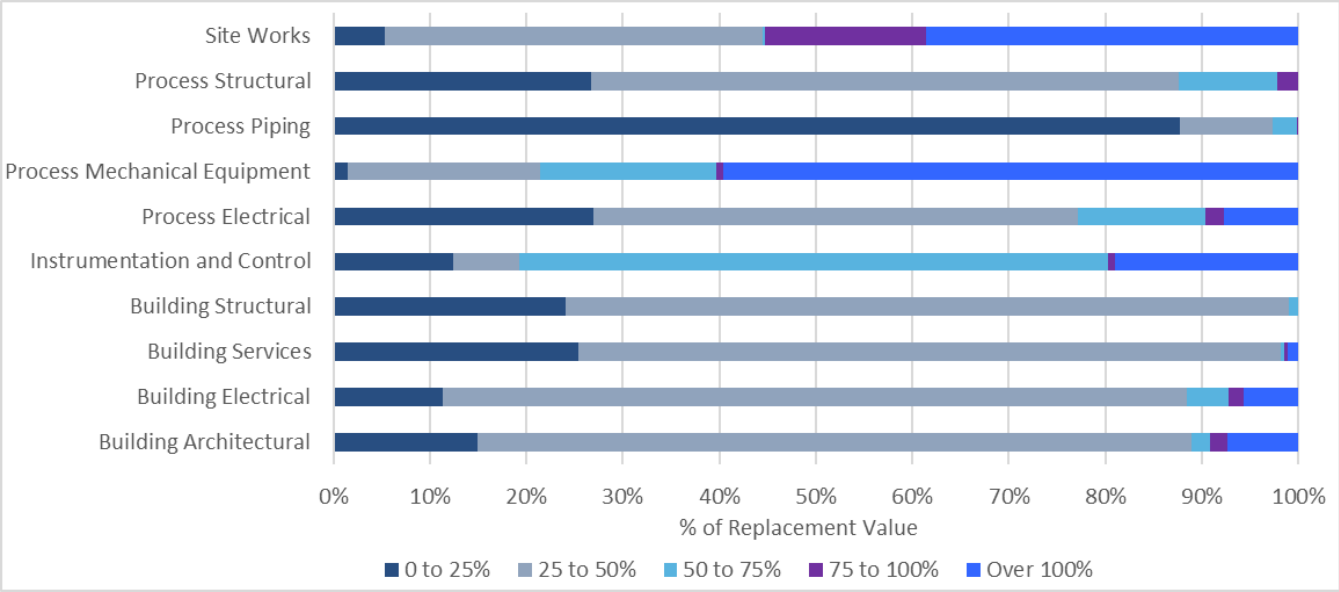

Figure 3-11: Age Profile of Vertical Assets by Expended Lives.

3.3.2 Wastewater Portfolio by Asset Condition Rating

Condition Rating Scale

Condition ratings have been assigned to all wastewater assets on a scale of 1 (Very Good) to 5 (Very Poor). Where possible, these conditions were informed by physical condition or performance testing (e.g., CCTV inspection for sanitary sewers, or visual inspection for pump stations). Age was used as a proxy where condition data was unavailable.

Condition Profile of the Wastewater Assets

The average condition of the wastewater collection system (Figure 3-12) indicates that the system is in excellent condition, with nearly 95% of the pipe segments receiving 'Very Good' or 'Good' ratings.

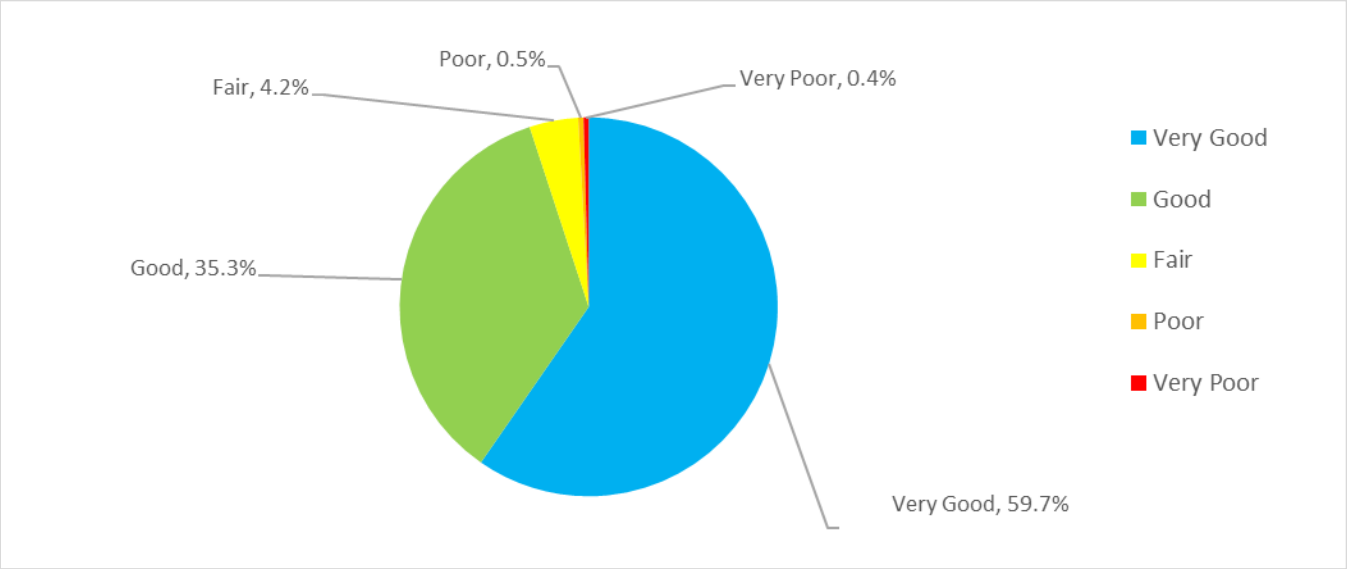

Figure 3-12: Condition Profile for Linear Assets as Percent of Replacement Value.

The pipe segments in the best average condition are those constructed with HDPE (Table 3-5), which is expected because these are also the newest segments. CCTV inspections of the concrete pipe segments showed that these pipes are also in 'Very Good' to 'Good' condition, despite being generally two times older than the HDPE pipes. This indicates that the condition of concrete pipes has held up well over time.

Table 3-5: Average Sewer Condition and Age by Pipe Material

PIPE MATERIAL	AVERAGE AGE	AVERAGE CONDITION RATING	AVERAGE CONDITION DESCRIPTION
Asbestos Cement	45	1.4	Very Good to Good
Concrete	31	1.3	Very Good to Good
Ductile Iron	25	2.0	Good to Fair
HDPE	16	1.2	Very Good to Good
PVC	22	1.3	Very Good to Good
Vitrified Clay	65	2.5	Good to Fair

The vertical wastewater assets are generally in good condition (Figure 3-13). Approximately 78% of the vertical assets by total replacement value are in 'Good' to 'Very Good' condition.

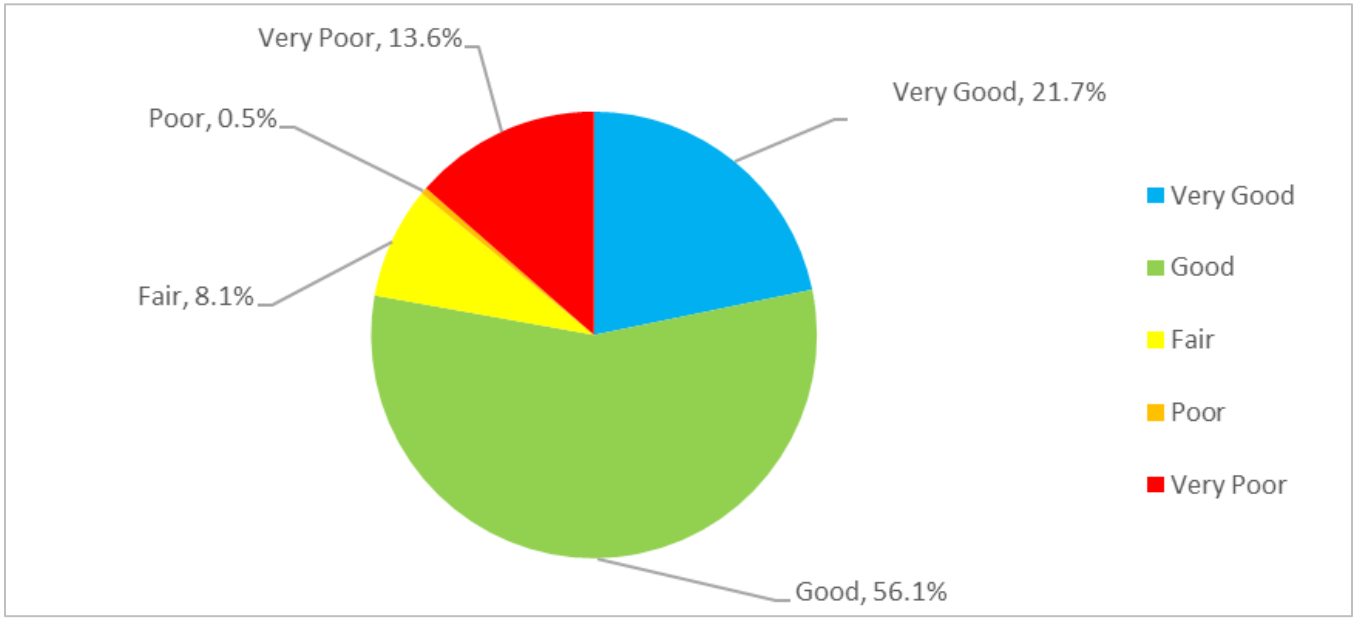

Figure 3-13: Condition Profile for Vertical Assets as Percent of Replacement Value.

The condition of vertical assets within the wastewater portfolio varies greatly, according to the asset category (Table 3-6). Assets belonging to site works, include fencing, curbs, and site lighting, are not critical to the process at the WWTF and the Biosolids Facility. Replacing siteworks assets is not generally a high priority and can often be deferred. Categories such as Instrumentation and Control, which includes assets like flow meters and control panels, are important to the process at these facilities and their replacement needs to be prioritized.

Analysis of the wastewater assets at the sanitary pumping stations showed that the existing condition of assets in all categories are in good condition. However, the instrumentation and control related assets in six pumping stations are in fair condition. This category includes assets which are critical for the process and monitoring of vertical wastewater facilities. Their repair and replacement should be prioritized over other asset lifecycle categories.

It should be noted that a portion of the asset conditions were evaluated based on their age and their condition ratings should be validated by visual inspections or detailed condition assessment, with a focus on the high-risk assets first. The condition ratings are expected to change in the future as more robust methods for condition or performance assessment are applied to assets and the capacity assessed relative to changing demands.

Table 3-6: Average Vertical Asset Condition Rating by Category.

ASSET CATEGORY	WWTF AVERAGE CONDITION	BIOSOLIDS FACILITY AVERAGE CONDITION	PUMPING STATION AVERAGE CONDITION
Building Architectural	2.0 (Good to Fair)	2.0 (Good to Fair)	2.1 (Good to Fair)
Building Electrical	2.1 (Good to Fair)	2.2 (Good to Fair)	2.0 (Good to Fair)
Building Services	2.0 (Good to Fair)	2.0 (Good to Fair)	2.0 (Good to Fair)
Building Structural	1.8 (Very Good to Good)	1.5 (Very Good to Good)	1.9 (Very Good to Good)
Instrumentation and Control	2.6 (Good to Fair)	3.0 (Fair to Poor)	2.5 (Good to Fair)
Process Electrical	1.8 (Very Good to Good)	2.0 (Good to Fair)	1.9 (Very Good to Good)
Process Mechanical Equipment	3.9 (Fair to Poor)	2.1 (Good to Fair)	2.2 (Good to Fair)
Process Piping	1.1 (Very Good to Good)	1.0 (Very Good to Good)	1.9 (Very Good to Good)
Process Structural	1.8 (Very Good to Good)	1.8 (Very Good to Good)	2.0 (Good to Fair)
Site Works	3.7 (Fair to Poor)	3.3 (Fair to Poor)	2.1 (Good to Fair)

3.3.3 Asset Risk

In order to prioritize assets for inspection, maintenance, or renewal activities, it is important to consider the overall risk of the asset failing. This is done be considering the probability that the asset will fail as well as the consequences if the asset fails. Probability of failure is estimated based on the condition, age, and sometimes other characteristics of the asset such as the material of construction; while the consequence of failure is evaluated based on factors such as

the size or capacity, replacement value, and asset location (see Section 3). The risk assessment conducted for this AMP concluded that no assets are currently considered to be in the 'very high risk' category. However, approximately 8.8% of the assets in the City's wastewater portfolio ($119M) are considered 'high risk' assets (Figure ES-3). These high-risk assets are all components of the WWTF, many of which will be replaced or renewed as part of planned upgrades at the WWTF. The City should continue to monitor the condition of the remaining high-risk assets and implement renewal work as appropriate.

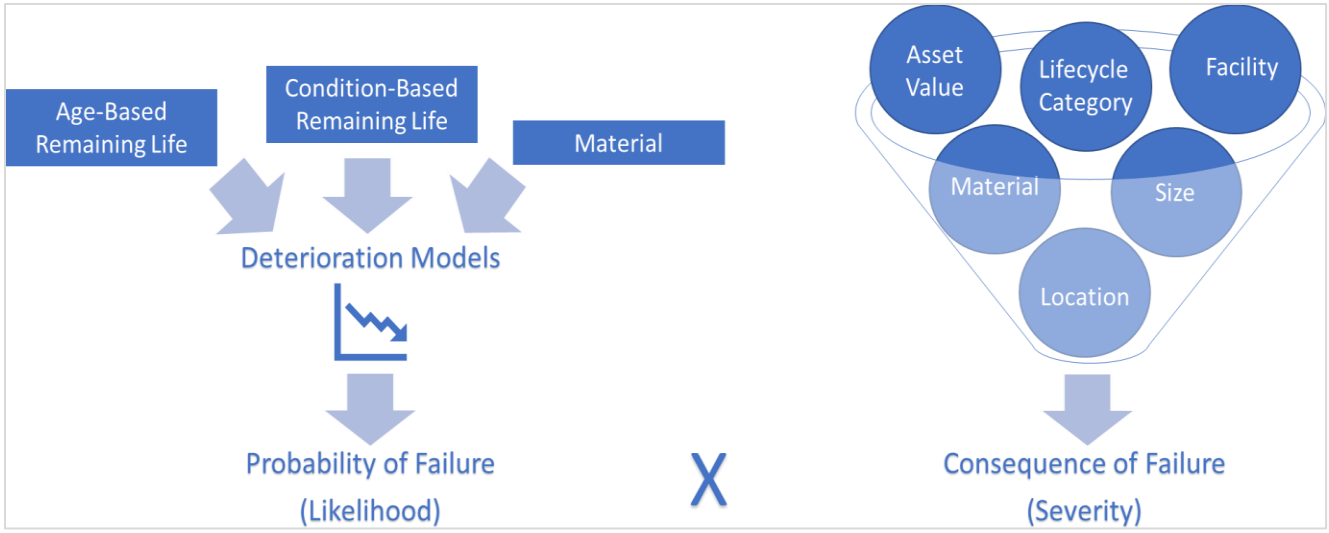

Figure 3-14: Risk Assessment Methodology

Probability of Failure (Likelihood)

The Probability of Failure (PoF), expressed as a value between 1 and 5, represents the likelihood that an asset will not be able to fulfill its intended purpose. A PoF of 1 implies that there is a rare chance that the asset will fail in a given year, whereas a PoF of 5 implies that the asset is very likely to fail in a given year.

Table 3-7 and Table 3-8 show the PoF scores for linear and vertical assets. It should be noted that for each of the linear assets, these scores were weighed to reflect the relative importance of the criteria and to produce an overall PoF.

Table 3-7: Linear Asset PoF Criteria.

PIPE SEGMENTS

PoF Factor	1 Rare	2 Unlikely	3 Possible	4 Likely	5 Very Likely	Weight
Age – Based Remaining Life (Years)	>65	< 65	< 35	< 20	< 5	0.3
Condition – Based Remaining Life (Years)	>65	< 65	< 35	< 20	< 5	0.5
Pipe Material	HDPE, PVC, Concrete		Ductile Iron	Asbestos Cement, Vitrified Clay		0.2
MAINTENANCE HOLES						
PoF Factor	**1 Rare**	**2 Unlikely**	**3 Possible**	**4 Likely**	**5 Very Likely**	**Weight**
Age – Based Remaining Life (Years)	>65	< 65	< 35	< 20	< 5	1.0

Table 3-8: Vertical Asset PoF Criteria.

POF FACTOR	1 RARE	2 UNLIKELY	3 POSSIBLE	4 LIKELY	5 VERY LIKELY
Remaining Life (Years)	RL >= 60	60 < RL <=30	30 < RL <= 15	15 < RL <= 5	RL < 5

Consequence of Failure (Severity)

The Consequence of Failure (CoF) represents the impact to stakeholders if an asset fails to fulfill its intended purpose and is a relative representation of an asset's criticality within its asset lifecycle category. For example, CoF can be used to describe the relative severity of one trunk sewer failing compared to a local sewer.

The CoF is determined for the different assets and asset types to account for various factors including the individual asset's geographic and technical contexts and features (e.g., location, size). CoF has been expressed as a value from 1 (Insignificant) to 5 (Catastrophic), with a general description of the consequences provided in Table 3-9.

Table 3-9: Consequence of Failure Rating System.

SEVERITY	DESCRIPTION	RATING
Minimal	No noticeable damage to environment or society, no injuries, not a nuisance, no time delays, little to no fines, no media	1
	Minor amount of damage to environment or society, less than a few or very minor injuries, easy work around, limited delays, small fines, no media	2
Moderate	Some damage to environment or society, a few injuries or minor injuries, work around available, some delay, subject to fines or investigation, possibly media attention	3
	Damage to environment or society, a number of injuries (varying degrees), work around are not easy to implement, large delays, large fines and investigation, local media attention	4
Catastrophic	Major damage to environment/society, life threatening injuries or death, work around are not possible or time consuming and costly, major delays, legal action, large fines, major investigations, national media attention	5

For the pipe segments (linear assets), the CoF (Table 3-10) is determined using a weighted average of four main factors:

— Pipe segment type
— Pipe material
— Pipe diameter
— Pipe location

The pipe location factor was further divided into 4 sub-factors to capture different geographical context of the pipe segment:

— The road class of the road adjacent to the pipe segment;
— The proximity of the pipe segment to LRSCA designated watercourses;
— The LSRCA designated land use of the area in which the pipe segment is located; and,
— Whether the pipe segment was in a Wellhead Protection Area.

The CoF for the maintenance holes (Table 3-10) is strictly based on their size and pipe location. Scores were assigned to each asset to account for these factors and then a weighted average was taken to determine the asset's CoF.

Table 3-10: Linear Asset COF Factors.

PIPE SEGMENTS						
COF FACTOR	**1 Insignificant**	**2 Minor**	**3 Moderate**	**4 Severe**	**5 Catastrophic**	**Weight**
Pipe Segment Type	-	-	Local	Trunk	Force	0.3
Pipe Material	Others	-	-	Asbestos Cement	-	0.1
Pipe Diameter	<200	<500	<1000	<1500	>1500	0.4
Pipe Location 1 (Road Class)	Road – Local (In-Blvd)	Road – Local (In-Road)	Road – Collector	Road – Arterial	Highway / Railway Crossing	0.2
Pipe Location 2 (Watercourses)[1]	-	-	Watercourse within 100m	Watercourse Within 50m	Watercourse Crossing	
Pipe Location 3 (LSRCA Ecological Land Use)	Urban Area	Agricultural – Low Use	Agricultural – Primary Use	Wetland	Environmentally Sensitive Area	
Pipe Location 4 (SGBLS Wellhead Protection Area)				Yes		
MAINTENANCE HOLES						
COF FACTOR	**1 Insignificant**	**2 Minor**	**3 Moderate**	**4 Severe**	**5 Catastrophic**	**Weight**
Maintenance Hole Size	<1200	<1800	<2400	<3600	>=3600	1.0

[1]: LSRCA Regulated Apparent Valley and equivalent for Nottawasaga CA Meander Belt.

For the vertical assets, the CoF is determined using a weighted average of three main factors:

— The facility to which the asset belongs
— The lifecycle category of the asset; and
— The replacement cost of the asset

Scores are assigned to each asset to account for these three factors and then a weighted average was taken to determine the asset's CoF based on the criteria in Table 3-11.

Table 3-11: Vertical Asset CoF Factors.

COF FACTOR	1 INSIGNIFICANT	2 MINOR	3 MODERATE	4 SEVERE	5 CATASTROPHIC	WEIGHT
Facility	Small[1] SPS	Medium[1] SPS	Large[1] SPS	Biosolids Facility	WWTF	0.35
Lifecycle Category	Building Architectural, Site Works, Building Services	Building Electrical, Building Mechanical	Process Electrical, Process Instrumentation	Process Mechanical Equipment, Process Piping	Building structural, process structural	0.35
Asset Cost	<$10,000	$10,000-$100,000	$100,000-$1,000,000	$1,000,000-$10,000,000	>$10,000,000	0.30

[1]: Based on replacement value of the entire SPS where <$1M is 'small', $1M-$5M is 'medium' and >$5M is 'large'.

Risk Evaluation

The results from the risk evaluation have been presented in a colour coded table that graphically represents risk (increasing up and to the right). Each category of risk has been assigned a colour code for ease of visualization (Table 3-12).

Table 3-12: Risk Evaluation Descriptions.

RISK SCORE (PRODUCT OF COF AND POF)	DESCRIPTION	COLOUR CODE
0 to 5	Negligible Risk	
5 to 10	Low Risk	
10 to 15	Medium Risk	
15 to 20	High Risk	
20 to 25	Very High Risk	

Risk Evaluation Results

The risk evaluation of the pipe segments (Table 3-13) showed that over 99% of the sewer pipe segments are in the 'negligible' and 'low' risk categories. This risk profile is indicative of a sewer network that is well managed, and that appropriate interventions have been adopted to mitigate the level of risk present in the sewers.

Table 3-13: Pipe Segment Risk Profile as Percentage of Replacement Value.

		PoF				
		1	2	3	4	5
CoF	5	0.1%	0.2%	0.0%	0.0%	0.0%
	4	3.9%	4.2%	0.2%	0.0%	0.0%
	3	39.5%	4.8%	13.8%	0.2%	0.2%
	2	0.3%	30.1%	0.5%	0.9%	0.1%
	1	0.0%	0.0%	1.0%	0.0%	0.0%

The risk profile for the maintenance holes is in similar state based on the risk evaluation (Table 3-14). Although the City does not currently use maintenance hole inspection data for condition ratings, 100% of their maintenance holes are estimated to be in the ‘negligible’ and ‘low’ risk categories based on age.

Table 3-14: Maintenance Hole Risk Profile as Percentage of Replacement Value.

		PoF				
		1	2	3	4	5
CoF	5	0.6%	0.0%	0.0%	0.0%	0.0%
	4	3.0%	0.0%	0.0%	0.0%	0.0%
	3	12.5%	0.0%	0.0%	0.0%	0.0%
	2	71.0%	1.9%	1.5%	0.0%	0.0%
	1	8.5%	0.3%	0.5%	0.1%	0.1%

The evaluation of vertical assets (Table 3-15) resulted in overall positive conclusions. The risk analysis concluded that over 76% of the vertical assets fall in the ‘low’ and ‘negligible’ risk categories. Approximately 12.5% of the vertical assets are currently in the ‘high risk’ category, they are predominantly at the WWTF. It is anticipated that the risk profile of the vertical assets will continue to generally improve as the upgrade and expansion projects at the Barrie WWTF are implemented, and coincidental asset replacement occurs. Monitoring the condition of ‘high-risk’ vertical assets through regular O&M and condition assessments can also be beneficial in prioritizing the renewals of these assets and reducing the overall risk.

The results of the analysis reflect positively on the City’s asset management approach and indicate that appropriate risk mitigation strategies have been employed to maintain a relatively low level of risk for vertical assets.

Table 3-15: Vertical Asset Risk Profile as Percentage of Replacement Value.

		PoF				
		1	2	3	4	5
CoF	5	0.0%	0.0%	0.0%	0.0%	0.0%
	4	19.1%	44.1%	7.1%	0.0%	12.5%
	3	1.0%	1.6%	7.1%	2.7%	1.5%
	2	0.0%	0.0%	0.1%	2.5%	0.4%
	1	0.0%	0.2%	0.1%	0.0%	0.0%

4 Lifecycle Activities to Maintain LOS

Implementing regular maintenance programs and completing timely renewal works will keep infrastructure performing at the desired levels of service and at the same time prolong the life of the infrastructure and reduce overall spending. The following sections describe the components and results of the Lifecycle Cost (LCC) forecasts.

4.1 Overview of Activities

Lifecycle models have been developed for each of the following asset categories:

- Local Gravity Sewers & Appurtenances
- Trunk Sewers & Appurtenances
- Process & Building Structural
- Architectural
- Process Mechanical Equipment
- Building Services
- Electrical and Instrumentation & Control
- Process Piping
- Site Works

In addition, a “run-to-failure” model was developed that only included replacement at the end of the asset’s estimated service life.

The lifecycle strategies document current operation and maintenance (O&M) and renewal/rehabilitation and replacement (R&R) activities (Table 4-1).

Table 4-1: Lifecycle Activities.

CATEGORY	ACTIVITY	DESCRIPTION
Operations and Maintenance (O&M) Activities	Preventative Maintenance	Regularly scheduled activities designed to ensure that the assets achieve their expected service lives
	Inspections	Regularly scheduled inspections to assess the condition, function and performance of assets, some of which are prescribed by regulations
	Operations	Routine activities necessary for correct/optimal operation of assets

CATEGORY	ACTIVITY	DESCRIPTION
	Reactive Maintenance	Activities designed to reinstate assets to their normal operating condition
Renewal/Rehabilitation and Replacement (R&R) Activities	Early Life Interventions	Activities taking place in the first quarter of an asset's life, typically related to the repair or replacement of an asset component that has a shorter lifespan
	Mid-Life Interventions	Activities taking place in the second/third quarter of an asset's life, typically related to the repair or replacement of an asset component that has a shorter lifespan
	Later Life Interventions	Activities taking place in the fourth quarter of an asset's lifespan, related to the activities used to extend service life of an asset until it is time for it to be replaced
	Reactive Renewal	Activities including renewal, replacement, or disposal that have not been planned in advance.

4.2 Non-Asset Based Activities

Non-infrastructure solutions can lower lifecycle costs and support long-term asset sustainability. Examples of non-infrastructure solutions include:

- Implementation of flow reduction programs (e.g., I&I programs, reduced water usage) as well as initiatives like Fats, Oils and Grease (FOG) and "Flushable" education programs to reduce maintenance issues
- Implementation of a corridor-based strategy, combining priorities of other divisions (i.e. Roads) with the priorities of the Wastewater portfolio

4.3 O&M and R&R Activities

Operation and management activities are essential to managing the City's infrastructure. O&M activities can also add significant life to assets and defer costly reactive interventions. The O&M

activities in this model have been determined based on asset categories for which the deterioration and appropriate activities were expected to be similar in nature (Table 4-2).

Rehabilitation/renewal activities are required when an asset does not perform to its desired level of service any longer, or is at an unacceptable risk of failure. Replacement activities are required when the deterioration of an asset is too great for rehabilitation/renewal intervention. The R&R activities in this model have been determined in a similar fashion to the O&M activities, with the activities based on the asset category (Table 4-3).

The lifecycle strategies model (Figure 4-1) developed for the wastewater assets is based on current O&M and R&R practices as well as proposed measures based on industry best practices. The model visualizes the different stages of an asset's life and accounts for the appropriate O&M and R&R activities based on the current stage of the asset's life. The model considers the changing O&M and R&R activities throughout the asset's life over the entire forecast period.

	Preventative Maintenance	Inspections	Operations	Reactive Maintenance	EUC	Comments
Operation, Maintenance & Inspection Activities	Describe any routine servicing or preventative maintenance tasks completed on these types of assets and how often these are done.	Describe all types of inspections done on these type of assets and how often they are done.	Describe any routine operational activities that are relevant to the lifecycle of the assets such as washing or cleaning etc.	Typically most reactive maintenance is simply *"As and when needed"*. However, add any other comment relevant to these assets that impacts the asset lifecycle for example *"Minor repairs are subject to available funding and may be left at a later date."*	Enter the estimated unit cost for these types of asset $ XXX	If the EUC is variable, enter "Variable" in the EUC column and add comment here to describe what the variability is based upon i.e *"Price is determined by size"*
New → Replace						
Renewal/Rehabilitation and Replacement Activities		Describe any rehabilitation or intervention options that may be considered for these types of assets throughout their lifecycle. For example *"Replace components as and when needed during life of asset", or "Consider pipe lining for critical ipes where condition is poor but not verry poor and treatment is cost effective"*		Describe what happens near the end of life of the asset. For example *"Toward end of life, re-assess expected fail year based on condition", or "At end of life, replace complete unit with new"*	Enter the estimated useful life for these types of asset	If the EUL is variable, enter "Variable" in the EUL column and add comment here to describe what the variability is based upon i.e *"Lifespan is determined by material type"*
	Early Life Interventions	Mid-life Rehab	Later Life Rehab Option	End of Life	EUL	

Figure 4-1: Visual Depiction of Lifecycle Strategies Model.

The O&M activity costs (Table 4-2) have been estimated based on historical values, and the frequencies based on the lifecycle strategies model developed through a workshop with the City.

Table 4-2: O&M Activities with Associated Cost and Timing

ASSET CATEGORY	O&M ACTIVITIES	COST	TIMING
Gravity sewers & appurtenances	— Flushing of ~50% and inspection of ~10% of the system — Emergency repairs	0.55% of the asset replacement cost for O&M activities	Annually
Trunk sewers & appurtenances	— Flushing and inspection of ~10% of the system — Evaluating if changes can be made to upstream sections of network — Emergency repairs	— $250K for flushing program — 0.2% of the asset replacement cost for remaining O&M activities	— Annually for flushing program — Annually for remaining O&M activities
Process Structural, Building Structural	— Cleaning blockages/debris — Other routine maintenance — Condition assessment of assets — Emergency repairs	3.5% of the replacement cost for O&M activities	Annually
Architectural			
Building Services			
Process Mechanical Equipment	— General housekeeping, routine testing and maintenance — Optimization studies — Condition assessment of assets — Emergency repairs		
Process Electrical, I&C			
Process Piping	— Cleaning blockages/debris — Condition assessment of the assets — Optimization studies — Emergency repairs		
Site Works	— Cleaning blockages/debris — Routine maintenance activity — Condition assessment of the assets — Emergency repairs		

Table 4-3: R&R Activities with Associated Cost and Timing

ASSET CATEGORY	R&R ACTIVITIES	COST	TIMING
Gravity sewers & appurtenances	— Replacement at end of life — In-Situ Repair Program — Full-length CIPP Program	— Replacement at 100% of the asset's CRV	— Replacement at the end of life
Trunk sewers & appurtenances	— Replacement at end of life	— Replacement at 100% of the asset's CRV	— Replacement at the end of life
Process Structural, Building Structural	— Renewal/rehabilitation at mid-life — Renewal/rehabilitation at later life — Replacement at end of life	— Mid-Life: 20% of CRV — Later-Life: 20% of CRV — Replacement: 100% of CRV	— Mid-Life: At 40% of ESL — Later-Life: at 75% of ESL — Replacement: At 100% of ESL
Process Mechanical Equipment		— Mid Life: 10% of CRV — Later Life: 10% of CRV — Replacement: 100% of CRV	— Mid-Life: At 20% of ESL — Later-Life: At 40% of ESL — Replacement: At 100% of ESL
Process Electrical, I&C		— Mid-Life: 10% of CRV — Later Life: 10% of CRV — Replacement: 100% of CRV	— Mid-life: At 20% of ESL — Later life: At 40% of ESL — Replacement: At 100% of ESL
Process Piping		— Mid-Life: 5% of CRV — Later-Life: 20% of CRV — Replacement: 100% of CRV	— Mid-life: At 50% ESL — Later life: At 70% of ESL — Replacement: At 100% of ESL
Architectural	— Minor repairs at mid-life — Replacement at end of life	— Mid-Life: 20% of CRV — Replacement: 100% of CRV	— Mid-Life: At 50% of ESL — Replacement: At 100% of ESL
Building Services	— Replacement at end of life	— Replacement: 100% of CRV	— Replacement: At 100% of ESL
Site Works	— Major repairs, rehabilitation at later life — Replacement at end of life	— Later Life: 25% of CRV — Replacement: 100% of CRV	— Later Life: At 70% of ESL — Replacement: At 100% of ESL

4.4 Asset Expansion

Expansion activities are those required to extend services to previously un-serviced areas or to accommodate for anticipated growth in demand.

The lifecycle strategies model includes forecasted assets associated with the Hewitt and Salem Secondary Planning Areas and other expansion projects outlined in the recommendations of the WWT and WWC Master Plans (see Table 4-4 and Table 4-5). These assets were given future estimated install dates to represent their impact on the cash flow forecast reflective of the anticipated timing of their construction.

The 2019 WWT and WWC Master Plans identified over $400M in expansion and upgrade projects that would be needed to address growth projections for the City by 2031. Approximately $170M ($2020) in expansion and upgrade needs are deferred beyond the 2031 horizon. These projected needs will be further refined for the 2022 Capital Plan and Outlook. More details in relation to the planned expenditure and needs for expansion and upgrade projects can be found in Section 5.

Table 4-4: Wastewater Collection System Expansion Projects Identified in WWC Master Plan.

ASSET CATEGORY	2021	2026	2031
Pump Station			Salem and Hewitt SPSs commissioning, pump capacity upgrades/replacements
Force Mains	1,700m addition		930m addition
Trunk Sewers	6,350m addition	1,200m addition	
Sanitary Sewers	1,500m addition		
Other	I&I program		

* Not including developer-contributed (assumed) assets

Table 4-5: Wastewater Treatment System Expansion Projects Identified in WWT Master Plan.

WWTF PROJECT COMPONENT	PROJECT DESCRIPTION	ESTIMATED INSTALL DATE*
Increasing treatment capacity	Components of plant expansion: - Raw sewage pumping station - Aerated grit tank - Horizontal screw conveyor - Primary clarifiers (2) - MBR and UV expansions	2031
	New Operations and Maintenance Facility	2023
Peak attenuation	Installation of a peak attenuation facility	2029
Increasing digestion capacity	Installation of two primary digesters with capacity of 8,300 m^3 each	2034

* Note: project timing shown is based on WWT Master plan, actual implementation may differ from the dates listed

4.5 Lifecycle Activity Risks to LOS

O&M activities are essential for achieving target levels of service from the wastewater assets. Regular maintenance and inspection are also important to help detect issues and determine appropriate interventions early. Asset failure can potentially pose a threat to City Staff, the public, and the environment. Through implementing the optimal lifecycle strategy, the City strives to maintain levels of service while also maintaining the sustainability of the service.

The LCC forecast has identified backlogs for capital work. The assets included in the capital renewal and rehabilitation backlog are either in ‘very poor’ condition or have surpassed their expected service lives. Risks of not renewing these assets include an increased risk of asset failure, unplanned maintenance, and failure to meet level of service objectives. It is recommended that City staff conduct inspections on these assets to verify the condition and then prioritize them for renewal as appropriate based on risk.

5 Growth and Demand

5.1 Population and Economic Growth Plan

The City of Barrie is located within the Greater Golden Horseshoe (GGH) Region of Ontario. The GGH is recognized as one of the fastest growing regions in North America. In 2017, the Provincial Government of Ontario developed a framework for growth management through the Growth Plan for the GGH. The Growth Plan is intended to inform decision-making regarding growth management and environmental protection for municipalities within the GGH.

In 2018, the City of Barrie completed a review of long-term growth scenarios and reviewed the population forecast prescribed by the Growth Plan for the GGH (Table 5-1). The findings in this report anticipate a doubling in the City's population from 2016 (the year the most recent census was completed) to 2051.

Table 5-1: Population Forecast Based on the Targets Prescribed in the Growth Plan.

	2016	2021	2026	2031	2036	2041	2051
Population[1]	145,800	167,600	189,200	210,000	229,500	253,000	298,000

[1]: Including the census undercount.

The City completed Wastewater Master Plans for the collection system and the wastewater treatment facilities in 2019, which considered the growth to 2041. Several recommendations such as capacity upgrades to the Barrie WWTF resulted from those studies. The 2051 population allocation was provided by the Province after the 2019 Master Plans were complete and therefore the infrastructure needs have not yet been contemplated for this horizon. Updates to the Master Plans, to consider growth to 2051 will be started in 2022.

Over the next 10 years, the City plans to add approximately 11.6 km of sewer mains and two sanitary pumping stations (Hewitt SPS and McKay SPS) to their wastewater asset portfolio, along with expansion and upgrades to the WWTF. The total estimated value of these projects is $358M (2020 $) (Table 5-2).

Table 5-2: Growth Projects.

ASSETS	QUANTITY	ESTIMATED ASSET VALUE ($M 2020)
Sewer mains	11.6 km	$53.85
Pumping Stations	2	$28.97
WWTF Upgrades	-	$275.43
TOTAL		**$358.25**

In addition to the projects identified in the master plans, the length of local sanitary sewers and the associated maintenance holes required to service the Secondary Planning Areas has been estimated (Table 5-3). The projection periods considered include 2021 to 2041, and 2042 to 2051. The anticipated length of local sewers reflects the total length of additional roads to service the Secondary Plan Areas.

In addition to the City directed growth projects, the City is expected to assume approximately 255 km of local sewers and 3927 maintenance holes between 2021 and 2041, and an additional 11 km of local sewers and 165 maintenance holes between 2042 and 2051, constructed through development. The estimated value of local service additions for the 2021 to 2041 forecast period is approximately $184M, and approximately $8M for the 2042 to 2051 period. It is important to note that Development Charges are expected to pay for the growth portion of the installation cost for service additions, particularly those in the new secondary planning areas. Costs for operating and maintaining the additional assets will be through the O&M budgets and the estimated impacts of new assets on future O&M requirements have been included in this asset management plan.

Table 5-3: Local Service Forecast for Secondary Planning Areas of Hewitt and Salem

	2021 TO 2041		2042 TO 2051	
Asset Type	Length/Quantity (km/ea.)	Estimated Value (2020 $M)	Length/Quantity (km/ea.)	Estimated Value (2020 $M)
200mm local sewer	25.5	$10.2	1.1	$0.4
250mm local sewer	191.4	$105.3	8.1	$4.4
300mm local sewer	25.5	$19.1	1.1	$0.8
375mm local sewer	12.8	$12.8	0.5	$0.5
Maintenance holes	3927	$36.1	165	$1.5
TOTAL ESTIMATED VALUE		**$183.5**		**$7.7**

The 2019 WWT and WWC Master Plans identified over $400M in expansion and upgrade projects that would be needed to address growth projections for the City by 2031. Since growth has been proceeding more slowly than projected, the City has further refined these needs, and this is reflected in the City's Capital Plan and Outlook. Notably, the WWT Master plan originally identified projects to upgrade the treatment capacity of the WWTF to 96 megalitres per day (MLD) as being needed between 2024 and 2031. The City's refined projections don't include this need until after 2031. As a result, approximately $170M ($2020) in expansion and upgrade needs are deferred beyond the 2031 horizon. Based on this, the City's 2021 Capital Plan and Outlook addresses all but $8.9M ($2020) in expansion and upgrade projects from the WWT and WWC Master Plans over the 10-year planning period (Figure 5-1). These projected needs will be further refined for the 2022 Capital Plan and Outlook. The planned expenditures in the City's

2021-2030 capital plan are $363 million, resulting in an investment gap of approximately $8.9 million over the 10-year planning period, or an average annual gap of $0.9 million.

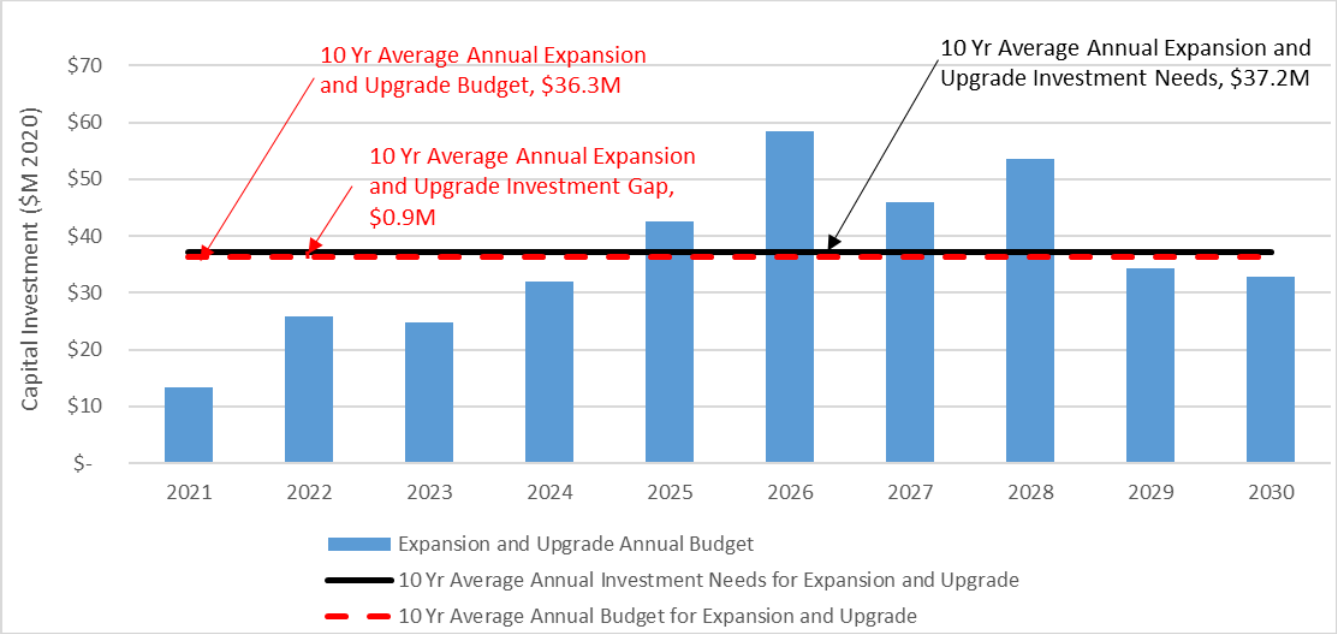

Figure 5-1: Wastewater Capital Budget for Expansion and Upgrade Related Projects.

6 Financial Investment Strategy

6.1 Short-term Financial Strategy

The short-term financial outlook includes a breakdown of the wastewater infrastructure needs (categorized by type of lifecycle activity) compared against the total planned budgets for Capital Renewals, O&M activities, and Expansion and Upgrade. As shown in Figure 6-1, there is a gap between the forecasted needs and the available budget.

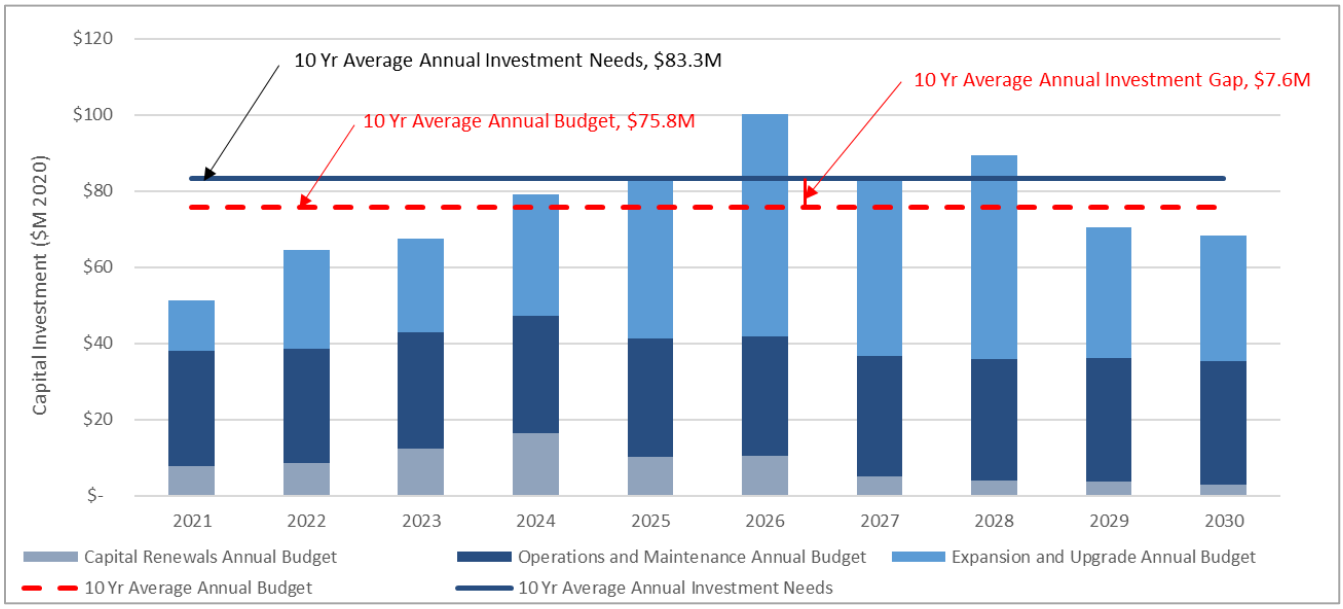

Figure 6-1: Forecasted Wastewater Expenditure.

The infrastructure renewal backlog in 2021, comprising assets that are currently past their theoretical service lives, is approximately $130M. This includes approximately $1.5M worth of sewers and maintenance holes which are overdue for replacement, $0.1M of pumping station components, $0.2M for renewal of site works at the biosolids storage facility, and the remainder is made up of component assets at the wastewater treatment facility. Of the WWTF assets included in this backlog, approximately $91 million worth is scheduled to be replaced or renewed as part of planned upgrades to the WWTF within the 10-year planning period.

At the end of the short-term forecast period, there will be an estimated cumulative investment shortfall of approximately $76M. The City must continue to inspect, monitor, and prioritize renewals of the most critical assets to minimize the risks associated with this investment gap.

Based on both the linear and vertical forecasts, the City is expected to achieve the target LOS for the coming 10-year period, however staff must work to actively manage the risks related to aging assets and propose timely renewal work as appropriate.

6.1.1 Renewal

The capital renewal investment needs forecast in this plan includes mid-life and later life renewal/rehabilitation and end-of-life replacement (see Table 4-3). As shown in Figure 6-2, the City would need to invest nearly $14M per year over the next 10 years to address the forecasted renewal needs for the existing wastewater infrastructure. The City's average annual budget for capital renewals over the 10-year horizon is $8.2M, resulting in an average annual investment gap of nearly $5.7M.

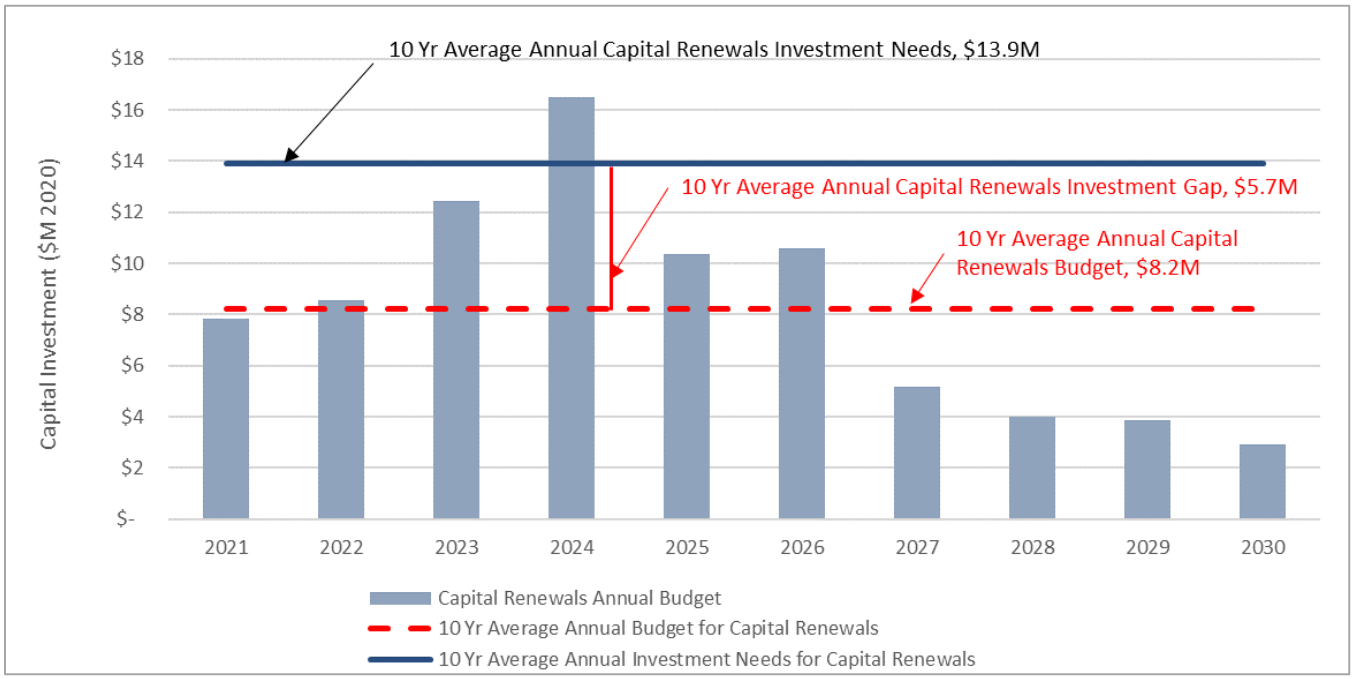

Figure 6-2: Forecast Capital Renewal Needs Compared to Capital Renewal Budget.

Another general indicator of the appropriateness of planned investment levels is shown by comparing the City's renewal rate to available benchmarks, such as the Canadian Infrastructure Report Card (CIRC). The renewal rate is the fraction of the budget allocated for asset renewal compared to the total value of the asset portfolio. As the annual renewal budget changes, so does the renewal rate.

The CIRC publishes reinvestment rates for various infrastructure recommended by asset management practitioners. The CIRC rates are empirical and intended to be informative rather

than prescriptive. Renewal rates may vary at an individual municipality depending on factors such as the LOS and the age of the infrastructure, which are not accounted for by the CIRC.

The City's current reinvestment rates for the vertical and linear assets (Table 6-1) were calculated and compared against those recommended in the 2016 CIRC, with the aim of benchmarking the City's renewal rate against the recommended CIRC values. On average over the next 10 years, the City's reinvestment rate for vertical wastewater assets is 0.5% versus the CIRC recommendations in the range of 1.7% - 2.5% of the asset value. For the linear wastewater infrastructure, the City is currently reinvesting at an average rate of 0.9% over the next 10 years versus the CIRC recommendations of between 1.0% - 1.3%. It should be noted that the City's current asset portfolio is relatively young and a reinvestment rate lower than the CIRC averages may be appropriate to address current needs. As assets continue to age and progress through their lifecycles, the City's asset renewal needs will continue to grow, which will lead to a greater need to increase investment in renewal and align with the CIRC recommendations.

Table 6-1: Asset Renewal Rates Compared to CIRC Recommendations

ASSETS	10-YEAR RENEWAL BUDGET (2020, $K)	PORTFOLIO VALUE (2020$K)[1]	10-YEAR AVERAGE RENEWAL RATE	CIRC RECOMMENDED RATE
Vertical Assets	$45,848	$947,900	0.5%	1.7% to 2.5%
Linear Assets	$36,174	$405,681	0.9%	1.0% to 1.3%

[1]: Only accounts for existing assets.

6.1.2 Operation and Maintenance

Operations and maintenance activities maintain assets in a good state of repair. There are various risks involved if O&M activities are neglected ranging from inefficient operation of the assets to premature failure. Recommended O&M activities, and projected costs, were developed based on the desired levels of service and activities required to achieve these levels of service. Considering the existing asset portfolio along with those expected to be added through growth projects and development, the City is expected to require an average of approximately $32M per year for O&M over the next 10 years (Figure 6-3).

The City's O&M budget is projected based on the 2021 business plan including the approved 2021 operating budget and the forecasted operating budget from 2022-2024. The City does not forecast the operating budget for the full 10 years, so for this project the O&M budget beyond 2025 has been assumed to increase at an annual rate of 1% for illustrative purposes.

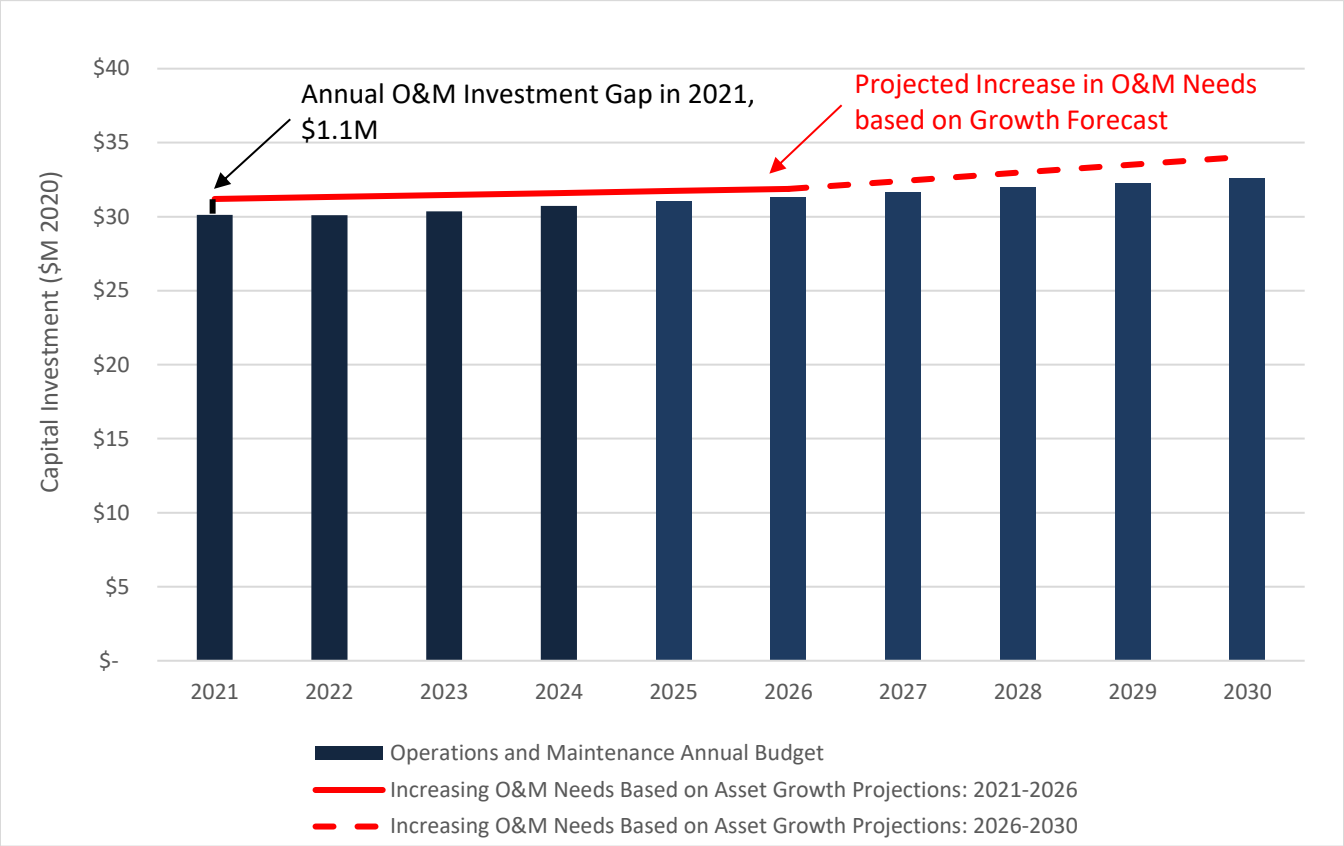

Figure 6-3: Forecast O&M Needs Compared to O&M Budget.

Comparing the projected budget to the projected needs, the average O&M investment gap over the next 10-years is approximately $1M per year. The O&M investment shortfall in 2021 is primarily a result of recommended lifecycle activities that are currently not funded including increased O&M resources for the collection system. After 2021, the O&M needs shown have been increased based on projected additions to the wastewater asset portfolio. If the City does not increase its wastewater operating budget to match the increased needs of new assets being added, the gap will continue to widen, and the associated risk will increase. It should be noted that the O&M investment needs forecast in this plan only addresses existing and new assets and does not account for inflationary pressure on the City's operations.

6.2 Long-term Renewal Investment Needs

In addition to the short-term renewal needs discussed above, it is also important to understand the needs of the City's wastewater assets over the long term. The aim of this analysis is to understand the long-term renewal investment needs of the city's current wastewater asset portfolio.

The City should aim to build adequate reserves and/or other sources of funding capacity to ensure that renewal activities can be undertaken for the right assets at the right time.

The specific timing of renewal needs shown in Figure 6-3 are theoretical; The actual timing and implementation of renewal activities should be based on an up-to-date understanding of each asset's condition and risk as well as annual priorities and the City's capacity to deliver projects.

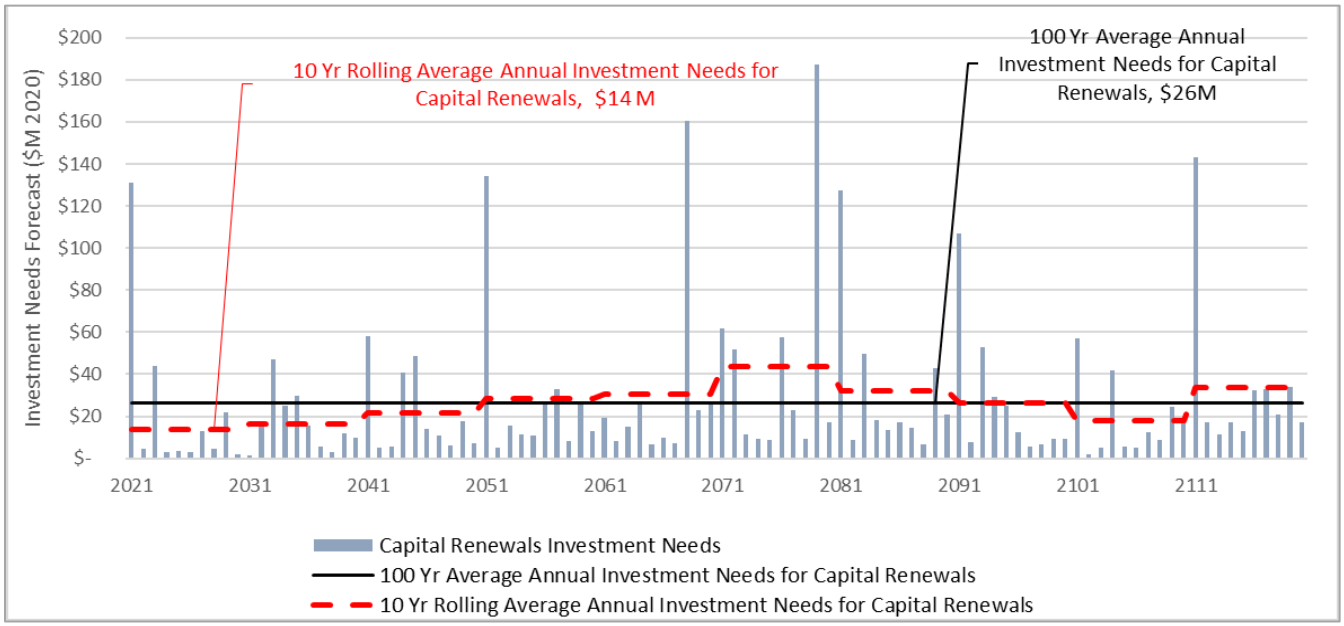

Figure 6-4: Long-Term Investment Needs

The long-term forecast above shows several peaks due to assets which are forecasted to reach the theoretical end of their service lives at the same time. These replacement needs will have to be shifted and prioritized from peak periods into valley years to sustainably manage the asset renewals required. According to this forecast, an average of approximately $26M per year should be invested to meet long-term capital renewal needs.

Several tools may be considered to help manage the long-term investment needs, including:

- Maintaining existing assets versus installing new assets
- External funding sources
- Capital prioritization (e.g., environmental compliance, risk, legislation, others)
- Changes to levels of service
- Increasing wastewater rates to build reserves (e.g. as recommended in the 2021 Water Wastewater Financial Plan)

Going forward, the information in this financial analysis will be used to support future wastewater financial plans, development charge study updates, and long-range planning exercises with the goal of identifying sustainable funding needs and mechanisms including rates, reserves, debt, and development charges to ensure the City's long-term financial health.

7 Assumptions and Limitations

Key assumptions and/or limitations made in developing this AMP are documented in this section (Table 7-1). In many cases, the assumptions and limitations were also noted throughout the document. As the City's asset management program matures with respect to policies, procedures, and asset data collection, many of these assumptions and limitations may be reduced or eliminated.

This asset management plan was started in early 2020 with data from 2019 and 2020$ being the most current information available. The bulk of the analysis was complete while this was still the most relevant information and updating to 2020/2021 info would not materially change the outcomes, findings, and recommendations of the report.

Table 7-1: Assumptions and Limitations

DOCUMENT SECTION	ITEM	ASSUMPTION(S)	LIMITATION(S)
Levels of Service and Performance	Performance Measures	- Calculation of inflow and infiltration is based on treated water produced and received sewage. This may not accurately reflect the I&I in the system.	- Current performance of several LOS (condition data, effluent violations, I&I, pipe inspections) based on most recently available data which may be greater than 2 years old
Asset Inventory	State of the Infrastructure	- A system modified from PACP's scoring framework for pipes is used for condition for linear assets. - Age-based condition was used for the WWTF, BSF and maintenance holes.	- The modified scoring system considers age, material and MPL of the pipe when the condition information is not available from CCTV. It may not fully capture operational defects or defect patterns. - Age-based assessments may provide an overly conservative estimate of the condition for assets not inspected.

DOCUMENT SECTION	ITEM	ASSUMPTION(S)	LIMITATION(S)
Lifecycle Activities to Maintain LOS	Lifecycle Strategy Cashflow Forecast (Model)	- Assets are replaced at the end of their ESL. The following year represents the first year of a new lifecycle period, or age of 1. - Assets currently past their ESL are considered part of the backlog to be replaced in Year 0 of the forecast period - Assets not yet installed will begin their lifecycle profiles at the beginning of their prescribed install year - All the recommended projects from the WWT and WWC Master Plans will be completed	-
Growth and Demand	Population and Economic Growth Plan	- The timing of some recommended projects from the WWT and WWC Master Plans have been revised since the Master Plans were completed - The length of future linear assets was estimated when specific information was not available	- Estimated values were taken from City's capital forecasts (if available), otherwise taken from the Master Plan cost estimates
Financial Investments Strategy	Short – Term Financial Strategy	- Operation and maintenance budgets beyond 2024 forecast based on a nominal assumed rate - Studies and special projects were not considered when reviewing the cumulative shortfall. These projects do not directly contribute to asset renewals	- Actual yearly budgets may differ from the assumed budgets
	Renewal rate analysis		- Renewal rate analysis only includes existing assets in the portfolio value
	Long – Term Financial Strategy	- The 100-year forecast does not include growth assets	- Growth assets will likely increase the average yearly investment required to meet renewal needs.

8 Improvement Plan and Next Steps

8.1 Improvement Plan

The AMP is a dynamic document intended to be continuously improved as available resources and asset understanding improves. The discussion in this section focuses on several items that can be improved on in the AMP (Table 8-1). The suggested improvements are focused on improving decision-making and bringing asset management tools to a state from which greater insight is gained into the wastewater asset portfolio.

Table 8-1: AMP Improvement Tasks

DOCUMENT SECTION	ITEM	IMPROVEMENT TASK(S)	PRIORITY
Levels of Service and Performance	Performance Measures – Inflow and Infiltration	— Investigation of I&I concerns to better understand the problem and prioritize options for improvements (Underway)	High
	Performance Measures – Condition Rating of Vertical Assets	— Continue expanding use of visual inspections and monitoring to determine condition ratings	High
	Performance Measures – Sewer Backups	— Investigation to monitor risks of backups in sewer mains more accurately	Medium
Asset Inventory	Vertical Asset Inventory	— Update inventory for vertical assets to be more current than the 2016 SOAR — Fill in information in the description field of inventory to describe the specific asset — Populate required information to complete the asset hierarchy	High Medium Medium
	Linear Asset Inventory	— Improve maintenance hole inventory with more accurate information on size and material	Low
	Condition Ratings	— Condition assessments of vertical assets and maintenance holes to determine condition ratings	Medium/Low

DOCUMENT SECTION	ITEM	IMPROVEMENT TASK(S)	PRIORITY
Lifecycle Activities to Maintain LOS	Lifecycle Strategy	— Connect the LOS outcomes with lifecycle activities by collecting information in terms of actual investments in specific assets and the observed condition/performance over time — Expand use of corridor-based planning to optimize management of adjacent infrastructure over the long term — Development of capital renewal plans for vertical assets — Investigate tools to enable resource-limited optimization and risk-based prioritization to model outcomes and determine the optimal interventions based on financial/other constraints	High Low High High
Growth and Demand		- Update growth forecasts as more information becomes available about anticipated growth projects	Medium
Financial Investments Strategy	Short – Term Financial Strategy	- Update budget forecasts in each spending category regularly (annually) as more information becomes available	Medium
	Renewal rate analysis	- Implement sustainable investment levels to build reserves for both linear and vertical infrastructure, considering the whole life of the assets	High
	Long – Term Financial Strategy	- Include growth assets for special areas in long-term financial strategy once their installation date is better understood	Low

9 Summary and Conclusion

The City's wastewater asset portfolio is worth approximately $1,35B. On average, these assets are relatively early in their service lives and in good condition. A risk assessment was performed considering both the consequence and probability of failure of each wastewater asset. No assets are in the 'very high risk' category, but approximately 8.8% of the assets in the City's wastewater portfolio were considered 'high risk.' Regular condition monitoring and renewal prioritization is necessary to manage these risks. It should be noted that updates to the vertical wastewater asset inventory are currently underway and more detail will be available for future analysis.

As per O.Reg. 588/17 requirements, the City's current community and technical LOS are documented in this AMP. Over 99% of linear assets and over 85% of vertical assets are in 'fair' to 'very good' condition. It should be noted that for the treatment and biosolids facilities, the condition rating is mainly based on the assets' age and expected service life, and should be confirmed by visual inspections or detailed condition assessment where appropriate. The anticipated upgrades to the WWTF are expected to positively influence the average condition rating of the vertical assets as many aging and deteriorated assets at the WWTF will be upgraded or replaced in the coming years.

Historical data shows that effluent discharged from the WWTF is of a high quality with no instances of exceeding regulatory limits. Overall, the City's wastewater assets are in acceptable condition, of adequate capacity, and performing well at their intended functions. The City is positioned to provide the proposed LOS for the period from 2021-2030; though some risks are expected to increase over time if the City continues to underinvest in needed lifecycle activities. To quantify the needed investment, lifecycle models were developed for each asset category. These estimates suggest that, on average, the City will need to invest approximately $26M annually to complete the renewal activities needed to sustain the proposed levels of service over the long term. The specific needs however, will vary from year to year and the City should plan proactively to ensure adequate funding and resources are available to address asset needs at the optimal time. The forecast currently shows a theoretical renewal backlog that will need to be monitored, prioritized, and addressed based on risk and affordability. Not addressing the backlog could lead to an increased risk of asset failure, unplanned maintenance, increased costs and failure to meet level of service objectives.

New assets are planned for construction, alongside expanded capacity of current assets, to meet increased wastewater service demand due to population growth. Growth needs are based on projects identified in the wastewater treatment and collection master plans as revised for implementation though the City's Capital Plan. The 2019 WWT and WWC Master Plans identified over $400M in expansion and upgrade projects that would be needed to address growth projections for the City by 2031. Since growth has been proceeding more slowly than projected, the City has further refined these needs, and this is reflected in the City's Capital Plan and Outlook. In addition to new assets added through City projects to support growth, the City will also be assuming new assets constructed by developers. As the City will need to operate,

maintain, and renew these new assets throughout their service lives, their lifecycle needs will have an impact on future operation, maintenance, and renewal plans.

The City's current average renewal rates for linear and vertical wastewater assets over the next 10 years are 0.9% and 0.5%, respectively. This is lower than CIRC recommendations of 1.0% - 1.3% for linear assets, and 1.7% - 2.5% for vertical assets. Based on the state of the City's wastewater asset portfolio, the proposed levels of service, and the lifecycle activities identified in this plan to ensure our assets are able to provide the proposed levels of service, the City is underinvesting by an average of $7.6M per year over the next 10 years. To mitigate the near-term risks associated with underinvestment, the City must continue to prioritize lifecycle activities based on risk and affordability. Over the long term, the City should continue to strive toward sustainable investment levels that accurately reflect the lifecycle needs of the wastewater asset portfolio.

APPENDIX

A WWTF PERFORMANCE

The City must report on the performance of the Barrie WWTF annually as part of the facility's Environmental Compliance Approval (ECA No. 0284-B2ML52). The most recently available annual report for the Barrie WWTF at the time the City prepared this AMP was for 2019. This appendix section summarizes the performance of the Barrie WWTF as it was described in the 2019 Annual Performance Report (Table A-1 and Table A-2). The Barrie WWTF consistently produced high quality effluent based on the information reported in the 2019 annual report.

Table A-1: Barrie WWTF Effluent Concentration Performance

	AVG FLOW (MLD)	CBOD5 (MG/L)	SOLIDS (MG/L)	AMMONIA (MG/L) - JUNE TO OCT.	AMMONIA (MG/L) - NOV. TO MAY	TP (MG/L)	E. COLI. (CFU/100 ML)
2019 Average Effluent Performance	49.9	2.03	1.86	0.28	0.87	0.03	1.06
ECA Limit	76[1]	15.0	15.0	4	10	0.18	200
ECA Objective		10.0	10.0	-	-	0.12	100

[1]: The rated capacity for the Barrie WWTF.

Table A-2: Barrie WWTF Effluent Loading Performance

	CBOD5 (KD/D)	SOLIDS (KG/D)	AMMONIA (KG/D) - JUNE TO OCT.	AMMONIA (KG/D) - NOV. TO MAY	TP (KG/D)
2019 Effluent Performance	101.1	93.3	13	45.7	1.5
ECA Limit	1140	1140	304	760	7.6