Utilities Kingston

Water and Wastewater Utilities

Asset Management Plans

2021 to 2030

Report: September 30, 2021

Table of Contents

List of Tables

List of Figures

Executive Summary

1. Overview

Utilities Kingston is a corporation dedicated to the operation and maintenance of the City's Water, Wastewater, Gas, Electric and Fibre Utilities. Utilities Kingston is an asset management corporation responsible for ensuring that the five utilities are operated effectively, efficiently, safely, and reliably. This is reflected in the Utilities Kingston Mission, Vision and Values:

Mission: Our mission is to manage, operate, and maintain community infrastructure to deliver safe, reliable services and a personal customer experience.

Vision: Our vision is to advance the unique multi-utility model to benefit our customers and build better communities.

Values: Our values are safety, integrity, innovation, and reliability.

This fifth iteration of the Water and Wastewater Utility Asset Management Plan documents the current state of Asset Management at Utilities Kingston and prescribes recommendations for further evolving and formalizing the process to maximize the benefits of Asset Management.

Asset Management is current best practice. As an Asset Management system is formalized, adopted, and entrenched in the organization, it is expected that it will provide:

i) Stronger governance and accountability,
ii) More sustainable decision-making,
iii) Enhanced customer service,
iv) More effective risk management, and,
v) Improved financial efficiency.

The 2021-2025 Strategic Plan for Utilities Kingston identifies Asset Management as a corporate priority for the next several years. Asset Management does not begin or end

with this document. Asset Management has been the core function of Utilities Kingston since its inception. This plan documents the current processes and provides recommendations on moving forward and improving the way Utilities Kingston manages the Water and Wastewater Infrastructure.

This version of the Water and Wastewater Asset Management plan is identical to the previous 2017-2026 plan with numbers, figures, project lists and quantities updated to end-of-2020 conditions. No new or supplementary reports have been done in the interim to guide projects or expenditures.

2. Asset Inventory Summary

The Utilities Kingston Water Utility provides potable water to over 39,000 customers through a treatment and distribution network consisting of 3 Water Treatment Plants, 5 Booster Stations, 3 Storage Reservoirs, 5 Elevated Towers and over 586 kilometers of watermains. Watermains are also equipped with 5,440 valves and 3,529 hydrants. It is estimated that the system contains approximately 420 kilometers of water services as well.

The Wastewater Utility collects and treats the wastewater through a network of over 474 kilometers of Gravity Mains, 29 kilometers of sewage Forcemain, 29 Pumping Stations, 9 Combined Sewage Overflow Tanks, and 3 Wastewater Treatment Plants. The Gravity Mains are also equipped with approximately 6,700 Maintenance Holes. In addition, approximately 38,400 services exist to customers, and services to the property line represent an additional 415 kilometers in pipeline.

The Water and Wastewater Utilities have “Net Book Values” of approximately $234 million and $225 million respectively, and “Replacement Values” of $589 million and $774 million respectively. Facilities represent 26% of the total assets for the Water Utility and 56% of the total assets for the Wastewater Utility.

Within the Water Utility, approximately 57 kilometers of Watermains are considered to be at the end of their lifecycle from an age perspective. Most of the non-linear

infrastructure is in average to good condition, with the facilities recently constructed in excellent condition.

Within the Wastewater Utility, up to 12.3% of the linear assets are considered to be at the end of their lifecycle from an age perspective (with much of this percentage assumed to be older pipe with unknown age). From condition assessment information however, only approximately 5.1% of gravity mains are in poor condition warranting rehabilitation. Forcemain condition remains unknown. The one remaining Wastewater Treatment Plant (WWTP) that was deemed in poor condition, the Cataraqui Bay WWTP, is currently being upgraded, with Cana WWTP recently replaced. There are also 2 Pump Stations (SPS) that are in a condition suggestive of major rehabilitation works. The largest of those, the Days Road SPS, is currently undergoing full facility replacement.

3. Levels of Service

Utilities Kingston has developed Level of Service Statements that align with several major theme areas of the 2021-2025 Strategic Plan. The Levels of Service Statements are general statements that illustrate qualitative objectives with which to manage the Utilities. Theme areas are as follows:

- The Impact of COVID-19 over next 5 years
- The Pivotal Relationship with the City of Kingston
- Networking Business
- Meeting Customer Expectations
- Asset Management
- Climate Action Leadership

From these theme areas, the Levels of Service Statements were crafted. These are shown in the table below:

Theme	Level of Service Statement
Performance and Reliability	Utilities Kingston will operate the Utility efficiently, effectively, safely, and reliably to meet customer service expectations.
Risk Management	Utilities Kingston will identify, prioritize, and mitigate risks associated with management of the Utility.
Growth and Planning	Utilities Kingston will facilitate the growth of the customer base, ensuring the Utility can meet current needs and the needs of the future.
Sustainability	Utilities Kingston will improve the environmental and operational sustainability of the Utility to support the community vision of becoming Canada's most Sustainable City.
Financial Management	Utilities Kingston will operate the utility in a manner that is adequately funded and financially responsible to the shareholder and customers.

Each Level of Service Statement is supported by a suite of Key Performance Indicators that relate to the theme of the statement. Key Performance Indicators are primarily quantitative facets of the Utility that are rated against standards developed by staff. Where possible, regulatory, and frequently reported Key Performance Indicators are utilized. For example, several are from the annual Municipal Performance Measurement Program reporting.

The section of the report characterizes how the Utility perceives its current level of Asset Management in the defined theme areas. In many cases, it is not only the current value of the Key Performance Indicator that is important, but the trend demonstrated by

the KPI's change over time. These will evolve over time as will the KPI's to ensure that there are benefits to calculating and tracking them.

4. Asset Management Strategy

The Asset Management Strategy focuses on 4 main sections:

i) Growth Planning and Demand Management
ii) Risk Management
iii) Lifecycle Decision Making
iv) Maintenance Management

Growth Planning and Demand Management

Infrastructure Planning is responsible for ensuring that infrastructure is adequate to meet the needs of the existing and future customer loads in consideration of existing and future regulatory requirements and anticipated growth of the services offered. Planning for growth involves numerous studies completed by both the City of Kingston and Utilities Kingston. Studies that identify infrastructure needs for growth include Growth Strategies and updates, Master Planning exercises, Impost Review Studies, Environmental Assessments, Development Studies and Secondary Plans, Plant Capacity Analyses and Capacity Assurance programs.

Typical results of such studies include identification of projects including the replacement or major upgrades, construction of new assets, decommissioning of existing assets as well as specific strategic initiatives to either reduce the need or change the outcome of growth-based requirements.

The Water Utility has identified approximately $34.5 million of expenditure over the next 10 years specifically to support growth (to 2031).

The Wastewater Utility has identified approximately $66.6 million of expenditure over the next 10 years to support growth (to 2031).

Demand Management is also included in this section as they are programs and processes instrumental in reducing the demand for new assets. The Water Utility is

engaged is three primary programs including investigating means to reduce the use of treated potable water for not-potable purposes, implementing water conservation programs as well as reducing non-revenue water losses.

The Wastewater Utility makes gains from the efforts of demand management focused on the Water Utility as well as efforts that reduce the use of sanitary sewers. The Wastewater Utility undertakes several programs to reduce the impact of extraneous flows, including both private- and public-side efforts to reduce inflow and infiltration of runoff, surface, and groundwater, as well as moving forward with sewer separation projects to eliminate storm water directed to the sanitary sewer system.

Risk Management

Risk Management is the process of identifying projects required to mitigate the increase in risks to the Utilities that occurs due to age and degradation of existing assets. The Risk Assessment process utilizes both indicators of consequence of failure (criticality) and likelihood of failure (condition) to generate a risk score or grade, which is then used to prioritize actions and expenditures to remedy the deficiencies.

Fundamental to risk management is the completion of condition assessments on a frequency commensurate with the criticality of the assets. For both Utilities, this includes completion of the significant water and wastewater Facility Condition Assessment to assess the condition, value, criticality, and risk associated with the plants and pump/booster facilities. Wastewater linear infrastructure is assessed using an annual cleaning and inspection program and trunk sewers are treated with a greater frequency than collector and local sewers. A condition assessment process is required for forcemains as none currently exists. Watermains are not currently assessed using a true condition assessment processes, however this is recommended for larger water mains, at minimum. Other programs in place include valve and hydrant inspection and maintenance, hydrant flow testing and watermain leak detection.

Within the Wastewater Utility additional risks are present, and these include the risks of sewage bypass to the environment by way of combined sewer overflows, as well as the additional risks of sewage backups into basements. Both are subject to studies

including the Pollution Prevention and Control Plan (PPCP) and basement flooding studies completed in 2012, 2013 based on major flooding events of March and July 2011.

Most risks identified through these various processes are typically condition-based risks that result due to degradation of assets over their lifecycle. As such, tackling these risks on a priority basis forms what is referred to as lifecycle replacement, or annual renewal of assets. However, there are at times new assets that are recommended during risk-based studies. This is specifically the case with the Wastewater Utility that has identified approximately $20.5 million of new assets required over the next 10 years.

Lifecycle Decision Making

The life cycle decision making process identifies one of the following categories as the most appropriate course of action: New, increased or accelerated maintenance, rehabilitation or major upgrade, and replacement, through an informal benefit cost analysis. The lifecycle process also considers multi-criteria factors such as: impacts to parent or child assets, budget/timing constraints, and overlapping needs between assets.

The treatment plants and non-linear facilities are managed with a focus on maintenance and minor upgrades over major upgrades and replacement. However, when triggers are identified from planning exercises that indicate a need for a significant capacity increase, change or improvement in process, then a major upgrade or facility replacement is then required. The linear assets are typically managed on a “worst first” basis with low risk minor deficiencies addressed through dig and repair, or, where planning studies have identified pipes with capacity issues, in which case they may be promoted to the joint reconstruction program. Higher risk linear assets are typically addressed through replacement, or rehabilitation lining.

Maintenance Management

Maintenance activities are an integral part of optimizing the lifecycle of assets. Where no triggers for replacement, upgrades, capacity increase, or treatment standards are

required, routine maintenance shall be completed to ensure continued effective operation of the Water and Wastewater Utilities. Condition and risk indicators should be the driver for works, even after the estimated lifecycle of the facility is complete.

All maintenance activities are recommended to be documented and tracked by the asset and to be visible to all staff of Utilities Kingston. Currently, this is not fully implemented for the all the asset classes in the utilities and the tracking systems that are in place are not consistently accessible and require significant manipulation in order to coordinate asset management activities across the asset classes. This has been identified as a priority moving forward.

5. Financial Strategy

The Asset Management Strategy documented identifies projects that are required to ensure that the utilities can meet the needs of today and in the future. These projects range from those required to maintain existing infrastructure to those required to support growth of the customer base as the population of the City of Kingston grows.

A simple model is used to estimate the funding requirements for each Utility. The model uses the following primary 'expenditure categories':

- Renewal of existing infrastructure. This includes capital projects required to maintain and upgrade existing infrastructure as required based on lifecycle. This category assumes that an asset is replaced at the ends of its life expectancy.
- Construction of new assets. This includes the capital projects identified by Growth-based and Risk-based studies.
- Renewal of new assets. This represents a growing addition to the asset base that requires upkeep in the future and represents the growth of item i) described above over time.
- Inflation.

In 2021, the Water Utility requires approximately $15.8 million in annual funds for renewal of existing infrastructure, and this will grow to approximately $16.7 million by 2030 as new assets are constructed and added to the inventory. In addition, over the

next 10-year period, approximately $34.5 million is required for construction of new assets to meet growth-based demands which represents an annual requirement of approximately $3.4 million per year over the next 10 years.

In 2021, the Wastewater Utility requires approximately $21.9 million in annual funds for renewal of infrastructure, and this will grow as new assets are constructed and added to the inventory. In addition, over the next 10-year period, approximately $5.2 million is required for risk-driven projects and $66.6 million is required for growth-driven projects. Together these represent an additional $7.2 million per year over the next 10 years for a total average of $29.0 million per year.

Funding for these activities will be sourced from rate-based revenues, impost, new debt (as required) and Provincial/ Federal Grants when available.

In consideration of existing budget levels from user rates, impost and new debt, there is a funding deficit of approximately $52.3 million for the Water Utility and $90.9 million for the Wastewater Utility, over the next 10 years.

Increases in rates are planned for the Water Utility totaling 22.8% to 2031. Increases in rates are planned for the Wastewater Utility totaling 27.3% to 2031. These increases are considered in the deficit estimates and the deficits described above will need to be taken further into consideration moving forward.

Financial Budget Forecasts and Funding are preliminary and will require further development during future iterations of these Asset Management Plans (AMPs).

6. Moving Forward

The AMPs sections contain indices that provide an indicator of the maturity level of that portion of the AMP. The indices are not intended to be a rating of the AMP, but to describe different levels that an organization should strive towards. Overall Asset Management within UK is currently considered to be in the “Minimum” Maturity Index for the water and wastewater AMPs. Implementation of the recommendations enclosed within the AMPs will not directly relate to improvements within the Maturity Indices but

will improve the overall asset management programs within UK striving towards an overall “Core” Maturity Index.

The Asset Management herein focuses on Capital Asset Management, touches in a minor way on the role of Maintenance Management, but does not address Operational Management. Future revisions of the Asset Management Plan should include report sections on Maintenance and Operational Strategies.

Asset Management Software, specifically for the Non-Linear Assets, is deemed to be essential to advance the Utilities Kingston Wastewater Utilities Asset Management plans. Appropriate asset management software is recommended to be assessed and implemented as a tool within UK AMP and strategies.

A. Introduction

1 Introduction

The City of Kingston is a modern society serviced by vast interdependent infrastructure networks that provide a platform for economic development and meet the social and functional needs of the community. Good quality infrastructure is the cornerstone of public health and safety and supports sustainable societies.

The Water and Wastewater Utilities are two such infrastructure networks that provide service to the Kingston community. The Wastewater Utility includes three primary functions: i) collection, ii) conveyance and iii) treatment of wastewater. The Water Utility includes two primary functions, i) treatment of potable water, and ii) distribution/conveyance. These Utilities represent a significant societal investment which has developed over the past hundred years and longer.

While the Water and Wastewater Utilities are currently managed using principles inherent to asset management, the state of asset management is basic and lacks formality. These documents are the first iteration of what is likely to be many revisions to formalize and continually improve asset management within the Water and Wastewater Utilities.

The benefits of improved asset management include:

- strong governance and accountability,
- more sustainable decisions,
- enhanced customer service,
- effective risk management, and,
- improved financial efficiency,

1.1 What is Asset Management?

There are numerous definitions of asset management, but they all generally touch on common items. The following definition of asset management is one provided in the International Infrastructure Management Manual (IIMM) (NAMS, 2011):

- To meet a required level of service, in the most cost-effective manner, through the management of assets for present and future customers.

The IIMM also defines key elements of infrastructure asset management plans as follows:

- providing a defined level of service and monitoring performance,
- managing the impact of growth through demand management and infrastructure investment,
- taking a lifecycle approach to developing cost-effective management strategies for the long-term that meet the defined level of service,
- identifying, assessing, and appropriately controlling risks, and,
- having a long-term financial plan which identifies required expenditure and how it will be funded.

Lifecycle asset management encompasses all aspects of an asset's lifecycle from beginning to disposal, with the objective being to minimize lifecycle costs while providing the defined level of service. This includes the following:

- asset planning,
- asset creation and/or acquisition,
- asset operations and maintenance,
- monitoring the condition and performance of assets,
- asset rehabilitation or replacement,
- asset disposal or rationalization, and,
- financial management.

This initial iteration of the Asset Management Plan will focus on capital investment strategies that contribute to lifecycle management.

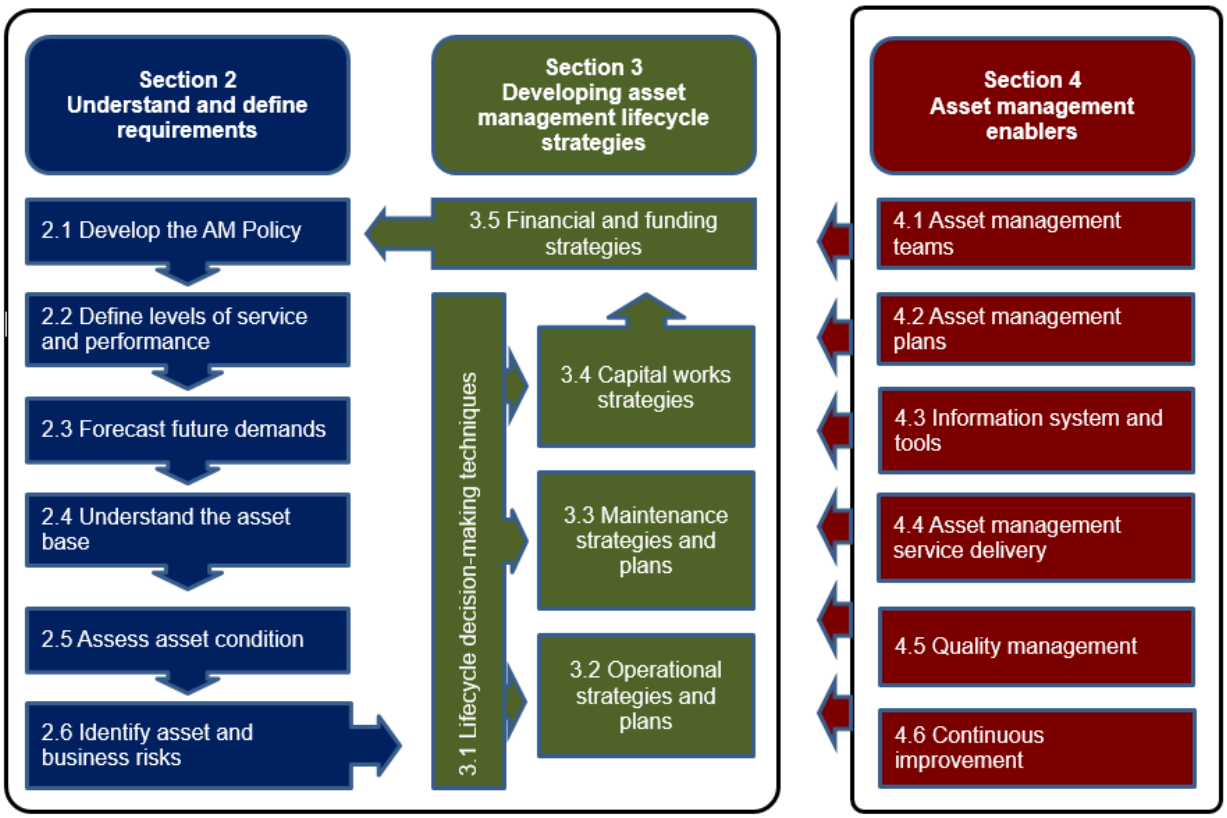
1.2 Developing the Asset Management Plan

Two primary references were consulted when developing the Water and Wastewater Utility Asset Management Plans:

- “Building Together: Guide for Municipal Asset Management Plans.” Ministry of Infrastructure of Ontario, 2012.
- “International Infrastructure Management Manual (IIMM).” New Zealand Asset Management Support (NAMS), 2011.

The Building Together document expresses in general terms what elements are required to meet the Ministry’s Guidelines. The IIMM document is a much more prescriptive and complete document used by many organizations throughout the world in establishing infrastructure asset management plans.

The Asset Management process is summarized in the IIMM as per



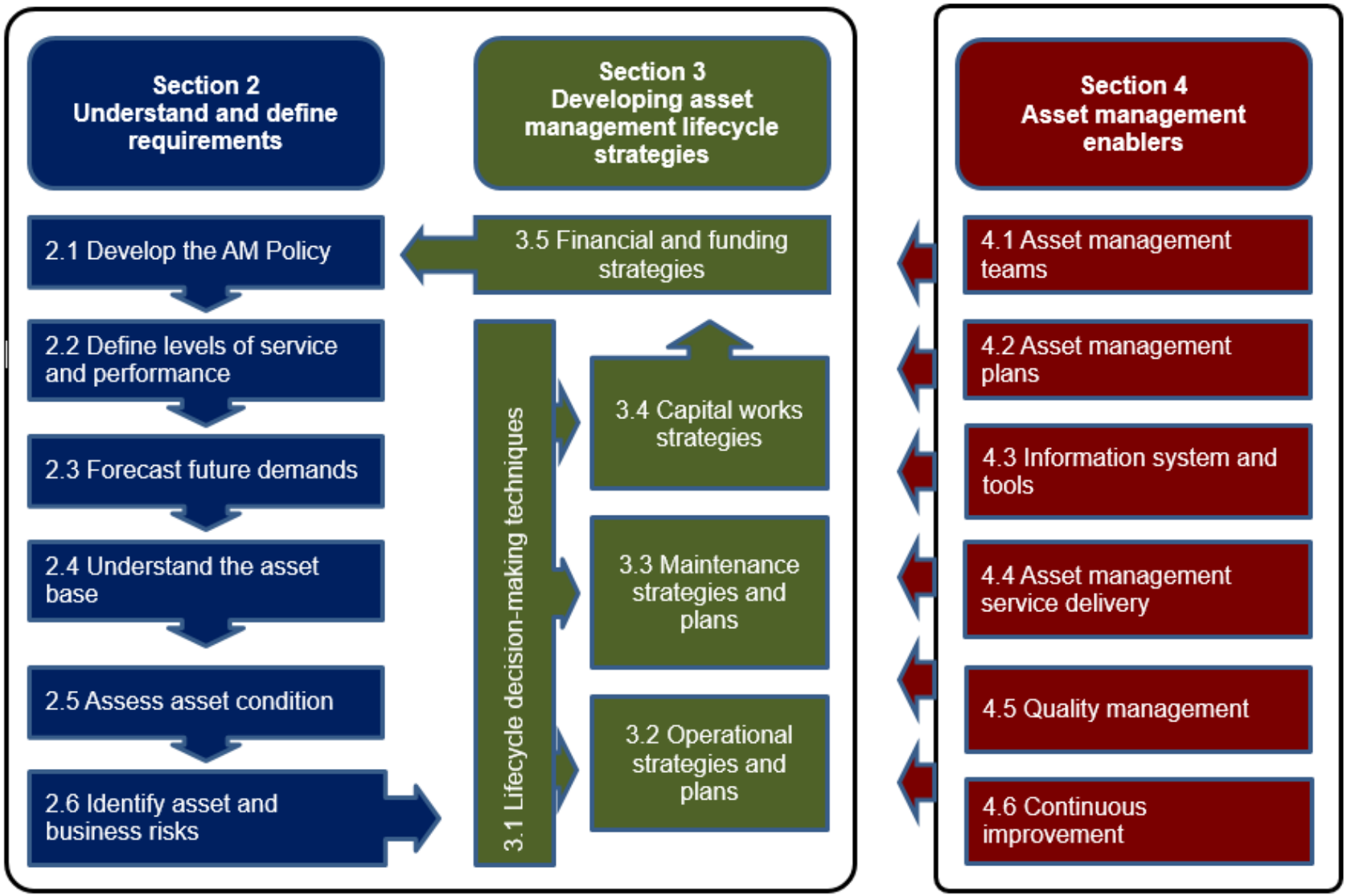


Figure A-1-1 Asset Management Process (NAMS 2011).

As can be seen from the Figure, the process is divided into 2 main undertakings as follows:

- Understanding and defining requirements, and,
- Developing Asset Management Lifecycle Strategies.

While the report follows a format as per the provincial ‘Building Together’ Guidelines, inherently the elements defined by IIMM are being used as a template for providing a complete and functional plan.

The 2021 Water and Wastewater Utility Asset Management Plans will focus on capital asset management (item 3.4 in

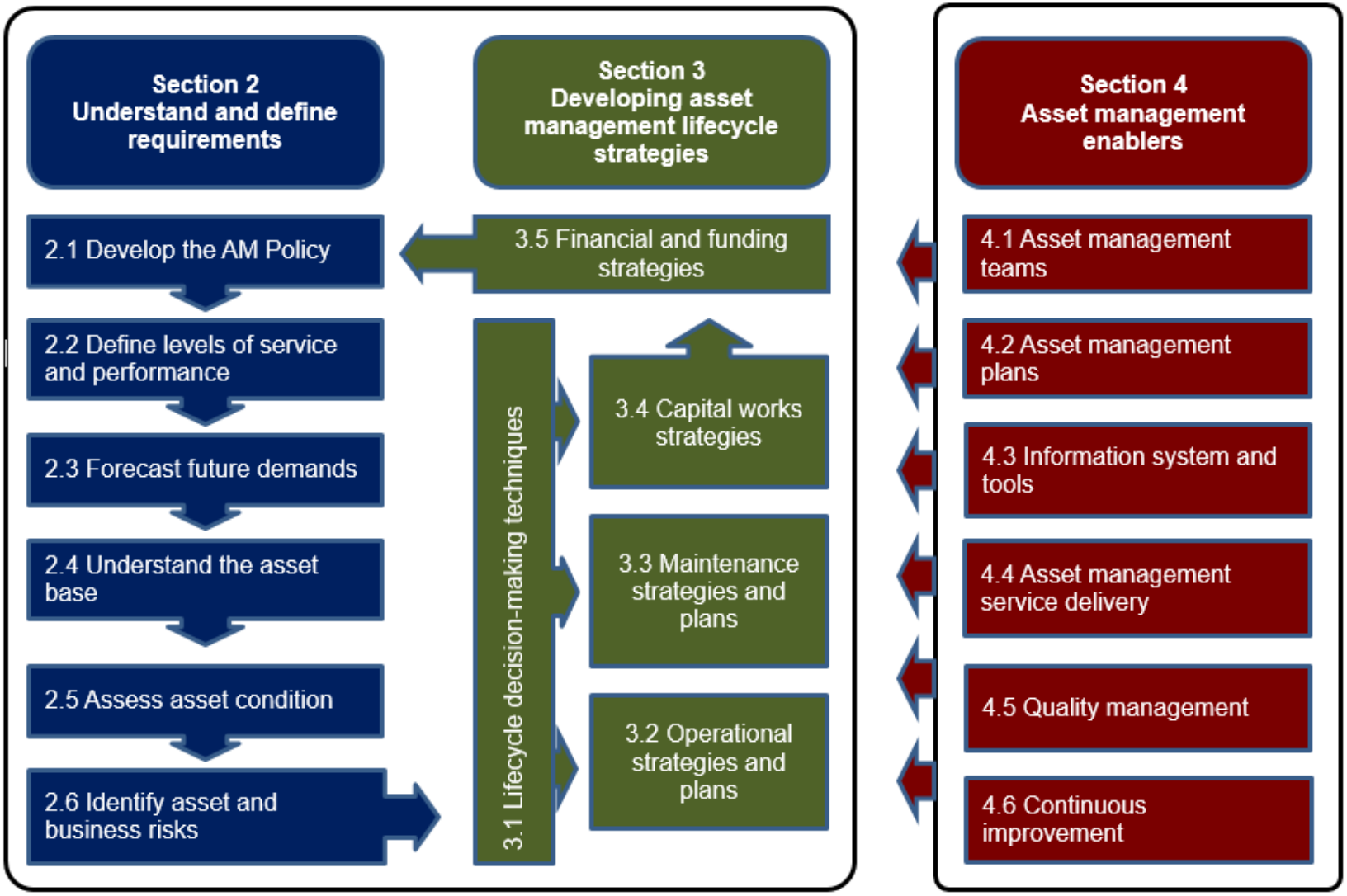


Figure A-1-1) and not Maintenance and Operational aspects of Utility management.

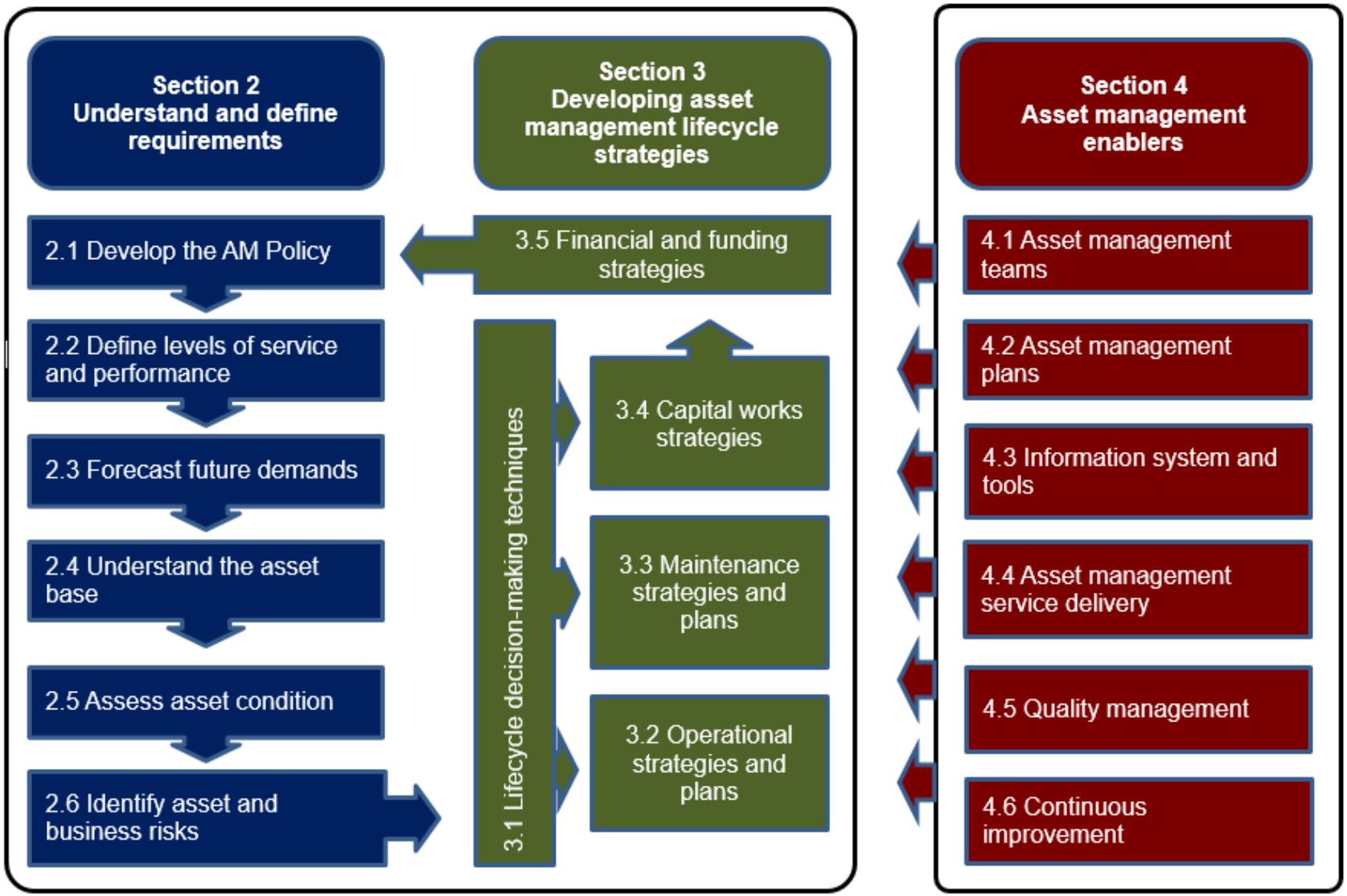


Figure A-1-1 Asset Management Process (NAMS 2011)

1.3 State of the Asset Management Plan

This document represents an update to previous iterations of the asset management plans for the Water and Wastewater Utility based on 2020 figures and statistics. Primarily, the report establishes the processes of asset management, and less so the execution of the plan. It is intended to represent stand-alone plans for the Water and Wastewater Utilities, but it is recognized that they will function in concert with an integrated plan encompassing multiple asset groups, i.e. Water, Wastewater, Roads and Bridges, for starters. Although the Water and Wastewater Utilities are both rate-based and thus have their own dedicated revenue streams, it is recognized that asset decision-making will include multi-asset classes in some cases. A prime example is the City of Kingston Multi-Year Joint Road Reconstruction Program that involves works on Roads, Water Utility and Wastewater Utility assets. This multi-disciplinary activity is a fundamental part of the strategy for managing both water and wastewater assets.

The report frequently highlights areas that will need further development. These are typically summarized at the end of the report sections.

In addition to highlighting areas for further development, as per the IIMM, many major sections or processes inherent to the asset management plan will be complimented by a ‘maturity index’. This index is simply a measure of how basic or advanced the portion of the plan is relative to standards identified in the IIMM.

Table A-1-1 illustrates an example maturity index scale for the ‘Decision-Making’ process. It should be stated that these initial versions of the plans are striving to meet the ‘Core’ rating but will have certain elements in more-or-less advanced state.

Table A-1-1. Example Maturity Index Scale.

Maturity Level	Description
Minimum	Basic physical information recorded in a spreadsheet or similar (e.g. location, size, type), but may be based on broad assumptions or not complete.
Core	Sufficient information to complete asset valuation – as for 'minimum' plus replacement cost and asset age/life. Asset hierarchy, asset identification and asset attribute systems documented.
Intermediate	A reliable register of physical and financial attributes recorded in an information system with data analysis and reporting functionality. Systematic and documented data collection process in place. High level of confidence in critical asset data.
Advanced	Information on work history type and cost, condition, performance, etc. recorded at asset component level. Systematic and fully optimized data collection program. Complete database for critical assets; minimal assumptions for non-critical assets

1.4 Utilities Kingston Asset Management Policy

Utilities Kingston has developed an Asset Management Policy and provides the guiding principles for the Asset Management strategy and plan which are inherently linked to the organization's Mission, Vision and Values.

Mission: Our mission is to manage, operate, and maintain community infrastructure to deliver safe, reliable services and a personal customer experience.

Vision: Our vision is to advance the unique multi-utility model to benefit our customers and build better communities.

Values: Our values are safety, integrity, innovation, and reliability.

The Utilities Kingston Asset Management Policy is provided in Appendix A.

The current 2021-2025 Strategic Plan includes the following six theme areas:

- Impact of Covid-19 over the next 5 years.
- The pivotal relationship with the City of Kingston
- Networking business
- Meeting customer expectations
- Asset Management
- Climate action leadership

The asset management directive is contained within the Theme Area “Asset Management”, which continues to be a core focus area of the Utilities Kingston mandate and activities. Critical to its success in infrastructure management are strategic initiatives that:

- Provide the organization with a leadership role in asset management.
- Provide for long-term infrastructure planning that is appropriately linked to all aspects of financial management, including rate revenue and non-rate revenues.
- Respond to new initiatives driven by intensification, extreme weather, and urban growth expansion.

The Asset Management theme contains several goals and initiatives as follows:

- Goal 1 – Manage Assets for sustainability.
    - Initiative 1: Continue with a long-term capital infrastructure plan. The plan should balance asset renewal strategies with growth-related asset expansion. It should meet the infrastructure needs of new commercial and residential investors, while ensuring continued reliability for existing customers.
    - Initiative 2: Review and evaluate the construction and contract management methodologies implemented at Cataraqui Bay Wastewater Treatment Plant, with the intent to adopt these practices in managing future facility asset renewal or replacement projects.

    - Initiative 3: Investigate new and innovative ways to understand asset condition, replace or rehabilitate infrastructure assets and apply pilot applications.
- Goal 2 – Manage assets for climate action.
    - Initiative 1: Review and report on the implications of greenhouse gas reduction planning, within the natural gas and electricity service areas.
    - Initiative 2: For facility renewal or replacement, ensure that: a) clean energy benchmarks and standards form part of the strategy; b) all projects consider the goal of reducing the total energy footprint of the facility.
- Goal 3: Manage assets for a smart utility.
    - Initiative 1: Plan and implement proactive capital asset replacement programs in facility upgrades.
    - Initiative 2: Inventory technology communicating with existing assets, to develop a long-term plan for capable, reliable and secure communications.
    - Initiative 3: Plan and prioritize the application of real-time data collection technologies to infrastructure to support data-driven decision making.

B. Water Assets

1 State of Local Infrastructure – Water Utility

The purpose of this section is to identify the water assets managed by Utilities Kingston, through a review of the existing inventories of each asset class, its condition, and how much it's worth. Assets have been separated into two categories: Linear and Non-Linear. Linear assets are those that form the linear water distribution system and include several Asset Classes including the watermain pipe (parent asset) and the valves, hydrants, meters, and services (child assets). Non-linear assets are plants and facilities that deliver water to the distribution system and include treatment plants, booster stations, reservoirs, and elevated tanks.

This chapter provides an overview of available information on assets that are part of the water utility, and the sources of data which are currently available within the asset inventory, and those that are still required.

Sources of information for this section include:

- GIS Asset Inventory. The GIS Asset Inventory is primarily a system for management of linear infrastructure. The GIS inventory includes Plants and Facilities as a whole; however, it does not include a detailed component breakdown and thus is not considered sufficient for management functions.
- PSAB Reporting. Utilities Kingston reports its valuations of assets as required by the Public Sector Accounting Board.
- Water and Wastewater Facility Condition Assessment Report. This report was completed in 2008 and provides condition indicators for water booster stations.
- Other reports. Several other reports, files and databases provide ancillary information to this report section, including replacement cost estimates (initially developed for PSAB in 2007).

1.1 Asset Inventory

Asset inventory information has been extracted primarily from the City of Kingston administered Enterprise GIS system, which is a reliable resource for this purpose. Initially the GIS inventory was developed based on data collection efforts both in the

office and in the field. Historical construction and as-constructed drawings were used as the preliminary source of information and field verification was used for missing or unknown data where possible. For newly constructed or rehabilitated infrastructure, “as constructed” or field drawings are used to make additions or adjustments to the existing GIS.

Table B-1-1and Table B-1-2 summarize assets in Kingston’s water distribution system.

Table B-1-1 Asset Summary - Plants and Facilities (Non-Linear)

Asset	In Asset Inventory	Quantity (5)
Water Treatment Plants	Yes	3
Booster Stations	Yes	5
Reservoirs	Yes	3
Elevated Tanks	Yes	5

Table B-1-2Asset Summary - Water System (Linear)

Asset	In Asset Inventory	Quantity (5)
Water Pipe	Yes	586.3 km
Valves	Yes	5,440
Hydrants	Yes	3,529
Meters	No	39,207(2)
Services	No(1)	39,527 (3) 427 kilometers (4)

Notes:

1) New and replacement services are being included in the Asset Inventory

2) Not included in the Asset Inventory, meter totals from Meter Shop.

3) Not included in the Asset Inventory, service totals from Customer Billing.

4) Length of services estimated using a 21.6 m average right of way, assuming each service is ½ this length, on average.

5) Based on October 4, 2017 Enterprise Asset Inventory.

1.1.1 Linear Assets

1.1.1.1 Watermain

An attribute summary for watermains is provided in Table B-1-3 to Table B-1-4. Table B-1-3 shows the length of existing watermain by material. It can be seen that the majority of the system is comprised PVC, Cast Iron (CI), and Ductile Iron (DI), with CI predominantly installed prior to 1970, see Figure B-1-1. PVC and DI have been the primary material installed since 1980. As the water systems are upgraded, or added, the CI components will decrease, and the PVC and DI will increase.

Table B-1-3 Length of Watermain by Material

Material	Length (km)	Percent
160 Poly Vinyl Chloride	5.83	1.0%
Asbestos Cement	1.83	0.3%
Cast Iron	138.63	23.7%
Cast-In-Place Pipe	38.70	6.6%
Concrete Pressure Pipe	25.38	4.3%
Copper	0.74	0.1%
Ductile Iron	115.31	19.7%
High Density Polyethylene	2.06	0.4%
Poly Vinyl Chloride	242.62	41.4%
Unknown	15.04	2.6%

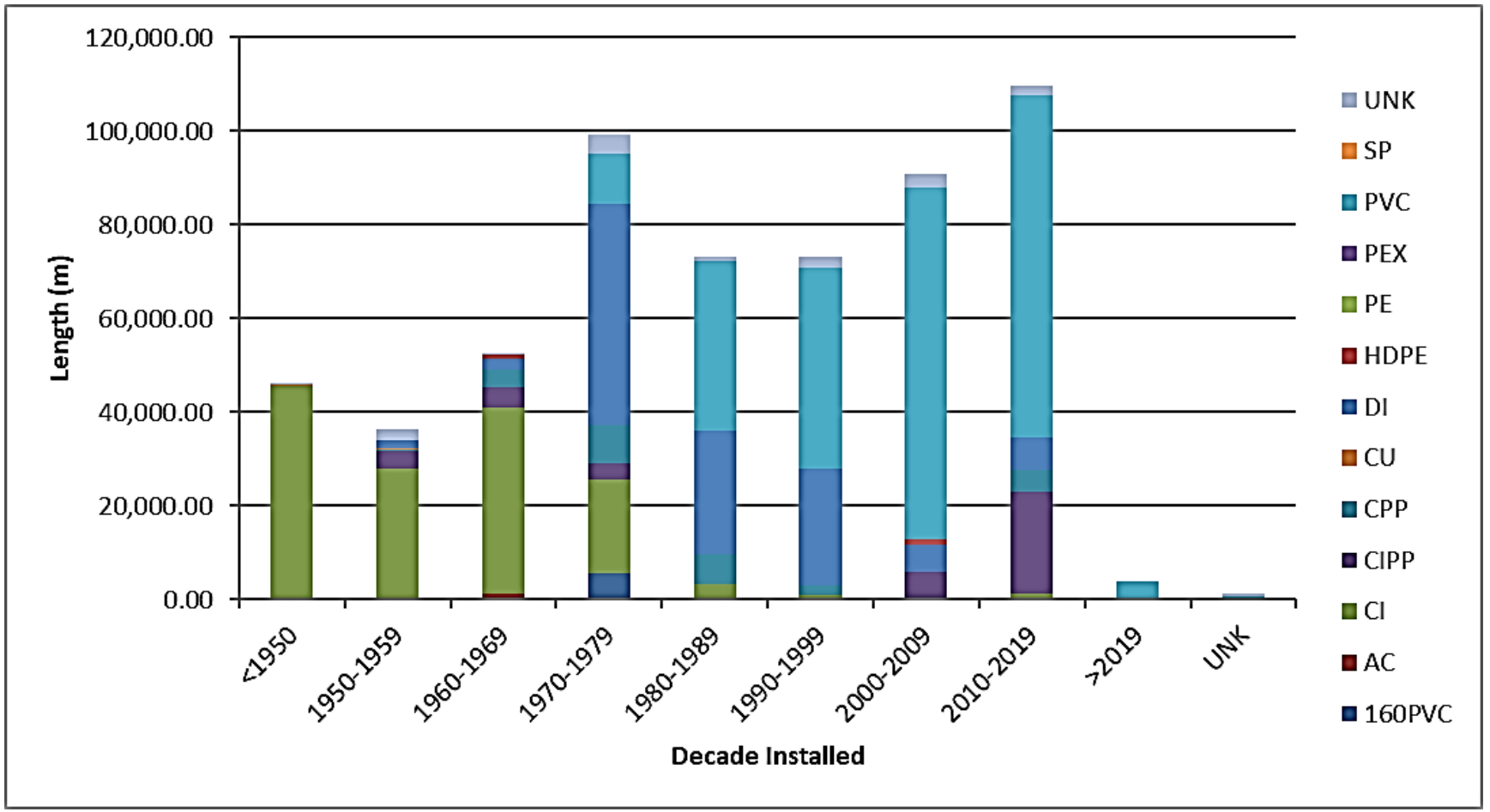


Figure B-1-1 Watermain Installed by Material and Decade

The Kingston water system is made up of watermains ranging in diameter from 25 millimeters to 1200 millimeters. Table B-1-4 shows the length of watermain by diameter and illustrates that the majority of the system is made up of 150mm and 200mm diameter watermain. The current minimum standard diameter for watermains in the City of Kingston is 200mm and therefore as mains are replaced throughout the system the length of 150mm (and smaller) watermain will decrease.

Table B-1-4 Length of Watermain by Diameter

Diameter	Length (km)	Percent
smaller than 150	7.79	1.3%
150	143.58	24.5%
175	0.19	0.0%
200	197.13	33.6%
250	33.56	5.7%
300	99.66	17.0%
400	57.10	9.7%
450	10.65	1.8%
larger than 450	36.64	6.2%

1.1.1.2 Valves

Table B-1-5 shows a breakdown of the valve inventory in the water system. The table includes all valves within the linear system but does not include valves at the facilities, which are accounted for in the non-linear section of this Asset Management Plan. It can be seen from the figure that the number of 150mm and 200mm valves correspond closely with the length of 150mm and 200mm watermain (parent asset), and as watermains are replaced, the ratios of 150mm to 200mm valves will reflect the new 200mm standard. Table B-1-6 shows the number of valves installed by decade.

Table B-1-5 Number of Valves by Size

Size (mm)	Count
<150	116
150	1,396
175	1
200	2,277
250	286
300	878
400	302
450	53
> 450	103
UNK	28

Table B-1-6 Number of Valves by Size and Decade

DECADE	<150	150	175	200	250	300	400	450	> 450	UNK	TOTAL
<1950	35	378	1	65	9	38	16	3	6	11	562
1950-1959	12	155	0	19	13	23	9	2	15	0	248
1960-1969	8	137	0	81	19	65	4	0	10	0	324
1970-1979	3	148	0	235	56	122	41	9	14	0	628
1980-1989	4	158	0	191	28	139	38	3	1	0	562
1990-1999	13	80	0	307	18	152	64	9	9	0	652
2000-2009	17	91	0	680	78	73	68	11	7	0	1,025
2010-2019	23	240	0	651	63	250	59	16	41	16	1,359
>2019	1	9	0	48	2	16	3	0	0	1	80
UNK	0	0	0	0	0	0	0	0	0	0	0
TOTAL	**116**	**1,396**	**1**	**2,277**	**286**	**878**	**302**	**53**	**103**	**28**	**5,440**

1.1.1.3 Hydrants

Hydrants were typically installed as a child asset to the watermain.

Table B-1-7 shows a breakdown of Hydrants in the linear water system, based on decade installed. As anticipated, the age profile of the hydrants is similar to the watermain profile.

Table B-1-7 Number of Hydrants by Decade

Decade Installed	Number Installed
< 1950	101
1950-1959	120
1960-1969	189
1970-1979	499
1980-1989	465
1990-1999	444
2000-2009	561
2010-2019	1019
>2019	3378
TOTAL	**6776**

1.1.1.4 Meters

Inventory data for meters is not part of the GIS database and therefore the information regarding meters is lacking in comparison to other assets. The documentation of the age of the meters is inconsistent, with incomplete installation records because of the 1998 municipal amalgamation. The installation records will be updated with new data as meters are replaced.

Table B-1-8 shows the meter size information available from the meter shop. Note that inches are traditionally still referenced for meter sizing.

Table B-1-8 Number of Meters by Size

Size (Inches)	Count
5/8”	12,563
5/8” x 3/4"	23,437
3/4"	1,578
1	698
1.5	444
2	266
3	162
4	47
6	8
8	2
10	2
Total	**39,207**

1.1.1.5 Services

Like meters, information regarding services is not currently maintained in the GIS database and therefore available information is limited. UK maintains the services to the curb stops at the property line. Based on the average road right of way, 21.6m, and assuming that services are ½ this length, there are approximately 409 kilometers of services in the asset class.

1.1.2 Non-Linear Assets

Table B-1-9 shows a breakdown of the non-linear assets used for water distribution and treatment. Point Pleasant Water Treatment Plant (WTP) services the west distribution area while the King Street WTP services the central and east distribution areas. Cana is an independent water system located in the northern portion of the City.

Booster stations are located throughout the water system to convey water from one pressure zone to another. Reservoirs and elevated storage tanks are also located

throughout the system and are spread out between the three distribution systems and pressure zones.

Non-linear assets can be further broken down into components including tankage, building structure, mechanical equipment, electrical equipment, and general. For the purposes of this asset management plan the breakdown into these components has not been fully utilized.

Table B-1-9 Non-Linear Asset Summary

Asset Class	Asset Name
Treatment Plants	Point Pleasant WTP
Treatment Plants	King St. WTP
Treatment Plants	Cana
Booster Stations	Collins Bay
Booster Stations	Old Colony
Booster Stations	O'Connor Dr.
Booster Stations	Sydenham Rd.
Booster Stations	James St.
Reservoirs	Industrial Park Res
Reservoirs	O'Connor Dr. Res.
Reservoirs	Third Ave.
Elevated Storage	Creekford Rd.
Elevated Storage	Princess St.
Elevated Storage	Tower St.
Elevated Storage	Milton Rd.
Elevated Storage	Innovation Dr.

1.1.3 Summary

The asset inventory presented in this section was constructed by sourcing a number of documents and data sources. The Enterprise GIS is a logical and reasonable location to store asset information for true linear infrastructure, i.e. Water Mains, Hydrants, Valves and Services. However, it isn't clear if a GIS system is a suitable location for

populating and storing information about complex asset classes, in this case the Plants and Facilities of the Water Utility. It is recommended that UK and the City of Kingston assess and select a suitable software package for an assist registry.

1.2 Valuation and Replacement Costs

This section of the report summarizes the current understanding of financials for the Water Utilities functional asset groups and classes.

Replacement costs are based on most recently available data sources. Valuations are based on 2016 PSAB reporting and represent 'Net Book Value'.

1.2.1 Linear Assets

Replacement costs for linear infrastructure are based on averaged rates from recently tendered reconstruction projects, expressed in 2020 Dollars. The level of confidence of the "Replacement Cost" for the linear infrastructure is considered to be "high" and is presented in Table B-1-10 below.

Table B-1-10Linear Asset Value and Replacement Cost

Asset	Net Book Value (PSAB 2020)	Replacement Cost (1) (2020)
Pipes	$198,248,573	$432,632,262.65
Valves	$12,934,376	$21,489,587.64
Hydrants	$15,074,946	$26,202,166.09
Meters	$7,585,045	$6,274,952.10
Services (3)	N/A Included in Pipes	$102,768,265.39
TOTAL	**$233,842,941**	**$589,367,233.87**

Notes:

1) Replacement cost based on combined infrastructure reconstruction projects with auxiliary services and road reconstruction.
2) Not currently included in the GIS asset inventory. Replacement cost estimated from meter replacement program.
3) Length of services estimated using 21.6 meters average right of way, assuming each service is ½ this value in length and average reconstruction costs.

1.2.2 Non-Linear Assets

Table B-1-11 provides a comparison of “Net Book Value”, “Replacement Cost” and “Planning Level Replacement Cost” for non-linear infrastructure. The Net Book Value is based on the PSAB report, while the replacement cost is based on the recommendations contained either in third party consultant reports, retained by Utilities Kingston, and/or the actual facility construction costs with annual rate adjustments. The level of confidence of the “Replacement Cost” for the Non-linear infrastructure is considered to be “Low”. To account for the Low confidence factor the “Planning Level Replacement Costs” have been adopted utilizing adjusted rates, with a variable confidence factor applied, to compensate for additional anticipated costs to reconstruct facilities due to; anticipated process improvements or historical variation between Opinions of Probable Cost (OPC) and construction costs, i.e. in many instances UK will not be able to reconstruct under a “like for like” manor due to changes in processes and the requirement for continuous facility operations. Note: The Planning Level Replacement Cost for the Point Pleasant WTP is based on the recent tender and award value for the facility capacity upgrade, which is currently under construction. It is recommended that that the Planning Level Replacement Costs be utilized in the Financial Planning section of the AMP. No Planning level replacement cost has been assigned to the Collins Bay and Gardiners Road Booster Stations as they are currently slated for decommissioning.

Table B-1-11 Non-Linear Asset Valuation and Replacement Cost Summary

Asset Class	Asset Name	Net Book Value (2020)	Replacement (2020)	Planning Level Replacement Cost (2020)
Treatment Plant	Point Pleasant WTP	$48,201,191.53	$64,018,691.59	$85,358,255.45
Treatment Plant	King St. WTP	$3,471,132.38	$64,469,926.05	$90,257,896.47
Treatment Plant	Cana	$368,072.25	$926,162.78	$926,162.78
Treatment Plant	**Sub-Total**	**$52,040,396.16**	**$129,414,780.41**	**$176,542,314.70**
Booster Station	Collins Bay (1)	$28,371.99	$0.00	$0.00
Booster Station	Old Colony (1)	$48,222.96	$377,514.36	$500,941.99
Booster Station	O'Connor Dr.	$1,388,971.18	$5,265,403.06	$5,265,403.06
Booster Station	Sydenham Rd. (1)	$41,586.33	$371,407.34	$519,970.72
Booster Station	James St.	$6,585,201.56	$5,446,923.68	$8,109,034.27
Booster Stations	**Sub-Total**	**$8,092,354.02**	**$11,461,248.44**	**$14,395,350.05**
Water Reservoir	Industrial Park Res	$965,297.81	$2,803,040.26	$3,658,586.69
Water Reservoir	O'Connor Dr. Res.	$2,112,219.67	$3,653,249.65	$3,653,249.65

Asset Class	Asset Name	Net Book Value (2020)	Replacement (2020)	Planning Level Replacement Cost (2020)
Water Reservoir	Third Ave.	$206,042.18	$7,007,600.66	$9,810,640.92
Water Reservoir	**Sub-Total**	**$3,283,559.66**	**$13,463,890.58**	**$17,122,477.26**
Elevated Storage	Creekford Rd.	$2,260,655.86	$4,561,937.90	$4,561,937.90
Elevated Storage	Princess St.	$151,540.49	$1,541,672.14	$2,251,437.96
Elevated Storage	Tower St.	$2,243,782.89	$4,500,000.00	$2,251,437.96
Elevated Storage	Milton Rd.	$230,575.84	$1,191,292.11	$2,251,437.96
Elevated Storage	Innovation Dr.	$3,433,836.05	$4,474,673.29	$4,474,673.29
Elevated Storage	**Sub-Total**	**$8,320,391.13**	**$16,269,575.44**	**$15,790,925.07**
ALL	**TOTAL**	**$71,736,700.97**	**$170,609,494.87**	**$223,851,067.08**

Note:

1) Booster Station no longer in service but infrastructure remains in place.

1.2.3 Summary

Linear Infrastructure replacement costs for all asset classes are estimated with reasonable accuracy from recent road reconstruction contracts.

Replacement costs for Plants and Facilities are not as easily estimated and utilize numerous sources of information for the replacement costs that result in inconsistency and lack of accuracy. Contingency factors will need to be considered when planning for the replacement costs to be utilized in the annual capital projections.

1.3 Asset Age and Condition Assessment

Tracking asset age and condition is a very important aspect of infrastructure management, which allows UK to anticipate and prioritize the need for replacement or rehabilitation and develop capital programs for infrastructure improvements.

This section identifies the general condition of assets within the system based on a variety of measures and indicators for both linear and non-linear assets.

1.3.1 Linear Assets

For continuity of evaluation, the life expectancy (LE) of each asset class was extracted from the PSAB reporting. The percentage of linear assets currently past their expected service life as well as those that will reach the end of their service life expectancy in the next five and ten years has been summarized in Table B-1-12 below. Further discussion regarding individual linear assets can be found throughout the Section.

Table B-1-12 Asset Age and Life Expectancy

Asset	Life Expectancy (1) (LE)	Past LE Current	Past LE in (2) Next Five Years	Past LE in (2) Next Ten Years
Watermain Pipe (km)	Varies by Material	57.0	95.3	138.2
Valves (ea)	50 years	1,176	1,523	1,854
Hydrants (ea)	60 years	307	409	617
Meters (ea)	N/A	N/A	N/A	N/A
Services (3)	N/A	N/A	N/A	N/A

1) Life Expectancy taken from PSAB reporting.
2) Cumulative total beyond LE.
3) Services are anticipated to match LE of pipes.

N/A - Information Not Available

1.3.2 Watermain Pipes

The weighted average life expectancy of the existing watermain in the distribution system, based on PSAB life expectancy (LE) for pipe materials and quantity, is 70 years.

Table B-1-13 shows the number of watermain breaks per 100 kilometers broken down into Cast Iron and all other materials. It can be seen that cast iron pipe clearly has the highest break rate compared with all other materials. Cast Iron (CI) was the predominant pipe material installed prior to the 1970s and represents the majority of the older pipe materials in the system. It is no longer being installed in the system and is slowly being replaced by other materials. The break rate for CI is decreasing correspondingly.

Table B-1-13 Watermain Breaks per 100 km, by Material

Year	Material Other Than Cast Iron	Cast Iron
2014	2.13	34.89
2016	1.23	29.31
2017	1.65	27.74
2018	1.39	23.85
2020	0.67	20.09

Due to the inherent inaccessibility of the watermain, formal condition assessments have not been conducted on the asset class. Historically the watermain asset has been operated through a run-to-failure methodology with dig and repair maintenance program. An informal condition assessment of the pipe sections is conducted during the repair process and break and repair locations are tracked in the GIS system.

1.3.3 Valves

Since it is an integral component of the waterline, the expected 50-year service LE for valves may be required as the minimum expected service life of a watermain, depending on material. For some pipe materials, such as PVC, the expected pipe service LE is actually much longer. Typically, the valves are replaced with the watermain (parent asset) which means a large percentage of the valves are used well past their expected service life. The number of valves currently past their LE is summarized in Table B-1-12.

The condition of the valves is assessed by UK through a Standard Operating Procedure (SOP) for the maintenance and operation of valves. Valves ≥400mm (large) are recommended to be operated on an annual basis and valves <400mm (small) are recommended to be operated on a 4-year cycle (i.e. 25% per year).

1.3.4 Hydrants

Table B-1-12 shows the distribution of hydrants currently past and nearing their LE. UK currently conducts inspections on all municipal hydrants on an annual basis, with

additional inspections for new and repaired hydrants prior to placing into service and after use. UK has also conducted hydrant flow rate testing on all hydrants within the system and continue to conduct flow tests for 20% of hydrants each year, on a rotating schedule. Hydrants rated “RED” in accordance with the NFPA Fire Flow Testing[1], i.e. flow rates <31 LPS, may be considered as either an indicator of the condition of the hydrant, or the local capacity of the water distribution system, i.e. not necessarily the hydrant.

1.3.5 Meters

There is limited information available regarding the age, expected service life, and condition of meters in the system. The current meter inventory lists the 1998 municipal amalgamation date as the installation date for a large portion of the meters in the system. UK has been completing a meter replacement program and has replaced over 15,000 customer meters since 2014.

1.3.6 Services

Currently there is limited information regarding the age, material or expected service life of water services as they are not tracked in the GIS inventory. Utilities Kingston maintains an archive of service cards that can be individually reviewed. It could be assumed that for most services, the age is equal to that of the watermain (parent asset) it comes from. This would not be applicable for services that have been replaced or for services where the main has been relined, effectively replacing the main but not the service. In this case the service could be much older than the watermain itself.

[1] NFPA 291, Recommended Practice for Fire Flow Testing and Marking of Hydrants

1.3.7 Non-Linear Assets

1.3.8 Summary

The condition for the water treatment plants (WTP), reservoirs, elevated storage tanks, and booster stations have typically been assessed in-house by Utilities Kingston Operations through routine inspections of the facilities. Where available, third party consultant condition inspections are incorporated into inspection summaries. In 2015 a third party inspection was completed on all the facilities as part of the Water Master Plan update.

Asset age is an attribute that is important for evaluating lifecycle decisions and developing average annual expenditure estimates. As detailed in Section 1.3.1 above, the IIMM would consider this a portion of standard information contained in the asset inventory. Moving forward, it is important to document this information more accurately for all asset classes including services and meters. As well, in conjunction with discretizing facility assets to process, component and sub-component levels, installation data and age should be contained within the scope of documented information to be included in an Asset Registry suitable for Non-Linear Assets (i.e. Plants and Facilities) as described in Section 1.3.3.

The following asset classes are adequately managed by a run-to-failure approach and therefore are deemed not to require a formal condition assessment programs; small local watermains, services and meters.

Table B-1-14 summarizes the condition assessment of the Non-Linear assets, including the original construction date and the most recent major upgrade to the facility.

1.3.9 Summary

Asset age is an attribute that is important for evaluating lifecycle decisions and developing average annual expenditure estimates. As detailed in Section 1.3.1 above, the IIMM would consider this a portion of standard information contained in the asset inventory. Moving forward, it is important to document this information more accurately for all asset classes including services and meters. As well, in conjunction with discretizing facility assets to process, component and sub-component levels, installation data and age should be contained within the scope of documented information to be included in an Asset Registry suitable for Non-Linear Assets (i.e. Plants and Facilities) as described in Section 1.3.3.

The following asset classes are adequately managed by a run-to-failure approach and therefore are deemed not to require a formal condition assessment programs; small local watermains, services and meters.

Table B-1-14 Non-Linear Asset Summary

Asset Class	Asset Name	Condition (1)	Original Build	Upgrade (3)
Treatment Plants	Point Pleasant WTP	Excellent	1971	2016
Treatment Plants	King St. WTP	Average	1950	2006
Treatment Plants	Cana	Good	2003	N/A
Booster Stations (2)	Collins Bay	Not in use	1987	1987
Booster Stations	Old Colony	Not in use	1973	2000
Booster Stations	O'Connor Dr.	Good	2011	N/A
Booster Stations	Sydenham Rd. (Purdy's Court)	Not in use	1996	N/A
Booster Stations	James St.	Excellent	1991	2017
Reservoirs	Progress Ave (Industrial Park Res.)	Average	1962	1992
Reservoirs	O'Connor Dr. Res.	Good	2011	N/A
Reservoirs	Third Ave.	Average	1964	1972
Elevated Storage	Creekford Rd.	Good	2006	N/A
Elevated Storage	O'Connor Dr. (Princess St.)	Average	1962	1996
Elevated Storage	Tower St.	Good	1954	2018
Elevated Storage	Milton Rd.	Average	1981	N/A
Elevated Storage	Innovation Dr.	Good	2012	N/A

Notes:

1) Condition obtained based on UK Operational Risk of Drinking Water System.
2) Condition input from Water and Wastewater Master Plan Update (WSP, 2015)
3) Most recent upgrade or major capital work conducted at the facility.

1.4 Maturity and Moving Forward

1.4.1 Asset Inventory and Valuation Maturity

The asset inventory is currently in a ‘minimal’ state, as per IIMM (NAMS, 2011) guidelines (see Moving forward, the following actions are recommended:

- Documented “Risk” Evaluation and Prioritization Strategy for Linear Assets – Continue to develop and Formalize the process for risk evaluation with a documented Risk Evaluation process.
- Linear System - Allow for inclusion of Services and Meters in the asset inventory. This will not be done retroactively, but as reconstruction and new projects take place.
- Plants and Facilities – Determine an appropriate formal asset inventory for Plants and Facilities and construct a hierarchy of information with Process, Component and Subcomponent levels.
- Consider future data requirements for inventories of Linear and Plants and Facilities, including the possibility to include other data such as material manufacturer, installation contractor, soil conditions, maintenance history, predictive maintenance scheduling, maintenance costs, condition, valuation, performance, risk and lifecycle data.

Table B-1-15). Certain asset classes of the Linear System approach a ‘core’ level of maturity with the Enterprise GIS providing a reasonably well-defined linear asset inventory with some detailed technical data, but not all. The Enterprise data is then supplemented manually with historical cost spreadsheet to determine replacement costs. There is the potential that the spread sheet summaries are not consistently utilized in the evaluation. The Plants and Facilities inventory is also in a ‘minimum’ level of maturity with various non-functional or incomplete inventories including the GIS (identifying only where the facilities are located) and spreadsheets (such as delivered with the Condition Assessment (Stantec, 2008)).

Moving forward, the following actions are recommended:

- Documented “Risk” Evaluation and Prioritization Strategy for Linear Assets – Continue to develop and Formalize the process for risk evaluation with a documented Risk Evaluation process.
- Linear System - Allow for inclusion of Services and Meters in the asset inventory. This will not be done retroactively, but as reconstruction and new projects take place.
- Plants and Facilities – Determine an appropriate formal asset inventory for Plants and Facilities and construct a hierarchy of information with Process, Component and Subcomponent levels.
- Consider future data requirements for inventories of Linear and Plants and Facilities, including the possibility to include other data such as material manufacturer, installation contractor, soil conditions, maintenance history, predictive maintenance scheduling, maintenance costs, condition, valuation, performance, risk and lifecycle data.

Table B-1-15 Current Maturity of Asset Inventory and Valuation.

Maturity Level	Description	Status of Current Plan
Minimum	Basic physical information recorded in a spreadsheet or similar (e.g. location, size, type), but may be based on broad assumptions or not complete.	We are here.
Core	Sufficient information to complete asset valuation – as for 'minimum' plus replacement cost and asset age/life. Asset hierarchy, asset identification and asset attribute systems documented.	Short-term Target for 2025
Intermediate	A reliable register of physical and financial attributes recorded in an information system with data analysis and reporting functionality. Systematic and documented data collection process in place. High level of confidence in critical asset data.	
Advanced	Information on work history type and cost, condition, performance, etc. recorded at asset component level. Systematic and fully optimized data collection program. Complete database for critical assets; minimal assumptions for non-critical assets	

1.4.2 Asset Age and Condition Assessment Maturity

It is estimated that the maturity of the Condition Assessment process is 'minimum' given the informality of completion, documentation, and storage of results (see Table B-1-16). The ability for Utilities Kingston to advance to a 'core' maturity level would require a classification of the linear infrastructure, such as transmission/feeder/local mains, in the GIS inventory to support a formal Risk based condition assessment program for all asset classes deemed appropriate with supporting documentation. The ability to implement a 'core' level condition assessment program also requires adoption of a suitable asset register for Plants and Facilities as described in Section 1.1.3 to provide a repository for information.

Table B-1-16 Condition Assessment Maturity Index

Maturity Level	Description	Status of Current Plan
Minimum	Basic physical information recorded in a spreadsheet or similar (e.g. location, size, type), but may be based on broad assumptions or not complete.	We are here.
Core	Sufficient information to complete asset valuation – as for 'minimum' plus replacement cost and asset age/life. Asset hierarchy, asset identification and asset attribute systems documented.	Short-term Target for 2025
Intermediate	A reliable register of physical and financial attributes recorded in an information system with data analysis and reporting functionality. Systematic and documented data collection process in place. High level of confidence in critical asset data.	
Advanced	Information on work history type and cost, condition, performance, etc. recorded at asset component level. Systematic and fully optimized data collection program. Complete database for critical assets; minimal assumptions for non-critical assets	

Moving forward, the following actions are recommended:

- Prepare a documented "Risk Evaluation" and Prioritization Strategy for Linear Assets – Formalize the process for risk evaluation with a documented Risk Evaluation process that supports the maintenance and replacement programs.
- Linear System - Allow for operational and maintenance data to be included in the asset inventory.
- It is recommended that UK Operations Group implement a valve exercise program schedule in accordance with SOPs.
- Hydrant flow testing is scheduled to be carried out at a rate of 20% per year (5-year cycle).

- Plants and Facilities – Determine an appropriate formal asset inventory for Plants and Facilities and construct a hierarchy of information with Process, Component and Subcomponent levels.
- Consider future data requirements for inventories of Linear and Plants and Facilities, including the possibility to include other data such as valuation, material manufacturer, installation contractor, maintenance history, predictive maintenance scheduling, maintenance costs, condition, performance, risk and lifecycle data.
- Watermains – a new condition assessment process should be considered for implementation, specifically for the larger transmission watermains that have a greater criticality.
- Standardize a data collection and condition assessment process for the distribution system watermains when conducting repairs or connections, i.e. hydrant/valve/break repairs or tapping connections. Include data in the asset inventory.
- It is recommended that any future Condition Assessment consulting assignments for Plants and Facilities should be standardized; and,
    i. include all facility types including Water Treatment Plants, Booster Stations, Reservoirs and Elevated Storage Tanks, and,
    ii. include estimation of Replacement Costs based on an analysis of local projects in Eastern Ontario that fit within the range of facility sizes operated by Utilities Kingston.

This data should be housed within an appropriate asset registry for Plants and Facilities as described below.

- Utilities Kingston and the City of Kingston should assess and select a suitable software package for the asset registry appropriate for both Linear and Non-Linear Assets.

2 Expected Levels of Service

Levels of Service (LOS) are statements of service performance delivery as the affect the asset management. In many cases, Levels of Service are related to Strategic Goals of Utilities Kingston and are established based on the needs or wants of the community as well as legislative and regulatory requirements. This report also includes Key Performance Indicators (KPI's) which are used to measure how well the LOS are being met. Using input from various groups within the organization Utilities Kingston has identified the following LOS and KPI's for the water utility.

Table B-2-1 (A) Performance & Reliability - Water

Utilities Kingston will provide a continuous supply of high quality, safe drinking water.

Key Performance Indicator	Current	Target
A.1) Percentage of time when Raw Water Flow is within 75% of Permit to Take Water Capacity	King St.: 0.0 Point Pleasant: 0.0 Cana: 0.0	Good: < 10% of the time Acceptable: 10 - 15% of the time Unacceptable: > 15% of the time
A.2) Percentage of time when Treated Water Flow is within 75% of Treatment Capacity	King St.: 0.0 Point Pleasant: 0.0 Cana: 0.0	Good: < 10% of the time Acceptable: 10 - 15% of the time Unacceptable: >15% of the time
A.3) Number of adverse Drinking Water Quality Notifications - Annually.	3	Good: < 10 Acceptable: 10 – 15 Unacceptable > 15
A.4) Number of days when a boil water advisory issued by medical officer of health	3	Good: 0.0 Unacceptable: > 0.0
A.5) Ministry of Environment, Drinking Water System Inspection Report, Inspection Rating Record (IRR)	Kings St.: 100% Point Pleasant:100% Cana: 100%	Good: > 95% Acceptable: 90 - 95 % Unacceptable < 90%

Table B-2-2 (B) Risk Management - Water

Utilities Kingston will minimize risk, maintaining infrastructure in condition sufficient to provide safe and secure water to the consumer.

Key Performance Indicator	Current	Target
B.1) Percent of watermain infrastructure beyond design service life.	10%	Good: < 5%, Acceptable: 5 - 10 %, Unacceptable: > 10%
B.2) Percent of watermain infrastructure considered to be a priority for replacement or rehabilitation - high risk.	0.9% (5.1 kilometers)	Good: < 5%, Acceptable: 5 - 10%, Unacceptable: > 10%
B.3) Number of watermain breaks per 100 kilometers of watermain per year	16.7	Good: < 10, Acceptable: 10 – 15, Unacceptable: > 15
B.4) Percent of red hydrants in the distribution system - risk impact for fire fighting requirements.	1.5%	Good: < 5%, Acceptable: 5 - 10%, Unacceptable: >15%
B.5) Percent of valves > 400mm diameter evaluated in 2020	8%	Good: > 90%, Acceptable: 80 - 90%, Unacceptable: < 80%
B.6) Percentage of valves = or < 300mm diameter evaluated in 2020	< 1%	Good: > 90%, Acceptable: 80 - 90%, Unacceptable: <80%
B.7) Percent of known non-operable valves in the system.	1%	Good: < 5%, Acceptable: 5 - 10%, Unacceptable: > 10%

Table B-2-3 (C) Growth and Planning - Water

Utilities Kingston will undertake sufficient planning to ensure the utility can meet existing and future needs.

Key Performance Indicator	Current	Target
C.1) Maturity of Water Master Plan	Last Update Complete 2017	Good: 5 years since update Acceptable: 6-7 years since update Unacceptable: 8+ years since update
C.2) Maturity of Condition Assessment (3rd Party) on Water Treatment Facilities	UNK	Good: <= 8 years, Acceptable: 8 -10 years Unacceptable > 10 years
C.3) Maturity of Condition Assessment (3rd Party) on Booster Stations	2015	Good: <= 8 years Acceptable: 8 -10 years Unacceptable: >10 years
C.4) Uncommitted Reserve Capacity at Water Treatment Plant - Based on Ministry Procedure D-5-1. Number of years of Growth Capacity, Point Pleasant WTP and King Street WTP	37.8	Good: > 10 Acceptable: 7-10 Unacceptable: < 7

Table B-2-4 (D) Sustainability - Water

Utilities Kingston will strive to achieve, maintain, or improve identified goals.

Key Performance Indicator	Current	Target
D.1) Percent of treated water that is non-revenue	33%	Good: < 15% Acceptable: 15 - 25 % Unacceptable: > 25 %
D.2) Cross connection backflow control program - Percent of customers in Compliance	65%	Good: > 40% Acceptable: 10 - 40 % Unacceptable: < 10 %

Table B-2-5 (E) Financial - Water

Utilities Kingston will be maintained as financially viable and responsible to its customers.

Key Performance Indicator	Current	Target
E.1) Combined Water & Wastewater Costs to Customer (a) As a percentage of household income (b) As a dollar amount	Residential: Burden: 1.22% Burden: $1,174 (Mid) 2.98% above average	Good: < 10% Acceptable: 10 - 20% Unacceptable: > 20%
E.2) Debt Repayment (a) Debt Interest repayment as a percentage of revenue (b) Total debt repayment as a percentage of revenue	 3.5% 6.9%	Good:<25% Undesirable: >25%
E.3) Water Debt Outstanding per Customer	$752	No ranges defined.
E.4) Estimated Annual Budget Deficit	$5.23 M per year	No ranges defined.

2.1 Maturity and Moving Forward

The above Levels of Service and supporting performance indicators serve as an initial starting point for the Water Utilities Asset Management Plan. With no consultation with customers, the maturity level of this section is very limited. For this version of the Asset Management Plan, the maturity level is considered 'minimal' (seeTable B-2-6).

Table B-2-6 Level of Service Maturity Index

Maturity Level	Description	Status of Current Plan
Minimum	Asset contribution to organization's objectives and some basic levels of service have been defined.	We are here.
Core	Customer Groups defined and requirements informally understood. Levels of service and performance measures in place covering a range of service attributes. Annual reporting against performance targets.	Short-term Target for 2025
Intermediate	Customer Group needs analyzed. Costs to deliver alternate key levels of service are assessed. Customers are consulted on significant service levels and options.	
Advanced	Levels of service consultation strategy developed and implemented. Technical and customer levels of service are integral to decision-making and business planning.	

Moving forward, the following actions are recommended:

- Review and develop KPIs focused on existing customer groups including residential, commercial, institutional, and development communities as well as internal Utility and City departments. KPIs may include feedback mechanisms/surveys and responsiveness to service calls.

3 Asset Management Strategy

The Asset Management Strategy for the Water Utility is founded on the following principles:

- Growth is the primary trigger for new asset construction, facility and system expansion/upgrades.
- Risk Management is a primary trigger for asset replacement, or major system upgrade.
- Maintenance activities will otherwise be responsible for maintaining adequate condition and function of assets and provide the lowest lifecycle cost (see example Figure B-3-1).

Asset management at Utilities Kingston is comprised of four predominant categories of effort:

1. Infrastructure Planning – These studies focus primarily on growth and ensuring that infrastructure meets the growth-driven needs of the City.
2. Risk Assessment – These efforts focus on steps required to determine the risk associated with assets and make appropriate maintenance, upgrade and replacement decisions. This includes assessment of criticality and condition.
3. Lifecycle Decision-Making – This process focuses on use of lifecycle knowledge to determine the most suitable solution for addressing deficiencies identified in Items 1 and 2 above.
4. Maintenance Management – This is the de facto means of maintaining assets in absence of triggers for asset replacement or major upgrade.

The four categories listed above are described in detail below.

3.1 Infrastructure Planning

Infrastructure Planning is responsible for ensuring that infrastructure is adequate to meet the needs of the existing and future customer loads in consideration of existing and future regulatory requirements. For the Water utility, this means that infrastructure is of adequate capacity to meet future growth conditions, including both linear

infrastructure and facilities, and the water treatment plants will be able to treat future demands to drinking water quality standards.

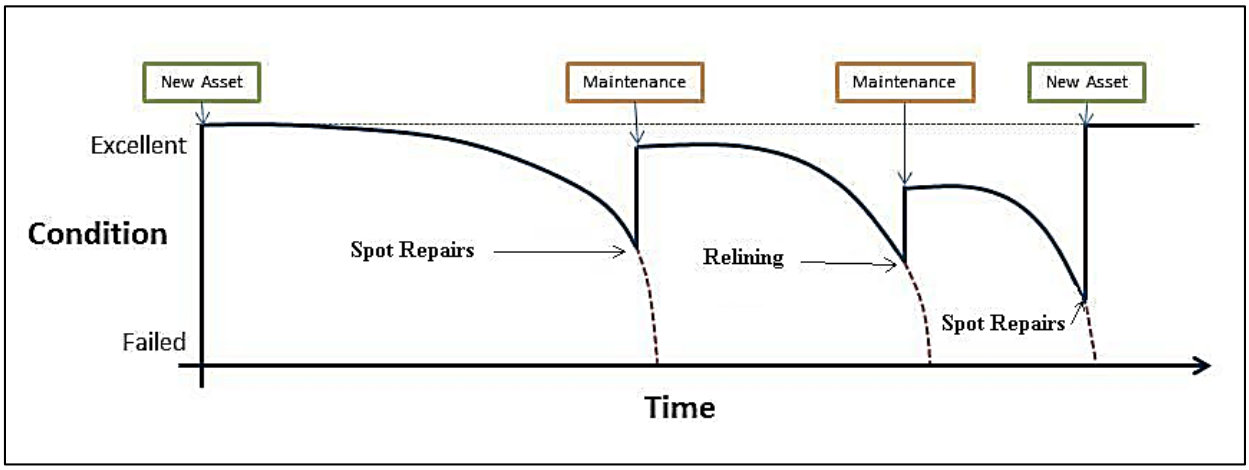


Figure B-3-1 Example lifecycle of a watermain pipe asset.

Table B-3-1 provides a list of Infrastructure Planning Studies and the asset classes that they impact.

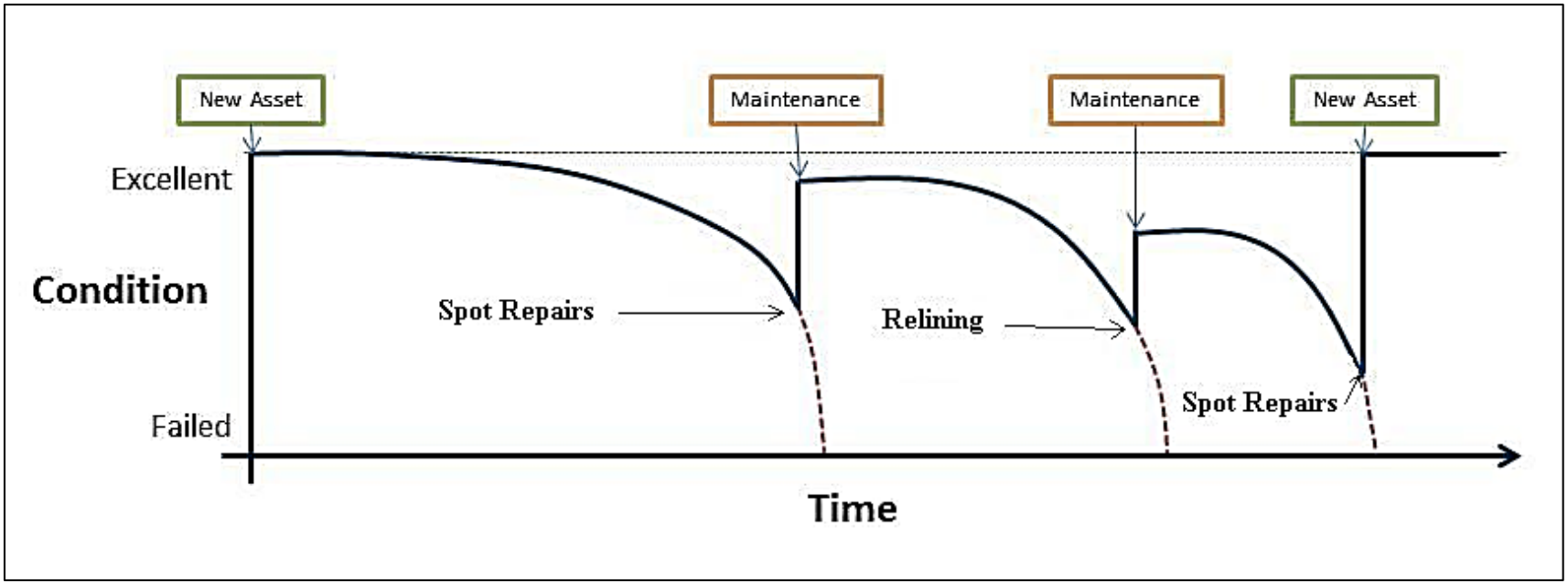


Figure B-3-1 Example lifecycle of a watermain pipe asset.

Table B-3-1 Infrastructure Planning Studies

Study	Description	Frequency	Assets
Growth Strategy	Growth Strategies are undertaken by the City of Kingston Planning Department to identify future areas for growth. Utilities are considered during the analysis at a high-level.	Typically ~5-10 year Cycle.	Major facilities including WTP, BS, reservoirs, elevated storage tanks and larger watermains.
Master Plan (MP)	Water Master Planning assignments are initiated by Utilities Kingston when a major change in the water infrastructure takes place or change in overarching growth projections. The MP typically precedes a Growth Strategy and examined all major development areas considered within a 25 year horizon. It provides recommendations on system upgrades or replacements required to meet growth projections.	Typically 5 - 10 year Cycle.	Major and moderate sized facilities including WTP, BS, reservoirs, elevated storage tanks, and linear distribution systems.
Development Charges Planning Studies	Development Charges as per the Municipal Act are imposed to recover the capital costs of sewer and water infrastructure related to future expansion of the service systems. Impost fee studies examine expected future growth within the city and relate that to future infrastructure needs. This forms the growth related components of the capital infrastructure plans which are then utilized to allocate the costs to be recovered through future impost fees.	Typically 5 year Cycle	Major facilities including WTP, BS, reservoirs, elevated storage tanks and larger watermains.

Study	Description	Frequency	Assets
Infrastructure Capital Planning	Capital Road Reconstruction Planning (and Linear Infrastructure Risk Assessment) assignments are initiated by Utilities Kingston and the City of Kingston in order to prioritize road reconstruction and utility replacement/rehabilitation projects.	Typically 4 year Cycle	All linear assets.
Environmental Assessments (EA)	Environmental Assessments are often conducted as a result of recommended projects from MP, but sometimes are initiated due to internally driven, or City-driven, initiatives. At times they include scales larger than the facility or asset being studied and may derive recommendations that impact other assets as well.	As required.	Variable. Can include any and all asset classes.
Development Studies	Larger-scale developments precipitate the need for studies that may generate recommendations for facilities or linear assets at any scale.	As required.	Variable. Can include any and all asset classes.
Uncommitted Plant Reserve Capacity Analyses	UK Internal - Water Treatment Plant Capacity tracking in conjunction with above Studies and Plans to ensure capacity upgrades are initiated in a timely manner. The exercise generally follows MOE Procedure D-5-1. The Analysis has not been conducted in recent years and the process needs to be reinitiated.	Annually	WTP

In addition to the planning-level studies, there are also likely to be asset-specific or asset-class specific studies from time to time, and condition-assessment activities. These are typically planning/capacity driven, or condition driven and are equally able to provide guidance on the need for replacement or upgrades, typically with shorter to more moderate time-horizons.

In general, infrastructure is not replaced unless a study provides a trigger. While this may seem non-proactive, the failure modes are such that interim failures can be managed through Operations and Maintenance. Infrastructure Planning studies generally produce the following:

- Triggers for replacement or major upgrades of assets due to insufficient sizes, or system capacity.
- Triggers for construction of new assets.
- Triggers for decommissioning of existing assets.
- Strategic approaches to accomplishing stated goals.
- Approximate timing associated with the above.

It is recommended that Water Master Plan Studies/Updates take place on a 5- to 10-year cycle and includes a summary of system implementations/upgrades for the proceeding 5-year period, minimum, plus an outlook for the following 15 and 25-year horizons. Water and Wastewater Master Planning should be undertaken concurrently utilizing common growth and development conditions and assumptions.

The City of Kingston and/or Utilities Kingston has also incorporated initiatives that support the Sustainable Kingston Plan. The City has enacted a Summer Water Use Restriction By-Law to reduce the amount of treated water being used for non-potable purposes, i.e. watering of lawns, etc. Utilities Kingston has also implemented water conservation program, which provides an incentive for larger water consumers to develop alternative or more efficient processes/equipment to reduce water consumption.

3.1.1 Growth Estimation

The studies identified in

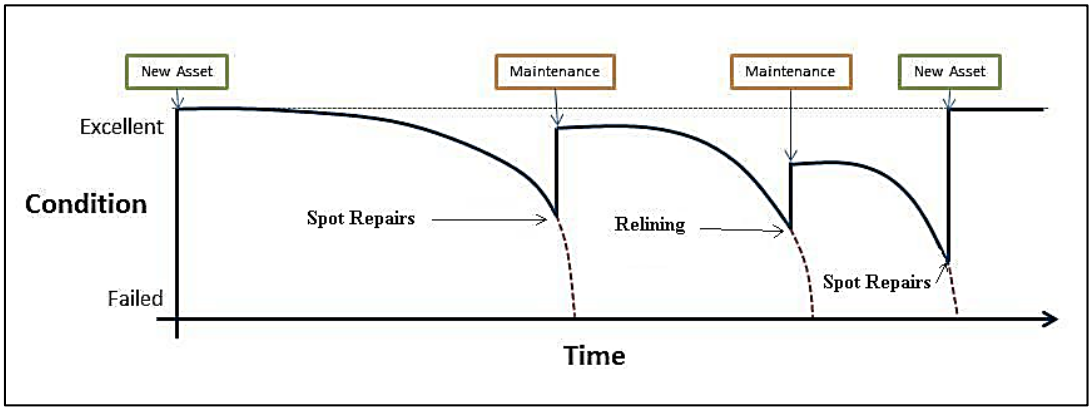


Figure B-3-1 Example lifecycle of a watermain pipe asset.

Table B-3-1 are responsible for identifying specific projects required to meet the water treatment and distribution needs of the existing and future anticipated loads. Examples of the output include Water Treatment Plant expansions, new Booster Stations, new Elevated Storage Tanks and Reservoirs to provide service to new growth areas. However, this does not assist in determining the anticipated increase in expenditures required to support infrastructure once it has been constructed. For example, if annual capital expenditure for watermain rehabilitation and replacement is directly related to the quantity of assets in the asset class, then an increase in assets will require a corresponding increase in annual capital expenditure (and Operations and Maintenance as well). Given that growth of asset quantity will be accompanied by growth of the customer base, on average there will not necessarily be a required increase in rates.

Two recent sources of information for growth-based are discussed here-in to assist in projecting necessary increases to annual budgets.

- The past 11 years of customer accounts has been reviewed and this can be used to anticipate short-term growth requirements.
- For longer-term projections, the City of Kingston and Kingston CMA Population, Housing and Employment Projections study, currently in Draft form, September 2013, is referenced.

The average annual growth in customer base is 1.3% per year of which the majority is residential customers. The last two years have seen slower growth at five year 1.0%. There is little difference in the number of commercial customers over the past 11 years. The data indicates a slight decrease in growth rate over the past eleven years due to an apparent dip in growth between 2015 and 2017.

The general results of the longer-term study entitled, “City of Kingston Population, Housing and Employment Forecast Report” (Watson and Associates Economists Ltd, 2019), are as follows:

- The study projects growth at roughly 0.9%/year in the short-term (2016-) declining to 0.2%/year towards 2046.

- Student population is included in this analysis. As students are generally present at minimum 8 out of 12 months (i.e. majority of the year), they must be taken into consideration for infrastructure planning.
- Within the 10-year horizon as covered by this report, growth of approximately 0.8% per year is forecasted.

As a result, it is worthwhile assuming an increase in assets by a rate commensurate with customer base growth, in the order of 0.8% over the next 10 years. While master planning studies will identify the need for larger trunk mains associated with this growth, local mains are constructed by developers and transferred to City ownership later, and not identified in plans. One might therefore consider the total asset base for Asset Classes such as local mains, hydrants, valves, and services to increase at a similar rate.

3.1.2 Water Demand Management

Water demand management as it relates to capacity of the infrastructure is aimed at reducing water use and focuses on the following primary areas.

a. Use of treated potable water for non-potable purposes.
b. Water Conservation programs.
c. Non-Revenue Water Losses.

The City of Kingston has enacted By-Law 2006-122 that provides for the Regulation for the Water Supply for the City of Kingston. Part 7 of the By-Law deals with the external use of water and provides restrictions during the period of June 15 to September 15 each year, i.e. the traditional drier summer months.

Utilities Kingston water rate structure is a two-part structure consisting of a volumetric charge and a monthly fixed charge. To attempt to curtail higher than normal water use and encourage residential consumer conservation, Utilities Kingston implemented an increasing block water rate structure for the residential class volumetric charge. For residential consumers the volumetric water rate increases after the first 25m^3 usage

each month. The current residential commodity rates are $1.4867 per m^3 for the first 25 m^3 usage, and $1.8583 per m^3 thereafter.

In addition to various water conservation programs and customer information sessions, i.e. water conservation garden, conservation tips, rain barrel programs, Utilities Kingston has also implemented a Water Efficiency Retrofit Incentive Program (WERIP) to its commercial, institutional, and multi-residential customers to make investments in water efficiency that help minimize the cost of providing water and sewer service to all Utilities Kingston customers. Projects that can apply for custom WERIP incentives include institutional toilet replacement projects, retrofits of heavily used commercial laundry or commercial kitchen equipment, or any other projects that permanently reduce water consumption and sewer discharges.

Utilities Kingston has also initiated a Water Loss Reduction Strategy with the objective of reducing the quantity of non-revenue water in the system. Non-Revenue water is identified as the difference between the volume of water produced and the volume of authorized consumption. Non-revenue water may be attributed primarily to meter inaccuracies, non-metered consumption, and leakage from the system. The historical water loss is shown in Figure B-3-2 and Figure B-3-3. Key recommendations of the water loss reduction strategy include; installation of District Metered Areas (DMA) to identify and locate regions of high water loss, improving active leak control processes to identify and repair leak locations, and implementing a team of dedicated staff responsible to identify locations of unauthorized use.

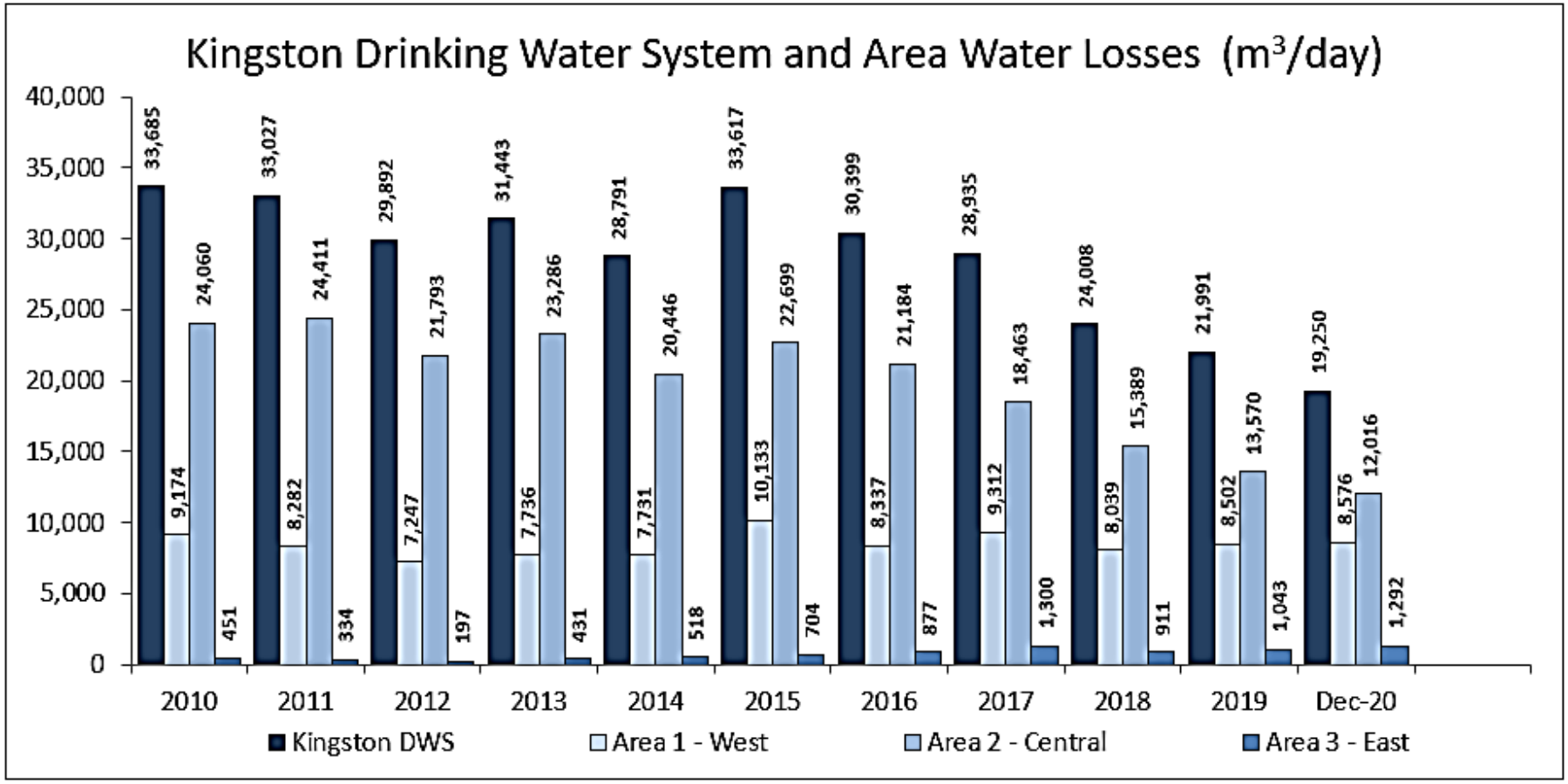


Figure B-3-2 Water System Losses by Cubic Metres per Day

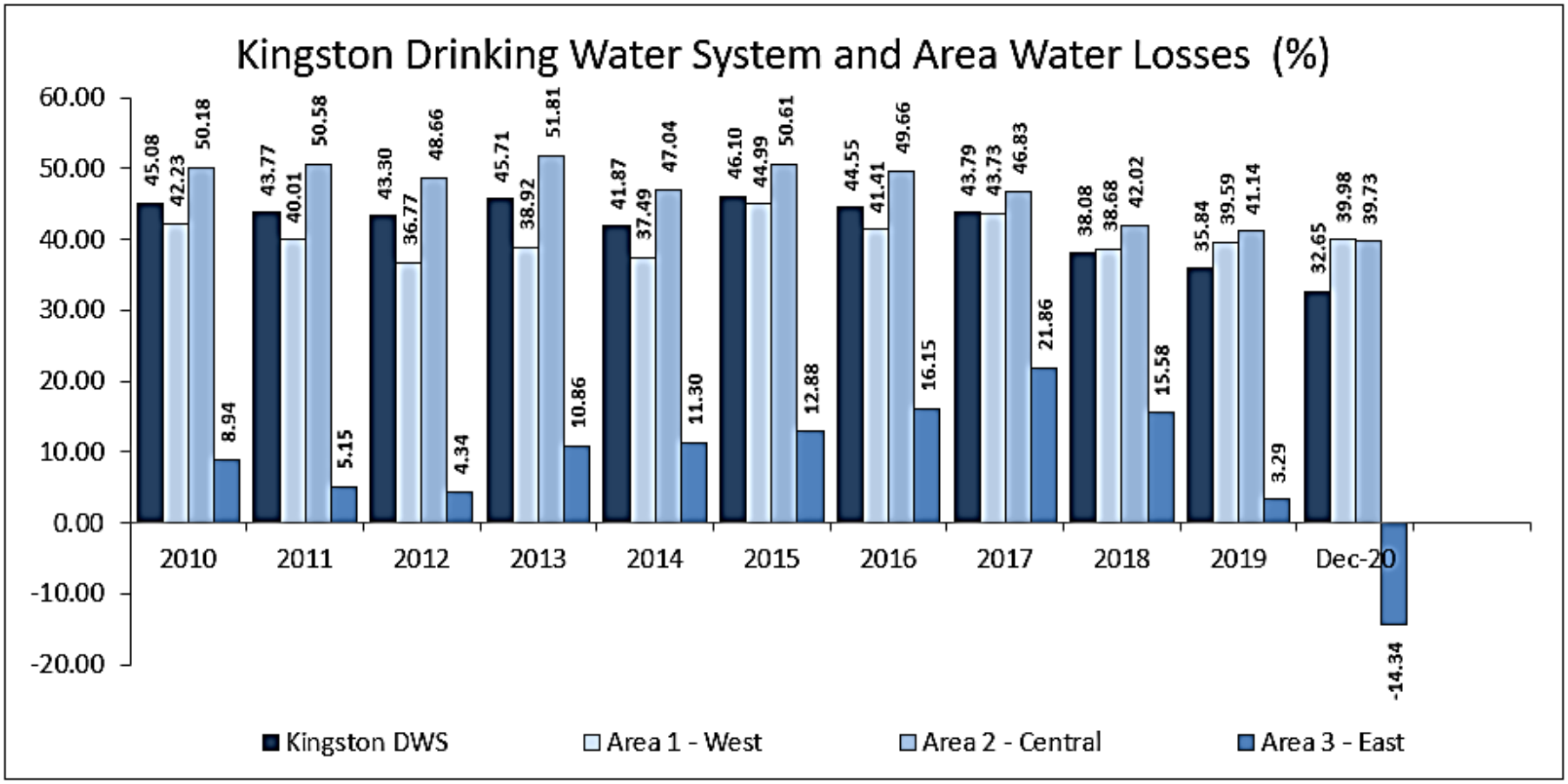


Figure B-3-3 Water System Losses by Percent

While the demand management strategies are not anticipated to affect the overall budgeting requirements in the short term, they will have positive impacts in the long run since they may; delay requirements for expansion of treatment plants, delay distribution system capacity upgrades, and reduce operating and treatment costs due to the reduced quantities of water used or lost from the system.

3.1.3 Planning and Growth Implications

The 2006 and 2015 Water Master Plan have identified several projects to be implemented in support of the City of Kingston preferred growth alternative [Growth Alternative 2 (West and East)] identified in the City of Kingston Urban Growth Strategy, Final Report 2004. Separate consultant and internal condition reports, risk assessments and planning activities have also identified upgrade/replacement projects. These projects are identified in Table B-3-2 for facilities and Table B-3-3 for linear infrastructure. They include either a consultant Opinion of Probable Costs (OPC) or a budget estimate based on previous construction projects. The OPC have been related to 2020$ utilizing Construction Price indexes.

It should be noted that the Opinions of Probable Cost are highly suspect. Projects that have been recently completed have actual costs that are in the order of 140-150% of the OPC, while the anticipated project costs for the Point Pleasant WTP Capacity increase are in the order of $76million, approximately 100% of the OPC.

It is an unfortunate aspect of the business that there is risk inherent with interpreting and budgeting on OPC's provided by consultants, with the added complexity of yearly construction costs variations. Given what has been seen, it would be prudent to plan for an additional 40-50% minimum to OPCs for the water system.

The water master plan was recently updated in 2016 which resulted in several recommendations for infrastructure improvements and additions to the water system. Table B-3-2 and Table B-3-3 list the recommended works.

It should be noted that the list of projects in these tables is not considered to be “all encompassing” as other projects may be identified during subsequent studies or planning phases.

Table B-3-2 Recommended Works and Implementation Status to 2036 Non-Linear

Project	Timing	Implementation Status	Probable Cost ($2020)	Driving Force
Decommission Old Colony, Sydenham Road, and Collins Bay Booster Stations	2018-2021	Identified	$300,000	Planning (1)
Install PRV at former site of Old Colony Booster Station	2018-2021	Identified	$200,000	Planning
Progress Avenue Booster Station upgrades(s)	2026-2036	Identified	$400,000	Condition
King Street WTP Upgrades	2021 / 2026 /2036	Identified	$500,000	Condition/ Planning
Third Avenue Booster Station Upgrade	2021	Identified	$2,500,000	Condition/ Planning
Decommission O’Connor Drive EST	2021 - 2026	Identified	$1,400,000	Planning
Forest Drive Standpipe Upgrade	2031	Identified	$250,000	Condition
James St Booster Station	2036	Identified	$80,000	Condition
O'Connor Dr. Reservoir Storage capacity increase and pumps	2036	Identified – more analysis required	$4,303,010	Growth (5)

Table B-3-3 Recommended Works and Implementation Status to 2036 Linear

Project	Timing	Implementation Status	Probable Cost ($2020)	Driving Force
Norman Rogers Ave, Watermain Upsize	2026	Identified	$1,900,000	Planning/ Reliability
Dalton Ave Watermain Replacement, Division to Don	2026	Identified	$1,900,000	Planning/ Reliability
Dalton Ave Watermain Twin, SJA Blvd to Grant Timmins	2036	Identified	$770,000	Planning/ Reliability
Balsam Grove, Rideau Trail Watermain	2021	Identified	$3,500,000	Planning/ Reliability
Creekford Road Watermain	2026	Identified	$6,700,000	Planning/ Reliability
Novelis property, East-West (300 mm and 400 mm) (6)	-	Pending	$1,778,475	Planning (1)
Cataraqui Woods Dr., Sydenham to 580m-E	2020	Identified	$600,000	Growth
Gardiners Road Upsize, O'Connor Dr to Fortune Cres.	2036	Identified	$2,600,000	Growth
Front Road Interconnect	2021	Design/ Implementation	$10,000,000	Growth/ Planning
Highway 15 Trunk Watermain and Pressure Zone modifications	2021	Design/ Implementation	$4,000,000	Growth/ Planning

Project	Timing	Implementation Status	Probable Cost ($2020)	Driving Force
King St., Sir John A. MacDonald to King St WTP	-	Identified in the 2006 Master Plan. Further studies underway. To be completed with Front Rd WM noted below.	-	Planning (1)
John Counter Blvd., Montreal St to Great Cat River (6)	2024	Identified in City of Kingston Planning options.	$364,100	Planning (1)

Total of Anticipated Capital Works (to 2036) **$44,045,585**

Total of Anticipated Capital Works (to 2030) **$32,792,575**

Average Annual Investment **$3,279,257.50**

Notes: (1) Internal Planning Estimates

3.2 Risk Management

The lifecycle of an asset contains numerous decision-making processes inherent to it. The primary decision-making process (on whether or not to do work on an asset) is the risk assessment process which is instrumental in managing risk.

The Risk Assessment process is the process of utilizing both condition and criticality information to estimate risk. Condition (or likelihood of failure) is determined as a result of a condition assessment and is generally time dependent. Criticality is determined as a result of where the asset is, what size it is, how many customers it services, and other factors, which is akin to the consequence of failure. Combining both factors forms the risk assessment. For the linear systems, this is completed mathematically such that risk is estimated in a quantitative manner and prioritization can be undertaken by sorting by risk.

Prioritization is the process of utilizing risk assessment results and generating a proposed sequence of works that is commensurate with the magnitude of risk. In other words, assets that present higher risks are those that logically receive attention sooner than those with lower risk.

The following sections describe the process:

3.2.1 Criticality Assessment

Upon creation of an asset, its criticality can be determined. Criticality is an indication of how important the feature is to the function of water utility and may also be an indication of the severity of the consequence of failure. For example, a large watermain that supplies a pressure zone from a treatment plant or booster station is an asset with higher criticality than a smaller watermain that services a small neighbourhood. This is because the larger watermain services more customers and the consequence of its failure is much more severe. Factors used in assigning criticality are as follows: Risk to Public Health and Safety, disruption to Customers, Customer Type, and, Environmental Impact, Difficulty of Repair, Confidence and Liability.

3.2.1.1 Plants and Facilities

The criticality of the Water Treatment Plants (WTP), Reservoirs, Elevated Storage Tanks, and Booster Stations were assessed using a combination of in-house operational risk assessment and consultant led criticality analysis, which was completed during the condition assessment component of the Water Master Plan update (WSP, 2015). The consultant led analysis-based criticality on customer type, number of customers serviced, risk to the public, and environmental impacts. Additionally, the UK in-house analysis considered how failure of the facility would impact the integrity of the water system. Taking both perspectives into account, an overall facility criticality was developed, described below, and summarized in Table B-3-4. By virtue of the purpose of WTP, all plants were assigned a criticality grade of A.

- The Cana distribution system is an independent system supplied by the Cana WTP.

- The Point Pleasant WTP supplies Pressure Zone 1 and the O'Connor Drive Booster Station (BS), which is the main feed for the Pressure Zone 2. The Old Colony and Purdy's Court BS currently do not operate and are slated for decommissioning in the coming years.
- The King Street WTP supplies the Central Pressure Zone and the James Street Booster BS, which is the main supply feed for Pressure Zone 3.
- The Collins Bay and Gardiners Road BS are both slated for decommissioning and have been assigned a criticality grade of C.
- With the exception of the Third Avenue reservoir, the water system reservoirs and elevated tanks are routinely taken out of service for operational and maintenance activities, and thus have been assigned a criticality grade of B. The Third Avenue reservoir provides the majority of the storage capacity for the central city distribution system.

Table B-3-4 Non-Linear Criticality Assessment

Asset Class	Asset Name	Criticality (1)(2)
Treatment Plant	Point Pleasant WTP	A
Treatment Plant	King St. WTP	A
Treatment Plant	Cana	A
Booster Station	Collins Bay (3)	C
Booster Station	Old Colony	B
Booster Station	O'Connor Dr.	A
Booster Station	Sydenham Rd. (Purdy's Court)	B
Booster Station	James St.	A
Reservoir	Industrial Park Res	B
Reservoir	O'Connor Dr. Res.	B
Reservoir	Third Ave.	A
Elevated Storage	Creekford Rd.	A
Elevated Storage	Princess St.	B
Elevated Storage	Tower St.	B
Elevated Storage	Milton Rd.	B
Elevated Storage	Innovation Dr.	B

Notes:

(1) Criticality obtained based on UK Operational Risk of Drinking Water System.

(2) Criticality input from Water & Wastewater Facility Condition Assessment (WSP, 2015).

(3) Currently not in operation or has been removed/decommissioned.

Table B-3-5 Criticality Definitions

Criticality	Description
A	Stations where the tolerance of failure is low due to the fact that Public Health, Environmental Impact or Disruption to Customers resulting from the failure are considered to be unacceptable. Redundancy or contingency plans must be in place to minimize the impacts.
B	Stations where the consequences associated with the Disruption of Customers, Public Health and Environmental Impacts can be mitigated using emergency pumping.
C	Stations where failures will not significantly impact the provision of service and emergency pumping capacity can be employed to provide continuation of service.

3.2.1.2 Linear Infrastructure

For linear infrastructure, criticality is assessed and reviewed in-house annually as part of the UK Infrastructure Capital Planning process. For linear infrastructure, criticality is assigned based on the parent watermain asset where valves, hydrants and services inherit the criticality of the parent asset. Meters are all assigned a low criticality.

The following factors were used in assigning criticality to linear assets:

- Size of watermain – larger watermains are assigned a higher criticality due to the impact to consumers and potential severity of consequence of failure.
- Location/accessibility (different street types, arterial/collector/local, may have greater impact of disruption and be less accessible).

3.2.2 Condition Assessment

Periodic condition assessment of assets is paramount to implementing an effective asset management plan. Condition is utilized in conjunction with criticality in determining the risk. Condition is akin to the likelihood of failure, where the more advanced the deterioration of the asset, the more likely the asset is to fail. Failure of an asset is indicative of an ineffective asset management program, as failure is to be

avoided by maintenance and asset replacement or rehabilitation in a proactive well-timed manner.

3.2.2.1 Plants and Facilities

Plants and facilities in the Water Utility are subject to periodic condition assessment by external consultants, as well as regular (daily, weekly, and monthly) inspections by staff. These processes are complimentary, as the consultant-lead processes generates work on larger scales whereas the staff-lead works are typically smaller-scale process-related and managed using Utilities Kingston's maintenance management system called WaterTrax. Table B-3-6 summarizes the condition assessment process for Plants and Facilities.

Table B-3-6 Condition Assessment – Non-Linear

Process	Description	Frequency	Asset Classes
Facility Condition Assessment (consultant-lead)	The Facility Condition Assessment study is a rigorous process that involves assessment of criticality and condition down to the major component level and uses a risk assessment framework to recommend proactive works on all facilities and/or recommendations for replacements and/or major upgrades. It also reviews regulatory and code compliance issues. Includes a 10-year outlook to the next cycle. Improvements need to be made to this program and recommendations for maintenance need to be reviewed.	~10 years	Water Treatment Plants (3) Booster Stations (6) Elevated Storage Tanks (6) Storage Reservoirs (3)
Facility Condition Assessment (staff-lead)	Treatment Group staff in the Water and Wastewater Infrastructure Department undertake light to rigorous condition assessments on a daily, weekly and monthly basis. As per above, this process should take into consideration recommendations from consultant-lead condition assessment projects.	~continuous	Water Treatment Plants (3) Booster Stations (6) Elevated Storage Tanks (6) Storage Reservoirs (3)

3.2.2.2 Linear Infrastructure

UK has several programs already in place for linear infrastructure condition assessment, but the suite of programs is not yet complete. Generally, as the watermain and services asset classes are not readily accessible, they are not assessed distinctly in formal programs but in a more reactive manner with break and repair history and leak detection surveys being the primary assessment tool. The valve and hydrant assets are

assessed through routine inspection, flow testing programs and leak detection surveys, as indicated in Table B-3-7. Due to the low inherent criticality of the individual meters and services and the cost associated with inspection, they will not be subjected to a formal condition assessment program. As per the criticality assessment on linear infrastructure, the asset class of services assumes the assessed condition of the parent watermain asset.

The following factors were used in assigning Condition to linear assets:

- Age of watermain – watermains near the end of their life expectancy typically exhibit higher failure rates.
- Material Composition (older cast iron pipes exhibit higher break and failure rates).
- Condition and maintenance history (watermains with higher break rates and maintenance issues are typically in poor condition).
- Capacity Adequacy (watermains that are identified as under-capacity are typically triggered for replacement versus rehabilitation).
- Utility Standard Size (Current minimum size is 200mm, watermains that are identified as under-size are typically triggered for replacement versus rehabilitation).

Table B-3-7 Condition Assessment - Linear

Program	Description	Frequency	Asset Classes
Large Diameter Watermain Condition Assessment	No formal program has yet been developed and implemented for condition assessment of the Water Pipe asset class. This requires immediate development and implementation, specifically for the larger critical watermains. Visual inspections of pipes are conducted, where possible, on completion of break repairs.	Frequency to be assigned based on criticality.	Water Pipe
Valve Inspection and Maintenance (SOP)	Valve inspection is to be conducted on all municipal valves with the following recommended frequency: • > 400 mm in Ø and larger - annually. • =<300 mm in Ø - valve operation program every four years. • Valves are also inspected and exercised prior to water main isolation for maintenance, repair, and reconstruction activities. Valves requiring repairs are flagged for operations. Currently the valve inspection program is not fully implemented.	Frequency assigned based on valve size.	Valves

Program	Description	Frequency	Asset Classes
Hydrant Inspection and Maintenance (SOP)	Hydrant inspection is conducted on all municipal hydrants on an annual basis, with additional inspections for new and repaired hydrants prior to placing into service. Hydrants are also inspected after use. Hydrants requiring repairs are flagged for operations.	Annually and as required.	Hydrants
Hydrant Flow Testing	Hydrant Flow testing is scheduled to be conducted on 100% of the municipal system in the summer of 2013. Hydrants are scheduled to be Flow tested 20% per year going forward.	20% per year cycle.	Hydrants
Leak Detection Survey	A Leak Detection survey is conducted on municipal hydrants on an annual basis, with specific surveys conducted in areas of suspected leaks. Areas of potential leaks are flagged for repair with operations.	In Conjunction with Hydrant Survey and Flow Testing	Water Pipe, Hydrants, Valves and Services
Services Condition Assessment	No formal program has been developed for Services and none is anticipated. Due to the low inherent criticality of individual services, and the cost associated with inspection, Services will not be subjected to a condition assessment program. Water services may be a major contributor to system water loss.	A run-to-failure approach is deemed acceptable for Services.	Services

3.2.3 Risk Assessment and Prioritization

The risk assessment is undertaken by considering criticality and condition in a quantitative manner across all assets in an asset class. Upon completion of the risk assessment and prioritization exercises on all assets, Utilities Kingston has logically and

defensibly identified where works are required addressing the first of two primary decisions. The second decision process is that of determining how to do the work.

3.2.3.1 Plants and Facilities

The Operation Group within Utilities Kingston utilizes an Operational Risk assessment for all of the major non-linear asset classes, (and some of the more critical linear assets) in the system as part of the requirement for the Drinking Water Quality Management System (DWQMS). The risk assessment is completed within the context of maintaining a safe water supply to the system and considers treatment facility failures, storage system failures, booster stations failures, and individual facility component failures. The risk assessment provides an overview of facility processes and components that are addressed through the maintenance program.

The risk assessment reviews potential impacts to the system and provides appropriate responses to mitigate the impacts of the risk, i.e. in the event of a pump failure within the treatment facility or the break in a large distribution watermain. Typically, risk is mitigated through the use of redundancy, such as backup pumps, backup power, storage capabilities within the system and standardized operator responses and processes.

Where they exist, the consultant-lead condition assessment projects are incorporated to produce a thorough and robust prioritized list of efforts required to maintain all Plants and Facilities from a risk management perspective. This list must be developed in conjunction with results from Infrastructure Planning studies to ensure recommendations include those for full facility replacement, major upgrades, and process and component level maintenance activities.

The consultant-lead risk assessment covers the planning window, which is anticipated to be 10 years, with the frequency subject to change as a result of the degree of success of the Asset Management Plan.

3.2.3.2 Linear Infrastructure

The risk assessment for linear infrastructure is completed in-house on an annual basis and is focused on the parent watermain asset which is linked in GIS inventory to the City of Kingston Road Inventory Management System (RIMS) Section. The risk assessment incorporates a bottom-up evaluation utilizing a weighted combination of probability factors of failure (age, material type and break history) and consequence of failure (size and distribution impact) which results in a quantitative risk score. Due to the accessibility restraints, condition assessments of the watermain asset is limited based on inspections and observations during break or valve repair, etc.

The results can then be sorted by risk score and used to develop a prioritized list of recommended works for review or study within the asset class. This forms a defensible and logical manner in which to; a) utilize available funding; and b) to maintain a healthy and functional utility. The use of the GIS RIMS Sections allows for an efficient coordination in reviewing priorities with other overlapping needs such as Wastewater, Gas, and City Roads and Infrastructure, to achieve best value for reconstruction or replacement of the asset.

The most recent risk assessment analysis conducted on the watermain asset identifies the following risk results per Table B-3-8.

Table B-3-8 Watermain Assets – Risk Evaluation

Priority Risk Category	Watermain Length (km)	% of Asset Class
1 (Poor)	5.4	0.9%
2 (Fair/Average)	67.9	11.5%
3 (Good)	513.3	87.5%

3.3 Lifecycle Decision Making

Both the Infrastructure Planning and Risk Assessment exercises described above, together, provide a means to determine what assets require rehabilitation or replacement. Once the assets have been identified through this process, decisions are made on how the assets are to be remedied. This part of the process is called the

Lifecycle Decision Making process and it identifies one of the following categories as the most appropriate course of action:

- New, increased or accelerated maintenance
- Rehabilitation or Major Upgrade
- Replacement

The decision-making process is unique to each asset group and class, and factors in two-primary considerations:

- Cost of works
- Service life of works

Together these factors produce an informal benefit-cost analysis (BCA), i.e. estimate of cost/year of service. In many cases, the best value is attained by utilizing the course of action that provides best value, or in other words, the lowest cost per year of service. However, there are other factors, such as multi-criteria analysis (MCA), that also need to be considered, including the following:

- Impacts to parent or child assets (i.e. if we choose to line a watermain, what about the services?)
- Budget/timing constraints (i.e. even if a watermain is best replaced, perhaps lining is preferred since a joint reconstruction program will not make it here in time).
- Overlapping needs (i.e. even if the watermain could be lined, perhaps reconstruction is a better option for the right-of-way as a whole, due to adjacent asset groups' needs).

The following sub-sections provide lifecycle decision-making considerations for each asset group.

3.3.1 Plants and Facilities

In general terms, Plants and Facilities are managed with a focus on maintenance and minor upgrades over major upgrades and replacement. However, when triggers are

identified from planning exercises that indicate the need for a significant increase in capacity or a change or improvement to the treatment process, a major upgrade or facility replacement is then required.

3.3.1.1 Water Treatment Plants

- Routine Maintenance
- Continued or additional prescribed maintenance.
- Major Upgrade.
- Replacement.

3.3.1.2 Booster Stations

- Routine Maintenance.
- Based on operation staff and contractor input, other maintenance activities.
- Maintenance activities prescribed by the Condition Assessment.
- Major Upgrade.
- Replacement.

3.3.1.3 Reservoirs and Elevated Storage Tanks

- Routine Maintenance.
- Maintenance activities prescribed by the Condition Assessment.
- Consider upgrades as per Planning exercises, specifically Master Plans (MP).
- Consider decommissioning or repurposing as per Planning exercises.

3.3.2 Linear Infrastructure

3.3.2.1 Watermains, Valves and Services

The asset management process for watermains is not well established and is typically evaluated on a "worst first" basis and run to failure maintenance process. The Lifecycle decisions are also subject to a number of planning studies and the risk assessment process discussed above in Section 3.2.3.2. Due to the parent/child relationship, valves and services are typically included in the Life Cycle Decision management for watermains.

- If the asset displays minor deficiencies (i.e. through leak detection, valve exercise program) and lower risk of failure, maintenance activities shall be completed, typically dig and repair. These activities do not impact the expected lifecycle of the asset since the majority of the asset and its dependents remain in the current condition.
- Where Planning studies have identified features for capacity up-sizing, they shall be promoted to the Joint Reconstruction Program, if possible, within the anticipated timeframe. If they cannot be accommodated in the Joint Reconstruction Program, Utilities Kingston may undertake the asset replacement as a unique one-off project.

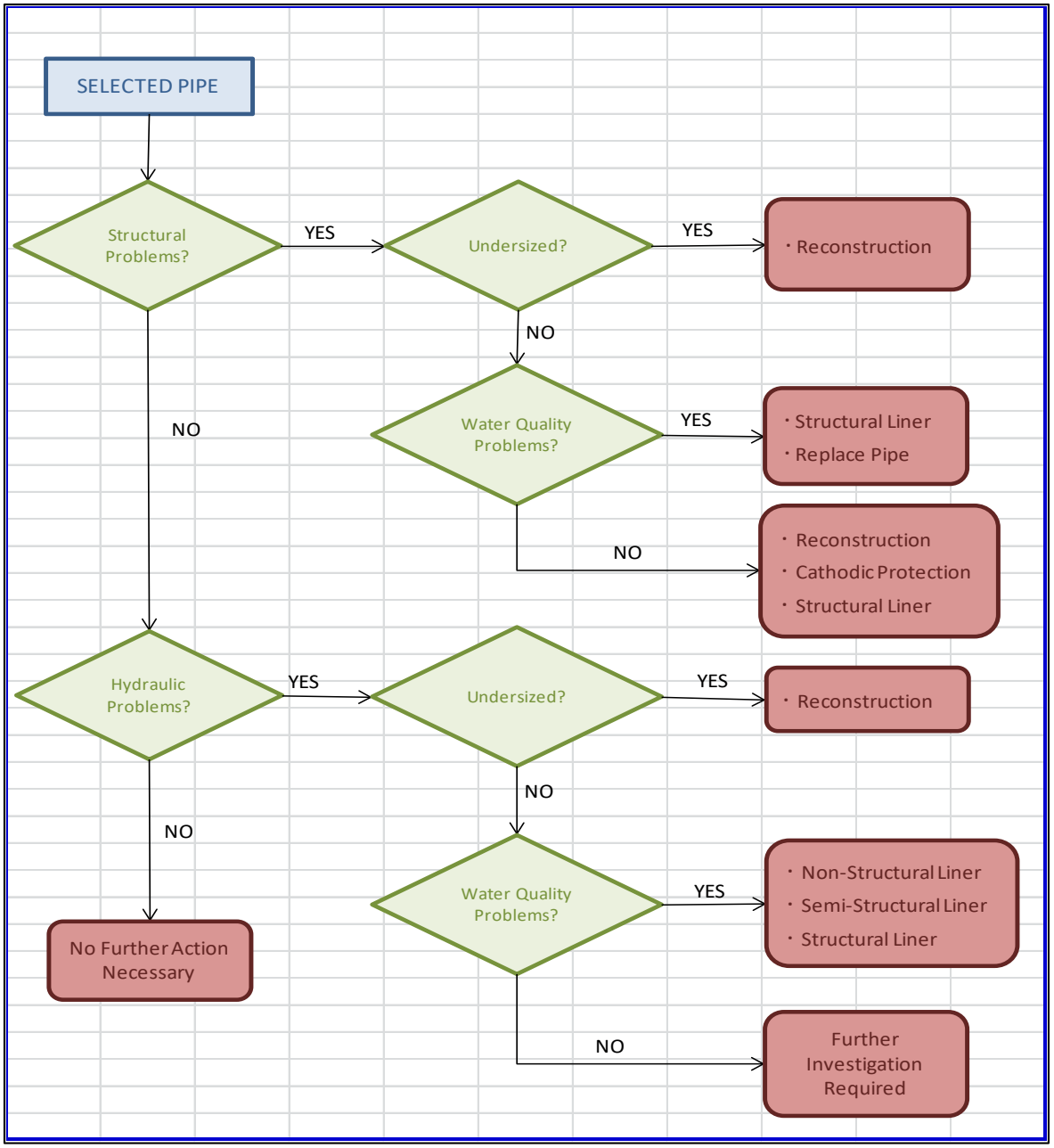


Figure B-3-4 Example Remediation Decision Tree

Where high-risk assets are identified, and it is determined that maintenance activities will not be cost-effective in reducing the risk, the following options shall be considered utilizing a process like that in Figure B-3-4:

- Replacement of the asset and its dependents (Valves, and Services) in conjunction with a joint (City/UK) Road Reconstruction Project where feasible.

- Reconstruction outside of Joint Program: Replacement of pipe including dependent asset classes.
- Rehabilitation lining, with due consideration to the condition of dependent assets and appropriate rehabilitation, cathodic protection, or replacement of dependent assets.

3.3.2.2 Hydrants

As the criticality/consequence of an individual hydrant failure is low, the lifecycle of Hydrants is typically founded on a run-to-failure approach. Hydrants are also typically considered as sub-dependent assets to the parent watermain asset on which they are situated. The following describes the decision-making process for this asset class:

- If operations staff (UK Hydrant Inspections or City of Kingston Fire Dept.) identifies deficiencies, maintenance shall be completed using dig and repair techniques. Tracking of repairs is implemented through SOP and updated in the Hydrant Asset Inventory.
- Replacement of the asset in conjunction with parent watermain upgrades or a joint (City/UK) Road Reconstruction Project where feasible.

3.4 Maintenance Management

Maintenance activities are an integral part of optimizing the lifecycle of assets. Where no triggers for replacement, upgrades, or capacity increase or treatment standards are required, routine maintenance shall be completed to ensure continued effective operation of the Water Utility. Condition and risk indicators should be the driver for works, even after the estimated lifecycle of the facility is complete

All maintenance activities should be documented and tracked by asset and visible to all staff of Utilities Kingston. Currently, the tracking systems that are in place are not consistently accessible and require significant manipulation in order to coordinate asset management activities across the asset classes. The following items are in place:

- Various tracking sheets maintained by “Operations” for linear infrastructure; watermain break repairs, hydrant repairs, valve repairs, meters, etc.

- A GIS Asset Inventory capable of tracking works on the Linear Infrastructure. Aside from replacements and lining, works are tracked on the individual sheets. It is recommended that all maintenance works be tracked and cataloged in GIS or other asset management software.
- WaterTrax maintenance management system, capable of tracking works on Plants and Facilities. This is in its infancy but is deemed a suitable and useful tool for maintenance management. However, it is not currently a suitable tool for asset management, risk assessment and producing facility report cards based on system and component discretization. The WaterTrax system is not utilized for the linear system.

Currently, the individual processes are not capable of adequately supporting asset management across the water utility, as a whole, and this is identified as a priority moving forward.

3.5 New Assets

New assets are constantly being added to the Water Utility, primarily because of two activities:

- Acquisition from a developer (based on Growth).
- In-house construction of new assets (based on Growth, re-assessed capacity issues, or internal operational risk assessments).

This may include assets in all asset classes. Assets should be documented in the Asset Inventory and added to the Replacement Cost and PSAB Valuation financial summaries.

Most new major assets are identified within Master Planning exercises. Master Planning exercises produce Opinions of Probable Cost (OPC) with a suggested timing. This feeds directly into budgetary requirements.

3.6 Decommissioning

When an asset is deemed no longer required, the asset shall be decommissioned or re-purposed (if applicable). This may apply at the completion stage of a facility replacement of a facility or an upgrade of distribution system, since often the activity at that facility must continue during construction of the replacement facility. The following options for decommissioning are available:

- Undertake facility decommissioning in conjunction with replacement where applicable.
- Consider re-purposing if applicable. i.e. Booster Stations scheduled for decommissioning may be repurposed into metering stations or alternative pressure feed locations between pressure zones.
- Undertake the necessary decommissioning studies and process to properly decommission a facility that is no longer required.

Where possible, consideration for salvage activities should take place.

3.7 Summary

To facilitate asset management, a variety of programs and related processes are required. All asset classes require consideration for what programs and processes will provide for adequate management, and this includes several classes of programs including:

a. Infrastructure Planning – these studies generally comprise overarching studies that identify primarily growth-based needs, distribution system improvements and needs for major capital projects.
b. Risk Assessment – these studies are generally desktop condition assessment reviews and when coupled with criticality assessment, they identify risk-based needs.
c. Lifecycle Options – these are the actual physical intervention processes which result in a repaired, upgraded, or new asset or facility.

Table B-3-9 provides an overview of programs, projects and other processes that contribute to asset management of the water utility as well as the asset classes that they contribute to.

It should be noted that this is not an exhaustive detailed list. It covers the primary activities being completed; however, there may be other regular support activities that take place.

Table B-3-9 Summary of Programs for Water Utility Asset Management

Type / Program	Frequency	Tactic	Watermain	Valves	Hydrants	Meters	Services	WTP	Booster	Reservoirs	Elevated
Infrastructure Planning: Growth Strategy	~10 yrs	Proactive	Yes	Yes				Yes	Yes	Yes	Yes
Infrastructure Planning: Master Plan	~5-10 yrs	Proactive	Yes	Yes				Yes	Yes	Yes	Yes
Infrastructure Planning: Development Charges	~5 yrs	Proactive	Yes					Yes	Yes	Yes	Yes
Infrastructure Planning: Infrastructure Capital Planning	4-yr Plans	Proactive	Yes	Yes	Yes		Yes	Yes	Yes	Yes	Yes
Infrastructure Planning: Project-Specific Environmental Assessments	As Required	Proactive	Yes					Yes	Yes	Yes	Yes
Infrastructure Planning: Development-Specific Studies	As Required	Proactive	Yes					Yes	Yes	Yes	Yes
Infrastructure Planning: Uncommitted Plant Capacity Reserve Analyses	Annually	Proactive						Yes			
Risk Management: Facility Condition Assessment (External)	10 yrs	Proactive						Yes	Yes	Yes	Yes
Risk Management: Facility Condition Assessment (Internal)	Continuous	Proactive						Yes	Yes	Yes	Yes
Risk Management: Large Diameter Watermain Condition Assessment	TBD	Proactive	Yes								

Type / Program	Frequency	Tactic	Watermain	Valves	Hydrants	Meters	Services	WTP	Booster	Reservoirs	Elevated
Risk Management: Valve Inspection and Maintenance	Size Specific Cycle	Proactive		Yes							
Risk Management: Hydrant Inspection and Maintenance and Flow Testing	Annually/5-yr Cycle	Proactive	Yes		Yes						
Risk Management: Leak Detection Survey	Annually	Proactive	Yes	Yes	Yes		Yes				
Lifecycle Options: Scheduled Maintenance	Asset Specific	Proactive						Yes	Yes	Yes	Yes
Lifecycle Options: Unscheduled Maintenance	As Required	Reactive	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lifecycle Options: Rehabilitation (Lining, minor upgrades etc.)	Asset Specific	Proactive	Yes	Yes	Yes			Yes	Yes	Yes	Yes
Lifecycle Options: Facility Major Upgrades	Asset Specific	Proactive						Yes	Yes	Yes	Yes
Lifecycle Options: Asset Replacement	Asset Specific	Proactive	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lifecycle Options: Asset Replacement	As Required	Reactive	Yes	Yes	Yes	Yes	Yes		Yes		
Lifecycle Options: New Asset Construction/ Assumption	As Required	N/A	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lifecycle Options: Asset Decommissioning/ Retirement	As Required	N/A	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

3.8 Maturity and Moving Forward

3.8.1 Forecasting Future Demand

Utilities Kingston employs a robust suite of tools for estimating future growth areas and evaluating how they will impact the Water Utility. The implications of growth are well understood at a high level through the use of population growth studies, growth strategies, master planning exercises, and subdivision development reviews. Once these studies identify the need for growth-based infrastructure works, UK conducts project-specific analyses during the environmental assessment process. The maturity level for forecasting future demand is considered to be at the 'Core' level with some attributes progressing to "Intermediate" and is suitable for the Water Utility's size (see Table B-3-10). Moving forward, the Uncommitted Plant Reserve Capacity Analysis needs to be reinitiated.

Table B-3-10 Maturity Index - Forecasting

Maturity Level	Description	Status of Current Plan
Minimum	Demand forecasts based on experienced staff predictions, with consideration of known past demand trends and likely future growth patterns	
Core	Demand forecasts based on robust projection of a primary demand factor (i.e. population growth) and extrapolation of historic trends. Risk associated with demand change broadly understood and documented.	We are here.
Intermediate	Demand forecasts based on mathematical analysis of past trends and primary demand factors. A range of demand scenarios is developed.	Short-term Target for 2025
Advanced	As above, plus risk assessment of different demand scenarios with mitigation actions identified.	

3.8.2 Identifying Risks

UK has developed Operational Risk frameworks for all Plants and Facilities (and major critical watermains) utilizing internal and consultant-based reports. The risk assessment reviews potential impacts to the system and provides appropriate responses to mitigate the impacts of the risk, i.e. in the event of a pump failure within the treatment facility or the break in a large distribution watermain. Typically, risk is mitigated through the use of redundancy, i.e. backup pumps, backup power, storage capabilities within the system and/or standardized operator responses and processes. The risk assessment for the majority of the linear infrastructure is completed in-house on an annual basis and is focused on the parent watermain asset in a GIS linked section. The risk assessment incorporates a bottom-up evaluation utilizing a weighted combination of probability factors of failure (age, material type and break history) and consequence of failure (size and distribution impact) which results in a quantitative risk score. Due to the accessibility restraints, condition assessments of the watermain asset is limited, based on inspections and observations during break or valve repair, etc. The Risk Assessment framework and strategies for the Linear Assets is not well documented and requires further development. Although the Non-Linear Risk framework is considered to be at the “Core” level and approaching “Intermediate”, the Risk Framework for the Linear Assets are considered to be at the ‘Minimum’ level of maturity for its process of identifying high-risk assets (see Table B-3-11).

Table B-3-11 Maturity Index - Risk Identification

Maturity Level	Description	Status of Current Plan
Minimum	Critical assets understood by staff involved in maintenance/renewal decisions.	We are here.
Core	Risk framework developed. Critical assets and high risks identified. Documented risk management strategies for critical assets and high risks.	Short-term Target for 2025
Intermediate	Systemic risk analysis to assist key decision making. Risk register regularly monitored and reported. Risk managed consistently across the organization.	
Advanced	Formal risk management policy n place. Risk is quantified and risk mitigation options evaluated. Risk is integrated into all aspects of decision-making.	

While the process utilized is deemed sufficient to justify a 'Core' rating, in order to advance from the assigned 'Minimum' maturity level for Risk Identification, Utilities Kingston needs to formalize and document the risk assessment processes for the linear assets.

3.8.3 Lifecycle Decision-Making

Lifecycle decision-making is currently conducted in a manner that is roughly in alignment with the 'Minimum" level of maturity as per the International Infrastructure Management Manual (NAMS, 2011), see

Table B-3-12. For Non-Linear Assets, i.e. Plants and Facilities, and larger projects and programs a formal or informal benefit-cost analysis (BCA) will be completed prior to proceeding with the works and multi-criteria analysis (MCA) is typically completed within the context of the Environmental Assessment Framework. Decisions on Linear Infrastructure are typically done on the merits of the need from Growth or Risk-based drivers, which is typically commensurate with the size and cost of the project.

Table B-3-12 Maturity Index - Lifecycle

Maturity Level	Description	Status of Current Plan
Minimum	AM decisions based largely on staff judgement and agreed corporate priorities.	
Core	Formal decision-making techniques (MCA/BCA) are applied to major projects and programs.	We are here.
Intermediate	Formal decision-making and prioritization techniques are applied to all operational and capital asset programs within each main budget category. Critical assumptions and estimates are tested for sensitivity to results.	Short-term Target for 2025
Advanced	As for 'intermediate', plus… The framework enables projects and programs to be optimized across all activity areas. Formal risk-based sensitivity analysis is carried out.	

3.8.4 Capital Works Strategies

While financial budgeting requirements for Capital expenditures are typically projected for a 10-year horizon, a business-case analysis is not always competed. For this reason, it is estimated that Utilities Kingston current level of Strategizing for Capital Works is roughly at a 'Core' level of maturity (see
Table B-3-13) but with planning elements that approach the 'Intermediate' level.

Table B-3-13 Maturity Index - Capital Works Strategies

Maturity Level	Description	Status of Current Plan
Minimum	There is a schedule of proposed capital projects and associated costs, based on staff judgement of future requirements.	
Core	Projects have been collated from a wide range of sources such as hydraulic models, operational staff and risk-processes. Capital projects for the next three years are fully scoped and estimated.	We are here.
Intermediate	As above, plus formal options analysis and business case development has been completed for major projects in the 3-5year period. Major capital projects for the next 10-20 years are conceptually identified and broad cost estimates are available.	Short-term Target for 2025
Advanced	Long-term capital investment programs are developed using advanced decision-making techniques such as predictive renewal modeling.	

3.8.5 Moving Forward

Moving forward the Asset Management Strategy may be improved by:

- Asset Management software is required to adequately track activities on all asset classes and merge the asset maintenance and planning aspects of asset management with that of other utility assets (i.e. wastewater) and financial management.
- Criticalities for plants and facilities should be completed (or updated) in conjunction with the consultant lead Condition Assessment Process and should be broken down into major components or system processes.

- Efforts shall be made to include all non-linear assets in condition assessments. The condition assessment will provide additional value to the Risk Assessment process.
- A condition assessment program needs to be considered for implementation for the larger more critical transmission watermains.
- Several additional Asset Sub-classes should be identified and included in future Asset Management Plans. This will require support by an appropriate facility asset registry to adequately manage the more detailed information.
    - Consideration for watermains to be subdivided into sub-asset classes such as Transmission Mains, Feeder, Local, etc.
    - Water Treatment Plants should be further broken down into a finer level of detail, i.e. subdivided into major processes and component levels such as filter beds, chlorination chambers, pumps, etc.
    - Booster Stations, reservoirs and Elevated Storage Tanks also require further breakdown into a finer level of detail to the component level.

In addition, the Asset Management herein focuses on Capital Asset Management, touches in a minor way on the role of Maintenance Management, but does not address Operational Management. Future revisions of the Asset Management Plan should include report sections on Maintenance and Operational Strategies.

C. Wastewater Assets

1 State of Local Infrastructure – Wastewater Utility

This chapter provides an overview of available information on assets that are part of the sanitary sewage collection, conveyance and treatment system that form the Wastewater Utility. The primary purpose of this chapter is to illustrate the data which is currently available within the asset inventory and other sources, and that which is still required.

Sources of information for this section include:

- GIS Asset Inventory. The GIS Asset Inventory is primarily a system for management of linear infrastructure. The GIS includes Plants and Facilities but not sufficient for management functions. For this plan iteration, a snapshot of the Entreprise GIS current to January 2021 was used.
- CCTV Database. The CCTV inspection database is a GIS-based feature class that contains results of all prior CCTV inspections on gravity mains and includes summary condition scores. For this plan iteration, the CCTV database as of February 2021 was used, which includes a blend of PACP- (newer) and WRC-coded defect and condition data.
- PSAB Reporting. Utilities Kingston reports its valuations of assets as required by the Public Sector Accounting Board. This plan iteration utilizes end-of-2020 figures obtained from the City of Kingston.
- Water and Wastewater Master Plan Update. This study was completed in January 2017 and provides both growth- and condition-based upgrade recommendations as well as overall condition/risk assessment results for facilities. The applicability of recommendations from the Master Plans is becoming less relevant and a Master Plan update is pending ~2023-2024.
- Other reports. Several other reports, files and databases provide ancillary information to this report section, including replacement cost estimates (initially developed for PSAB 3150 Reporting in 2007).

1.1 Asset Inventory

Utilities Kingston primary inventory of wastewater infrastructure assets is contained within an Enterprise GIS system administered by the City of Kingston. The asset

inventory provided herein is based on a snapshot of the Enterprise GIS from January 2021.

Table C-1-1 presents a summary of the Asset Classes for the Wastewater Utility and an indication of whether or not they are currently contained within the Asset Inventory.

Table C-1-1 Overview of Wastewater Utility Asset Classes

Group	Class	In GIS Inventory?	Count[(1)]	Quantity (km)[(1)]
Linear	Gravity Mains	Yes	7536	474.0 km
Linear	Force mains	Yes	157	29.0 km
Linear	Maintenance Holes	Yes	6697	-
Linear	Fittings/Junctions	Yes	1692	-
Linear	Services	No[(4)]	~38,384[(2)]	~414.7 km[(3)]
Facilities	Wastewater Treatment Plants	Yes	3	-
Facilities	Sewage Pump Stations	Yes	29	-
Facilities	CSO Storage Tanks	Yes	9	-

Notes:

1) As per Enterprise GIS, summarized January 2021, rounded.
2) Customer count as of January 2021. Assumed one service per customer.
3) The average Right-of-Way width is 21.61m, and the average sewer lateral length is estimated at half this amount.
4) Work in progress. Services are added to GIS as built/replaced.

1.1.1 Linear Assets

The following tables provide additional detail about linear assets in the Wastewater Utility. This data is contained within the Asset Inventory (Enterprise GIS). Linear assets include all non-facility features of the sewage collection system. Table C-1-2 provides a more detailed breakdown of linear assets into sub-classes.

Table C-1-2 Summary of Linear Asset Quantities

Class	Sub-class	In Asset Inventory	Quantity (Count)[1]	Quantity (Length)[1]	% by length
Gravity Mains	Trunks	Yes	504	42.8 km	9.0%
Gravity Mains	Collectors	Yes	774	50.7 km	10.7%
Gravity Mains	Locals	Yes	6258	381.0km	80.4%
Gravity Mains	TOTAL	Yes	7536	474.0 km	100.0%
Force Mains	Trunk	Yes	69	17.5 km	60.5%
Force Mains	Collector	Yes	0	0.0 km	0.0%
Force Mains	Locals	Yes	88	11.5 km	39.5%
Force Mains	TOTAL	Yes	157	29.0 km	100.0%
Services	Laterals	No(4)	38,384(2)	414.7 km(3)	-
Junctions	Manholes	Yes	6697	-	-
Junctions	Fittings	Yes	1692	-	-
Junctions	TOTAL	Yes	8,389	-	-

Notes:

1) As per Enterprise GIS, summarized January 2021, rounded.
2) Customer count as of January 2021. Assumed one service per customer.
3) The average Right-of-Way width is 21.61m, and the average sewer lateral length is estimated at half this amount.
4) Work in progress. Services are added to GIS as built/replaced.

Table C-1-3 and Table C-1-4 contains a size breakdown of linear features included both Gravity Mains and Forcemains. Most of the collection system is serviced by mains less than 400mm in diameter.

Table C-1-3 Gravity Mains by Size

Diameter (mm)	Length (m)	Length (km)	%
< 200	228,670.11	228.67	48.2%
201-400	169,340.38	169.34	35.7%
401-600	39,503.57	39.50	8.3%
601-900	19,957.59	19.96	4.2%
>900	15,235.19	15.24	3.2%
Unknown	1,788.87	1.79	0.4%
TOTAL	**474,495.72**	**474.50**	**100.0%**

Table C-1-4 Forcemain by Size

Diameter (mm)	Length (m)	Length (km)	%
< 200	9,804.16	9.80	33.8%
201-400	4,373.33	4.37	15.1%
401-600	5,500.97	5.50	19.0%
601-900	3,799.13	3.80	13.1%
>900	5,383.28	5.38	18.6%
Unknown	117.30	0.12	0.4%
TOTAL	**28,978.16**	**28.98**	**100%**

Table C-1-5 and Table C-1-6 contain material breakdowns of linear features included both Gravity Mains and Forcemains. Material data on linear assets has not been maintained adequately in the Asset Inventory. This is important because life expectancy varies based on material type and this information could be used to improve capital planning. As can be seen further in this report, a single value life-expectancy is applied to all pipes due to the incomplete material data. This reduces its usefulness.

Table C-1-5 Gravity Mains by Material

Materials	Quantity (m)	%
Concrete	43,188.07	9.1%
Plastic	187,595.17	39.5%
Asbestos-Cement	65,665.60	13.8%
Cured-In-Place	4,498.23	0.9%
Clay	6,193.95	1.3%
Stone	1,623.66	0.3%
Unknown	165,731.05	34.9%
Total	**474,495.72**	**100.0%**

Table C-1-6 Forcemain by Material 1

Materials	Quantity (m)	%
Asbestos-Cement	1,063.15	3.7%
Cured-In-Place	2.76	0.0%
Concrete	2,839.58	9.8%
Plastic	4,502.03	15.5%
Metallic	2,096.13	7.2%
Unknown	18,474.50	63.8%
Total	**28,978.16**	**100.0%**

Table C-1-7 and Table C-1-8 provide an overview of sizes classes of Gravity Mains and Forcemains. Size classes generally include “Trunk”, “Collector” and “Local” groups that are partly related to size, but also partly related to location and service area. Frequency of condition assessment and applicability of program types is pertinent to the size class attribute, more so than just the pipe size. For example, trunk gravity mains are of inherently greater criticality than local sewers and as such, warrant a more frequent condition assessment cycle. The impact of criticality on condition- and risk-assessment frequency is discussed in Section 5 of this Plan.

Table C-1-7 Size Class Summary of Gravity Mains

Size Class	%
Trunk	9.01%
Collector	10.69%
Local	80.30%

Table C-1-8 Forcemain Asset Classes 1

Size Class	%
Trunk	60.46%
Collector	0.00%
Local	39.54%

Table C-1-9 illustrates the remaining pipes in the Gravity Mains asset class that are classified as ‘combined sewer’. Combined sewers service both sanitary sewage and storm runoff and are target for replacement with separated sewers as directed by the Master Plan (WSP, 2017). Combined sewers are inherently higher-risk due to the risks to public health and safety they pose due to basement flood and overflow potential. Elimination of combined sewers will contribute to the goal of ‘virtual elimination’ of combined sewage bypasses and contribute to meeting Sustainability objectives. Sewer separation was completed at roughly 3-4% from 2008 through roughly 2014, which is considered a reasonable pace. The pace has decreased over the last 7 years. The City however has, since the completion of the Master Plan and associated Pollution Prevention and Control Plan update (WSP, 2017) committed to a 20-year sewer separation program for full eradication of combination sewers beginning 2023 which, if followed, shall establish a moving-forward average 2.5% rate of progress for the remaining area (relative to 2008 conditions). The next Master Plan and PPCP update will reflect adoption of this goal.

Table C-1-9 Gravity Main Breakdown by Type – Combined Sewers

Gravity Main Type	%
Combined Sewers	3.78%
Separated Sewers	96.22%

The feature set entitled “junctions” requires additional attention in future Asset Management Plan iterations. Junctions contain a variety of differing point-based features in the linear portion of the wastewater system and include functional mechanical features such as backwater valves and forcemain/system valves which warrant a proactive maintenance program. Many other junction feature types include static features such as tee’s, reducers/expanders, and otherwise. This feature class should be expanded upon.

1.1.2 Plants and Facilities

Facilities (or non-linear assets) are identified within the GIS Asset Inventory as point features, but otherwise, it does not contain details on the nature and size nor their complex componentry.

Table C-1-10 summarizes the assets that are part of the Plants and Facilities asset group. There are Wastewater Treatment Plants (WWTP), Sewage Lift/Pump Stations (SPS) and Combined Sewage Overflow (CSO) Storage Tanks. A more detailed list is provided in the following sections.

Table C-1-10 Plants and Facilities Asset Summary

Class	Sub-class	In Asset Inventory	Quantity (Count)
Wastewater Treatment Plants	Large (>10,000 customers)	Yes	2
Wastewater Treatment Plants	Very Small (<100 customers)	Yes	1
Sewage Pump Stations	Large (>10,000 customers)	Yes	2
Sewage Pump Stations	Medium (1,000-10,000 customers)	Yes	5
Sewage Pump Stations	Small (100-1,000 customers)	Yes	15
Sewage Pump Stations	Very Small (<100 customers)	Yes	7
CSO Storage Tanks	Large (Active) (2,400-10,000m^3)	Yes	3
CSO Storage Tanks	Small (Passive) (<500m^3)	Yes	6

Notes:

1) Small (Passive) CSO tanks are static retention features (enlarged pipe sections). For the remainder of this report, they are considered linear infrastructure.

The Enterprise GIS is not an adequate tool for inventory and management of Plants and Facilities and componentry, whereas for linear assets, it is adequate.

1.1.3 Summary

The asset inventory presented in this section was constructed by sourcing various data sources. The Enterprise GIS is a logical and reasonable location to store asset information for true linear infrastructure (Gravity Mains, Forcemains and Services) and point-based infrastructure with limited complexity (Junctions). However, a GIS environment is not a suitable location for populating and storing information about complex point-based asset classes, in this case, all the Plants and Facilities of the Wastewater Utility. A dedicated non-GIS asset registry is required for this purpose.

Moving forward, Utilities Kingston should assess and select a suitable software package for an asset registry appropriate for Plants and Facilities. In addition, Utilities Kingston

should continue to populate data on sewer laterals and expand upon and develop further the junction feature set.

1.2 Replacement Costs and Valuation

This section of the report summarizes the current understanding of valuations for the Wastewater Utilities asset groups and classes.

Replacement costs are based on most recently available data sources and include a most-recent ‘documented or estimated’ replacement cost, and a planning-level replacement cost. Unfortunately, these differ considerably and for the sake of providing conservative estimates for annual budget planning, the higher values (planning-level) shall be used. This is due to staff experience where many recent opinions-of-probable-costs (OPC) have been far too low and result in a lack of funding for specific projects. In fact, recent projects have demonstrated that even the planning-level replacement costs may be low, specifically for Plants and Facilities.

Valuations are based on 2020 PSAB 3150 Tangible Assets Reporting and are considered to represent ‘Net Book Value’.

Table C-1-11 provides a summary by Asset Class. More detailed tables for Linear Infrastructure and Plants and Facilities are provided in subsequent tables.

Table C-1-11 Summary of Wastewater Utility Replacement Costs and Valuations.

Group	Asset Class	Documented Replacement Cost (in 2020$)	Planning-Level Replacement Cost (2020$)	Net Book Value (PSAB, 2020$)
Linear	Gravity Mains	$211,144,599	$211,144,599	$98,050,902
Linear	Force mains	$31,338,165	$31,338,165	N/A(2)
Linear	Junctions	$28,997,436	$28,997,436	$7,055,000
Linear	Services	$71,184,138	$71,184,138	N/A(2)
Linear	**Subtotal**	**$342,664,337**	**$342,664,337**	**$105,105,902**
Facilities	Wastewater Treatment Plants	$204,795,653	$325,090,756	$88,747,000
Facilities	Pump Stations	$47,580,229	$85,402,340	$20,385,000
Facilities	CSO Tanks (1)	$21,220,758	$21,220,758	$10,438,000
Facilities	**Subtotal**	**$273,596,758**	**$431,713,854**	**$119,570,000**
ALL	**TOTAL**	**$616,260,977**	**$774,378,191**	**$224,675,902**

Notes:

(1) Only the large CSO tanks are considered under facility valuation. Small tanks are included in linear infrastructure since they are simply oversized pipes.

(2) Net Book value is pooled with Gravity Mains.

Note there is a substantial difference between the documented replacement cost and the planning-level replacement cost for Plants and Facilities. The sources of these differing data sets are explained in more detail in section 3.2.2.

1.2.1 Linear Assets

Table C-1-12 provides a detailed breakdown of the replacement costs and 'net book' valuations for Linear Infrastructure Assets.

Table C-1-12 Detail of Linear Infrastructure Replacement Costs and Valuations.

Group	Size	Quantity	Units	Replacement Cost ($2020)	PSAB Valuation
Gravity Main	<150mm	205.1	m	$51,542	$7,962,466
Gravity Main	150mm	3379.8	m	$849,364	$2,895,068
Gravity Main	200mm	231944.9	m	$58,289,545	$14,719,684
Gravity Main	250mm	79826.3	m	$20,718,692	$7,071,861
Gravity Main	300mm	57300.0	m	$17,103,589	$8,673,321
Gravity Main	375mm	25296.1	m	$8,493,511	$11,124,423
Gravity Main	450mm	24465.0	m	$9,071,175	$7,638,265
Gravity Main	525mm	6171.9	m	$2,898,672	$6,913,220
Gravity Main	600mm	8866.7	m	$5,461,123	$5,445,443
Gravity Main	675mm	2446.0	m	$3,098,417	$317,957
Gravity Main	750mm	4000.6	m	$7,671,417	$15,403,412
Gravity Main	825mm	3636.3	m	$8,843,437	$777,278
Gravity Main	900mm	9874.8	m	$24,497,422	$2,414,093
Gravity Main	1050mm	3733.4	m	$10,047,536	$2,478,416
Gravity Main	1200mm	9673.9	m	$28,070,526	$2,318,484
Gravity Main	1350mm	1385.4	m	$4,143,090	$480,443
Gravity Main	>1350mm	442.6	m	$1,494,593	$1,316,099
Gravity Main	Unknown	1356.7	m	$340,949	$100,970
Gravity Main	**Subtotal**	**474,005.2**	**m**	**$211,144,599**	**$98,050,902**
Force Main	<150mm	843.3	m	$211,936	N/A[(1)]
Force Main	150mm	5783.2	m	$1,453,373	N/A[(1)]
Force Main	200mm	3177.6	m	$798,551	N/A[(1)]
Force Main	250mm	1482.7	m	$384,830	N/A[(1)]
Force Main	300mm	2024.1	m	$604,184	N/A[(1)]
Force Main	375mm	866.5	m	$290,942	N/A[(1)]
Force Main	450mm	2184.2	m	$809,859	N/A[(1)]
Force Main	600mm	3316.8	m	$2,042,848	N/A[(1)]

Group	Size	Quantity	Units	Replacement Cost ($2020)	PSAB Valuation
Force Main	900mm	3799.1	m	$10,224,414	N/A(1)
Force Main	975mm	2289.8	m	$6,162,387	N/A(1)
Force Main	1050mm	3093.5	m	$8,325,361	N/A(1)
Force Main	Unknown	117.3	m	$29,479	N/A(1)
Force Main	**Subtotal**	**28,978.2**	**m**	**$31,338,165**	**N/A(1)**
Junction	Manholes	6697	ea	$28,828,236	$7,055,000 For both manholes and fittings.
Junction	Fittings[2]	1692	ea	$169,200	$7,055,000 For both manholes and fittings
Service	All	414,700.00	m	$71,184,138	N/A(1)
ALL	**TOTAL**			**$342,664,337**	**$ 105,105,902**

Notes:

1) Forcemains and services are pooled with Gravity Mains for PSAB valuation.

2) Fixtures valued at $100 each.

Data sources are as follows:

- Replacement costs for Gravity Mains up to 600mm are estimated from former City and Utilities Kingston Reconstruction contracts and inflated to 2020 dollars.
- Replacement costs generally assume that works are completed in conjunction with a full road right-of-way reconstruction contract.
- Replacement costs for Gravity Mains greater than and including 750mm are estimated from former CIPP lining contracts. Typically, mains of this size would be lined using trenchless methods instead of replaced by conventional excavation methods. Values are inflated to 2020 dollars.
- Replacement costs for Forcemains are assumed the same as Gravity Mains.
- Replacement costs for Junctions and Services are estimated from former City and Utilities Kingston Reconstruction contracts and inflated to 2020 dollars.

Confidence in the replacement cost estimation for Linear Infrastructure assets is considered high. At this time, sources are now out of date and should be reviewed against more recent data during the next major plan update (circa 2025).

1.2.2 Plants and Facilities

Table C-1-13 provides a detailed breakdown of the replacement costs and net book valuations of the Plants and Facilities. Table C-1-13 also includes additional estimates of replacement value since it has been found, that often, opinions-of-probable-cost (OPC) and replacement costs have proven to be inaccurate and often too low relative to actual project costs. For this reason, for budget planning purposes, the "Planning-Level" replacement costs should be used. This highlights that replacement costs for all facilities should be completed during a study conducted in the short-term, as it leaves considerable uncertainty.

Data was obtained from various sources for the replacement cost estimates. These should be revisited during a future Facility Condition Assessment project, or a Plant Replacement Cost Valuation exercise since they are inconsistent not only between Asset Classes but also relative to PSAB 3150 Valuation. It should be noted that the Planning Level Replacement costs as shown in Table C-1-13 are determined using a study prepared specifically for the Ministry of Infrastructure in 2005, for the purpose of providing guidance on estimating replacement cost for existing facilities. Documented values may be more representative of the inherent value of the facility, which is not as useful for planning purposes.

1.2.3 Summary

Linear Infrastructure replacement costs are estimated with reasonable accuracy from recent road reconstruction contracts. This includes all Asset Classes. Confidence in the estimates of replacement cost for linear infrastructure is considered high. It should be emphasized that replacement cost does not equate to lifecycle cost.

Replacement costs for Plants and Facilities are not as easily estimated. As can be seen from Table C-1-13, there are numerous sources of information for the documented replacement costs which will create inconsistency and lack of accuracy. It is

recommended, moving forward, that any future Condition Assessment consulting assignments for Plants and Facilities should; i) include ALL facility types including WWTP, PS and CSO Tanks, and ii) include estimation of Replacement Cost based on an analysis of local projects in Eastern Ontario that fit within the range of facility sizes operated by Utilities Kingston. This data can be housed within an appropriate Asset Registry for Plants and Facilities as described in Section 3.1.3 above.

Table C-1-13 Detail of Plant and Facilities Replacement Costs and Valuations.

Asset Class	Name of Facility	Documented Replacement Cost (2020$)	Planning-Level Replacement Cost (2020$)[1]	Net Book Value (PSAB) (end-of-2020)[2]
Wastewater Treatment Plants	Cana Subdivision	$ 3,803,171[7]	$ 5,088,250	$ 3,697,000
Wastewater Treatment Plants	Cataraqui Bay	$ 71,477,527[3]	$ 97,444,486	$ 9,921,000
Wastewater Treatment Plants	Ravensview	$ 129,514,956[4]	$ 222,558,020	$ 75,129,000
Wastewater Treatment Plants	**Subtotal**	**$ 204,795,653**	**$ 325,090,756**	**$ 88,747,000**
Sewage Pump Stations	Hwy 15	$ 1,490,887[5]	$ 2,658,948	$ 119,000
Sewage Pump Stations	James St	$ 1,338,959[5]	$ 3,842,079	$ 148,000
Sewage Pump Stations	Bath Rd	$ 1,300,656[7]	$ 1,630,041	$ 574,000
Sewage Pump Stations	Barrett Ct	$ 1,328,444[5]	$ 3,810,559	$ 25,000
Sewage Pump Stations	Bath-Collins Bay	$ 335,246[5]	$ 656,294	$ 5,000
Sewage Pump Stations	Coverdale	$ 804,643[5]	$ 1,658,184	$ 51,000

Asset Class	Name of Facility	Documented Replacement Cost (2020$)	Planning-Level Replacement Cost (2020$)[1]	Net Book Value (PSAB) (end-of-2020)[2]
Sewage Pump Stations	Crerar Blvd	$ 819,912[6]	$ 2,197,403	$ 231,000
Sewage Pump Stations	Days Rd	$ 4,205,685[5]	$ 8,751,339	$ 521,000
Sewage Pump Stations	Lakeshore Blvd	$ 808,258[5]	$ 3,124,996	$ 1,358,000
Sewage Pump Stations	Greenview Dr	$ 1,226,710[5]	$ 1,982,391	$ 853,000
Sewage Pump Stations	Riverview Dr	$ 1,594,813[7]	$ 1,594,813	$ 1,796,000
Sewage Pump Stations	Collins Bay	$ 315,298[5]	$ 906,204	$ 46,000
Sewage Pump Stations	Bath-Lower	$ 165,631[5]	$ 489,688	$ 15,000
Sewage Pump Stations	John Counter Blvd	$ 2,285,412[7]	$ 1,610,904	$ 1,398,000
Sewage Pump Stations	King-Lake Ontario Park	$ 339,273[5]	$ 656,294	$ 1,000
Sewage Pump Stations	Hillview Rd	$ 1,306,850[5]	$ 4,041,331	$ 147,000
Sewage Pump Stations	Morton St	$ 647,201[5]	$ 802,638	$ 78,000
Sewage Pump Stations	Dalton Ave	$ 6,128,196[5]	$ 9,394,125	$ 2,160,000
Sewage Pump Stations	Notch Hill Rd	$ 72,175[5]	$ 112,572	$ 13,000
Sewage Pump Stations	King St	$ 4,220,897[6]	$ 8,492,424	$ 2,364,000
Sewage Pump Stations	Palace Rd	$ 413,608[5]	$ 1,619,910	$ 137,000
Sewage Pump Stations	King-Portsmouth	$ 2,146,222[5]	$ 4,356,532	$ 461,000

Asset Class	Name of Facility	Documented Replacement Cost (2020$)	Planning-Level Replacement Cost (2020$)[1]	Net Book Value (PSAB) (end-of-2020)[2]
Sewage Pump Stations	Rankin Cres	$ 331,034[5]	$ 840,912	$ 25,000
Sewage Pump Stations	River St	$ 11,138,350[5]	$ 14,887,634	$ 6,997,000
Sewage Pump Stations	Schooner Dr	$ 340,459	$ 802,638	$ 0
Sewage Pump Stations	Bayridge	$ 634,220[5]	$ 749,729	$ 96,000
Sewage Pump Stations	King-Elevator Bay	$ 670,176[5]	$ 1,597,395	$ 147,000
Sewage Pump Stations	Westbrook	$ 597,085[6]	$ 712,580	$ 538,000
Sewage Pump Stations	Kenwoods Circle	$ 516,642[5]	$ 1,309,211	$ 55,000
Sewage Pump Stations	Yonge St	$ 57,287[5]	$ 112,572	$ 26,000
Sewage Pump Stations	**Subtotal**	**$ 47,580,229**	**$ 85,402,340**	**$ 20,385,000**
Combined Sewer Overflow Tanks	Collingwood	$ 5,360,506[7]	$ 5,360,506	$ 1,976,000
Combined Sewer Overflow Tanks	Emma Martin Park	$ 11,192,537[7]	$ 11,192,537	$ 7,074,000
Combined Sewer Overflow Tanks	O'Kill/King	$ 4,667,716[3]	$ 4,667,716	$ 1,388,000
Combined Sewer Overflow Tanks	**Subtotal**	**$ 21,220,758**	**$ 21,220,758**	**$ 10,438,000**
All	**Total**	**$ 273,596,640**	**$ 431,713,854**	**$ 119,570,000**

Notes

1) Values estimated using Water and Wastewater Asset Cost Study (Burnside, 2005)

2) Values obtained from PSAB (2020) Reporting.

3) Values estimated from Plant Replacement Value Evaluation ("PRVE", CG&S, 2000)

4) Values estimated from PRVE (CGandS, 2000) plus 50% of recent upgrade costs

5) Values estimated from Water and Wastewater Facility Condition Assessment ("W&WWFCA", Stantec, 2008)

6) Values estimated from W&WWFCA (Stantec, 2008) + 50% of recent upgrade costs.

7) Values estimated from facility construction cost, including planning and design.

- All values, as applicable, converted to 2020 dollars using Consumer Price Index

1.3 Asset Age

This section presents the known age information of assets in Utilities Kingston's Wastewater Utility.

1.3.1 Linear Assets

Table C-1-14 illustrates the age distribution of Gravity Mains. As determined during the development of PSAB 3150 Reporting, an average 'expected useful life' or 'life-expectancy' for all pipe assets including both Gravity Main and Forcemain asset classes is 64 years. Ideally, life-expectancy should vary based on material type, but material data is incomplete, and as such, no variation is life expectancy based on material is considered in the analysis of linear assets. Age expressed as % of useful life expended is shown in

Table C-1-15.

Table C-1-14 Gravity Main Age Distribution

Age	% of pipes
0-10 years	10.2%
11-20 years	18.6%
21-30 years	15.0%
31-40 years	10.9%
41-50 years	18.6%
51-60 years	12.4%
61-70 years	6.8%
71-80 years	1.8%
81-90 years	0.5%
91-100 years	0.3%
>100 years	2.8%
Unknown Age	2.2%

Table C-1-15 % of Expected Useful Life

Age	Life %	% of life expended
<32	<50%	44.7%
32-64	50-100%	45.2%
>64	>100%	7.9%
Unknown	Unknown	2.2%

Approximately 7.9% of all Gravity Mains are over 64 years old (including the unknown age assets). Approximately 2.2% have unknown age, which are likely to be in the older range of age due to lack of records that tends to occur with older road sections. As such, there may be up to 10.1% of pipes that have exceeded their 64-year lifecycle. It should be noted that this is based on an estimated installation year. True installation year is not available or documented in the Asset Inventory for many assets.

Table C-1-16 illustrates the age distribution of Forcemains in 10-year bins as well as % of 'expected useful life' in

Table C-1-17(assuming average 64-year lifecycle).

Table C-1-16 Forcemain Age Distribution

Age	% of pipes
0-10	2.0%
11-20	4.8%
21-30	8.2%
31-40	17.8%
41-50	6.2%
51-60	7.6%
61-70	8.3%
71-80	1.7%
81-90	0.0%
91-100	0.0%
>100	0.3%
Unknown	43.0%

Table C-1-17 Percentage of Expected Useful Life

Age	Life %	% life expended
<32	<50%	16.0%
32-64	50-100%	35.9%
>64	>100%	5.1%
Unknown	Unknown	43.0%

The data on forcemain age is limited with considerable age unknown. It is likely however that the majority of forcemain is in the 50- to 70-year old range due to the fact the majority of the sewer system and collection by Ravensview WWTP commenced in the late 1950's which puts an unfortunately large percentage of the forcemains near or at end-of-life.

The Junctions asset class does not have age documented in the Asset Inventory. However, it is reasonable to estimate the age distribution of junctions based on the parent Gravity Main asset class. It is rare for Junctions to be replaced without the pipe and vice-versa, except during CIPP Lining or Pipe Bursting projects. The estimated useful life as per PSAB for manholes (which form most of the Junction asset class) is 75 years. It is estimated that approximately 6 or 7% of maintenance holes are the end of their service life, along with the host pipe.

Services are only beginning to be cataloged in the Asset Inventory recently and as such, no useful data is currently available.

1.3.2 Non-Linear Assets

Table C-1-18 provides an indication of the age of Plants and Facilities including major upgrade years as well.

As Plants and Facilities are not currently managed by a Utility-wide asset management tool, documented construction year and upgrade years were determined from available construction drawings. These do not consider non-capital upgrades and maintenance.

Table C-1-18 Summary of Plant and Facility Age and Upgrades

Asset Class	Name of Facility	Estimated Year Built	Major Upgrades
Wastewater Treatment Plants	Cana WWTP	2017 (new)	Replacement of original facility.
Wastewater Treatment Plants	Cataraqui Bay WWTP	1962	1973, 1989, 1993, 2004, Underway(2)
Wastewater Treatment Plants	Ravensview WWTP	1957	1973, 1994, 2009
Pump Stations	Hwy 15	1979	1995
Pump Stations	James St.	1979	1995
Pump Stations	Bath Rd.	1968	2011(1)
Pump Stations	Barrett Ct.	1975	1986(1)
Pump Stations	Bath-Collins Bay	1977	-
Pump Stations	Coverdale	1991	-
Pump Stations	Crerar Blvd.	1962	1995(1), 2011
Pump Stations	Days Rd.	1978	1995, Replacement is underway(2)
Pump Stations	Lakeshore Blvd.	1974	1995, 2017
Pump Stations	Greenview Dr.	1970	2017
Pump Stations	Riverview Way	2018 (new)	-
Pump Stations	Collins Bay Rd.	1997	-
Pump Stations	Bath-Lower	1981	-
Pump Stations	John Counter Blvd.	2012	-
Pump Stations	King-Lake Ontario Park	1966	-
Pump Stations	Hillview Rd.	1997	-
Pump Stations	Morton St.	1959	2005
Pump Stations	Dalton Ave.	1958	2007
Pump Stations	Notch Hill Rd	1970	-
Pump Stations	King St.	1957	1996(1),2012
Pump Stations	Palace Rd.	1979	2005(1)

Asset Class	Name of Facility	Estimated Year Built	Major Upgrades
Pump Stations	King-Portsmouth	1954	2000
Pump Stations	Rankin Cres.	1981	-
Pump Stations	River St.	1957	2004, 2012
Pump Stations	Riverview Way	2018	
Pump Stations	Schooner Dr.	2001	Decommissioned in 2020. Replaced by Riverview Way.
Pump Stations	Bayridge Dr.	2000	-
Pump Stations	King-Elevator Bay	1988	-
Pump Stations	Westbrook	1994	2018
Pump Stations	Kenwoods Circle	1990	-
Pump Stations	Yonge St.	1979	1993, 2011(1)
CSO Storage Tank	Collingwood CSO	2006	-
CSO Storage Tank	Emma Martin Park CSO	2006	-
CSO Storage Tank	O'Kill CSO	1996	2012

Notes:

1) Complete replacement or rebuild of facility (or believed to have been).
2) Upgrade is currently underway.

1.3.3 Summary

Asset age is an attribute that is important for evaluating lifecycle decisions and developing average annual expenditure estimates. As detailed in Section 3.1 above, the IIMM would consider this a portion of standard information contained in the asset inventory. Moving forward, it is important to document this information more accurately for all asset classes. As well, in conjunction with discretizing facility assets to process, component and sub-component levels, installation data and age should be contained within the scope of documented information to be included in an Asset Registry suitable for Plants and Facilities as described in Section 3.1.3.

1.4 Asset Condition

1.4.1 Linear Assets

Utilities Kingston employs multiple contract types to undertake condition assessment of its linear assets. These are described in more detail in Section 3.2.2 of this report. Table C-1-19 illustrates the current level of understanding of the condition of Gravity Mains (based on end of 2020 results). Condition grade is based on mixed results from WRc third Edition and NASSCO PACP, both commonly used standards for assessing gravity sewer mains, with PACP being the newer standard and used from 2015 onwards.

Table C-1-19 Condition Grade Summary of Gravity Main Asset Class

Gravity Main Condition Grade	%
0 or 1 (Excellent)	71.0%
2 (Good)	15.9%
3 (Satisfactory)	7.9%
4 (Poor)	4.0%
5 (Fail)	1.1%

Utilities Kingston considers Gravity Mains with a condition grade equal to 4 (poor) to be undesirable and 5 (failed) to be unacceptable. This suggests that roughly 5.1% of the inspected Gravity Mains may require attention by way of condition-based risk. This is down from 5.5% in 2017. It should be noted that the condition grade summary is simply that, and, at times, it does not represent a scrutinized assessment of CCTV video and data files which is deemed necessary. This is because condition grade assignment may vary considerably from contractor to contractor and be vastly changed by a single erroneous or inappropriate defect ‘call’. A good example is the defect call for a “pick hole” or a hole specifically in the pipe to permit placement, used commonly in the 1960-1980’s with concrete pipe. This type of defect may receive a “H” call for a hole (despite having an external repair), which carries a defect weight of 5, immediately causing the pipe to be graded as ‘failed’. Post-processing of CCTV data and condition-grade

validation is necessary to avoid these pitfalls. A CIPP lining program is currently in progress which includes this validation in area-specific locations and remedies those assets considered poor or failed.

Forcemains do not currently have a condition assessment process. CCTV is not a suitable technology for Forcemain condition assessment. A methodology needs to be developed, tested, and implemented. The use of a condition assessment technology on Forcemains will likely be based on Criticality and/or Risk, as it may only be cost effective to assess Trunk, or Trunk and Collector asset sub-classes.

Junctions and Services do not have dedicated condition assessment programs and there is no intent to initiate condition assessment programs for those asset classes. Junctions are managed as dependents of the Gravity Main asset class.

Services are managed as 'run-to-failure'. This is described further in Section 3.2.2.

1.4.2 Plants and Facilities

Utilities Kingston is continuously assessing the condition of its Plants and Facilities as will be described in Section 3.2.2 of this report. However, more formally, an external consultant-based review of facilities is completed. The most recent study was conducted as part of the Water and Wastewater Master Plan Updates (WSP, 2016). Summary results of the condition assessment are provided in Table C-1-20 and it focused on sewage pump stations.

Table C-1-20 Pump Station Condition Assessment Summary

Name of Pump Station	Facility Criticality [1]	Condition Rating [1]	Overall Rating[1]
Hwy 15	2.9	1.7	B
James St	3.3	1.6	B
Bath Rd	2.8	1.2	B
Barrett Ct	3.3	1.8	C
Bath-Collins Bay	2.8	1.7	B
Coverdale	2.1	1.4	B
Crerar Blvd	2.9	1.4	B
Days Rd	4.8	2.5[2]	D[2]
Lakeshore Blvd	2.5	1.6	B
Greenview Dr	2.1	N/A[3]	A[3]
Riverview Way[4]	TBD	N/A[3]	A[3]
Collins Bay	2.5	1.4	B
Bath-Lower	1.9	2.1	B
John Counter Blvd	2.0	1.2	A
King-Lake Ontario Park	1.8	1.5	A
Hillview Rd	3.5	1.5	C
Morton St	2.8	1.2	A
Dalton Ave	4.3	1.5[2]	C[2]
Notch Hill Rd	1.8	1.8	A
King St	3.8	1.5	C
Palace Rd	2.0	1.7	B
King-Portsmouth	2.0	1.6	B
Rankin Cres	2.0	1.6	B
River St	3.8	1.3	B
Schooner Drive[5]	~~2.0~~	~~1.8~~	~~B~~
Bayridge	3.0	1.4	B

Name of Pump Station	Facility Criticality [1]	Condition Rating [1]	Overall Rating[1]
King-Elevator Bay	2.0	1.6	B
Westbrook	2.0	N/A[3]	A[3]
Kenwoods Circle	2.0	1.7	B
Yonge St	1.9	1.8	B

Notes:

1) Data from Water and Wastewater Master Plans - Condition Assessment Report (WSP, 2016), unless otherwise noted.
2) Facility Replacement or Upgrade is currently underway.
3) Assumed rating, due to recent construction activities or new facility.
4) Facility added since last Asset Management plan iteration.
5) Facility decommissioned since last Asset Management plan iteration.

contains the key for overall rating scores used in Table C-1-20.

Table C-1-21 Total Rating Key for Table C-1-20

Overall Rating	Description
A	No action Required.
B	Minor repairs may be required to non-critical components. Review required, but no work required immediately.
C	Certain Assets/Equipment may need replacing in the near future. Review and plan maintenance.
D	Certain Assets/Equipment may need replacing in the immediate future and review is required to outline maintenance.

In the future, condition assessment of the Wastewater Treatment Plant and CSO Tank Asset Classes shall also be included in the next consultant-based assessment study. In the interim, Utilities Kingston staff have completed a basic qualitative assessment for WWTP and CSO Tanks, as per Data from any and all condition and criticality assessments should estimate risk and should be completed on all Asset Classes. Assessments should drill down to 2-3 additional levels of detail, including the process

level, component level and even the subcomponent level when required. Condition, criticality, and risk information should be date-stamped and added to the proposed Asset Registry, where in conjunction with deterioration curves, lifecycle predictions and proactive actions can be taken.

Table C-1-22.

Data from any and all condition and criticality assessments should estimate risk and should be completed on all Asset Classes. Assessments should drill down to 2-3 additional levels of detail, including the process level, component level and even the subcomponent level when required. Condition, criticality, and risk information should be date-stamped and added to the proposed Asset Registry, where in conjunction with deterioration curves, lifecycle predictions and proactive actions can be taken.

Table C-1-22 Qualitative Condition Assessment for WWTP and Large CSO Tanks

Asset Class	Facility Name	Criticality	Condition	Code Violations
Wastewater Treatment Plant	Cana Subdivision	A-	Good(1)	N/A
Wastewater Treatment Plant	Cataraqui Bay	A	Poor(2)	N/A
Wastewater Treatment Plant	Ravensview	A	Good(1)	N/A
CSO Storage Tank	Collingwood CSO	B	Good(1)	N/A
CSO Storage Tank	Emma Martin Park	B	Good(1)	N/A
CSO Storage Tank	O'Kill / King St	B	Good(1)	N/A

Notes:

1) Estimated based on Utilities Kingston Staff knowledge.
2) Plant upgrade is under construction with completion anticipated for 2021.

1.4.3 Summary

Formal Condition Assessments are currently conducted by contract for the following asset classes:

- Gravity Mains
- Pump Stations

In-house informal condition assessments are conducted by staff for the following asset classes. These should be augmented in near future:

- Wastewater Treatment Plants
- Pump Stations
- CSO Tanks

The following asset classes are adequately managed by a run-to-failure approach and therefore are deemed not to require formal condition assessment programs:

- Services
- Manholes and Fittings

Note that fittings should be expanded to identify a new feature class for valves and other functional/mechanical fitting that do warrant a proactive maintenance plan and some frequency of condition assessment.

Moving forward, a new or revised condition assessment process is required for the following asset classes:

- Forcemains – new condition assessment process should be developed and implemented.
- All Plants and Facilities - Condition Assessment process needs to be formalized with in conjunction with development and implementation of a suitable asset register for Plants and Facilities.

1.5 Maturity of Plan

1.5.1 Asset Inventory Maturity

The asset inventory is currently in a ‘Minimal’ maturity state, as per IIMM (NAMS, 2011) guidelines (see Table C-1-23). Certain asset classes of the Linear System approach a ‘Core’ level of maturity with the GIS providing a reasonably well-defined asset inventory with some detailed technical data, but not all. The Plants and Facilities inventory is also in a ‘minimum’ level of maturity with various non-functional or incomplete inventories including the GIS (identifying only where the facilities are located), spreadsheets (such as delivered with the Condition Assessment (Stantec, 2008)) and Watertrax (no longer used).

1.5.2 Condition Assessment Maturity

It is estimated that the maturity of the Condition Assessment process is ‘minimum’ given the informality of completion, documentation, and storage of results (see

Table C-1-24). The ability for Utilities Kingston to advance to a 'core' maturity level would require formal condition assessment programs for all asset classes deemed appropriate, with supporting documentation. The ability to implement a 'core' level condition assessment program also requires adoption of a suitable asset register for Plants and Facilities as described in Section 1.1.3 to provide a repository for information.

Table C-1-23 Maturity Index - Asset Inventory

Maturity Level	Description	Status of Current Plan
Minimum	Basic physical information recorded in a spreadsheet or similar (e.g. location, size, type), but may be based on broad assumptions or not complete.	We are here.
Core	Sufficient information to complete asset valuation – as for 'minimum' plus replacement cost and asset age/life. Asset hierarchy, asset identification and asset attribute systems documented.	Short-term Target for 2025
Intermediate	A reliable register of physical and financial attributes recorded in an information system with data analysis and reporting functionality. Systematic and documented data collection process in place. High level of confidence in critical asset data.	
Advanced	Information on work history type and cost, condition, performance, etc. recorded at asset component level. Systematic and fully optimized data collection program. Complete database for critical assets; minimal assumptions for non-critical assets	

Table C-1-24 Maturity Index - Condition Assessments

Maturity Level	Description	Status of Current Plan
Minimum	Condition assessment at asset group level ('top-down'). Supports minimum requirements for managing critical assets and statutory requirements (e.g. safety).	We are here.
Core	Condition assessment program in place for major asset types, prioritized based on asset risk. Data supports asset life assessment. Data management standards and processes documented. Program for data improvement developed.	Short-term Target for 2025
Intermediate	Condition assessment program derived from benefit-cost analysis of options. A good range of condition data for all asset types (may be sampling-based). Data management processes fully integrated into business processes. Data validation process in place.	
Advanced	The quality and completements of condition information supports risk management, lifecycle decision-making and financial/performance reporting. Periodic reviews of program suitability carried out.	

1.6 Moving Forward

Table C-1-25 summarizes action or improvement items to advance the maturity of the existing knowledge base.

Table C-1-25 Summary of Asset Management Improvement Items

Asset Group	Asset Class	Description	Time and Effort
Linear Infrastructure	Services	Include in Enterprise GIS with pertinent attribute data.	Minimal, moving forward.
Linear Infrastructure	Sanitary Cleanouts	Introduce a new asset class for cleanouts that are soon to be required infrastructure to support the Consolidated ECA (MECP)	Develop and implement.
Linear Infrastructure	Gravity Mains and Forcemains	Make sure to include material and installation year. Consider the ability or need to include operational data.	Minimal, moving forward.
Linear Infrastructure	Gravity Mains	A CCTV condition grade validation program is required to validate CCTV results.	Moderate.
Linear Infrastructure	Forcemains	A condition assessment process is required for Forcemain Asset Class.	Moderate.
Linear Infrastructure	Junctions	Expand on this asset class and further develop into functional/mechanical junctions such as valves, that require a proactive maintenance plan, and those that are static features that do not require a maintenance plan	Minimal to moderate.
Plants and Facilities	ALL	Research, select and implement a suitable asset management tool (Asset Registry) for Plants and Facilities.	Substantial in terms of time, effort and cost.
Plants and Facilities	ALL	Undertake a facility valuation study including valuations and replacement costs for all Plants and Facilities.	Moderate.
Plants and Facilities	WWTP and CSO Tanks	Include all Asset Classes in Condition, Criticality and Risk Assessment assignments.	Moderate.

2 Expected Levels of Service

An Asset Management Plan is instrumental for best-practices management of the Wastewater Utility. However, without well-defined Levels of Service, the success of the Asset Management Plan cannot be evaluated, and improvements may not be triggered appropriately.

This section presents a preliminary suite of Level of Service (LOS) statements for the Wastewater Utility. To support these Level of Service statements are several Key Performance Indicators (KPI). The Level of Service statements are general in nature, while the Key Performance Indicators are specific and quantifiable.

In many cases, Levels of Service are related to Strategic Goals of Utilities Kingston. The theme areas of Utilities Kingston include:

- Growth
- Risk Management
- Customer Focus
- Infrastructure Investment and Community Sustainability
- Technology and Innovation.

The following tables provide the Level of Service statements and supporting KPI's for identified theme areas:

- Table C-2-1: A) Performance and Reliability
- Table C-2-2: B) Risk Management
- Table C-2-3: C) Growth and Planning
- Table C-2-4: D) Sustainability and the Environment
- Table C-2-5: E) Financial

Table C-2-1 (A) Performance and Reliability - Waste Water

Utilities Kingston will operate the Wastewater Utility efficiently, effectively and reliably.

Key Performance Indicator	Score (2020)	Units/Notes	Ranges
A.1) Number of Sewage backups	**8.08**	#/10,000 customers (sourced from On-line Reporting Tool)	Good:<2, Acceptable: 2-10, Unacceptable: >10.
A.2) Service/Lateral repairs	**6.25**	#/10,000 customers (sourced from Underground Infrastructure Dig Database)	Good: <10, Acceptable: 10-50, Unacceptable >50
A.3) Gravity Main Backups	**1.30**	#/100km of Main (source: MPMR Report, Item 6.4)	Good: <1, Acceptable: 1-2, Unacceptable >2
A.4) Pump Station Failures	**0**	# of unplanned events causing sewage backups or bypassing. (Source: Bypass Log)	Good: 0, Acceptable: 1-2, Unacceptable: >2
A.5) WWTP Effluent Quality (relative to Regulatory Standards).	**Ravens view: 100%** **Cataraqui Bay: 100%** **Cana: 100%**	% of time WWTPs meets Regulatory Standards	Good: 100%, Unacceptable: <100%

Key Performance Indicator	Score (2020)	Units/Notes	Ranges
A.6) WWTP Effluent Quality (relative to Process Objectives).	**Ravens view: 100%** **Cataraqui Bay: 58%[(1)]** **Cana: 33%[(2)]**	% of months WWTP meets Process Objectives (1) Wet-weather & Plant is in reconstruction (2). TP & TSS associated with unbalanced flows.	Good:≥11, Acceptable: 9-11, Unacceptable: <9
A.7) WWTP Daily Flows (relative to Rated Capacity)	**Ravens view: 95.9%** **Cataraqui Bay: 92.6%** **Cana: 95.4%**	% of days that daily flow is less than rated capacity (average daily). (Source: WWTP Data)	Good: >95%, Acceptable: 90-95%, Unacceptable: <90%
A.8) Amount of Wastewater Treated	**99.5%**	% of total wastewater that has received Secondary Treatment (Source: WWTP Data & Overflow Log)	Good: >99%, Acceptable: 98-99%, Unacceptable: <98%
A.9) Wet-weather flow capture	**95.8%**	% of estimated total wet-weather flows at Ravensview treated. (Source: WWTP Data & Overflow Log)	Good: >95%, Acceptable: 90-95%, Unacceptable: <90%

Table C-2-2 (B) Risk Management – Wastewater

Utilities Kingston will identify prioritize and mitigate risks associated with the management of the Wastewater Utility.

Key Performance Indicator	Score	Units/Notes	Range
B.1) Gravity Mains Risk Level	**Trunks: 92.2%** **Collectors: 95.1%** **Locals: 97.8%**	% of pipes that are considered to be of acceptable risk level. (Source: Gravity Mains Risk Assessment)	Good: >95%, Acceptable: 90-95%, Unacceptable: <90% (or unknown)
B.2) Forcemain Risk Level	**All: To be determined**	% of forcemain length that is considered to be of acceptable risk level. (Source: N/A)	Good: >95%, Acceptable: 90-95%, Unacceptable: <90% (or unknown)
B.3) Pump Station Risk Level (by size class)	**Large: 1/2 (50%)** **Medium: 1/5 (20%)** **Small: 15/15 (100%)** **Very Small: 7/7 (100%)**	# (and %) of facilities that are considered to be of acceptable risk level . Those that are not graded at "Good" are noted. Days Rd SPS (large) graded at "D" (Upgrades are underway). Medium: Barrett Ct SPS graded at "C", King St SPS graded at "C", Hillview SPS graded at "C" and Dalton SPS graded at "C".	Good: Low Risk [A,B], Acceptable: Moderate Risk [C]. Unacceptable: High Risk [D]

Key Performance Indicator	Score	Units/Notes	Range
B.4) CSO Tank Risk Level	**All: Low**	The perceived risk associated with the condition of the three facilities (Source: Staff)	Good: Low, Acceptable: Moderate, Unacceptable: High
B.5) Wastewater Treatment Plant Risk Level	**Ravensview: Low** **Cataraqui Bay: High** **Cana: Low**	The perceived risk associated with the condition of the facility (Source: Staff) * Cat Bay under construction.	Good: Low, Acceptable: Moderate, Unacceptable: High

Table C-2-3 (C) Growth and Planning - Wastewater

Utilities Kingston will facilitate growth of the customer base by ensuring services can meet current needs and the needs of the future.

Key Performance Indicator	Score	Units/Notes	Range
C.1) Sewer Master Plan Maturity	**4.5yrs Old**	The age of the most recent Sewer Master Plan (latest: January 2017)	Good: <4 years, Acceptable: 4-6 years, Unacceptable: >6years
C.2) Facility Condition Assessment Maturity	**4.5yrs Old**	The age of the most recent Plants & Facilities Condition Assessment (Latest: January 2017, part of MP)	Good: <5 years, Acceptable: 5-8 years, Unacceptable: >8years
C.3) WWTP Uncommitted Reserve Capacity (estimated years)	**Ravensview: >20** **Cataraqui Bay: >20** **Cana: N/A**	Estimated number of years required prior to next WWTP capacity upgrade, as per MOE D-5-1. (Source: UK May 2021). Cana not assessed since no growth is permitted in service area.	Good: >20 years, Acceptable: 12-20 years, Unacceptable: <12 years
C.4) Linear System Risk Assessment Completeness	**Gravity Mains: 91.3%** **Forcemains: 10.5%**	Risk Assessment is founded on the Condition Assessment Results. This % represents the fraction of all assets with completed condition assessment. Note that only Dalton Ave SPS Forcemains have had a condition assessment completed.	Target: 100%, Acceptable: 80-99%, Unacceptable: <80%

Table C-2-4 (D) Sustainability and the Environment – Wastewater

Utilities Kingston will improve the environment and operational sustainability of the Wastewater Utility to support the Community Vision of becoming Canada's Most Sustainable City.

Key Performance Indicator	Score	Units/Notes	Range
Eliminate Combined Sewers			
D.1) Rate of Sewer Separation (relative to 2008 benchmark conditions)	**2.5%** **(or, 1.6% by area)**	% of street blocks of completed sewer separation expressed as % relative to January 2008 total. (source: GIS)	High: >3.0%, Moderate: 2.0-3.0%, Low: <2.0%
D.2) Remaining Combined Sewer Service Area (relative to 2008 benchmark conditions).	**50.5%** **(or, 55.7% by area)**	Estimated remaining combined sewer service area (by serviced hectare) relative to January 2008 total. (Source: GIS) Ranges are for end of 2020.	N/A, for Information
Reduce Extraneous Flows			
D.3) Bulk Extraneous Flow	**48.1%**	Calculated as Total Wastewater Treated / Total Potable Water Produced (Source: WPP & WWTP data)	Good: <10%, Acceptable: 10-20%, Unacceptable: >20%

Table C 2-5 (E) Financial – Wastewater

Utilities Kingston will operate the utility in a manner that is adequately funded and financially responsible to the shareholders and customers.

Key Performance Indicator	Score	Units/Notes	Range
E.1) Combined Water & Wastewater Costs to Residential Customer, as percentage of household income.	**1.22%**	UK's sewage rates as a percentage of provincial average (Source: Municipal Study, 2015). Burden is average cost to residential customer versus average household income.	Good: <10%, Acceptable: 10-20%, Unacceptable: >20%
E.2) Debt Repayment a) Debt Interest Repayment as percentage of revenue. b) Total Debt Repayment as percentage of revenue	**a) 9.5%** **b) 17.1%**	This % represents the total debt repayment as compared to total revenue (Source: UK Finance)	Good: <25%, Undesirable: >25%
E.3) Wastewater Debt Outstanding per Customer	**$1,700**	Source: UK Finance	No Ranges defined.
E.4) Estimated Annual Budget Deficit	**$9.1M**	Total Estimated Required Capital less estimated available funds (per year). (Source: UK Finance)	No Ranges defined.

Supplementary detail on Key Performance Indicators can be found in Appendix B.

2.1 Maturity

The above Levels of Service and supporting performance indicators serve as a starting point for the Wastewater Utilities Asset Management Plan. With no consultation with customers, the maturity level of this section is limited. For this preliminary version of the Asset Management Plan, the maturity level is considered 'minimal' (see Table C-2-6).

Table C-2-6 Maturity Index - Levels of Service

Maturity Level	Description	Status of Current Plan
Minimum	Asset contribution to organization's objectives and some basic levels of service have been defined.	We are here.
Core	Customer Groups defined and requirements informally understood. Levels of service and performance measures in place covering a range of service attributes. Annual reporting against performance targets.	Short-term Target for 2025
Intermediate	Customer Group needs analyzed. Costs to deliver alternate key levels of service are assessed. Customers are consulted on significant service levels and options.	
Advanced	Levels of service consultation strategy developed and implemented. Technical and customer levels of service are integral to decision-making and business planning.	

2.2 Moving Forward

Table C-2-1 through Table C 2-5 are first iterations of Levels of Service (LOS) and Key Performance Indicators (KPIs). In very general terms, improved asset management as envisioned through this Plan should create improvements to the KPIs and ultimately result in positive change and/or improvements to processes and programs. Because of

this, it is often the trend of the data that is more important than the magnitude of the KPI.

The KPI's listed above should be updated annually and trend lines illustrated. In some cases, it may be prudent to look back historically to initiate a trend that is established 5-10 years ago. In addition to this, it is also prudent to assign timelines to the KPI targets for those that are found to be deficient. This can help increase efforts in one are or another and determine what areas can have decreased effort/expenditure to compensate.

Additional KPI's should be considered for future iterations of the Wastewater Utility Asset Management Plan.
Additional theme areas and KPI's to consider may include:

- Customer Service:
    - Complaint Tracking. Good asset management includes good customer service. Complaint tracking from customers lets us know how our performance is perceived to the consumer. Frequency of complains about specific issues should precipitate a review for action.
    - Responsiveness to Service Calls. Part of good customer service is quick response to issues that warrant it.
    - Overall Customer Satisfaction (via Survey). The IIMM (NAMS,2011) recommends customer satisfaction surveys to assist with quantifying the quality of service to the consumer.

3 Asset Management Strategy

The Asset Management Strategy for the Wastewater Utility is founded on the following principles:

- Growth is a primary trigger for new assets, asset replacement, or major upgrade.
- Risk is a secondary trigger for asset replacement, or major upgrade.
- Maintenance will otherwise be responsible for maintaining reasonable risk levels and reasonable function of assets and provide the lowest lifecycle cost while providing the desired level of service (see **Figure C-3-1**).

Asset management at Utilities Kingston is currently comprised of four main categories:

1. **Infrastructure Planning and Demand Management** – These studies focus on growth management and ensuring that infrastructure meets the needs of the City, typically using a 20- to 25-year future window. Studies result in identification of capacity upgrades, process improvements and/or new infrastructure.
2. **Risk Assessment** – These efforts focus on steps required to determine the risk associated with assets and make appropriate maintenance, upgrade and replacement decisions in a proactive manner. This includes assessment of criticality and condition. Risk Assessments result in identification of assets that require remedial works and/or new assets that can assist in risk reduction.
3. **Lifecycle Decision-Making** – This process focuses on use of lifecycle knowledge to determine the most suitable solution for addressing items identified in by Planning, Demand Management and Risk Assessment studies described above.
4. **Maintenance Management** – This is the de facto means of maintaining assets in absence of triggers for asset replacement, rehabilitation, or major upgrade.

The four categories listed above are described in detail in the sub-sections below.

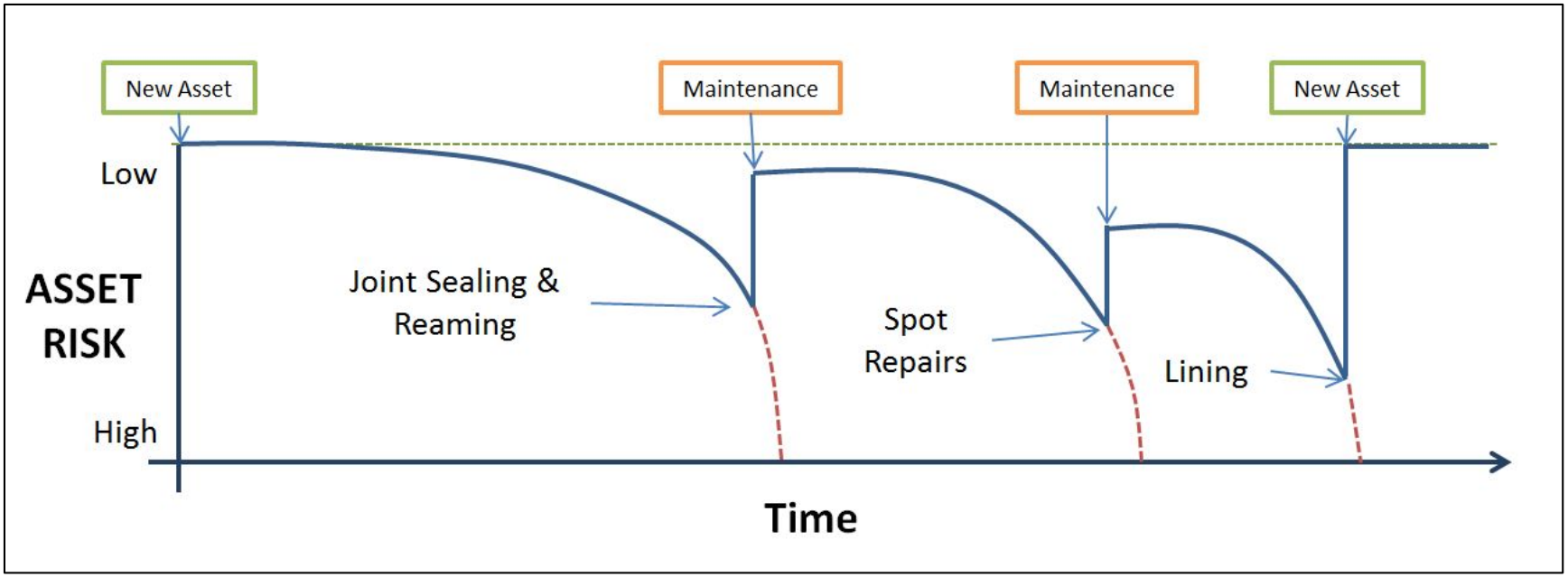


Figure C-3-1 Conceptual lifecycle of a pipe asset

3.1 Infrastructure Planning and Demand Management

Infrastructure Planning is responsible for ensuring that infrastructure is adequate to meet the needs of the existing and future customer loads in consideration of existing and future regulatory requirements. For the Wastewater Utility, this means that infrastructure is of adequate capacity to meet future growth conditions, including both Linear Infrastructure as well as Plants and Facilities. For example, the wastewater treatment plants must be able to treat future loads at existing and any anticipated regulatory standards for effluent quality within a reasonable planning window.

Table C-1-1 provides a list of Infrastructure Planning Studies.

Infrastructure Planning studies generally produce the following:

- Triggers for replacement or major upgrades of existing assets due to insufficient size, capacity, or effluent quality to meet existing or future needs.
- Triggers for construction of new assets to service future growth areas.
- Triggers for decommissioning of existing assets.
- Strategic approaches to accomplishing stated goals.
- Approximate timing associated with the above.

It is recommended that Master Planning and Pollution Prevention and Control Planning Studies take place on a 5-year cycle (optimal frequency) and produce recommendations for 20-25 years into the future. A Master Plan typically accomplishes the above.

Water and Wastewater Master Planning should be undertaken concurrently utilizing common growth and development conditions and assumptions. Where Growth Strategy Updates or Official Plans do not suggest major deviations from previous assumptions, Master Plans can be delayed. They should be completed no later than 10 years after the previous.

Projects identified through planning exercises require capital expenditure that originates from sewer rates and/or development charges (for growth-related activities). At times, significant projects may require additional funding from sources such as grants and/or new debt.

Table C-3-1 Infrastructure Planning Studies

Study	Description	Frequency	Assets
Growth Strategy and Updates	Growth Strategies are undertaken by the City of Kingston Planning Department to identify future areas for growth. Utilities are considered during the analysis at a high-level to identify where major infrastructure upgrades are required.	Variable	Major facilities including WWTP, PS, CSO, larger Gravity Sewers and Forcemains.
Master Plan (MP)	Sewer Master Planning assignments are initiated by Utilities Kingston with new development plans or growth projections. A Master Plan typically follows a Growth Strategy and should examine all major development areas considered within a 25-year horizon. It provides recommendations on what facility upgrades or new facilities are required to meet growth demands.	Typically 5-7 years.	Major facilities including WWTP, PS, CSO, larger Gravity Sewers and Forcemains.
Pollution Prevention and Control Plan (PPCP)	A Pollution Prevention and Control Plan (PPCP) is typically completed in conjunction with a Master Plan. It focuses specifically on sewage overflows, combined sewer areas, extraneous flows relative to MOE Procedure F-5-5. It provides guidance on how to proceed with reduction of bypasses.	Typically 5-7 years	Major facilities including WWTP, PS, CSO Tanks, larger Gravity Sewers and Forcemains.

Study	Description	Frequency	Assets
Development Charges Bylaw Review	The Development Charges Act, 1997, subsection 2(1) authorizes municipalities to pass a bylaw to impose development charges against land to pay for increased capital costs required because of increased needs for services arising from development. The City collects development charges pursuant to Bylaw 2019-116, "A Bylaw To Establish Development Charges For The City Of Kingston", passed by Council on September 3, 2019	Typically every 5 years	May include all asset classes and scales.
Environmental Assessments (EA)	Environmental Assessments are conducted for recommended projects from MP or PPCP, or, as initiated due to UK-driven or City-driven initiatives. At times they include scales larger than the facility or asset being studied itself and may derive other recommendations that impact other assets as well.	As required.	May include all asset classes and scales.
Site-Specific Development Studies	Larger-scale developments require area-specific studies that may generate recommendations for facilities or linear assets at any scale.	As required.	May include all asset classes and scales.
Uncommitted Plant Reserve Capacity Analyses	Treatment Plants require diligence in tracking available capacity to ensure upgrades are initiated in a timely manner. The exercise follows MOE Procedure D-5-1.	As required.	WWTP

Study	Description	Frequency	Assets
Capacity Assurance	A capacity assurance program should be implemented. This is not currently in place and needs to be developed.	TBD	Gravity Mains, Forcemains, Pump Stations.

3.1.1 Growth Estimation

The studies identified in Table C-3-1 are responsible for identifying specific projects required to meet the wastewater collection and treatment needs of the existing and future anticipated loads. Examples of the output include Wastewater Treatment Plant expansions, new Trunk Gravity Sewers, or new Pump Stations to provide service to new growth areas. However, this does not assist in determining the anticipated increase in expenditures required to support infrastructure once it has been constructed. For example, if annual capital expenditure for Gravity Sewer rehabilitation and replacement is directly related to the quantity of assets in the Gravity Main asset class, then an increase in assets will require a corresponding increase in annual capital expenditure (and Operations and Maintenance as well). Given that growth of asset quantity will be accompanied by growth of the customer base, on average there will not necessarily be a required increase in rates unless Levels of Service cannot be met.

Two recent sources of information for growth-based are discussed here-in to assist in projecting necessary increases to annual budgets.

- The past 11 years of customer accounts has been reviewed and this can be used to anticipate short-term growth requirements.
- For longer-term projections, the City of Kingston and Kingston CMA Population, Housing and Employment Projections study, currently in Draft form, September 2013, is referenced.

3.1.1.1 Short-term Growth

The volume of customer accounts over the past 11 years is shown in Figure C-3-2.

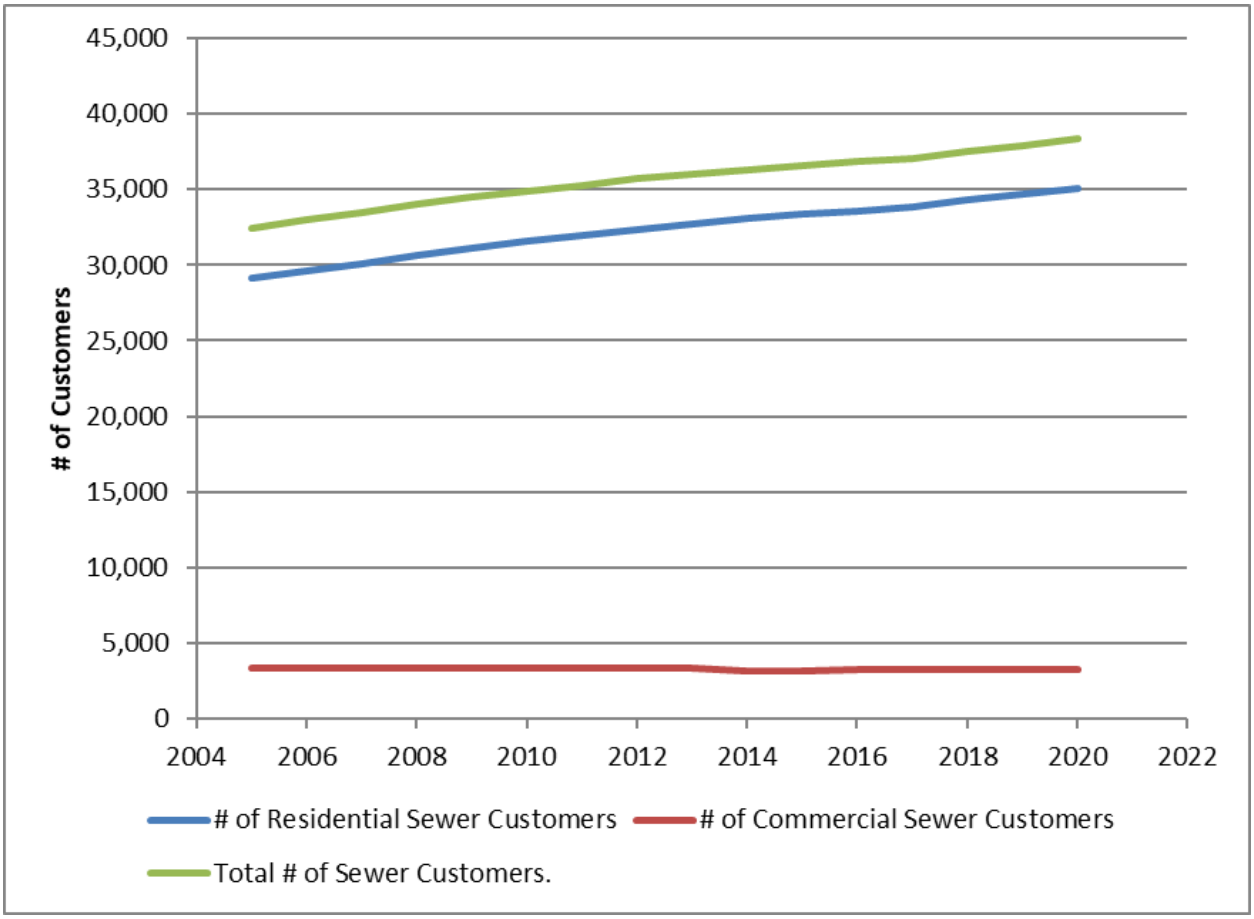


Figure C-3-2 Customer Accounts over past Eleven Years

The average annual growth in customer base is 1.3% per year of which the majority is residential customers. The last two years have seen slower growth at five year 1.0%. There is little difference in the number of commercial customers over the past 11 years. The data indicates a slight decrease in growth rate over the past eleven years due to an apparent dip in growth between 2015-2017.

3.1.1.2 Long-term Growth

The general results of the longer-term study entitled, “City of Kingston Population, Housing and Employment Forecast Report” (Watson and Associates Economists Ltd, 2019), are as follows:

- The study projects growth at roughly 0.9%/year in the short-term (2016-) declining to 0.2%/year towards 2046.
- Student population is included in this analysis. As, students are generally present at minimum 8 out of 12 months (i.e. majority of the year), they must be taken into consideration for infrastructure planning.
- Within the 10-year horizon as covered by this report, growth of approximately 0.8%/year is forecasted (see Figure C-3-3).

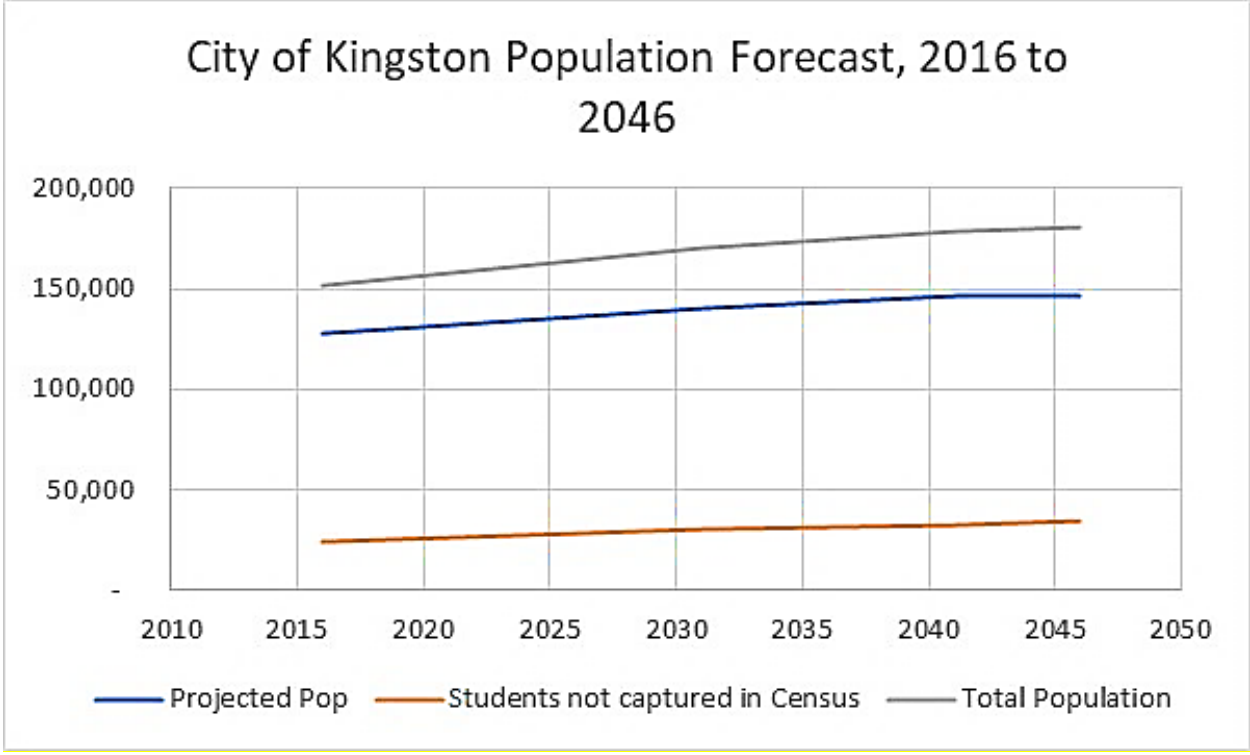


Figure C-3-3 Population Forecast (Watson and Associates, 2019, Figure i-1)

As a result, it is worthwhile assuming an increase in assets by a rate commensurate with customer base growth, in the order of 0.8% over the next 10 years. While master planning studies will identify the need for larger trunk sewers associated with this growth, local sewers are constructed by developers and transferred to City ownership later, and not identified in plans. One might therefore consider the total asset base for Asset Classes such as local Gravity Mains, Manholes and Services to increase at a similar rate.

3.1.2 Demand Management

The term ‘demand’ management for sewage infrastructure is unique to the Wastewater Industry. Demand is perhaps an illogical term for reducing capacity usage of the existing system.

For the Wastewater Utility, controlling demand on the capacity of infrastructure is to address the three primary components that comprise sewage flow:

a) Water use
b) Extraneous Flows
c) Combined Sewage

Demand management for water use is addressed in the Water Utility Asset Management Plan (Section B of this report). Primary components to reducing water use include Water Conservation efforts, as well as significant efforts to reduce Unaccounted-for-Water.

The problem of extraneous flow is currently being addressed by two programs:

- Public-side extraneous flow reduction programs. These programs utilize various means to identify and eliminate extraneous flow sources, including joint sealing, spot repairs, cured-in-place-pipe (CIPP) lining, as well as finding and eliminating storm cross-connections. These assist in restoring capacity.
- Private-side extraneous flow reduction program. Private side extraneous flow reductions are being realized through both the Preventative Plumbing Program and Bylaw Enforcement (of Sewer-Use Bylaw 2008-192. Both target removal of illegal connections such as downspouts, sump pumps and foundation drains.

Combined sewage is continually being reduced by pursuing sewer separation in the City of Kingston. Over the past 11 years, approximately 4% per year on average is being reconstructed as separated sewer systems. This pace has slowed from an average around 4-5% per year circa 2008-2011 to 2-3% circa 2013-2020. The council-endorsed plan to complete full sewer separation in a 20-year window beginning 2023 will ensure elimination of the remaining 50% (relative to 2008).

Demand Management mechanisms for the Wastewater Utility focus on reduction of wet-weather inputs to the system. While these will not tend to affect the budgeting requirements in the shorter term (since decisions on the system are typically not based on wet-weather issues), they will have positive impact in the long run since they may; i) delay works, ii) eliminate the needs for works, and iii) result in less need to recondition or reconstruct facilities purposed for wet-weather flow control issues (CSO Tanks).

Utilities Kingston is committed to continuing with all programs described herein to reduce the demand on wastewater collection, conveyance and treatment infrastructure.

3.1.3 Planning and Growth Implications

Planning studies have identified several projects that do not fit in the context of typical annual infrastructure renewal projects. These projects are identified in Table C-3-2 and they need to be considered for capital budgeting. These projects originate from Master Plans as well as other more localized growth or development studies. Note that the Pollution Prevention and Control Plan (PPCP) update, while considered a 'planning' type study, provide a list of additional projects that fit the 'risk-based' category better and are included in Section 3.2.

Table C-3-2 Identified Growth-Based Projects

Asset Class	Project Location/Detail	Cost Estimate (2020$)	Timing	Notes
WWTP	Cataraqui Bay,	$ 1,000,000	By 2031	1
Pump Stations	Westbrook PS Upgrade	$ 500,000	By 2021	3,5
Pump Stations	Days Rd PS Upgrade	$ 4,400,000	By 2021	3,4
Pump Stations	Portsmouth PS Upgrade	$ 2,000,000	By 2021	1,2,3,7
Pump Stations	New Riverview PS and FM	$ 2,000,000	By 2021	3,5
Pump Stations	New Quarry PS and FM	$ 1,700,000	By 2026	3
Pump Stations	New "Sands" PS and FM	$ 2,510,000	2016-2017	2,6
Gravity Mains	Hwy 15 Trunk Sewer Upsize	$ 1,030,000	By 2021	1,2,6
Gravity Mains	Barriefield Sewer Upsize	$ 330,000	2017	1,2,6
Gravity Mains	North End Trunk Sewer Twin Phase 1and2	$ 3,000,000	By 2021	1,2,4
Gravity Mains	King St Collector Upsize	$ 670,000	By 2021	1,4
Gravity Mains	Alfred/Elm Sewer Upsize	$ 450,000	By 2021	1,2,5
Gravity Mains	Princess St (Williamsville connection)	$ 675,000	By 2021	3,7
Gravity Mains	Princess St Collector Upsize Phase 1	$ 1,200,000	By 2021	1,2,6
Gravity Mains	Augusta Sewer Extension	$ 310,000	2015	2

Asset Class	Project Location/Detail	Cost Estimate (2020$)	Timing	Notes
Gravity Mains	Beaver Ct/Safari Dr Collector Upsize	$ 1,030,000	2026	2
Gravity Mains	Collins Ck Sewer	$ 340,000	2014	2
Gravity Mains	Notch Hill Collector Upsize	$ 660,000	By 2026	1
Gravity Mains	NorthWest Collector Upsize	$ 2,300,000	By 2026	1
Gravity Mains	Princess St Collector Upsize Phase 2	$ 1,900,000	By 2026	1,2
Gravity Mains	North End Trunk Sewer Twinning Phase 3	$ 3,400,000	By 2036	1
Gravity Mains	Princess St Collector Upsize Phase 3	$ 1,200,000	By 2036	1,2
Forcemains	Westbrook FM flow redirect.	$ 230,000	By 2021	1,7
Forcemains	Portsmouth PS FM redirect	$ 8,000,000	By 2021	1,2,3,4
Forcemains	Hillview Dr PS FM Upsize	$ 190,000	By 2021	1,2
Forcemains	Barrett Court PS FM Upsize	$ 200,000	By 2021	3
TOTALS	All Works	$71,225,000	to 2036	
TOTALS	All Works (to 2031)	$66,625,000	to 2031	

Notes:

(1) Source: 2017 Wastewater Master Plan (WSP Canada Ltd)

(2) Source: 2014 Kingston DC Background Study (Watson and Associates)

(3) Source: Internal study or Environmental Assessment

(4) Status: In Progress as of January 1, 2021

(5) Status: Project is Complete as of January 1, 2021

(6) Status: Project has been deferred.

(7) Status: Project is planned for within next 3 years.

All of the projects listed in Table C-3-2 are to be funded or partially funded by the development community via Development Charges, and as such, a large portion of those will have multiple funding streams. This is pertinent when examining the budget forecast in Section D.

3.2 Risk Management

Optimization of asset lifecycle contains numerous decision-making processes inherent to it. After any growth/capacity-based needs are considered, the secondary decision-making process is the risk assessment process which is instrumental in managing risk.

The Risk Assessment process is the process of utilizing both criticality and condition information to estimate risk and thus the urgency in completing rehabilitation.

- **Criticality** is estimated using factors such as: where the asset is, what size it is, how many customers it services, and other factors, which is akin to the 'consequence of failure'. The higher the criticality, the higher the consequence of failure.
- **Condition** is determined from condition assessment and is generally time dependent. It represents the likelihood of failure, in that the worse the condition, the higher the likelihood of failure.

Consideration of these two factors forms the risk assessment. Risk is calculated in a quantitative manner and prioritization can be undertaken by sorting by risk score.

Prioritization is the process of utilizing risk assessment results and generating a proposed sequence and timing of works that is commensurate with the magnitude of risk. In other words, assets that present higher risks are those that logically receive attention and sooner than those with lower risk.

The following sections describe the process.

3.2.1 Criticality Assessment

Upon creation of an asset, its criticality can be determined. Criticality is an indication of how important the feature is to the function of wastewater utility. It is also an indication

of the severity of the consequence of failure. For example, a large sewage forcemain that crosses a river is an asset with higher criticality than a smaller forcemain that services a small neighbourhood. This is because the larger forcemain services more customers and the consequence of its failure is much more severe.

Criticality assessments have been completed on Wastewater Treatment Plants, Pump Stations, CSO Tanks, Gravity Mains and Forcemain Asset Classes. These processes should be formalized and documented.

3.2.1.1 Plants and Facilities

To date, for the Wastewater Utility, criticality for pump stations has predominantly been determined via two studies. The 2008 Condition Assessment (Stantec, 2008, see Table C-1-20) assigned a letter criticality grade of A, B or C, with A being most critical and C being the least critical. More recently, the Master Plan (WSP, 2017) also reviewed and confirmed criticality ratings using a numeric approach. The criticality for the WWTP and CSO Tanks has been assigned in-house utilizing a similar process to that used in previous reports. By virtue of the purpose and service area of Wastewater Treatment Plants, all were assigned a criticality grade of A or B. The same applies to CSO tanks.

Factors used in assigning criticality are as follows:

- Disruption to Customers
- Customer Type
- Risk to Public Health and Safety
- Environmental Impact
- Difficulty of Repair
- Confidence and Liability

Verification of criticality for plants and facilities should be completed during the Condition Assessment process that typically accompanies the Master Planning process and should take place on a 10-year cycle maximum if not done during a Master Plan update. Criticality is presented in Table C-1-20 and Table C-1-20.

3.2.1.2 Linear Infrastructure

For linear infrastructure, criticality has been assessed in-house first in 2013 and more recently in 2021. For linear infrastructure, criticality is assigned based on the Gravity Main or Forcemain asset classes. Manholes and Junctions inherit the criticality of the parent asset. Services are all assigned a low criticality.

The following factors were used in assigning criticality to linear assets:

- Size of pipe (which is akin to # of customers)
- Redundancy
- Shape (i.e. historic box sewers are more critical)
- Accessibility (i.e. less accessible infrastructure is more critical)
- Type (i.e. combined sewers are more critical since they provide two functions, sewage collection and storm drainage and have environmental issues associated with them, i.e. overflows)
- Capacity Adequacy (sewers that are identified as under-capacity by today's standards are more critical and are actually triggered for replacement versus rehabilitation)
- Material (to be employed when data set is populated, i.e. Vitrified Clay as more critical due to consistently observed problems).

The above is applied in a manner to provide a quantitative criticality score.

The criticality of linear infrastructure should be updated for each iteration of the Asset Management Plan to ensure new assets are scored, or sooner, based on planning needs.

3.2.2 Condition Assessment

Periodic condition assessment of assets is paramount to implementing an effective asset management plan. Condition is utilized in conjunction with criticality in determining the risk. Condition is akin to the likelihood of failure, where the more advanced the deterioration of the asset, the more likely the asset is to fail. Failure of an asset is indicative of an ineffective asset management program, as failure is to be

avoided by maintenance and asset replacement of rehabilitation in a proactive well-timed manner.

3.2.2.1 Plants and Facilities

Plants and facilities in the Wastewater Utility are subject to periodic condition assessment by external consultants, as well as regular (daily, weekly and monthly) inspections by staff. These processes are complimentary, as the consultant-lead processes generates work on larger scales whereas the staff-lead works are typically smaller-scale process-related. Table C-3-3 summarizes the condition assessment processes for Plants and Facilities.

Table C-3-3 Condition Assessment Processes for Wastewater Plants and Facilities

Process	Description	Frequency	Asset Classes
Facility Condition Assessment (consultant-lead)	The Facility Condition Assessment study is a rigorous process that involves assessment of criticality and condition down to the major component level and uses a risk assessment framework to recommend proactive works on all facilities and/or recommendations for replacements and/or major upgrades. It also reviews regulatory and code compliance issues. Includes a 10-year outlook to the next cycle. Improvements need to be made to this program and recommendations for maintenance need to be reviewed and entered into a suitable Asset Registry A high level condition assessment is conducted now with master plans.	Typically 5 years ±	Wastewater Treatment Plants (3) Pump Stations (29) CSO Tanks (3)
Facility Condition Assessment (staff-lead)	Staff in the Water and Wastewater Infrastructure Department undertake light to rigorous condition assessments on a daily, weekly and monthly basis. Watertrax was a software package formerly used to store maintenance requirements, but this is currently under review for a replacement asset management package for facilities. As per above, this process should take into consideration recommendations from the consultant-lead condition assessment project.	Continuous	Wastewater Treatment Plants (3) Pump Stations (29) CSO Tanks (3)

3.2.2.2 Linear Infrastructure

Multiple programs are already in place for linear infrastructure condition assessment, but the suite of programs is not yet complete. Generally, as per the criticality assessment on linear infrastructure, the Gravity Mains and Forcemain asset classes are assessed, and the dependent asset class of Manholes and Junctions assumes the assessed condition of the parent asset. Aside from the prescribed programs indicated in Table C-3-4, both the Manholes and Junctions and Services asset classes are not assessed distinctly in formal programs but in a more reactive manner, which is deemed adequate.

Table C-3-4 Condition Assessment Process for Wastewater Linear Infrastructure

Program	Description	Frequency	Asset Classes
CCTV/ Cleaning Program	This is an annual contract that is responsible for cleaning/flushing of sewers as well as CCTV inspection of gravity mains. Various metrics are produced, and condition of assets inspected is summarized by structural defect score using NASSCO PACP. Problem manholes are noted during the process.	Program is run annually: Collectors and Locals – 12yr	Gravity Mains – Locals and Collectors and smaller Trunk Sewers. Problem Manholes noted.
Large Pipe Condition Assessment	Cleaning is undertaken separately as needed. This contract is run periodically to attain full condition assessment coverage on all Trunk Sewers utilizing structural defect score using NASSCO PACP. CCTV is employed as well as other technologies as required. Trunk Manholes are typically assessed during the process but the use of the formal NASSCO MACP program for defect coding has not be deemed necessary at this time.	All Trunk Gravity Mains inspected on 6-year cycle.	Gravity Mains – Trunk Sewers Manholes – Trunk manholes inspected.
Forcemain Condition Assessment	No formal program has yet been developed and implemented for condition assessment of pipes in the Forcemain asset class. This requires development and implementation on a risk-based prioritization scheme.	Frequency to be assigned based on parent PS criticality.	Forcemains

Program	Description	Frequency	Asset Classes
Services Condition Assessment	No formal program has been developed for Services and none is anticipated. Due to the low inherent criticality of individual services, and the cost associated with inspection, Services will not be subjected to a proactive condition assessment program.	A run-to-failure approach is deemed acceptable for Services. They are inspected as required to remedy issues.	Services

3.2.3 Risk Assessment and Prioritization

Assessing risk and prioritizing works based on risk is the risk management process.

The risk assessment is undertaken by taking into consideration criticality and condition in a quantitative manner across all assets in an asset class. The results can then be sorted by risk score and used to develop a prioritized list of recommended works by addressing the assets with the greatest assigned risk first. This forms a defensible and logical manner by which to; a) utilize available funding, and b) to maintain a healthy and functional wastewater utility.

3.2.3.1 Plants and Facilities

The risk assessment shall be completed within the context of the consultant-lead condition assessment project. Input to the consultant-lead condition assessment will include results from the staff-lead condition assessments, this will produce a thorough and robust prioritized list of efforts required to maintain all Plants and Facilities from a risk management perspective. This list must be developed in conjunction with results from Infrastructure Planning studies to ensure recommendations include those for full

facility replacement, major upgrades, and process and component level maintenance activities.

The risk assessment should cover a 10-year planning window. The process should be repeated after a maximum of 10 years from the previous study. The frequency is subject to change as a result of the degree of success of the Asset Management Plan.

Table C-3-5 provides the most recent Risk Assessment results of Wastewater Plants and Facilities. This is a result of a quantitative assessment of results provided in Table C-1-20 and Data from any and all condition and criticality assessments should estimate risk and should be completed on all Asset Classes. Assessments should drill down to 2-3 additional levels of detail, including the process level, component level and even the subcomponent level when required. Condition, criticality, and risk information should be date-stamped and added to the proposed Asset Registry, where in conjunction with deterioration curves, lifecycle predictions and proactive actions can be taken.

Table C-1-22. The pump station risk results are taken from the most recent Master Plan update (WSP, 2017) whereas the risk score results for wastewater treatment plants and CSO tanks are qualitative assessments and are simply indicated as high, moderate, or low, based on staff review.

Table C-3-5 Risk Assessment results for Wastewater Plants and Facilities

Asset Class	Facility Name	Size Class	Growth Trigger?	Risk Score
WWTP[2]	Cana Subdivision	Small (<100 customers)	No	A[2]
WWTP	Cataraqui Bay	Large (>10,000 customers)	Yes	C[2,3]
WWTP	Ravensview	Large (>10,000 customers)	No	A[2]
Pump Station	Hwy 15	Small (100-1,000 customers)	No	B
Pump Station	James St	Small (100-1,000 customers)	No	B
Pump Station	Bath Rd	Small (100-1,000 customers)	No	B
Pump Station	Barrett Ct	Medium (1,000-10,000 customers)	Yes	C
Pump Station	Bath-Collins Bay	Very Small (<100 customers)	No	B
Pump Station	Coverdale	Small (100-1,000 customers)	No	B
Pump Station	Crerar Blvd	Small (100-1,000 customers)	No	B
Pump Station	Days Rd	Large (>10,000 customers)	Yes	D[3]
Pump Station	Lakeshore Blvd	Small (100-1,000 customers)	No	B
Pump Station	Greenview Dr	Small (100-1,000 customers)	No	A
Pump Station	Riverview Way	Small (100-1,000 customers)	No	A
Pump Station	Collins Bay	Very Small (<100 customers)	Yes	B
Pump Station	Bath-Lower	Very Small (<100 customers)	No	B
Pump Station	John Counter Blvd	Small (100-1,000 customers)	Yes	A
Pump Station	King-Lake Ontario Park	Very Small (<100 customers)	No	A
Pump Station	Hillview Rd	Medium (1,000-10,000 customers)	Yes	C
Pump Station	Morton St	Very Small (<100 customers)	No	A
Pump Station	Dalton Ave	Medium (1,000-10,000 customers)	No	C

Asset Class	Facility Name	Size Class	Growth Trigger?	Risk Score
Pump Station	Notch Hill Rd	Very Small (<100 customers)	No	A
Pump Station	King St	Medium (1,000-10,000 customers)	No	C
Pump Station	Palace Rd	Small (100-1,000 customers)	No	B
Pump Station	King-Portsmouth	Medium (1,000-10,000 customers)	Yes	B
Pump Station	Rankin Crescent	Small (100-1,000 customers)	No	B
Pump Station	River St	Large (>10,000 customers)	No	B
Pump Station	Schooner Drive (Decommissioned)	Small (100-1,000 customers)	No	N/A
Pump Station	Bayridge	Small (100-1,000 customers)	No	B
Pump Station	King-Elevator Bay	Very Small (<100 customers)	No	B
Pump Station	Westbrook	Small (100-1,000 customers)	Yes	B
Pump Station	Kenwoods Circle	Small (100-1,000 customers)	No	B
Pump Station	Yonge St	Very Small (<100 customers)	No	B
CSO Storage Tank(2)	Collingwood	Medium (1,000-10,000 customers)	No	A(2)
CSO Storage Tank	Emma Martin Park	Large (>10,000 customers)	No	A(2)
CSO Storage Tank	O'Kill	Medium (1,000-10,000 customers)	No	A(2)

Notes:

(1) Data from Water & Waste Water Master Plan Updates, Condition Assessment Report (WSP, 2016)

(2) WWTP & CSO Tank risk has been assessed qualitatively primarily based on age.

(3) Upgrade is in progress.

The Master Plans (WSP, 2017) provided an initial set of recommendations for renewal of the sewage pump station asset class. It did not include a major review of needs of Wastewater Treatment Plants and the larger Storage Tanks. Hence, it serves as a specific subset of projects required to maintained functional condition of Sewage Pump Stations. This type of approach shall be expanded to include all facilities in the next Master Plan iteration.

3.2.3.2 Linear Infrastructure

The risk assessment for linear infrastructure is completed in-house on an annual basis. As condition assessment databases are updated annually for Gravity Mains, the risk assessment results should be refreshed annually. For Forcemains, the risk assessment should be refreshed upon completion of all Forcemains which is anticipated for a 5-10-year cycle dependent on the parent Pump Station criticality (to be developed).

Upon completion of the risk assessment and prioritization exercises on all assets, Utilities Kingston has logically and defensibly identified where works are required addressing the first of two primary decisions. The second decision process is that of determining how to do the work.

A summary of the Risk Assessment on Gravity Mains is provided in Table C-3-6**Error! Reference source not found.**. No risk assessment data is available for Forcemains at this time.

Table C-3-6 Risk Assessment summary for Wastewater Gravity Mains

Sub-Class	Very Low Risk	Low Risk	Moderate Risk	High Risk	Very High Risk
Trunk	45.2%	33.4%	13.7%	7.0%	0.8%
Collector	62.6%	19.6%	12.8%	1.4%	3.5%
Local	76.5%	12.0%	9.3%	1.6%	0.6%
All Average	**72.1%**	**14.9%**	**10.0%**	**2.2%**	**0.7%**

Notes:

(1) No data due to lack of matching condition assessment data.

(2) Percentages are based on pipe counts, not by pipe length.

Utilities Kingston perceives Gravity Mains with High or Very High risk to be undesirable and thus targeted for rehabilitation or replacement. This represents 2.9% of the total Gravity Mains. Previously reported large proportion (5.9%) of Trunk Gravity Mains that was in the Very High Risk category in 2013 spurred significant works, including the CIPP lining of the Ravensview Trunk Sewer (completed 2014) and the North End Outlet (Completed in multiple phases, by 2016).

The risk assessment for gravity mains is a formalized process and documented in an internal report, entitled, “2021 Gravity Sewermain Risk Assessment” (Utilities Kingston, 2021).

3.2.4 Non-Condition Based Risks

The process described above utilizes an approach to assigning risk to assets based on condition assessments or condition indicators. This is not the only form of risk to the Wastewater Utility, and other risk factors have potential to drive other infrastructure projects. The three additional primary risk factors are:

- Environmental impact
- Risks to Public Health and Safety.
- Climate Change

Environmental impacts are assessed during preparation of the Pollution Prevention and Control Plan. Appropriate risk mitigating works are identified and recommended in the PPCP and Sewer Master Plan.

The primary additional risk to Public Health and Safety originates from the occurrence of basement flooding that may occur during extreme weather events. Utilities Kingston takes this seriously and several programs and projects have been identified during internal studies as documented in several reports to council. The following are included:

- Implementation of the Preventative Plumbing Program. This is described in the section on Demand Management. It assists in reducing extraneous flows originating from private property.
- Implementation of the public-side Extraneous Flow Reduction program. This is also described in the section on Demand Management. It contributes to a reduction in extraneous flows entering the municipal sewage collection system.
- Capital Works, including consideration for:
    - Further twinning of the North End Trunk Sewer (currently underway as of June 2021)
    - Upsizing the Yonge St Collector (completed)
    - Upgrades to the Earl Street combined sewer overflow (PCP#23, completed in fall 2020).
    - Portsmouth Sewage Pump Station redirection to Cataraqui Bay WWTP (currently underway).

Climate change represents an additional risk to the system and the sewer system is subject to extraneous flows as described above. The additional risk associated with climate change is a topic that should be considered in the context of future planning studies.

3.2.5 Risk Assessment Implications

This section summarizes the implications of the Risk Assessment portion of the analysis. It should be noted that due to the nature of the asset classes, it is reasonable to identify specific Plants and Facilities that are due for works, but not so for listing specific pipes, segment by segment. Some of the major pipe rehabilitation projects are mentioned.

Table C-3-7 provides a list of projects, OPC based on estimated ‘Replacement Cost’ and timing.

Table C-3-7 Risk-Based Wastewater Projects

Asset Class	Project	Cost Estimate (2016$)	Timing	Notes	Details
Pump Stations	Crerar Blvd PS Hydraulic Investigation	$8,000	By 2021	1,3	Review capacity and basement flooding issues.
Pump Stations	Dalton Ave PS Improvements	$1,800,000	By 2021	1,2,3	For overflow and basement flood reduction.
Pump Stations	Palace Rd Upgrades (Backup Power)*	$150,000	By 2036	1	For overflow reduction PCP35
Gravity Mains	Sewer Separation (2016 to 2020)	$5,775,000	By 2021	1,6	For overflow reduction (all locations)
Gravity Mains	Bath Road Collector Interconnect*	$20,000	By 2021	1,7	Surcharge reduction
Gravity Mains	Collingwood St Collector Upsize	$600,000	By 2021	1,5	To address overflows at PCP34
Gravity Mains	Sewer Separation (2021-2025)	$3,525,000	By 2026	1	For overflow reduction (all locations)
Gravity Mains	Sewer Separation (2026-2035)	$3,550,000	By 2036	1	For overflow reduction (all locations)
Gravity Mains	River St PS Inlet Sewer Twin*	$1,100,000	By 2036	1	For overflow reduction (all locations)
Gravity Mains	Rideau St Collector Upsize	$460,000	By 2036	1	To address overflows at PCP52

Asset Class	Project	Cost Estimate (2016$)	Timing	Notes	Details
Gravity Mains	Ravensview Trunk Sewer Twinning*	$27,000,000	By 2036	1	For overflow reduction (all locations)
Force mains	Dalton Ave 450mm Forcemain Replacement	$3,750,000	By 2021	1	Asset renewal (breaks)
Force mains	King St PS Forcemain Twinning*	$560,000	By 2026	1	Redundancy
Force mains	Days Rd PS Forcemain Twinning (2nd half)*	$4,500,000	By 2026	1	Redundancy
TOTALS	**All Works (to 2036)**	**$45,223,000**			**Underway**
TOTALS	**All Works (10yr window - to 2031)**	**$14,738,000**			**Underway**
TOTALS	**All Works producing new infrastructure (to 2036)**	**$33,330,000**			**Underway**
TOTALS	**All Works producing new infrastructure (10yr window - to 2031)**	**$5,230,000**			**Used as 10yr budget required for risk-based projects.**

Notes:

(1) Source: 2017 Wastewater Master Plan (WSP Canada Ltd)

(2) Source: 2014 Kingston DC Background Study (Watson and Associates)

(3) Status: ‘in progress’.

(4) Status: ‘planned, in 3-year horizon’.
(5) Status: Project replaced with Johnson St reconstruction which includes redirection of Palace Rd SPS discharge to avoid need for work on Collingwood Collector.
(6) Status: ‘works complete’.
(7) Status: Project deferred indefinitely.

This equates to a total of $45,223,000 over 15 years. This represents an annual average expenditure of roughly $3,000,000 over 18 years, but this is a mix of new and refurbished infrastructure. For budgeting, it is important to differentiate projects that create new assets versus revitalize existing assets. The projects highlighted in Table C-3-7 with an asterisk (*) are those that specifically create new infrastructure as opposed to revitalization of existing infrastructure. These projects represent a total of $33,330,000 which is mostly larger projects later than 2031. To 2031, $500,000 per year would cover new infrastructure required for risk mitigation projects. However, as this will underestimate the funding required, the 15-year average will be used that includes major projects such as the Ravensview Trunk Sewer Twinning, and that is closer to $2,200,000 per year.

3.3 Lifecycle Decision-Making

Both the Infrastructure Planning and Risk Assessment exercises described above, together, provide a means to determine which existing at assets require rehabilitation or replacement. Once the assets have been identified through these processes, decisions are made on how the assets are to be remedied. This part of the process is called the Lifecycle Decision Making process and it identifies, generally speaking, one of the following categories as the most appropriate course of action:

- Increased or accelerated Maintenance
- Rehabilitation or Major Upgrade
- Replacement

The decision-making process is unique to each asset group and class, and factors in two-primary considerations:

- Estimated Cost of works

- Service life of works

Together these factors produce an estimate of cost/year of service, which is akin to value. Best value is obtained by selecting an option, in comparison to others, which offers best-value over the full lifecycle. In many cases, the best value is attained by utilizing the course of action that provides best value, or in other words, the lowest cost/year of service. However, there are other factors that also need to be considered, including the following:

- Impacts to parent or child assets (i.e. if we choose to line a sewer main, what about the services? Are 100-year old services acceptable from a risk and maintenance perspective?)
- Budget/timing constraints (i.e. even if a sewer is best replaced, perhaps lining is preferred since a joint reconstruction program will not be possible in a reasonable timeframe).
- Overlapping needs (i.e. if the Gravity Main could feasibly be lined, reconstruction may be the preferred option if the road surface and water mains also need to be replaced).

The following sub-sections provide Lifecycle Decision-Making considerations for each asset group but do not provide details on the results of applying the methodology. Some examples are provided. Please note that the current cursory-level assessment of financial requirements to sustain the wastewater assets presented in Section D.2.2 does not include the benefits of smart lifecycle management decision-making.

3.3.1 Plants and Facilities

In general terms, Plants and Facilities are managed with a focus on maintenance and minor upgrades over major upgrades and replacement. However, when triggers are identified from planning exercises that indicate the need for a significant increase in capacity or a change or improvement to the treatment process, a major upgrade or facility replacement is then required. As these are significant in terms of budgeting, planning and execution, at times taking 6 to 10 years from initiation to completion, the role of planning exercises in identifying these needs is critical.

3.3.1.1 Wastewater Treatment Plants

Wastewater Treatment Plants represent the largest facilities in the Plants and Facilities asset group, yet to date, appear to have the least formal approach to decision-making, or one that does not currently fit the Growth and Risk-Assessment framework described above. This is due to two primary issues:

- Formal condition assessment and risk assessment by external consultants is not yet completed on a regular basis.
- Management of WWTP is complex and requires a process and component level of discretization for asset management. For this initial version of the Wastewater Utility Asset Management Plan, this level of detail is not available.

At the current time, management of capital upgrades are triggered as follows, generally using a bottom-up approach:

- By growth (as per Master Plan, Growth Strategy, and/or Uncommitted Reserve Capacity Analysis) – this may lead to a component upgrade, a process upgrade, or a full facility upgrade (multiple processes)
- Regulatory changes – typically leads to process upgrades or new processes.
- Condition Assessments – when completed, these may lead to upgrades at the component, process or facility level.
- Operator input – typically results in Operations and Maintenance expenditures, but can also lead to component and process upgrades, at the capital expenditure level.

In terms of resulting efforts, the following are possible resulting levels of effort:

- Continued or additional prescribed maintenance (~up to 20yrs)
- Major Upgrade (~10-30yrs)
- Replacement (~20-50yrs)

To put context to this process, consider the following two projects:

- Cana WWTP. This facility was 40 years old, was in poor condition, but not subject to growth. This is a very small WWTP. The condition assessment in

conjunction with regulatory changes led to the decision to fully replace the entire facility and upgrade the process from pseudo-secondary treatment to tertiary treatment. Primary factors: Condition-based Risk, Regulatory changes. This project was completed in 2017.

- Cataraqui Bay WWTP: The original facility is 50 years old, but several major upgrades have taken place over time. The primary trigger for proposed upgrades is growth. Uncommitted reserve capacity is low. Process improvements are also required. Primary factor: Growth. This construction on this project commenced in 2016 and continues into 2021.

The role of maintenance should not be understated. Staff-led condition assessments are continually being completed which often results in remedial maintenance. In addition, use of maintenance management software would allow for capture of these works in addition to scheduling of regular maintenance activities. Currently, a replacement software package to Watertrax is being investigated for facility asset management.

3.3.1.2 Pump Stations

Like Wastewater Treatment Plants, the decision-making process for Pump Stations needs to be formalized. Also, like WWTP, decisions need to be based on a more discretized view of the facility, as this will lead to more targeted maintenance and upgrades which are typically more cost effective than full facility replacement.

In general terms, for Pump Stations, the current decision-making process for capital upgrades is as follows:

- By growth (as per Master Plan or Growth Strategy (for the larger PS)) – this may lead to a component upgrade, or a full facility upgrade. An example is Days Rd SPS, which is currently under construction for full replacement.
- Condition Assessments – when completed, these may lead to upgrades at the component or facility level. An example is Greenview SPS, where upgrades were completed in 2015.

- Staff input – typically results in O and M expenditures but can also lead to component upgrades at the capital expenditure level.

As mentioned above, it is recommended that a Capacity Assessment be complete for Pump Stations like that for WWTP (by MOE Procedure D-5-1) and Gravity Mains (In-house Capacity Assurance). This will be used similarly as a growth-based trigger.

3.3.1.3 CSO Storage Tanks

Based on the most recent Sewer Master Plan (CH2M, 2010), no new CSO storage tanks are required. As the Utility progresses with sewer separation, it is anticipated that tank usage will decline, but this may take decades to reach the point where the tanks are unnecessary. Prudent planning includes primarily maintenance and only electrical and process component upgrades to CSO tanks into the future. The following highlights decision-making for the CSO Storage Tank asset class:

- Maintain as required by directed by maintenance management programs and Condition Assessments.
- Consider upgrades only as per Planning exercises, specifically Master Plans (MP) and Pollution and Prevention Control Plans (PPCP).
- Consider decommissioning or repurposing as per Planning exercise determinations.

There is currently no growth-based, pollution prevention and control, or risk-based triggers for works on the CSO tanks. They are currently in decent condition and working to assist in meeting the MECP's F-5-5 procedure.

3.3.2 Linear Infrastructure

3.3.2.1 Gravity Mains

The asset management process for Gravity Mains is reasonably well established as is the lifecycle decision making process. This asset class is subject to several planning studies (for the larger assets, typically the Trunk and Collector sub-classes) and a thorough risk assessment process. High-risk assets are addressed using the following decision-making process, which is depicted in Figure C-3-4:

- Where Planning studies have identified features for up-sizing, they shall be promoted to the Joint Reconstruction Program, if possible, within the anticipated timeframe.
- If they cannot be accommodated in the Joint Reconstruction Program, Utilities Kingston shall undertake the asset replacement as a stand-alone project within the required timeframe.
- If the asset displays minor deficiencies, or highly localized deficiencies, maintenance activities may be completed. These include dig and repair solutions and localized trenchless options. ($0-200/m, 0-20yrs). These activities do not impact the expected age-based lifecycle of the asset, since the majority of the asset and its dependents remain in the current condition. Activities however may decrease the condition score and hence the risk associated with such features thereby reducing replacement need and priority.
- Where higher-risk assets are identified, and it is determined that small-scale maintenance activities will not be cost-effective in reducing the risk, the following options shall be considered:
    - Replacement of the asset and its dependents (Manholes and Services) in conjunction with a Joint (City/UK) Road Reconstruction Project where feasible ($$$, 50-100yrs)
    - Reconstruction by replacement outside the Joint City/UK Program: Replacement of pipe including dependent asset classes ($$$$, 50-100yrs). This tends to be the costliest option and a last resort since there is no cost-sharing of road works.
    - Replacement by lining, with due consideration to the condition of dependent assets and appropriate rehabilitation or replacement of dependent assets ($$, 50-100yrs). Prior to utilizing lining, the sizing adequacy should be verifying by reviewing capacity assurance data to ensure pipes are not being lined that need to be upsized. Lining is only possible on assets that are not significantly deteriorated and represent proactive replacement.

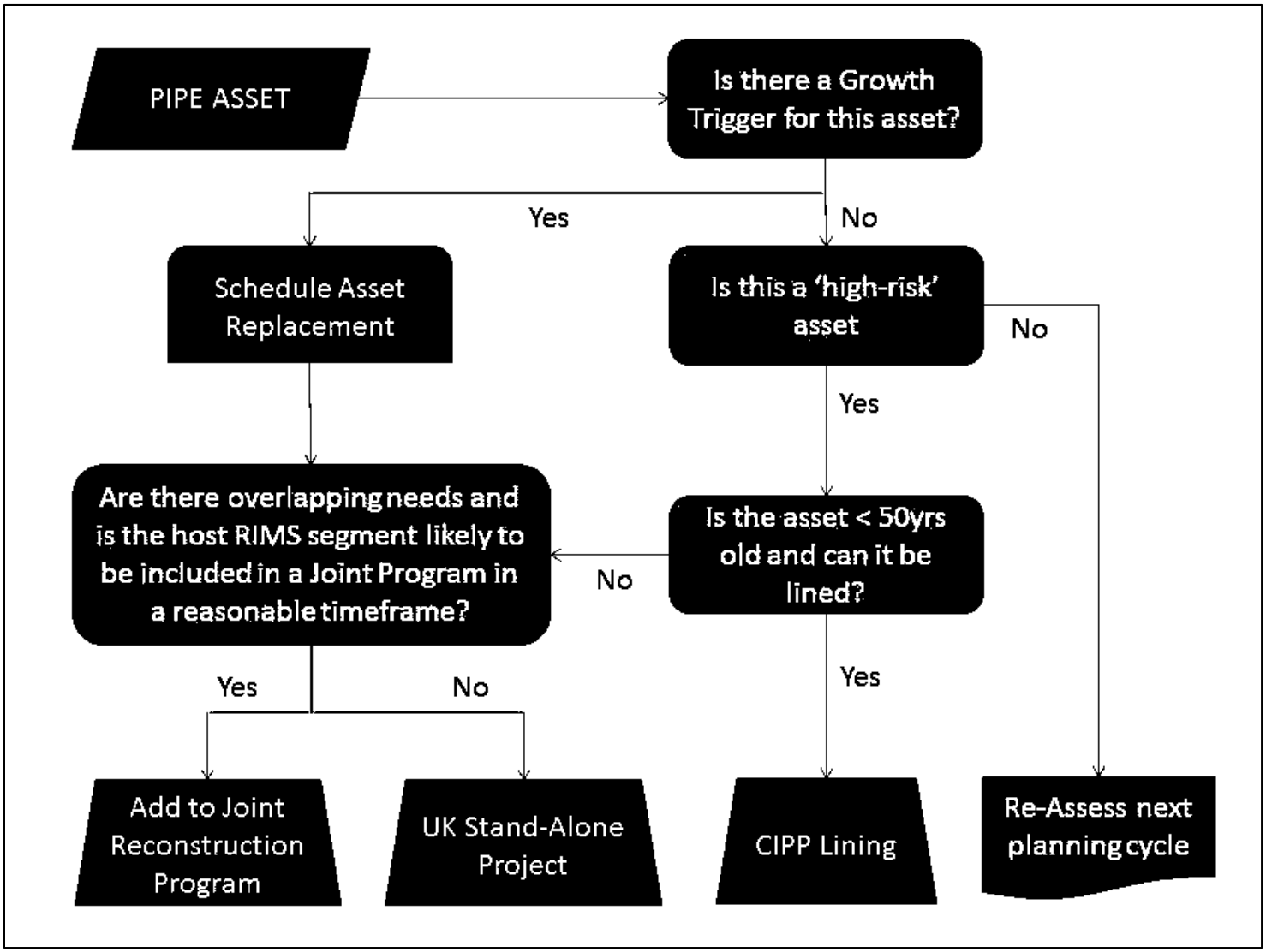


Figure C-3-4 Generalized Gravity Mains Lifecycle Decision-Making Process

In general, for Gravity Mains, for the first 50 years of an asset's life, focus should be placed on maintenance, including regular cleaning and CCTV, supplemented by spot repairs, blockage clearing, joint sealing and other maintenance activities as required. Past 75 years, given the comparable aging of dependent assets (Services and Junctions), preference should be placed towards replacing the asset and dependent asset classes. Between 50-75 years, the decision should be based on experience and budget availability. Ultimately, the need for works is based upon condition and resulting risk score. This is a very general guide and is not to be treated as a firm decision-making methodology.

Figure C-3-5 illustrates the influence of asset age on the decision-making process. In absence of a thorough condition assessment of localized dependent assets (Services and Junctions), it shall be assumed that a full solution is required that includes the dependent assets.

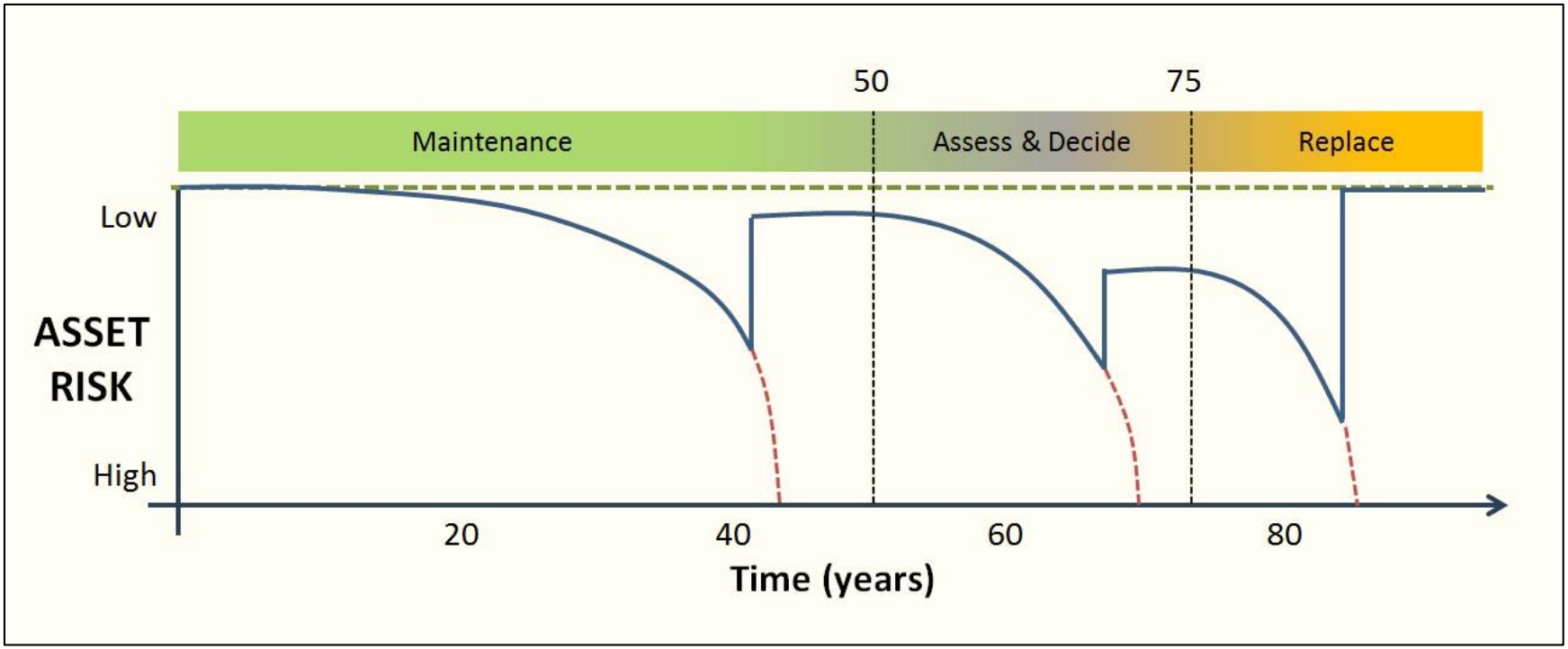


Figure C-3-5 Gravity Main Lifecycle Decision Making

With Gravity Mains and Forcemains, an increase in capacity can be accomplished by replacing the asset with a larger pipe size, or by twinning the flow route of interest. While there are a few benefits to twinning (including redundancy and future ease of maintenance), twinning should not be planned without due consideration for the lifecycle cost implications. In other words, the benefits of twin pipes may be overshadowed by the need to maintain two parallel assets rather than just one. Twinning should only be considered where redundancy is an identified project goal. This is infrequently the case.

3.3.2.2 Forcemains

The asset management process for the Forcemain asset class requires development but should closely resemble that of Gravity Mains described above. A condition assessment program is still required to provide the Risk Assessment deemed necessary for this asset class. The proposed decision-making process is as follows:

- The Planning process may result in triggers for replacement or twinning of the Forcemain due to an anticipated increase in Pump Station capacity. Twinning is typically the preferred approach as it allows the facility to remain in service.
- If operations staff or contractors identify deficiencies, maintenance shall be completed using dig and repair or trenchless techniques. Tracking of repairs should be implemented.
- Complete replacement of high-risk forcemains by a suitable lining process. This should include all appurtenances including valves.
- Replace high-risk forcemains in conjunction with a joint (City/UK) Road Reconstruction Project where feasible.

With Forcemains, decision-making is made slightly easier by the fact that there are no dependent assets inherent to Forcemain assets.

3.3.2.3 Junctions

The lifecycle of the Junction Asset Class is founded on a run-to-failure approach and they are considered as dependent assets to the ‘parent’ Gravity Main asset on which they are situated. The Manhole and Junction asset class is not subject to a dedicated

condition and risk assessment process but is tied to that of the sewer main. The following describes the decision-making process for this asset class:

- All remaining non-manhole junctions should be replaced with proper manholes when opportunity presents or required to facility maintenance.
- Where issues are noted by operations staff or contractors, manhole repairs are completed as necessary to prevent failure of the asset (maintenance).
- As part of the gravity main lining process, the need to replace or remediate manholes is considered. Unfortunately, no rehabilitation techniques exist with a sufficient lifecycle to warrant the cost, except on trunk systems where the replacement cost is prohibitive. This may result in remediation or replacement of the manhole.
- Replace the manholes in conjunction with a joint (City/UK) Road Reconstruction Project

3.3.2.4 Services

The lifecycle of services is founded on a run-to-failure approach due to the low inherent risk associated with individual services. As a result, condition assessment is only undertaken on services as needed to troubleshoot issues with a customer's service. The following describes the hierarchy of decision-making options for sewer laterals:

- Inspection and maintenance/repairs are completed because of direct customer contact. This may include repair or replacement of the public side of the lateral, and at times, the customer is invited to cost-share replacement of the entire service if warranted.
- Services are considered a dependent asset class to the sewer main to which they connect. When a trigger, via risk assessment or planning exercise, indicates replacement is required, the following options are available:
    - Replace the services in conjunction with a joint (City/UK) Road Reconstruction Project (preferred), or,
    - Complete lining or replacement of services in conjunction with a UK-only sewer lining Project.

Only under a scenario where Services are inspected and concluded to be in good condition should any Gravity Main replacement or lining works be completed without including this asset class, particularly when greater than 75 years old.

3.4 Maintenance Management

Maintenance activities are an integral part of optimizing the lifecycle of assets. Where no triggers for replacement, upgrades, capacity increase or treatment standards are required, routine maintenance shall be completed to ensure continued effective and reliable operation of the Wastewater Utility. Even after the estimated lifecycle of the facility is complete, condition and risk indicators should be the driver for works.

All maintenance activities should be documented and tracked by asset and visible to all staff of Utilities Kingston. Currently, this is not in place. The following items are in place:

- A GIS Asset Inventory capable of tracking works on the Linear Infrastructure. Aside from replacements and lining, works are not tracked. All maintenance works should be tracked by asset and cataloged in GIS.
- WaterTrax maintenance management system, capable of tracking works on Plants and Facilities. This is in its infancy but is deemed a suitable and useful tool for maintenance management. However, it is not a suitable tool for asset management, risk assessment and producing facility report cards based on system and component discretization. Update (2021): This was in place but has since been abandoned. A new maintenance management and asset management software package is being sought.

Both are not currently capable of adequately supporting asset management and this is identified as a priority moving forward.

3.5 New Assets

New assets are regularly being added to the Wastewater Utility because of two activities:

- Acquisition from a developer who is building a new subdivision with wastewater services (based on Growth).
- In-house construction of new assets (based on Growth, PPCP, Risk or Capacity issues).

This may include assets in all classes. Assets should be documented in the Asset Inventory and added to the Replacement Cost and PSAB 3150 Valuation financial summaries.

Most new major assets are identified within Master Planning exercises. Master Planning exercises produce opinions of probable cost (OPC) with a suggested timing. This feeds directly into budgetary requirements.

3.6 Decommissioning

When a facility is deemed no longer required, the facility shall be decommissioned or re-purposed (if applicable). This may apply during a replacement of a facility, since often the activity at that facility must continue during construction of the replacement facility. The following options for decommissioning are available:

- Undertake facility decommissioning in conjunction with replacement where applicable, typically accomplished within a single Environmental Assessment.
- Consider re-purposing if applicable. E.g. CSO Tanks may be repurposed for storm runoff collection and treatment.
- Undertake the necessary decommissioning studies and process to properly decommission a facility that is no longer required.

Where possible, salvage activities should be considered.

3.7 Summary

To facilitate asset management, a variety of programs and related processes are required. All asset classes require consideration for what programs and processes will provide for adequate management, and this includes a number of types of programs, including:

- Infrastructure Planning – these studies generally comprise overarching studies that identify primarily growth-based needs and needs for major process improvements.
- Risk Assessment – these studies are generally condition assessment processes. When coupled with criticality assessment, they identify risk-based needs.
- Lifecycle Options – these are the actual physical intervention processes which result in a repaired, upgraded or newly constructed asset or facility.

Table C-3-8 provides an overview of programs, projects and other processes that contribute to asset management of the sewer utility as well as the asset classes that they contribute to.

It should be noted that this is not an exhaustive detailed list. It covers the primary activities being completed, however, there are several regular support activities that take place. Examples include the following:

- Flow monitoring. Flow monitoring data is being completed at all Wastewater Treatment Plants, many Pump Stations, all CSO Tanks as well as Gravity Mains in select locations (approximately 25-30 locations at any given time)
- Combined Sewer Overflow Monitoring. This assists in directing attention to specific CSO locations for more study or works and supports a real-time public mapping feature for transparency.

Table C-3-8 Summary of Programs for Wastewater Utility Asset Management

Program	Frequency	Tactic	Gravity Mains	Forcemains	Services	Junction	WWTP	SPS	CSO Tanks
Infrastructure Planning: Growth Strategy	5 yrs.	Proactive	Yes	Yes			Yes	Yes	Yes
Infrastructure Planning: Master Plan	5-7 yrs.	Proactive	Yes	Yes			Yes	Yes	Yes
Infrastructure Planning: Pollution Prevention and Control Plan	5-7 yrs.	Proactive	Yes	Yes			Yes	Yes	Yes
Infrastructure Planning: Development Charges	5 yrs.	Proactive	Yes	Yes			Yes	Yes	Yes
Infrastructure Planning: Individual Environmental Assessments	As Required	Proactive	Yes				Yes	Yes	Yes
Infrastructure Planning: Development-specific Studies	As Required	Proactive	Yes	Yes			Yes	Yes	Yes
Infrastructure Planning: Capacity Analyses	Annually	Proactive	Yes	Yes			Yes	Yes	
Risk Management :Facility Condition Assessment (External)	10 yrs.	Proactive					Yes	Yes	Yes
Risk Management :Facility Condition Assessment (Internal)	Continuous	Proactive					Yes	Yes	Yes
Risk Management :CCTV/Cleaning Program	12 yrs.	Proactive	Yes			~			

Program	Frequency	Tactic	Gravity Mains	Forcemains	Services	Junction	WWTP	SPS	CSO Tanks
Risk Management :Large Pipe Condition Assessment	6 yrs.	Proactive	Yes			Yes			
Risk Management :Forcemain Inspection	TBD	Proactive							
Risk Management :Services Condition Assessment	As Required	Reactive			Yes				
Lifecycle Options: Scheduled Maintenance	Asset Specific	Proactive	Yes				Yes	Yes	Yes
Lifecycle Options: Unscheduled Maintenance	As Required	Reactive	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lifecycle Options: Rehabilitation (Lining, minor upgrades etc..)	Asset Specific	Proactive	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lifecycle Options: Facility Major Upgrades	Asset Specific	Proactive					Yes	Yes	Yes
Lifecycle Options: Asset Replacement	Asset Specific	Proactive	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lifecycle Options: Asset Replacement	As Required	Reactive			Yes	Yes		Yes	
Lifecycle Options: New Asset Construction/ Assumption	As Required	N/A	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lifecycle Options: Asset Decommissioning/ Retirement	As Required	N/A	Yes	Yes	Yes	Yes	Yes	Yes	Yes

3.8 Maturity

3.8.1 Forecasting Future Demand

Utilities Kingston employs a robust suite of tools for estimating future growth and the impact it will have on the Wastewater Utility. Via population growth studies, growth strategies and master planning exercises, the implications of growth are well understood at a high level. Once these studies identify the need for growth-based works, project-specific analyses are completed during the environmental assessment process. The maturity level for forecasting future demand is considered to be at the 'core' level and suitable for the Wastewater Utility's size (see Table C-3-9).

Table C-3-9 Maturity Index - Forecasting Future Demand

Maturity Level	Description	Status of Current Plan
Minimum	Demand forecasts based on experienced staff predictions, with consideration of known past demand trends and likely future growth patterns	
Core	Demand forecasts based on robust projection of a primary demand factor (i.e. population growth) and extrapolation of historic trends. Risk associated with demand change broadly understood and documented.	We are here.
Intermediate	Demand forecasts based on mathematical analysis of past trends and primary demand factors. A range of demand scenarios is developed.	Short-term Target for 2025
Advanced	As above, plus risk assessment of different demand scenarios with mitigation actions identified.	

3.8.2 Identifying Risks

Risk frameworks have been developed for all Plants and Facilities (based on consultant reports) and for Linear Infrastructure (in-house). The Risk framework uses both

condition assessment information, or condition indicators in some cases, in conjunction with a facilities assessed criticality to determine a risk score. Risk scores for all facilities within each asset class are reviewed and the most risk-prone features are then identified for works. Utilities Kingston is roughly in alignment with the 'Minimum' level of maturity for its process of identifying high-risk assets (see Table C-3-10).

Table C-3-10 Maturity Index - Risk Identification

Maturity Level	Description	Status of Current Plan
Minimum	Critical assets understood by staff involved in maintenance/renewal decisions.	We are here.
Core	Risk framework developed. Critical assets and high risks identified. Documented risk management strategies for critical assets and high risks.	Short-term Target for 2025
Intermediate	Systemic risk analysis to assist key decision making. Risk register regularly monitored and reported. Risk managed consistently across the organization.	
Advanced	Formal risk management policy n place. Risk is quantified and risk mitigation options evaluated. Risk is integrated into all aspects of decision-making.	

While the process utilizes is deemed sufficient to justify a 'Core' rating, in order to advance from the assigned 'Minimum' maturity level for Risk Identification, Utilities Kingston needs to formalize and document these processes.

3.8.3 Lifecycle Decision-Making

Lifecycle decision-making is currently conducted in a manner that is roughly in alignment with the 'Core' level of maturity as per the International Infrastructure Management Manual (NAMS, 2011), see Table C-3-11. For larger projects and programs, often a formal or informal benefit-cost analysis (BCA) will be completed prior to proceeding with the works. More importantly, for larger projects, a multi-criteria

analysis (MCA) is completed within the context of the Environmental Assessment Framework. This is often the case for Plants and Facilities. Decisions on Linear Infrastructure are typically done on the merits of the need from Growth or Risk-based drivers, which is typically commensurate with the size and cost of the project.

Table C-3-11 Maturity Index - Lifecycle Decision-Making

Maturity Level	Description	Status of Current Plan
Minimum	AM decisions based largely on staff judgement and agreed corporate priorities.	
Core	Formal decision-making techniques (MCA/BCA) are applied to major projects and programs.	We are here.
Intermediate	Formal decision-making and prioritization techniques are applied to all operational and capital asset programs within each main budget category. Critical assumptions and estimates are tested for sensitivity to results.	Short-term Target for 2025
Advanced	As for 'intermediate', plus… The framework enables projects and programs to be optimized across all activity areas. Formal risk-based sensitivity analysis is carried out.	

3.8.4 Capital Works Strategies

While financial budgeting requirements for Capital expenditures do project typically for a 10-year horizon, a business-case analysis is not always competed. For this reason, it is estimated that Utilities Kingston current level of Strategizing for Capital Works is roughly at a 'Core' level of maturity (see

Table C-3-12) but with planning elements that approach the ‘Intermediate’ level.

Table C-3-12 Maturity Index - Capital Works Strategies

Maturity Level	Description	Status of Current Plan
Minimum	There is a schedule of proposed capital projects and associated costs, based on staff judgement of future requirements.	
Core	Projects have been collated from a wide range of sources such as hydraulic models, operational staff and risk-processes. Capital projects for the next three years are fully scoped and estimated.	We are here.
Intermediate	As above, plus formal options analysis and business case development has been completed for major projects in the 3-5year period. Major capital projects for the next 10-20 years are conceptually identified and broad cost estimates are available.	Short-term Target for 2025
Advanced	Long-term capital investment programs are developed using advanced decision-making techniques such as predictive renewal modeling.	

3.9 Moving Forward

The following are major items for inclusion in future iterations of the Wastewater Utility Asset Management Plan:

- Uncommitted Reserve Plant Capacity Analyses were discontinued in 2008 but should be completed annually. An update to D-5-1 for Ravensview and Cataraqui Bay WWTP was completed for this report. The proposed methodology to assess the remaining capacity at Pump Stations should be included in this process but will make use of the Capacity Assurance tool recommended for the Linear Infrastructure.

- A Capacity Assurance Program should be initiated. Similar to the Uncommitted Reserve Plant Capacity analysis, a Capacity Assurance Program completes a similar exercise for other asset classes, including Gravity Mains, Forcemains and Pump Stations. It utilizes current design parameters to estimate the flow commitment for sewage collection and conveyance infrastructure. This is a key element for criticality analysis and is a very useful tool to assist with development applications in understanding available capacity in the system. It is projected that a large part of this will be accomplished with hydraulic modeling with a product called 'InfoSWMM' using 'all-pipes' models. These are in development and nearly complete.
- It has been identified that consultant-led Facility Condition Assessments are a required element of the Asset Management Program. It is recognized that the first undertaking was of limited benefit for two primary reasons; i) the report produced recommendations that were not in alignment with staffs understanding and opinions nor methodology for implementation. This should be corrected by having the project led by the Water and Wastewater Infrastructure Department and outcome clearly defined in advance; and, ii) all Plant and Facility Asset Classes should be included, including WWTP and CSO Tanks. Given the trial use of WaterTrax software, it is recommended that future output be compatible with this type of software and future assignments of this nature ought to be a joint effort between Utilities Engineering and the Water and Wastewater Operations group.
- Plant Valuation. There is considerable uncertainty in the existing inherent value in facilities as well as the replacement value. It is recommended that a facility valuation study be completed soon, prior to the next major Asset Management Plan update deadline in 2025.
- Risk Assessment procedures should be formalized and documented such that they are transparent, clear, and concise, and understood by the entire organization.
- Asset Management Software is deemed to be essential to take the Utilities Kingston Wastewater Utilities' Asset Management plan to a more advanced level.

Without being able to track assets, expenditures, lifecycles and works within a dedicated software tool, it will be difficult to mature.

Several additional Asset Classes should be identified and included in future Asset Management Plans. Some of these include the following:

- In the Linear Infrastructure:
    - CSO structures. (most are just manholes, but they have unique management issues associated with them).
    - Passive CSO Storage Tanks. There are 6 in-line storage tanks which have special management needs.
    - Flap/Tide Gates. The sanitary system contains numerous flap gates that protect from storm water intrusion or lake water intrusion. These should be identified in the asset inventory and subject to improved maintenance management. High lake levels experience in 2017 and 2019 have highlighted the need for this.
- For Plants and Facilities:
    - Wastewater Treatment Plants require further breakdown into a finer level of detail. WWTP should be further subdivided into Processes, Components and Subcomponent levels. This requires support by an appropriate facility asset registry to adequately manage the more detailed information.
    - Pump Stations and CSO Tanks also require further breakdown into a finer level of detail to the Component and Subcomponent level.

In addition, the Asset Management herein focuses on Capital Asset Management, touches in a minor way on the role of Maintenance Management, but does not address Operational Management. Future revisions of the Asset Management Plan should include report sections on Maintenance and Operational Strategies.

D. Financial Strategy

1 Overview

The development of asset management plans and practices is providing insight into the influences that go beyond just engineering, but into financial management, risk management, information management and service levels, which will have profound effects on the decisions Utilities Kingston makes in the management of all infrastructure. This section of the Asset Management Plan considers the strategy regarding financing the required infrastructure work and to identify funding shortfalls.

Utilities Kingston financial and funding strategy includes a combination of user rates and impost charges, debt financing, and applying for available government grants.

Rate revenue is used to fund all operating expenses and debt payments. Most capital expenditures are funded on a pay as you go method. However capital expenditures can vary considerably because of the nature of the assets and the long lifecycles. Therefore, larger capital projects may require debt financing, as was planned in 2018 for the Cataraqui Bay Wastewater Plant.

The following are sources of funding for both Water and Wastewater Utilities:

- Rates: Utilities Kingston employs a user pay basis for wastewater and water utility rates. This is a full cost recovery model which includes no funding from the tax base. Utilities Kingston completed a cost allocation study in 2014 to ensure the fair and appropriate allocation of rates among the different rate classes.
- Development Charges: On a five-year cycle, capital project needs are reviewed for those projects necessary to support growth within the context of the Development Charges Act. The current charges are defined by City of Kingston Bylaw 2019-116. The next update is due in 2024.
- Debt Financing: Utilities Kingston works with City of Kingston finance staff to ensure debt levels remain within certain levels in line with City policy. Debt is generally incurred for larger capital projects such as the upgrade to the Point Pleasant Water Treatment Plant and the upgrade to the Cataraqui Bay Wastewater Treatment Plant.

- Government Grants: Utilities Kingston and the City of Kingston recently applied for and were awarded government grants regarding a large wastewater capital project for rehabilitation of the Ravensview Trunk Sewer by CIPP lining.

This section of the Asset Management Plans summarizes the estimated required capital expenditures over the next 10 years and funding strategies to meet those needs. It should be highlighted that as the first iteration of the Asset Management Plan, the financial component will require further development, and this represents a first best approximation of funding needs based on a simple analysis of life-expectancy.

2 Capital Budget Forecasts

In alignment with the Building Together Guidelines for Asset Management Plans, the budget forecast has been developed using an 'end-of-life' replacement cost approach. This methodology assumes that an asset is replaced at the end of its estimated useful life. While this serves as a very basic manner by which to estimate capital budget requirements, it is a reasonable method to obtain an estimate.

The approach to determining average annual capital expenditure is illustrated in Figure D-2-1.

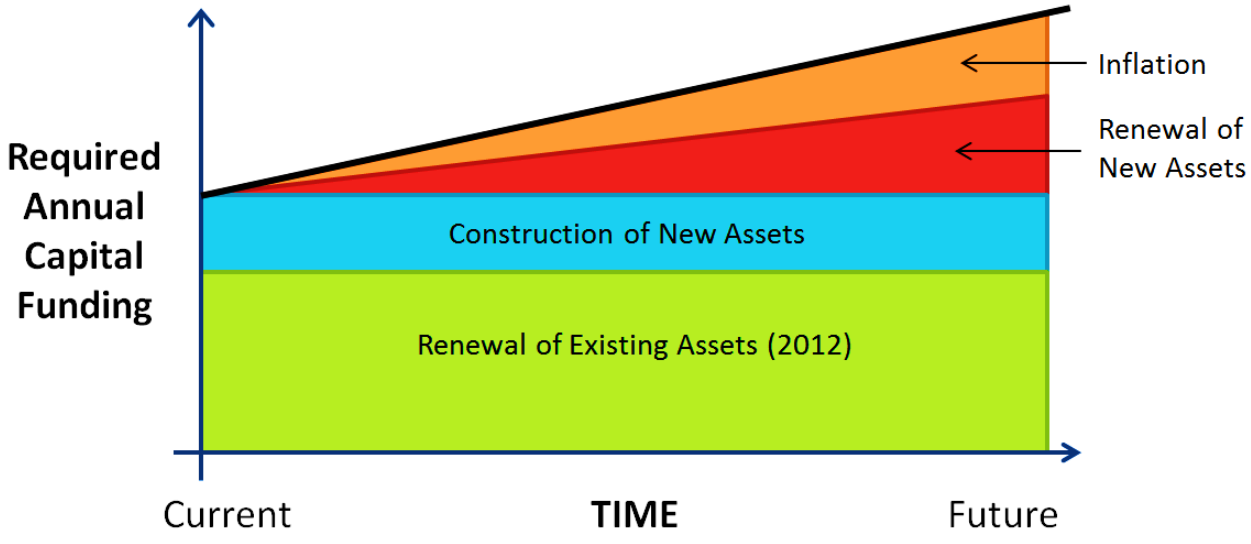


Figure D-2-1 Annual Capital Funding Requirements Model

The following describe these categories depicted in the Funding Requirements Model in further detail:

- Renewal of Existing Assets: This component of the Funding Model represents expenditures required to maintain existing assets. This component is calculated in a simple manner of utilizing the life-expectancy of the asset and then assuming that the Planning-Level Replacement Cost will be required at the end of the asset's life. This is broken down further to major components for facilities. An 'average annual expenditure' is a reasonable means to characterize this component. A simple example:
    - Linear Wastewater Infrastructure: A gravity main with a replacement cost of $100,000 has a life-expectancy of 64 years. In 64 years therefore, the asset will need to be replaced for $100,000. This averages to $1562.50/year, every year.
- Construction of New Assets: This component of the Funding Model represents expenditures required to construction new assets. New assets required are identified through Growth-Based studies as described in Subsections 3.1 of Reports Sections B and C as well as non-lifecycle-based Risk-based new assets described in Subsections 3.2 of Report Sections B and C. Unfortunately, this component is likely to fluctuate considerably. So, although an annual average expenditure is calculated for both the Water and Wastewater Utilities, it should be noted that averaging these over any given time period is highly dependent on 2 main things – the length of time over which the total is averaged, and the inclusion of major facilities with high cost.
- Renewal of New Assets: This component is similar to the Renewal of Existing Assets component described above. It represents the growing asset base, that results from new asset construction, all of which will require maintenance in the future. Another way to think of this is as a gradual increase in the Renewal of Existing Assets over time, since the asset base will be increasing over time.
- Inflation: A 2% increase will need to be taken into consideration over time. 2% is consistent with the current Bank of Canada inflation rate target.

2.1 Water Utility

The following provides an overview of the development of the Water Utility Capital Budget Forecast (estimated required budget).

2.1.1 Renewal of Existing Assets

Life Cycle Analysis -The estimated Average Annual Capital Investment (AACI) values presented below are based on a top-down assessment utilizing the replacement costs in section 1.2.1. The linear portion of the AACI was based on the replacement cost (see Table B-1-4) and weighted average Life Cycle (LC) of all watermain materials and lengths in the system, which was calculated as 70 years. The non-linear asset AACI was calculated applying a 75-year facility life cycle, factoring for the 5 major components of the asset, as per PSAB, i.e. a component with a 25-year life cycle is replaced 3 times in the 75-year life cycle. The 5 major components assessed in the non-linear LC evaluation include: concrete/tankage, building components, building fixtures, mechanical and electrical. Where the percentages of the components were found to be minimal, they were included within the other components, i.e. only 3 or 4 of the components were utilized in the LC evaluation, see Table D-2-1.

Table D-2-1 Recommended Infrastructure Investment for Water Non-Linear Assets

Asset Type	Component	% of Asset from PSAB	Life Cycle Years	Component Value Replacement Cost	Cost over Life Cycle (2020)
Treatment Plants	Concrete and Tankage	50%	75	$ 88,271,157.35	$ 88,271,157.35
Treatment Plants	Mechanical	40%	25	$ 70,616,925.88	$ 211,850,777.63
Treatment Plants	Electrical	10%	10	$ 17,654,231.47	$ 132,406,736.02
Treatment Plants	**ALL**	**100%**	**75**	**Subtotal**	**$ 432,528,671.00**
Booster Stations	Concrete and Tankage	10%	75	$ 1,439,535.00	$ 1,439,535.00
Booster Stations	Building	25%	50	$ 3,598,837.51	$ 5,398,256.27
Booster Stations	Mechanical	40%	25	$ 5,758,140.02	$ 17,274,420.06
Booster Stations	Electrical	25%	10	$ 3,598,837.51	$ 26,991,281.34
Booster Stations	**ALL**	**100%**	**75**	**Subtotal**	**$ 51,103,492.68**
Reservoirs	Concrete and Tankage	50%	75	$ 8,561,238.63	$ 8,561,238.63
Reservoirs	Building	5%	50	$ 856,123.86	$ 1,284,185.79
Reservoirs	Mechanical	40%	25	$ 6,848,990.91	$ 20,546,972.72
Reservoirs	Electrical	5%	10	$ 856,123.86	$ 6,420,928.97
Reservoirs	**ALL**	**100%**	**75**	**Subtotal**	**$ 36,813,326.12**
Elevated Storage	Concrete and Tankage	50%	75	$ 7,895,462.53	$ 7,895,462.53
Elevated Storage	Building	5%	50	$ 789,546.25	$ 1,184,319.38
Elevated Storage	Mechanical	40%	25	$ 6,316,370.03	$ 18,949,110.08

Asset Type	Component	% of Asset from PSAB	Life Cycle Years	Component Value Replacement Cost	Cost over Life Cycle (2020)
Elevated Storage	Electrical	5%	10	$ 789,546.25	$ 5,921,596.90
Elevated Storage	**ALL**	**100%**	**75**	**Subtotal**	**$ 33,950,488.90**

Full Life-Cycle Costs

Total (over 75yr cycle) **$554,395,978.70**

Average Annual Investment **$7,391,946.38**

The “required” AACI to maintain the existing infrastructure is $16.3 million. This represents a calculation of the asset replacement cost over the average lifecycle period in order to replace the existing infrastructure when it reaches the end of its useful life. The AACI for the linear infrastructure is fairly consistent, while the AACI for non-linear infrastructure over this lifecycle can vary dramatically, depending on the timing associated with major components reaching the end of their useful life. The annual investment requirement is anticipated to increase on an annual basis as new or upgraded assets are added to the water utility system.

2.1.2 New Asset Construction

Planning and Growth Analysis – The 2007 and 2015 Water Master Plan and Planning studies list a number of growth and planning driven projects that will result in approximately $34.5 million of capital works over the next 10 years (2021-2031), see Table B-3-2. Although the actual implementation and annual costs of the construction projects may vary dramatically, they have been expressed on an annual basis, in terms of 2020 dollars for simplicity of analysis. The annual cost of implementing the Master Plan and Planning Growth represents approximately $3.5M/year. Impost fees collected for development are anticipated to be the primary funding source for all major growth-related projects, with some possible rate-based funding where projects include some existing replacement as part of the project.

2.1.3 Renewal of New Assets

Based on the identified Growth-based projects, it is estimated that there will be an additional $28.9 million in linear assets and an additional $5.3 million non-linear assets forming the Water Utility.

2.1.4 Water Utility Budget Requirement Forecast

Table D-2-2 presents a summary of estimated budget requirements for 2020-2030.

Table D-2-2 Estimated Required Capital Investment for the Water Utility

Expenditure Group	Asset Classes and Details	2021-2031 Total (2020$)	Average Annual Expenditure
Renewal of Existing Infrastructure	Linear Infrastructure.	$86,500,000	$8,700,000
Renewal of Existing Infrastructure	Plants and Facilities.	$76,000,000	$7,600,000
Renewal of Existing Infrastructure	Subtotal:	$162,500,000	$16,300,000
Construction of New Assets	Risk-Mitigation	N/A	N/A
Construction of New Assets	Growth-based Projects	$34,500,000	$3,500,000
Construction of New Assets	Subtotal:	$34,500,000	$3,500,000
Totals	All (no inflation)	$197,000,000	$19,800,000

Note: Rounding to the nearest $100,000 post calculations results in some apparent errors in this table.

All figures are preliminary and require further review.

2.2 Wastewater Utility

2.2.1 Renewal of Existing Assets

Useful life of assets, at this time, will utilize assumptions made during the development of PSAB 3150 reporting. The following life-expectancies are used:

- Linear Assets
    - 64 years. (includes Gravity Mains and Forcemains, but also Junctions and Services as dependent asset classes)
- Facilities (including WWTP, CSO tanks and Pump Stations)

- Building Tankage – 75 years
- Building Structure – 50 years
- Building Fixtures – 15 years
- Electrical – 10 years
- Mechanical – 25 years

Using these life-expectancies and estimated facility breakdowns into 5 categories for facilities, an expenditure profile can be developed for each facility. Dollar figures will be estimated at 2020 values to the nearest $100,000.

Utilizing these assumptions, the capital budget forecast is developed as follows:

Linear Infrastructure, Renewal. Linear Infrastructure will be replaced or lined at the end of the pipe's lifecycle. For the purposes of the budget forecast, the life expectancy of all pipes was assumed at 64 years in alignment with PSAB as indicated above. All Junctions and Services were included with Gravity Mains. The analysis results in an annual capital investment of $5,600,000 to maintain existing infrastructure in 2021. If one assumes a rate of growth commensurate with population, this requirement will grow at 0.8% per year to $6,000,000 per year in 2031, for a total of approximately $57,900,000 over 10 years from 2021 to 2031. Due to the sheer volume of linear assets, individual projects will not be identified herein unless they are clearly not infrastructure renewal projects. An annual average expenditure thus makes practical sense, as many assets can be renewed every year. This item will include strategic reduction of backlog and may overlap with sewer separation (risk mitigation).

Plants and Facilities, Renewal. Based on life expectancies developed for PSAB, estimates were made on average annual capital investment for maintenance and replacement of Wastewater Utility Plants and Facilities. Planning-Level Replacement Cost estimates were used as the foundation of this calculation, as opposed to documented replacement costs. The results found that approximately $16,300,000 per year expenditure based on Planning Level Replacement Costs, in 2021 through 2031.

Together, the Linear and Non-Linear Infrastructure Renewal requirements represent a total 10-year capital budget requirement of approximately $21,900,000 per year, in 2021.

This estimate is very cursory in nature and does not include the benefits of a lifecycle management approach with proactive maintenance and rehabilitation as is dictated by elements of the plan. Effectively it can be considered as a worst case or high-side estimate, with no proactive maintenance activities (such as CIPP lining of mains, or proactive rebuild of sewage pumps, for example). This will be refined in a future iteration of the plan and the actual required expenditures are expected to be considerably less.

2.2.2 New Asset Construction

For the Wastewater Utility, new assets are required both to support Growth, as well as to mitigate risks.

Special Risk-based Projects resulting in New Assets. As discussed in Section C.3.2.5, there are several required risk-mitigation projects that stem primarily from basement flood risks and pollution prevention and control risks. Projects included in this category that create new assets represent a total of approximately $5,200,000 over the next 10 years. The remainder of expenditures in this category are replacement or upkeep of existing assets and therefore reasonably included in the annual renewal of assets described above.

Growth Projects, resulting in New Assets. Growth-based projections are identified in Section C.3.1 of the report. As a result of Master Planning, Impost Study and other exercises, total expenditures over the next 10 years of approximately $66,600,000 are required.

2.2.3 Renewal of new Assets

As new assets are constructed, the asset base will grow. In alignment with this, additional expenditures will be required to maintain and upgrade these facilities over time. This will therefore require an increased budget over time. Over the 10-year

window presented here-in, this is not estimated, but will be recalculated with each plan iteration on a 5-year cycle as a function of the growing asset inventory.

2.2.4 Wastewater Utility Budget Requirements Forecast

The budget requirements estimated for the Wastewater Utility are summarized in Table D-2-3.

Table D-2-3 Estimated Required Capital Investment for the Wastewater Utility

Expenditure Group	Asset Classes and Details	2021-2031 Total (2020$, 10 years)	Average Annual Expenditures
Renewal of Existing Infrastructure	Linear Infrastructure.	$55,800,000	$5,600,000
Renewal of Existing Infrastructure	Plants and Facilities.	$162,700,000	$16,300,000
Renewal of Existing Infrastructure	**SUBTOTAL**	**$218,500,000**	**$21,900,000**
Construction of New Infrastructure	Risk-Mitigation Projects	$5,100,000	$500,000
Construction of New Infrastructure	Growth-based Projects(1)	$66,600,000	$6,700,000
Construction of New Infrastructure	**SUBTOTAL**	**$71,700,000**	**$7,200,000**
TOTALS	**ALL (no inflation)**	**$290,300,000**	**$29,0200,000**

Note: Rounding to the nearest $100,000 post calculations results in some apparent errors in this table.

(1) Growth-based projects will be eligible for partial payment via Development Charges.

All dollar figures are preliminary and require further review and are highly theoretical in nature. It is very important to reiterate previous caveats that these estimated capital requirements are not based on application of logical lifecycle management principles

which are inherent at Utilities Kingston. Revision to this will be prepared as part of the next plan update to meet the 2025 deadline associated with O.Reg 588/17.

3 Funding Strategies

3.1 Water Utility

The asset management analysis from Table D-2-2 has identified an annual average of $19.8 million that is required to be spent on the water system in order to ensure proper replacement cycles of existing assets.

Currently, the financial plan has allowed for the following capital expenditures by year:

- 2021 - $13.1 million
- 2022 - $13.7 million
- 2023 - $14.4 million
- 2024 - $13.4 million
- 2025 - $12.5 million
- 2026 - $13.0 million
- 2027 - $16.8 million
- 2028 - $12.8 million
- 2029 - $12.5 million
- 2030 - $11.6 million
- TOTAL - $133.8 million

Plus, approximately $10.4M of funds from Development Charges are anticipated.

No new debt is anticipated for the next 10-year period.

Rate increases of approximately 22.8% are anticipated over the coming 10-year period.

The funding strategy for the Water Utility is shown in Table D-3-1 and funding sources by year presented in Figure D-3-1.

The difference between the above capital expenditures per the financial plan and the asset management figures noted above, over the 10-year period, leaves an

infrastructure deficit of $52.3 million as noted in Table D-3-1. Capital plans and financial plans are updated annually, and all avenues of financing are explored to ensure as much asset management work can be done.

Table D-3-1 Financing Strategy Summary for the Water Utility

Item	Expenditure Category	Total (2021-2031)
Budget Forecast (Required)	Renewal of Infrastructure	$162,000,000
Budget Forecast (Required)	New Assets	$34,500,000
Budget Forecast (Required)	Total Required	$196,500,000
Funding (Available)	Revenues available for Capital	$133,800,000
Funding (Available)	Impost/DC contributions	$10,400,000
Funding (Available)	Total Available	$144,200,000
Budget Deficit	**Difference**	**- $52,300,000**

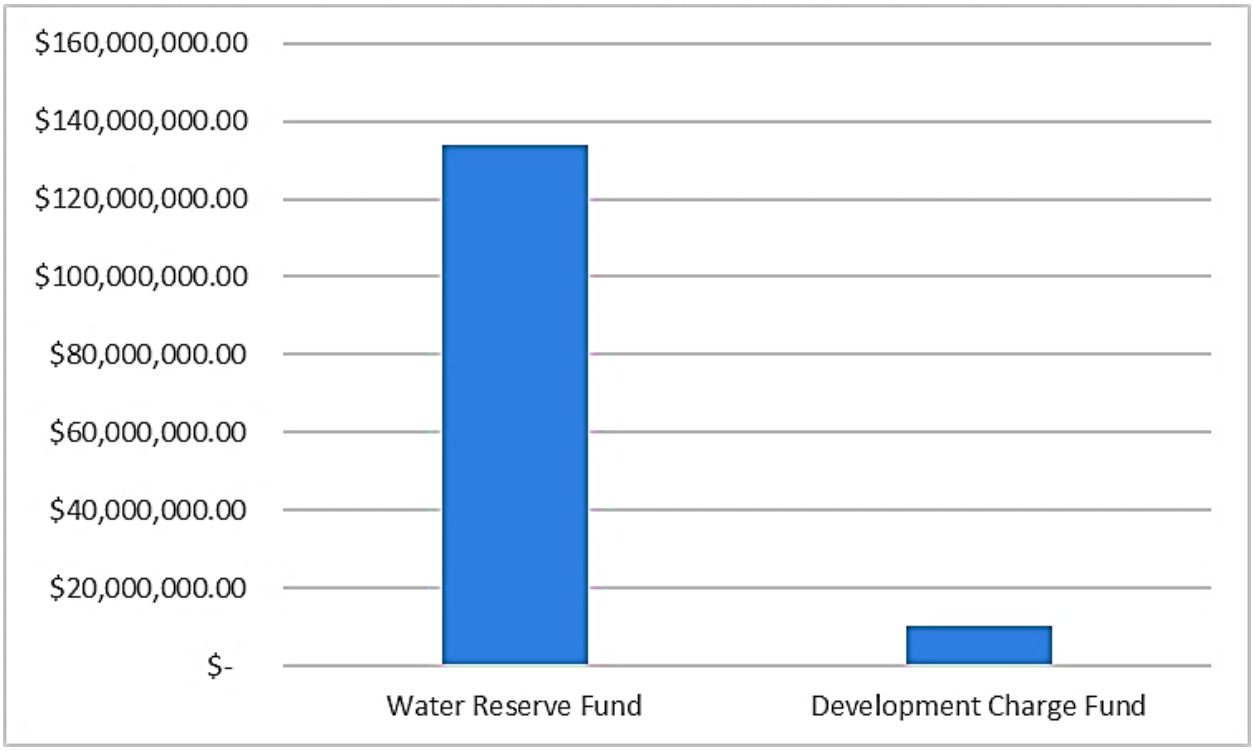


Figure D-3-1 Water Funding by Source

3.2 Wastewater Utility

The asset management analysis has identified an average of $29.2 million per year (or 10-year total of $292,300,000 from Table D-2-3) that is required to be spent on the wastewater system in order to ensure proper replacement cycles and address risk-based issues.

Currently, the financial plan has allowed for the following expenditures by year:

- 2021 - $12.6 million
- 2022 - $10.1 million
- 2023 - $13.2 million
- 2024 - $13.2 million
- 2025 - $15.0 million
- 2026 - $15.9 million
- 2027 - $28.9 million
- 2028 - $14.0 million
- 2029 - $14.0 million
- 2030 - $12.4 million
- Total - $149.3 million over next 10 years.

Plus, approximately $50,000,000 of funds from Development Charges are anticipated.

No new debt is anticipated for the next 10-year period.

Rate increases of approximately 27.3% are anticipated over the coming 10-year period.

The funding strategy for the Wastewater Utility is shown in Table D-3-2 and funding sources by year presented in Figure D-3-2.

The difference between the above capital expenditures per the financial plan and the asset management figures noted above, over the 10-year period, leaves an infrastructure deficit of $90.9 million. Capital plans and financial plans are updated annually, and all avenues of financing are explored to ensure as much asset management work can be done.

Table D-3-2 Financing Strategy Summary for the Wastewater Utility

Item	Expenditure Category	Total (2021-2031)
Budget Forecast (Required)	Renewal of Infrastructure	$218,500,000
Budget Forecast (Required)	New Assets	$71,700,000
Budget Forecast (Required)	Total Funding Required*	$290,200,000
Funding (Available)	Revenues available for Capital	$149,300,000
Funding (Available)	Development Charges	$50,000,000
Funding (Available)	New Debt (planned)	$Nil
Funding (Available)	Total Funding Available	$199,300,000
Budget Deficit	**Difference**	**- $90,900,000**

Note:

General: Figures represent initial estimates that will require further development during future revisions of the Asset Management Plan. Rounding errors are present. All figures are in 2020$.

Note1: Please see caveats on estimation of funding required in section D.2.2.4.

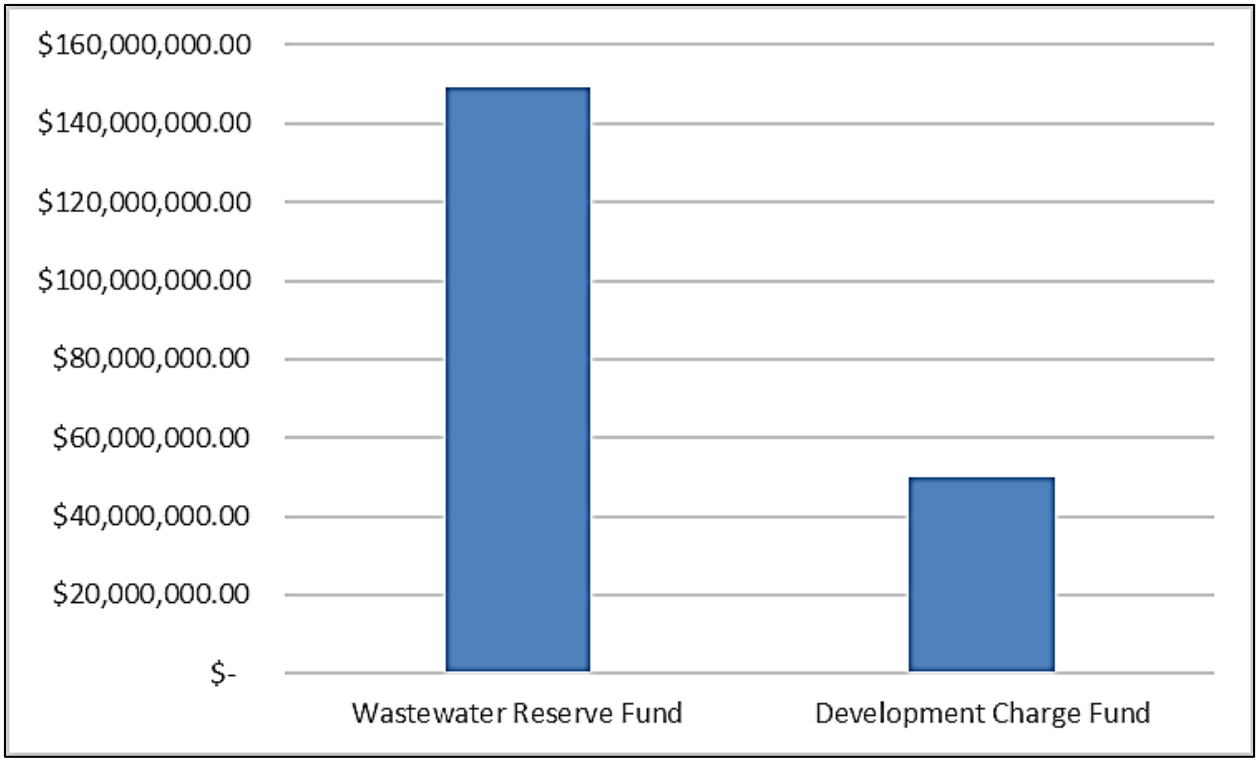


Figure D-3-2 Wastewater Funding by Source

E. Summary and Moving Forward

1 Summary

Asset Management has been the core function of Utilities Kingston (UK) since its inception, corporately responsible for ensuring that utilities are operated effectively, efficiently, safely, and reliably. These first iterations of the Water and Wastewater Utility Asset Management Plans (AMP) document the processes and provide a summary of the current state of Asset Management within Utilities Kingston. It is intended that the AMPs will be expanded and refined in future iterations, incorporating the recommendations and strategies, evolving to formalize the process to maximize the benefits of Asset Management. An effective Asset Management Plan is current best practice and if utilized properly is a tool that is expected to assist in stronger accountability, sustainable decision-making, enhanced customer service, effective risk management, and improved financial efficiency. Asset Management within UK does not begin or end with these documents.

2 Moving Forward

The AMPs sections contain indices that provide an indicator of the maturity level of that portion of the AMP. The indices are not intended to be a rating of the AMP, but to describe different levels that an organization should strive towards. Overall Asset Management within UK is currently considered to be in the “Minimum” Maturity Index for the water and wastewater AMPs. The AMP sections provide recommendations on moving forward and improving the manner in which UK manages the Water and Wastewater Infrastructure. Implementation of the following recommendations will not directly relate to improvements within the Maturity Indices but will improve the overall asset management programs within UK striving towards an overall “Core” Maturity Index.

2.1 State of the Local Infrastructure

Moving forward the asset inventories will be continually updated, tracking new assets, rehabilitation dates and repairs to assets. The water and wastewater linear asset inventories are being expanded to include new services as they are installed. An effort will be made to incorporate the various operational tracking sheets for the linear assets

(water and wastewater) into the Enterprise GIS inventory, with consideration to add data such as material manufacturer, installation contractor, soil conditions, maintenance history, predictive maintenance scheduling, operational history, maintenance costs, condition, valuation, performance, risk and lifecycle data. UK should determine an appropriate formal asset inventory for Plants and Facilities and construct a hierarchy of information with Process, Component and Subcomponent levels. A new condition assessment process should be considered for implementation, specifically for the wastewater forcemains and the larger transmission watermains that have a greater criticality. In addition, Utilities Kingston will consider a review of the data collection and condition assessment process for the distribution system watermains when conducting repairs or connections, i.e., hydrant/valve/break repairs or tapping connections and inclusion of the data in the asset inventory.

It is recommended that any future Condition Assessment consulting assignments for Plants and Facilities should be standardized, include all facility types including Treatment Plants, Booster Stations, Pump Stations, Reservoirs, Elevated Storage Tanks, and CSO Tanks. The Condition Assessments should include estimation of Replacement Costs based on an analysis of local projects in Eastern Ontario that fit within the range of facility sizes operated by Utilities Kingston. This data should be housed within an appropriate asset registry appropriate for both Linear and Non-Linear Assets. Selection of the asset registry will require research, evaluation and corporate direction for the utilization of the asset management tool. A CCTV condition grade validation program is required to validate CCTV results of the wastewater system. The condition grades and CCTV data should be linked and included in the asset inventory data.

Table E-2-1 Summary of Asset Management Improvement Items

Asset Group	Asset Class	Description	Time and Effort
Linear Infrastructure	Services	Include in Enterprise GIS with pertinent attribute data. Consider the ability or need to include operational data.	Minimal, moving forward.
Linear Infrastructure	Water Meters	Include in Enterprise GIS with installation year, manufacturer, size and other pertinent data. Consider the ability or need to link to CIS Billing data for operational tracking.	Minimal, moving forward.
Linear Infrastructure	Gravity Mains, Forcemains, and Watermains	Include material and installation year. Consider the ability or need to include operational and additional data. Consider classifying the assets with additional sub-classes.	Minimal, moving forward.
Linear Infrastructure	Gravity Mains	A CCTV condition grade validation program is required to validate CCTV results. Consider the ability or need to link into the GIS for operational tracking.	Moderate.
Linear Infrastructure	Wastewater Forcemains and Large Critical Watermains	A condition assessment process is required for the Forcemain and Large Watermain Asset Classes and should be linked to the Enterprise GIS inventory.	Moderate
Linear Infrastructure	Wastewater Junctions	Expand on this feature set to differentiate between valves that require maintenance and static fittings that do not.	Minimal to Moderate
Linear Infrastructure	ALL	Incorporate (link) Operational tracking sheets into Enterprise GIS, including maintenance history.	Moderate

Asset Group	Asset Class	Description	Time and Effort
Plants and Facilities	ALL	Research, select and implement a suitable asset management tool (Asset Registry) for Plants and Facilities.	Substantial - Substantial in terms of time, effort and cost.
Plants and Facilities	ALL	Determine appropriate Replacement Costs for all Plants and Facilities to eliminate uncertainty. Conduct an engineering valuation study, or, implement into next Master Plan update.	Moderate.
Plants and Facilities	ALL	Consider breaking the Assets into Component Sub-Component Processes for purposes of facility management.	Minimal to Moderate, moving Forward
Plants and Facilities	ALL	Include all Asset Classes and Sub-classes in Condition, Criticality and Risk Assessment assignments. .	Moderate.

2.2 Expected Levels of Service

Each Level of Service Statement is supported by a suite of Key Performance Indicators that are primarily quantitative facets of the Utility that are rated against standards developed by staff. It is not only the current value of the Key Performance Indicator that is important, but the trend demonstrated by the KPI's change over time. These will evolve over time as will the KPI's to ensure that there are benefits to calculating and tracking them. Moving forward UK will need to track, review the trends in the KPI reporting and modify the LOS, respective KPI and target values as required to improve asset management within the Utility. The KPI's should be updated annually and assign timelines to the KPI targets for those that are found to be deficient. This can help

increase efforts in one are or another and determine what areas can have decreased effort/expenditure to compensate.

Additional KPI's should be considered for future iterations of the Asset Management Plans. Additional KPI's to consider may include operational and financial data and Customer Service. Customer groups should include residential, commercial, institutional, and development communities as well as internal Utility and City departments. KPIs may include feedback mechanisms/surveys and responsiveness to service calls, complaint tracking, and overall customer satisfaction (via Survey).

2.3 Asset Management Strategy

UK currently manages the water and wastewater utilities through a series of Infrastructure Planning, Demand Management, Risk Management, Lifecycle Evaluation, Cost-Benefit Analysis and Maintenance Management processes. Several of these processes are formalized through; the Growth/Planning and Municipal Environmental Assessment processes, Standard Operating Procedures, or Routine maintenance procedures while others are conducted through informal evaluations and assessments.

Asset management within UK is a process of identifying projects and a course of action through the above noted processes. Moving forward UK should strive to formalize and document the internal risk evaluation and prioritization strategies for the assets such that they are transparent, clear and concise, and understood by the entire organization. The risk evaluation and prioritization strategies should include all asset and sub-asset classes. The Uncommitted Plant Reserve Capacity Analysis needs to be reinitiated for both the water and wastewater utilities. Similarly, a Capacity Assurance Program should also be conducted for the other asset classes, including watermains, sewer mains, Pump and Booster Stations. It utilizes current design parameters to estimate the flow commitment for collection, distribution and conveyance infrastructure. This is a key element for criticality analysis and is a very useful tool to assist with development applications in understanding available capacity in the system.

Asset Management Software is deemed to be essential to take the Utilities Kingston Wastewater Utilities' Asset Management plan to a more advanced level. Tracking all

assets for condition, risk, expenditures, lifecycles and works within a dedicated software tool will improve the evaluation and prioritization strategies and project reviews, resulting in better decision making.

In addition, the Asset Management herein focuses on Capital Asset Management, touches in a minor way on the role of Maintenance Management, but does not address Operational Management. Future revisions of the Asset Management Plan should include report sections on Maintenance and Operational Strategies.

Appendices

Appendix A. Utilities Kingston Asset Management Policy

Appendix B.1 – Water Utility Key Performance Indicators

#	Key Performance Indicator	Details	Purpose of KPI	Data Source(s)	Assets
A.1	Occurrence of Raw Water Flow within 75% of PTTW Capacity	The number of occurrences of daily raw water flow within set % of PTTW may be utilized as a planning/tracking tool to indicate the timing of facility capacity upgrades.	Utilities Kingston strives to plan understand the current and future demands on the system.	Operational group treatment plant flow tracking - UK Unet	Treatment Plants
A.2	Occurrence of Treated Water Flow within 75% of Treatment Capacity	The number of occurrences of daily treated water flow within set % of Treatment capacity may be utilized as a planning/tracking tool to indicate the timing of facility capacity upgrades.	Utilities Kingston strives to plan understand the current and future demands on the system.	Operational group treatment plant flow tracking - UK Unet	Treatment Plants
A.3	Number of adverse Drinking Water Quality Notifications - Annually.	Adverse Drinking Water Quality Notifications may be considered an indicator of operational or physical conditions in the system that may result in community health concerns.	Utilities Kingston strives to provide safe drinking water to the consumer.	Utilities Kingston Annual Water Quality reports - Utilities Kingston Website	Water Treatment Plants, Booster Stations, Storage Facilities, and distribution systems.
A.4	Weighted number of days when a boil water advisory issued by medical officer of health	Boil Water Advisory issued by the Medical Officer of Health may be considered an indicator of operational or physical conditions in the system that may result in community health concerns.	Utilities Kingston strives to provide safe drinking water to the consumer.	Annual Municipal Performance Measures Program (MPMP) report to City of Kingston	Water Treatment Plants, Booster Stations, Storage Facilities, and distribution systems.

#	Key Performance Indicator	Details	Purpose of KPI	Data Source(s)	Assets
A.5	Ministry of Environment, Drinking Water System Inspection Report, Inspection Rating Record (IRR)	The MOE IRR is conducted Annually and reviews the a Risk Management Framework (Likelihood and Consequence), for 8 modules, and provides a Non-Compliance Rating (NCR). Point Pleasant had an NCR of 0/364, Inspection Risk Rating of 0.00%, and a Final Inspection Rating of 100%. King Street had an NCR of 0/516, Inspection Risk Rating of 0.00%, and a Final Inspection Rating of 100%. Cana had an NCR of 0/486, Inspection Risk Rating of 0.00%, and a Final Inspection Rating of 100%.	Its objective is to determine the compliance of Municipal Residential Drinking Water Systems (MRDWS) with requirements under the Safe Drinking Water Act and associated regulations. It is the responsibility of the municipal residential drinking water system owner to ensure their drinking water systems are in compliance with all applicable legal requirements. The risk management approach used for MRDWS is aligned with the Government of Ontario's Risk Management Framework. Risk management is a systematic approach to identifying potential hazards, understanding the likelihood and consequences of the hazards, and taking steps to reduce their risk if necessary and as appropriate.	Operations Group - Annual Inspection and report conducted by MOE.	Treatment Plants and Distribution System

#	Key Performance Indicator	Details	Purpose of KPI	Data Source(s)	Assets
B.1	Length of watermain infrastructure beyond Design Service Life. (% of system)	The age of the watermain beyond the Design service life is a key indicator of the condition of the distribution system and the AMP needs to look at Life Cycle replacement.	The length of watermain beyond service life and condition "High Risk" is a function of watermain age, material, size, criticality of the system and # of breaks in a RIM section, that is currently utilized for the Infrastructure Capital Plan	Enterprise GIS Inventory and various tracking sheets.	Watermain Asset
B.2	Length of Watermain Infrastructure Considered to be Priority for Replacement/ Rehabilitation - High Risk (% of system)	The "High Risk" watermain is an indicator of the likelihood and consequence of failure. Risk is a function of age, size, # breaks, criticality, etc. The Risk evaluation is conducted manually utilizing Excel.	The length of watermain beyond service life and condition "High Risk" is a function of watermain age, material, size, criticality of the system and # of breaks in a RIM section, that is currently utilized for the Infrastructure Capital Plan	Enterprise GIS Inventory and various tracking sheets.	Watermain Asset
B.3	Watermain Breaks per 100 kilometers of Distribution System per year.	The number of breaks is the key indicator of the condition of the watermains in the system.	The number of watermain breaks is the key indicator of the condition for the distribution system and is one of the key factors in evaluating the "High Risk" watermain for replacement in the Capital plan.		

#	Key Performance Indicator	Details	Purpose of KPI	Data Source(s)	Assets
B.4	Number of "RED" hydrants in the distribution system - Risk Impact for Fire Fighting Requirements. (% of system or number of hydrants)	The "Red" hydrant classification is based on the Fire Hydrant Rating program and the following classifications. Red <31 LPS, Orange 31-63 LPS, Green 63-95 LPS, Blue >95 LPS. All hydrants were flow rated in 2013. The hydrant rating may be considered to be an indicator of water flow/conveyance in the distribution system.	Utilities Kingston's goal is to provide adequate water supply for fire protection throughout the City of Kingston. The City of Kingston Fire Dept. requested that all hydrants be evaluated and rated. When reviewed in plan the Red hydrants provide an indicator of areas of lower flow and concern for water supply for firefighting.	Operations Group and GIS Inventory.	Hydrant and Watermain Asset.
B.5	Number of valves > 400mm Ø Evaluated in the last year (% of large valves in system) SOP	Standard Operating Procedure WD-03-01 recommends that valves larger than 400mm be exercised on an annual basis, and valves <=300mm be exercised on a regular program every 4 years.	Indicator of the management of the operational condition of the valves in the system. Confidence level for the ability to isolate sections of watermain when required for maintenance and emergency repairs.	Operations Group - Valve maintenance tracking sheets	Valves

#	Key Performance Indicator	Details	Purpose of KPI	Data Source(s)	Assets
B.6	Number of valves =< 300mm Ø Evaluated in the last 4 years (% of small valves in system) SOP	Standard Operating Procedure WD-03-01 recommends that valves larger than 400mm be exercised on an annual basis, and valves <=300mm be exercised on a regular program every 4 years.	Indicator of the management of the operational condition of the valves in the system. Confidence level for the ability to isolate sections of watermain when required for maintenance and emergency repairs.	Operations Group - Valve maintenance tracking sheets	Valves
B.7	Number of known "non-operable" valves in the system. (% of total Evaluated Valves)		Indicator of the management of the operational condition of the valves in the system. Confidence level for the ability to isolate sections of watermain when required for maintenance and emergency repairs.	Operations Group - Valve maintenance tracking sheets	Valves
C.1	Maturity of Water Master Plan	The age of the most recent Water Master Plan (MP). A consultant lead MP process is recommended to be completed every 10 years, following City of Kingston Growth Strategy Planning. Internal review and updates to the MP are recommended to be conducted every 5 years.	Review of the Master Planning exercise timelines, which is the foundation for understanding growth-based upgrades to the water treatment capacity and distribution system, is kept current.	Water Master Plan (MP)	Water Treatment Plants, Booster Stations, Storage Facilities, and larger dia. distribution watermains.

#	Key Performance Indicator	Details	Purpose of KPI	Data Source(s)	Assets
C.2	Maturity of Condition Assessment (third Party) on Water Treatment Facilities	The KPI documents the age of the most recent third Party consultant lead Plants and Facilities Risk Assessment Study. Ideally, it should be completed every 10 years, on all non-linear facilities. The third party condition assessment report is intended to complement the internal UK operational risk assessment and provide input to the UK facilities maintenance program.	The KPI is intended to identify whether or not the Risk Assessment for Plants and Facilities is kept sufficiently current.	Condition Assessment Report	Water Treatment Plants, Booster Stations, and Storage Facilities.
C.3	Maturity of Condition Assessment (third Party) on Booster Stations	The KPI documents the age of the most recent third Party consultant lead Plants and Facilities Risk Assessment Study. Ideally, it should be completed every 10 years, on all non-linear facilities. The third party condition assessment report is intended to complement the internal UK operational risk assessment and provide input to the UK facilities maintenance program.	The KPI is intended to identify whether or not the Risk Assessment for Plants and Facilities is kept sufficiently current.	Condition Assessment Report	Water Treatment Plants, Booster Stations, and Storage Facilities.

#	Key Performance Indicator	Details	Purpose of KPI	Data Source(s)	Assets
C.4	Uncommitted Reserve Capacity at WTP - MOE Procedure D-5-1. (% of total capacity)	The reserve capacity calculations are based on the MOE Procedure D-5-1, and is intended to be an annual exercise to ascertain the ability of the WTP to service growth.	This KPI is important tracking tool, that when combined with the Water Master Plan process, will help identify the timing of major WTP capacity upgrades and expansions.	Uncommitted Reserve Capacity studies and Water Master Plan	Water Treatment Plants
D.1	Amount of unaccounted non-revenue water (% of water Treated)	The amount of unaccounted for water is an indicator of the condition of the water distribution system. Excess water loss through leakage has a significant impact on the overall capacity of the system.	This KPI is intended to provide an indicator of progress made in terms of reducing the volume of non-revenue water and increasing the system capacity that would otherwise be unavailable for growth.	Operations Group - Water Balance Spreadsheet	Distribution System, primarily watermains
D.2	Cross Connection Backflow Control Program - % of ICI Customers	The backflow prevention program is focused on ICI consumers, with the intention of reducing the risk of contamination of the distribution system from ICI consumers.	Utilities Kingston strives to provide safe drinking water to the consumer.	Backflow Prevention Program tracking sheets. Target 100% participation @ 5 years. Current program @ 2 year point 2013.	Distribution System - watermains

#	Key Performance Indicator	Details	Purpose of KPI	Data Source(s)	Assets
E.1	Combined Water and Wastewater Costs to Consumer	UK's water and sewer rates as a percentage of provincial average. Burden is the average cost to residential consumer versus average household income.	Utilities Kingston strives to provide an economical financially responsible source of safe drinking to the consumer.	Municipal Study for water/sewer cost data 2012	ALL
E.2	Total debt repayments as a percentage of total income	Debt repayment as compared to total revenue	Utilities Kingston will operate the utility in a manner that is adequately funded and financially responsible to the shareholder and customer.	UK Financial Plan	All
E.3	Estimated Budget Deficit	Total capital spending less current capital funding level based on rates only	Utilities Kingston will operate the utility in a manner that is adequately funded and financially responsible to the shareholder and customer	UK Financial Plan	All

Appendix B.2 – Wastewater Utility Key Performance Indicators

Item	Key Performance Indicator	Details	Purpose of KPI	Data Source(s)	Assets
A.1	Sewage Backups	Sewage backups into basements are an indicator that the sanitary collection system is not operating effectively and reliably. Backups may be due to major rain or runoff events or asset failure to perform. Excessive extraneous flows may cause such events, and this is an indicator that sewer maintenance may be insufficient. Equipment or power failures may also create this condition. Another cause may be internal structural failure of a sewer main or forcemain. Utilities Kingston has a responsibility to minimize the occurrence of sewage backups. This number is likely to be influenced greatly by the occurrence of extreme rain and/or snowmelt events.	Utilities Kingston is dedicated to reducing the occurrence of sewage backups as it relates to operation and maintenance of the collection system. An increasing trend demonstrated by this KPI is an indication that efforts are insufficient, misdirected or simply ineffective, and changes should be implemented to extraneous flow reduction programs and/or system operations and maintenance.	Website Reporting Tool (only those related to municipal infrastructure are counted)	Gravity Mains Forcemains Junctions Services Pump Stations

Item	Key Performance Indicator	Details	Purpose of KPI	Data Source(s)	Assets
A.2	Service/ Lateral repairs (City Side)	Utilities Kingston is responsible for the part of the sewer lateral that is located in the Municipal Right-of-Way. This KPI represents the number of documented repairs of sewer laterals, located between the property line and the main, expressed as quantity per 10,000 customers.	A pseudo run-to-failure approach is utilized for management of services. An increasing trend of lateral repairs as indicated by the trending of this KPI, indicates a need to alter the management model or perhaps undertake localized service rehabilitation or replacement.	Underground Infrastructure Group's Dig Database	Services
A.3	Gravity Main Backups	This number reflects an estimate of blockages documented on Gravity Mains requiring emergency response to clear. The count is expressed in terms of quantity per 100 kilometers of gravity main.	This can be considered an indicator of the adequacy of operations and maintenance performed on Gravity Mains. An increasing trend would suggest need for increased cleaning, inspection and rehabilitation.	MPMP Report	Gravity Mains

Item	Key Performance Indicator	Details	Purpose of KPI	Data Source(s)	Assets
A.4	Pump Station failures.	This number is reflected of the occurrence of failures of Pump Stations that creates conditions sufficient to cause either basement flooding or sewage backups. It includes events due to power failures. Although a power failure is not a fault of the Utility itself, it may be an indicator that backup power supply is warranted at a particular facility.	This KPI is an indicator of the reliability of the Pump Stations. Failures are an indication that operational and maintenance practices need to be altered or that equipment upgrades may be required.	Bypass Tracking Database	Pump Stations
A.5	WWTP effluent quality (relative to Regulatory Standards)	Each WWTP is subject to conditions as per its Environmental Compliance Approval (formerly “C of A” or Conditions of Approval). These include specific quality parameters, such as BOD5, TSS, TP and others and specify maximum discharge concentrations. This KPI indicates how frequently the facility successfully meets the effluent quality standards stipulated in the ECA. Note that Cana WWTP has no stipulated Regulatory effluent standards. Since there are a number of quality parameters included in the ECA, this KPI indicates values for the worst case (the most problematic contaminant of the year).	This is an indicator of plant effectiveness and reliability. A plant that shows a decreasing trend of this KPI may suggest the need for operational changes, increased maintenance or process upgrades.	Wastewater Operations	Wastewater Treatment Plants

Item	Key Performance Indicator	Details	Purpose of KPI	Data Source(s)	Assets
A.6	WWTP effluent quality (relative to Process Objectives)	Similar to A.1.e. above, ECA often also indicate Process Objectives, which tend to be more stringent that the Regulatory Standards. These represent more conservative targets for the facility to meet, which ensures that Regulatory Standards will be met. It serves as an early warning that the facility may struggle to meet the Regulatory Objectives. Exceedance of Process Objectives is acceptable while exceedance of Regulatory Standards is not. Note that Cana WWTP has no stipulated Process Objectives.	This is an indicator of plant effectiveness and reliability similar to A.1.f above. A plant that shows a decreasing trend of this KPI may suggest the need for operational changes, increased maintenance or process upgrades. It can be used as an earlier warning than A.1.e. above.	Wastewater Operations	Wastewater Treatment Plants

Item	Key Performance Indicator	Details	Purpose of KPI	Data Source(s)	Assets
A.7	WWTP daily flows (relative to Rated Capacity)	Similar to A.1.e and A.1.f above, ECA often indicate a rated flow capacity of the WWTP, in terms of average daily, peak daily and peak hourly. As each facility (Cana excluded) indicates average dialy, peak daily and peak hourly, this KPI looks at the average daily flows only. It is therefore acceptable to exceed the Rated Capacity for average daily flow from time to time without jeopardizing the ability to meet effluent quality standards.	Frequent exceedance of the rated capacity as demonstrated by this KPI is an indicator that the plant is possibly undersized and that the planning process has failed to identify the need to update in a timely manner and upgrades should be contemplated. It may also be an indicator of excessive extraneous flows and collection system integrity.	Wastewater Operations	Wastewater Treatment Plants Collection System

Item	Key Performance Indicator	Details	Purpose of KPI	Data Source(s)	Assets
A.8	Amount of Wastewater Treated	This KPI examines the amount of wastewater, City-wide, that receives secondary treatment. In other words, it is an indicator of how much flow escapes and circumvents the intended treatment process due to bypass events.	This KPI is intended provide an indication of the Utility's impact to the environment and given direction from the Sewer Master Plan towards Virtual Elimination of bypasses, an increasing trend should be observed as capital projects are completed to eliminate combined sewer service area and extraneous flows.	Bypass Tracking Database WWTP Plant Flow Tracking Database	Wastewater Treatment Plants

Item	Key Performance Indicator	Details	Purpose of KPI	Data Source(s)	Assets
A.9	Wet-weather flow capture	MOE Procedure F-5-5 stipulates 2 conditions to strive to achieve for service areas subject to bypass in combined sewer service area. This KPI relates to the wet-weather capture of flows between April to October of the given year. MOE Procedure F-5-5 suggests operators shall strive to capture 90% of wet-weather flows during this time frame. The analysis requires a separation of dry- and wet-weather flows (completed using daily flow data) and comparing overflow data to the wet-weather component. As per the Sewer Master Plan (2010), Utilities Kingston is striving for virtual elimination of overflows in wet-than-average years.	This KPI is intended provide an indication of the Utility's impact to the environment and given direction from the Sewer Master Plan towards Virtual Elimination of bypasses, an increasing trend should be observed as capital projects are completed to eliminate combined sewer service area and extraneous flows. This is calculated for the RAVENSVIEW SERVICE AREA ONLY.	Bypass Tracking Database WWTP Plant Flow Tracking Database	Wastewater Treatment Plants

Item	Key Performance Indicator	Details	Purpose of KPI	Data Source(s)	Assets
B.1	Gravity Mains Risk Level.	Utilities Kingston manages as CCTV program. The CCTV analysis provides structural condition scores, which are combined with a criticality assessment to estimate risk. Gravity mains with a risk score of above 5 are considered to be unacceptable.	This KPI is an indicator of the structural health of the Gravity Mains. A trend toward lower percentages indicates the need to allocate more capital investment towards gravity main rehabilitation and/or replacement.	Gravity Mains Risk Assessment	Gravity Mains
B.2	Forcemain Risk Level.	Utilities Kingston currently has no program in place to assess the condition of its Forcemains but this is a recommendation of this report. Ultimately, a risk assessment process similar to that summarized in A.3.a will be implemented.	This KPI is an indicator of the structural health of Forcemains. A trend toward lower percentages indicates the	Forcemain Risk Assessment	Forcemains

Item	Key Performance Indicator	Details	Purpose of KPI	Data Source(s)	Assets
			need to allocate more capital investment towards Forcemain rehabilitation and/or replacement.		
B.3	Pump Station Risk Level.	Utilities Kingston assesses the health of its facilities by way of the Plants and Facilities Condition Assessment. This program requires some expansions and improvements, but overall, it provides an assessment of risk for facilities. Currently, risk is estimated in house using condition and criticality information for its pump stations. CSO Tanks were estimated using staff input. A risk score over 3.25 was used to indicate high-risk facilities, regardless or not whether a run-to-failure approach is acceptable. A run-to-failure approach may be feasible for several of the very small facilities.	This KPI is an indicator of the health of the Pump Stations. In taking a risk management approach to scheduling facility upgrades, trends should indicate a reduced number of higher-risk facilities.	Plants and Facilities Condition Assessment (external and internal)	Pump Stations

Item	Key Performance Indicator	Details	Purpose of KPI	Data Source(s)	Assets
B.4	CSO Tank Risk Level	Similar to item B.3 above, UK needs to assess the condition and risk of its CSO Tanks. Currently this has not been completed formally, but it is recommended for future facility condition assessment studies. Recommended to be included in subsequent external assessments.	This KPI is an indicator of the health of the CSO Tanks. In taking a risk management approach to scheduling facility upgrades, trends should indicate a reduced number of higher-risk facilities.	Plants and Facilities Condition Assessment (internal).	CSO Tanks
B.5	Wastewater Treatment Plant Risk Level	A formal risk assessment program for wastewater treatment plants is recommended. At this time, risk level was estimated simply as low, moderate, and high based on staff input. At this time, it is understood that Cana is a liability and is currently in the design phase for replacement. Cataraqui Bay is of moderate risk from a condition perspective but is also required for growth. It is also in the planning	This KPI is intended to provide an overview of the perceived health of the Wastewater Treatment Plants. Utilities Kingston strives to maintain all	WWTP risk assessment (internal).	Wastewater Treatment Plants

Item	Key Performance Indicator	Details	Purpose of KPI	Data Source(s)	Assets
		stages. Recommended to be included in subsequent external assessments.	WWTP in a low-risk state. Indications of moderate- to high-risk shall result in consideration for additional maintenance or upgrades.		
C.1	Maturity of Sewer Master Plan	This KPI simply looks at the age of the most recent Sewer Master Plan. Ideally, the SMP should be updated every 5 years, in parallel with Growth Strategy updates.	This KPI is intended to identify whether or not the Master Planning exercise, which is the foundation for understanding growth-based upgrades to the sewage collection and treatment system, is kept current.	Sewer Master Plan	Wastewater Treatment Plants Pump Stations CSO Tanks Gravity Mains Forcemains

Item	Key Performance Indicator	Details	Purpose of KPI	Data Source(s)	Assets
C.2	Maturity of Plants and Facilities Condition Assessment	The KPI documents the age of the most recent Plants and Facilities Risk Assessment Study. Ideally, it should be completed every 10 years or less.	This KPI is intended to identify whether or not the Risk Assessment for Plants and Facilities is kept sufficiently current. This is more critical given the lack of formalized internal condition and risk assessment.	Water and Wastewater Facilities Condition Assessment	Pump Stations Future: to include WWTP and CSO Tanks.
C.3	Uncommitted Reserve Capacity at WWTP	MOE Procedure D-5-1 is intended to be an annual exercise to ascertain the ability of the WWTP to service growth. The Utility must strive to ensure that the planning process takes place over 10 years in advance of required upgrades, ideally 15 years to account for variations in growth.	This KPI is important to identify the urgency of planning for major WWTP upgrades and expansions. Along with Master	Sewer Master Plan Uncommitted Reserve Capacity Analysis (Annual)	Wastewater Treatment Plants

Item	Key Performance Indicator	Details	Purpose of KPI	Data Source(s)	Assets
			Planning, it shall be used to trigger all considerations required for plant upgrade and/or expansion to support growth. Ideally, consideration should begin at 15 years. An Environmental Assessment should commence prior the reserve capacity dropping below 10 years.		
C.4	Linear System Risk Assessment Completeness	The linear infrastructure represents approximately ½ of the Wastewater Utility. It is prudent therefore that Utilities Kingston complete risk assessment on the entire inventory of Gravity Mains and Forcemains such that best decisions can be made with a	This KPI indicates the degree of completion of condition assessment on	CCTV Database	Gravity Mains Forcemains

Item	Key Performance Indicator	Details	Purpose of KPI	Data Source(s)	Assets
		full understanding of system risk, not just a partial one. This is calculated as the total length of pipe inspected divided by the total length of pipe, for each asset class.	Gravity Mains and Forcemains. The trend shall be a rapidly increasing one until 100%, or as close as possible, is achieved, for both Gravity Mains and Forcemains		
D.1	Rate of Sewer Separation	This KPI is calculated as the reduction in street blocks serviced by combined sewers for the given year, divided by the total number of blocks serviced by combined sewers in 2008 (as the benchmark).	This KPI is intended to plot the rate of progress of sewer separation activities consistent with the recommendations of the Sewer Master Plan and City Sustainability objectives. On	GIS Inventory and Analysis	Gravity Mains

Item	Key Performance Indicator	Details	Purpose of KPI	Data Source(s)	Assets
			average, progress has been in the 4.5-5.5% range since 2008.		
D.2	Remaining Combined Sewer Service Area	This KPI is calculated as the total remaining combined sewer area (in hectares of surface drainage area) divided by the total combined sewer service area in 2008 (as the benchmark)	This KPI is intended to document the progress made in terms of effective reduction in storm capture in the wastewater collection system, consistent with recommendations of the Sewer Master Plan and City Sustainability objectives. Ranges are dynamic, and will decrease at 5% per year moving	GIS Inventory and Analysis	Gravity Mains

Item	Key Performance Indicator	Details	Purpose of KPI	Data Source(s)	Assets
			forward, starting with 100% at 2008.		
D.3	Estimated Bulk Extraneous Flow	This KPI utilizes a very basic method of estimating 'bulk extraneous flow'. It is calculated as the total Wastewater treated divided by the total Potable Water produced, in a given year. Extraneous flow reduction projects, sewer separation projects as well as water conservation and unaccounted-for-water reduction efforts all contribute to this KPI decreasing.	This KPI is intended to provide an indicator of progress made in terms of reducing the volume of stormwater and groundwater entering the sanitary sewer system and occupying valuable capacity that should otherwise be available for growth and domestic wastewater. Progress would	WWTP Data	

Item	Key Performance Indicator	Details	Purpose of KPI	Data Source(s)	Assets
			be indicated by a downward trend in this KPI over time, which would indicate gains being made by various Wastewater & Water projects.		
E.1	Combined Water and Wastewater Costs to Consumer	UK's water and sewer rates as a percentage of provincial average. Burden is the average cost to residential consumer versus average household income.	Utilities Kingston strives to provide an economical financially responsible source of safe drinking to the consumer.	Municipal Study for water/sewer cost data 2012	ALL
E.2	Total debt repayments as a percentage of total income	Debt repayment as compared to total revenue	Utilities Kingston will operate the utility in a manner that is adequately funded and financially	UK Financial Plan	All

Item	Key Performance Indicator	Details	Purpose of KPI	Data Source(s)	Assets
			responsible to the shareholder and customer.		
E.3	Estimated Budget Deficit	Total capital spending less current capital funding level based on rates only	Utilities Kingston will operate the utility in a manner that is adequately funded and financially responsible to the shareholder and customer	UK Financial Plan	All