The Municipality of Brooke-Alvinston

PUBLIC SECTOR PARTNERS

2023 Asset Management Plan

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Executive Summary

The Municipality of Brooke-Alvinston is responsible for providing a significant number of services to the community. Examples include roads, sidewalks, trails, fire services, underground pipe network (stormwater), stormwater management, and both indoor and outdoor recreational facilities. These types of services are supported by a wide range of infrastructure assets enabling a quality of life enjoyed by stakeholders.

This Asset Management Plan (AMP) is the Municipality of Brooke-Alvinston's (Municipality) first comprehensive AMP effort and will assist data-driven decision making for the Municipality's assets. The AMP includes the consideration of installation, maintenance, rehabilitation and replacement of the linear infrastructure that is the backbone to the community and has an estimated replacement value of $186 million. This document has been developed to meet Phase 1 of Ontario Regulation 588/17: Asset Management Planning for Municipal Infrastructure (O. Reg. 588/17) and is compliant with many components of Phase 2 and Phase 3. Areas requiring additional attention to achieve full compliance have been identified within Section 1.3 Legislative Requirements.

The Municipality's AMP has been developed using currently available data for asset inventory, performance, and deterioration rates. All of this information is captured within the Municipality's custom built asset management system (Infrallect) and allows for illustration of how planned renewal expenditures affect the performance of the assets over the next 25 years.

The 2023 AMP identifies a gap between the expenditures that are required to achieve an acceptable level of performance from the Municipality's infrastructure assets and the current planned expenditures in the capital and operating budgets. The analysis determined that reserve fund contributions require additional annual funding of approximately $145,000. The additional funding is required to achieve a level of service that is anticipated to be acceptable to most stakeholders. The required expenditures have been established based on an analysis of the most granular asset data available combined with professional management strategies to determine when and how each different type of asset is renewed. The work undertaken to prepare the 2023 AMP has determined that 38% of the Municipality's roads, bridges, culverts, and storm pipe assets are in good performance categories currently.

It is anticipated that the Municipality will continue to improve asset management capabilities including updates to reflect asset renewal and deterioration rates. This is critical as data is refined and technological or business process improvements influence infrastructure renewal costs.

In summary, the 2023 AMP is fully compliant with Phase 1 of O. Reg. 588/17 and with many of the future requirements in Phase 2 and Phase 3. The information presented in this AMP demonstrates that the Municipality is continuing to manage its assets in a responsible manner.

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Glossary

Capital Asset: Any item, thing or entity with a physical substance (the exception being software) with a useful economic life extending beyond one year.

Asset Management: Co-ordinated activities to realize optimal value from the organization's assets throughout their lifecycle.

Asset Management Plan (AMP): Documents how groups of assets (i.e., asset classes) are to be managed over a period of time. The plan describes the characteristics and performance of infrastructure assets, the levels of service expected from them, planned maintenance, rehabilitation, and replacement actions to enable the assets to provide the expected levels of service, and financing strategies to implement the planned actions. This document also addresses the impacts and maintenance risks associated with owning the assets.

Asset Management System: A set of processes and procedures which govern how Asset Management is to be practiced.

Betterment: Costs incurred for enhancements to the service potential of a capital asset such as:

- an increase in the previously assessed physical output or service;
- a reduction in associated operating costs;
- an extension of the estimated useful life; or
- an improvement in the quality of output of the asset.

Consumer Based Forecasting: The performance of infrastructure (i.e., Level of Service) is tailored to each individual community's need, asset class, and individual asset. Similar to private sector consumer-based management (e.g., retail, banking, insurance, etc.). Based upon principles of risk and reliability.

Level of Service (LOS): Defined service for a particular activity or service area against which service performance may be measured. Service levels usually relate to quality, quantity, reliability, responsiveness, environmental acceptability and cost. In the case of public infrastructure, Level of Service is directly and wholly proportional to its performance.

Lifecycle: The various phases of an asset's life that are identified as planning & construction, operations, maintenance and disposal. Each phase has its own opportunities, risks, impacts and costs.

Linear Asset: Assets that are connected in a linear network creating one larger asset or asset class and are not specific to a single location. Examples include roads and water distribution pipe.

Optimization: The Municipality will apply consistent application of practices, interventions and operations to achieve sustainability and provide optimum value for the public through the:

- Implementation of a life-cycle approach to managing infrastructure;
- Evaluation of risk related to environmental, social and external impacts; and,

- Incorporation of sustainability criteria into infrastructure projects to help ensure a responsible balance between cost, performance and risk.

Rehabilitation: Work completed to restore an asset to a better condition.

Renew / Renewal: Improvement activity or treatment of existing infrastructure assets.

Replacement: Undertaken when an asset has reached the end of its life and/or is no longer providing acceptable service.

Subject Matter Expert (SME): A person who has specialized knowledge in a particular area or topic.

Sustainable: Achieving or retaining an optimum compromise between performance, costs and risk of the asset life, while avoiding adverse long-term impacts to the organization from short term decisions.

Treatment: Any infrastructure improvement activity, including but not limited to maintenance, betterment, renewal, rehabilitation, reconstruction, replacement, lifecycle management activity.

Infrallect: The Municipality's customized analytical decision support system designed to aid asset project prioritization and provide analysis of asset class strategies.

1 Introduction

1.1 Overview of the Municipality of Brooke-Alvinston's Asset Management Plan

The 2023 AMP is the outcome of the Municipality of Brooke-Alvinston's asset management program which identifies the Municipality's infrastructure value, rehabilitation needs and funding requirements by using the following principles:

- Understanding that good asset management practices are fundamental to ensure that the services provided by infrastructure assets meet the expectations of the community;
- Incorporating Ontario Regulation 588/17 requirements;
- Understanding the current state of the Municipality's infrastructure;
- Recognizing the connection between an organization's strategic (societal) objectives and spending decisions;
- Appreciating the processes needed to bring clear line of sight from organizational objectives to day-to-day activities;
- Working with subject matter experts to determine asset lifecycle management activities (i.e. how infrastructure is operated, maintained, rehabilitated and replaced);
- Determining the lifecycle costing required to provide service levels that meet community expectations;
- Establishing a financial strategy for the rehabilitation and/or replacement of the Municipality's infrastructure assets; and,
- Participating in academic research of asset management as it applies to provision of public infrastructure.

1.2 Goals and Objectives

The 2023 AMP outlines how the Municipality's assets are being managed to meet the principles identified in the Strategic Asset Management Policy. The intent is to ensure the Municipality has sufficient information and understanding about the long-term and cumulative consequences of managing public infrastructure. This is achieved by ensuring that the systems and processes are in place to facilitate the optimal choices to deliver sustainable infrastructure related services. This will be accomplished by combining data-driven and evidence-based analysis with professional management in a structured method to evaluate assets, in order to:

- Facilitate effective decision-making and risk assessments;
- Meet legislative and regulatory requirements;
- Establish and monitor levels of service (LOS) and adjust as necessary to accommodate asset efficiency, effectiveness, sustainability and growth;
- Establish a financial strategy to fund the expenditures required to achieve LOS metrics; and,
- Address climate change implications.

1.3 Legislated Requirements

The Province of Ontario recognized the importance of asset management planning when Ontario Regulation 588/17: Asset Management Planning for Municipal Infrastructure (O. Reg. 588/17) was enacted on January 1, 2018. O. Reg. 588/17 outlines guidelines and expectations for the application of asset management principles for municipalities. Most municipal assets are intended to last for decades or beyond and as such it is imperative that the lifecycle costing, performance, risks and impacts of asset ownership are considered.

Lifecycle phases consist of demand requirements, design, construction/acquisition, operating, maintaining and disposals. Consideration of these factors will benefit both current and future generations utilizing the Municipality's assets. O. Reg. 588/17 identifies numerous phases that municipalities must meet and include in future AMPs over the 2020-2024 timeframe as summarized in **Figure 1**.

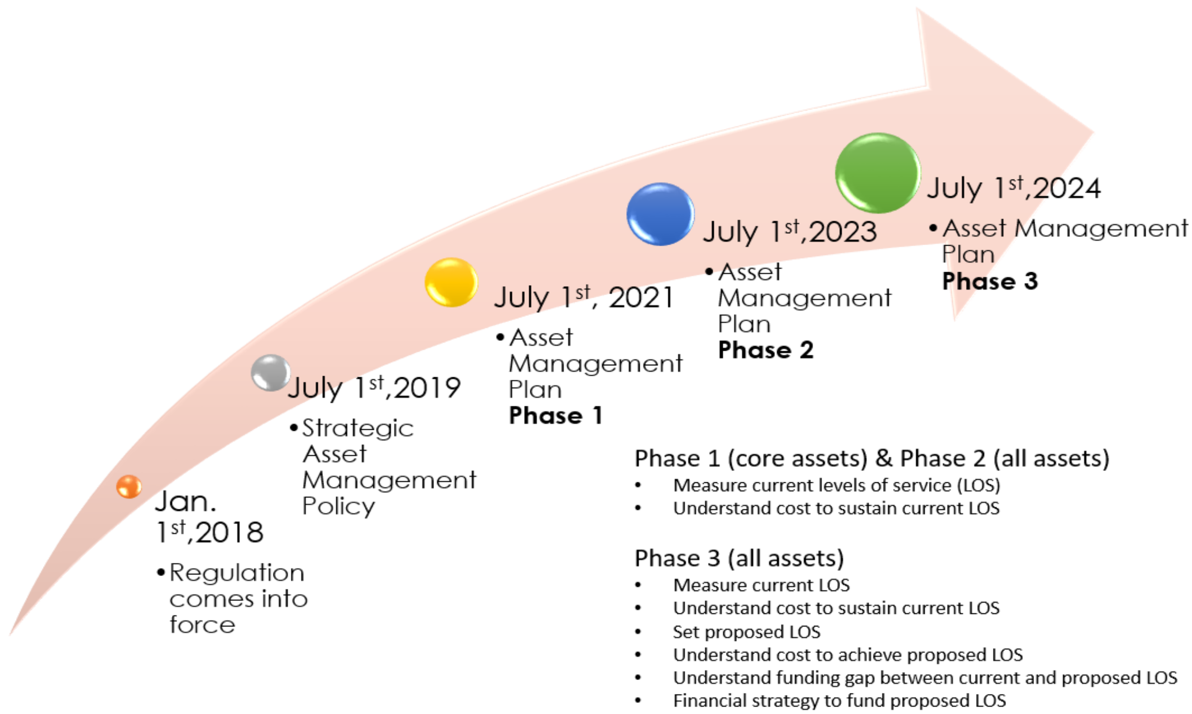

Figure 1: Ontario Regulation 588/17 Requirement Phase-In Timeline

Phase 1 Requirements: Core Assets

Phase 1 is specific to assets identified as 'core assets', comprised of roads, bridges, stormwater, water and sanitary. This phase was to be completed by July 1, 2021, and includes an inventory of core assets, current levels of service and the cost to maintain levels of services. The Municipality has an excellent inventory of core assets which is reflected in this AMP.

Phase 2 Requirements: Non-Core Assets

Phase 2 requirements is an expansion of Phase 1 by requiring the same information for non-core assets. This includes the development of an inventory, level of service metrics and the cost to maintain the current levels of service of all of the non-core assets included in the Municipal Financial Information Return (FIR). Examples of these assets include Facilities, Fire, and Parks. This phase is required to be approved by Council on or before July 1, 2023. Similar to core assets, a robust inventory of non-core assets has been collected.

Phase 3 Requirements

Due to the efforts undertaken, the Municipality has been able to comply with a significant amount of Phase 3 requirements. The intent of Phase 3 is to increase the amount of information within municipal AMPs with council endorsement received on or before July 1, 2024. The additional information to be incorporated includes:

1. Proposed Level of Service
   In addition to providing information on current LOS, municipalities are required to indicate proposed LOS. This information would need to be outlined each year, for a ten year period. The AMP also needs to outline why the proposed LOS are appropriate for the municipality including the consideration of LOS options, the related risk, how the proposed and current LOS are different from each other as well as the ability of the Municipality to achieve and afford the proposed LOS.

2. Lifecycle Management and Financial Strategy
   Municipalities are required to document a lifecycle management and financial strategy for assets for a ten year period. This includes outlining the lifecycle activities that would be undertaken to maintain the proposed levels of service and manage risk. This analysis would also be required to take into consideration the full lifecycle costs of the assets, including operating costs such as energy use. This phase is also required to include options for the lifecycle activities that can be considered to achieve the proposed LOS. If a funding gap is identified, municipalities are required to identify which lifecycle activities the municipality will undertake, and the risks associated with not undertaking the lifecycle activities.

As a result of the work undertaken over the past three (3) years, the Municipality of Brooke-Alvinston has been able to comply with a majority of O. Reg. 588/17 requirements from Phase 1 through Phase 3.

1.4 Development and Approval Methodology

O. Reg. 588/17 identifies the requirement that asset management policies be reviewed and updated as necessary at least once every five (5) years.

As part of the update process, AMPs require endorsement by the Executive Lead for Asset Management and passing of resolution by Council. The Municipality intends to table an updated AMP before the Executive Lead and Council once every four (4) years and to align with the appropriate budgeting process.

The Municipality's AMPs will be developed internally by the Asset Management section with the assistance of internal resources: subject matter experts and the Asset Management Working Group. These internal resources assist in making improvements to both the data and processes for asset management, such as the creation of processes to allow for data updates to occur organically from source data systems (e.g., GIS). This work is supported by the Asset Management Steering Committee through their advice, feedback and support to the Asset Management section.

In a continued effort to keep Council and the public informed of efforts to sustain existing and planned infrastructure, the Municipality will develop asset management report cards (RC). The RCs are intended to be a brief, two (2) -page snapshot of the performance and needs of the Municipality's infrastructure and will be updated on an annual basis. **Table 1** identifies the frequency of updates for asset management related documents.

Table 1: Frequency of Asset Management Updates

Document	Frequency
Strategic Asset Management Policy	Every five (5) years
Asset Management Plan	Every four (4) years
Report Cards	Annually

2 Asset Management Strategy

An Asset Management strategy is the set of planned actions that will enable the assets to provide the desired levels of service in a sustainable way, while managing risk, at the lowest lifecycle cost. This section of the AMP summarizes planned actions, including non-infrastructure solutions, maintenance activities, renewal/rehabilitation activities, replacement/reconstruction activities, disposal activities, expansion activities, procurement methods and risk. Each of these areas is highlighted in the following sub-sections.

Please see Appendix A for the Strategic Asset Management Policy document.

2.1 Maintenance Activities

The Municipality has created or follows established maintenance standards for many asset groups. These standards are used to guide maintenance and operations activities to ensure the assets can be relied on to provide the service for which they are intended.

Examples of asset maintenance activities for which the Municipality has created or follows Maintenance Standards include:

- Spills Response
- Vehicle Maintenance and Periodic Inspection Standards
- Elevator Maintenance
- Sidewalk Maintenance (Ontario Regulation 239/02)
- Roads Winter Operation (Ontario Regulation 239/02)
- Road Patrol (Ontario Regulation 239/02)

2.2 Renewal/Rehabilitation or Replacement Activities

The Municipality's asset groups utilize various types of performance information to inform the recommendations for treatment activities.

Examples of approaches used by the Municipality for determining the appropriate activities to undertake are:

- Facilities:
  - Facility performance information used to recommend projects and, where possible, coordinate the timing for projects to align with the needs of all assets within a specific facility.
- Fleet and Equipment:
  - Vehicle and equipment performance used information to determine individual rehabilitation strategies throughout a vehicle's life and to determine replacement needs on an individual basis.
- Linear Assets:
  - Performance information used for all assets located within the municipal right-of-way to recommend projects that align together. In some cases, all assets may benefit from replacement, while in other cases, only one asset may exhibit the need for rehabilitation.
- Parks:
  - Performance information used to recommend projects and, where possible, coordinate the timing for projects to align with the needs of all assets within a park.

2.3 Disposal Activities

Disposal activities are those associated with decommissioning an asset once it has reached the end of its useful life or is otherwise no longer needed by the municipality. Disposal activities are typically limited to equipment and vehicles under the Facilities, Fleet, Fire, and Information Technology asset classes, which make up less than 5% of the infrastructure portfolio. Civil engineering infrastructure composes the remainder of the portfolio, and these assets are typically treated rather than disposed of.

2.4 Procurement Methods

The Municipality is committed to ensuring its procurement decisions are fair, open, transparent and non-discriminatory. Purchases made by Municipality staff must comply with the Municipality’s Purchasing By-law. This by-law provides standard rules that govern the procurement of goods and services that reflect best value for the Municipality, protect the Municipality’s financial interests and encourage competitive bidding.

2.5 Risk

O. Reg. 588/7 includes a component requiring municipalities to identify the risks associated to lifecycle options that could be undertaken to maintain current levels of service. Risk is also used for project prioritization which can be attributed to the risk the project represents if it does not move forward. With respect to capital projects, a good quantification of risk can be developed by considering two factors associated with the asset: the probability of underperformance and the consequence of underperformance. For example, a malfunctioning air conditioning system at a small recreation center may lead to program and service disruptions for a small number of residents and clients (low consequence). However, the same situation at a large recreation center may lead to program and service disruptions for a large number of residents and clients (high consequence). Asset class specific information is contained in **Appendix B: Core Assets** and **Appendix C: Non-Core Assets**.

Subject matter experts are able to use the Brooke-Alvinston Infrallect asset management system to communicate various risks. This will assist in prioritizing a range of items from large lump sum budget allocations and capital projects to maintenance activities.

3 State of Brooke-Alvinston's Infrastructure

The Municipality has been practicing asset management for over 30 years. In the 1980's the implementation of computerized maintenance management systems were key drivers for the development of maintenance quality standards for infrastructure. This included the method and frequency of inspections and maintenance activities for infrastructure assets. As a result, the Municipality has several decades of data for many of its assets. The information provided in this section is aggregated and represents all asset groups that are managed by dedicated infrastructure management professionals within the Municipality.

3.1 Asset Attributes

To support consistency across asset classes, Asset Management maintains to a varying degree an inventory database of the following key attributes for each asset.

- Asset ID
  - A unique identifier that is assigned by the appropriate sub-system (e.g., GIS)
- Description
  - There are several categories in each asset class to allow for consideration of various types of information (e.g., type of road, type of facility).
  - Material type (e.g., gravel road, ductile iron pipe, polyvinyl chloride pipe)
  - Location (e.g., address or to/from address)
- Age
- Estimated Service Life
- Asset Valuation
  - The current estimate for replacement and typical treatment cost
- Size
  - This is asset dependent and may include length (e.g., meters or lane kilometers), square footage or the number of assets in the inventory
- Performance
  - Includes current performance and deterioration rates.

3.2 Assets and Their Value

Table 2: Replacement Value* of the Municipality's Infrastructure Asset

Asset Class	Replacement Value ($)	Portion of Total* Replacement Value ($)
Roads	35,163,721	25.49%
Sidewalks	488,393	0.35%
Bridges and Culverts	22,439,093	16.27%
Sanitary	19,302,200	13.99%
Water	19,250,700	13.96%
Storm	10,666,728	7.73%
Fleet	2,411,923	1.75%
Facilities	22,883,819	16.59%
Road Illumination	407,500	0.30%
Equipment and Furnishing:	3,192,975	2.31%
Land Improvements	1,731,148	1.26%
Total*	137,938,199	
gravel road	48,740,559	
Total + gravel road	186,678,758	

**Actual costing values are subject to market forces at the time of infrastructure construction / improvement activity. The above values are based on estimated replacement costs for a like-for-like replacement and industry standards.*

3.3 Measuring Performance of Assets

Measuring the performance of either an asset class or an individual asset is a complex process. There are many different factors that are integrated into the decision-making processes of the experts who decide when an asset is not achieving its intended performance targets. The factors that impact the performance of an asset are generally grouped into two categories: condition and function.

- Condition:
  - The physical condition of an asset is often the primary factor used to make decisions about when and how it should be renewed (replacement or rehabilitation or maintenance).
  - An example is the decision to rehabilitate surface asphalt of a road to prevent the entire road structure (e.g., base asphalt and granular base) from failing and subsequently needing full depth reconstruction.

- Function:
  - The functional performance of an asset can also impact decisions about when and how an asset should be renewed. Types of considerations that are captured in the functional performance of assets include:
    - The size of an asset (i.e., is it too big or too small?)
    - Whether the asset is functionally obsolete (e.g., outdated computer hardware)
    - Whether the asset is functioning as intended (e.g., greenhouse gas emissions from a facility are greater than an established target)

Asset Performance

The Municipality's current approach to projecting asset performance starts with a performance measure that can be derived from available data. In most cases, this is a measure of the physical condition of the asset. As a result, in most asset classes, the physical condition is still the primary driver for deciding when assets need to be renewed.

The performance percentages on the graphs provided in subsequent sections of this AMP are derived from the normalization of subject matter expert performance indicators to a scale of 0-1 (or 0 to 100%). **Table *3*** identifies the Municipality's approach to providing a qualitative description of the indicators. Depending on the asset class, the SME performance indicators typically include assessed or projected condition, estimated service life (ESL), or a mix of both. Examples may include the Pavement Quality Index for roads, number of pipe breaks for water distribution pipes, and assessed condition and ESL for facility components such as floor or heating-ventilation-air conditioning (HVAC) systems, respectively. **Table *3*** shows the corresponding qualitative category of the respective performance range.

Table 3: Qualitative Description of Performance Indicators

Asset Performance	Qualitative Description
0.5-1.0	Good
0.0-0.49	Fair
<0	Poor

Until recently, in cases where no other information was available, performance forecasting was constrained to using assets' ages. Through five (5) years of practical research collaboration with the University of Waterloo in public infrastructure asset management, breakthroughs have been made in understanding objective infrastructure performance. Amongst other items, it was discovered that age is a relatively reliable performance indicator for mechanical assets only, such as fleet and mechanical equipment. For civil engineered infrastructure, the situation has proven to be different. Accordingly, staff and researchers developed a scientific alternative that is based upon engineering reliability and consumer-based forecasting. In short, rather than age, historic and current spending is used to derive comprehensive performance measures.

Appendix D: contains further detail on this subject from industry partners, including related industry-wide research findings.

3.4 Levels of Service - Expenditure Needs and Asset Performance

Two scenarios are presented and described in this Asset Management Plan:

- The budget scenario
- The target scenario

3.4.1 Budget Scenario

The budget scenario provides perspective on the projected performance of the assets based on the planned expenditures.

The budget scenario is used to project future asset performance based on current planned funding allocations, performance and deterioration rates. As data and process improvements occur, staff are able to update Brooke-Alvinston Infrallect to project asset performance over a 25 year timeframe. Using this approach, **Figure 2** shows that 14% of the Municipality's assets currently exhibit poor performance. According to the budget forecast, this increases to 24% by the end of the 25 year span.

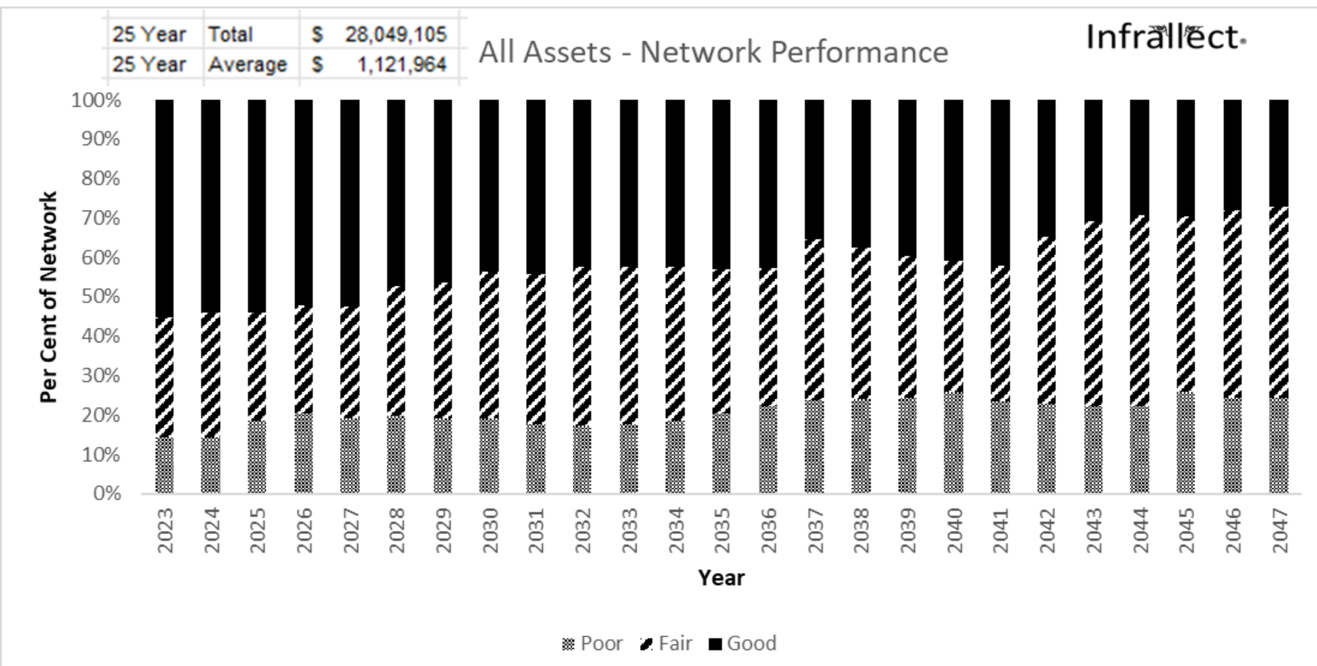

Figure 2: Performance Distribution of All Infrastructure for the Budget Scenario

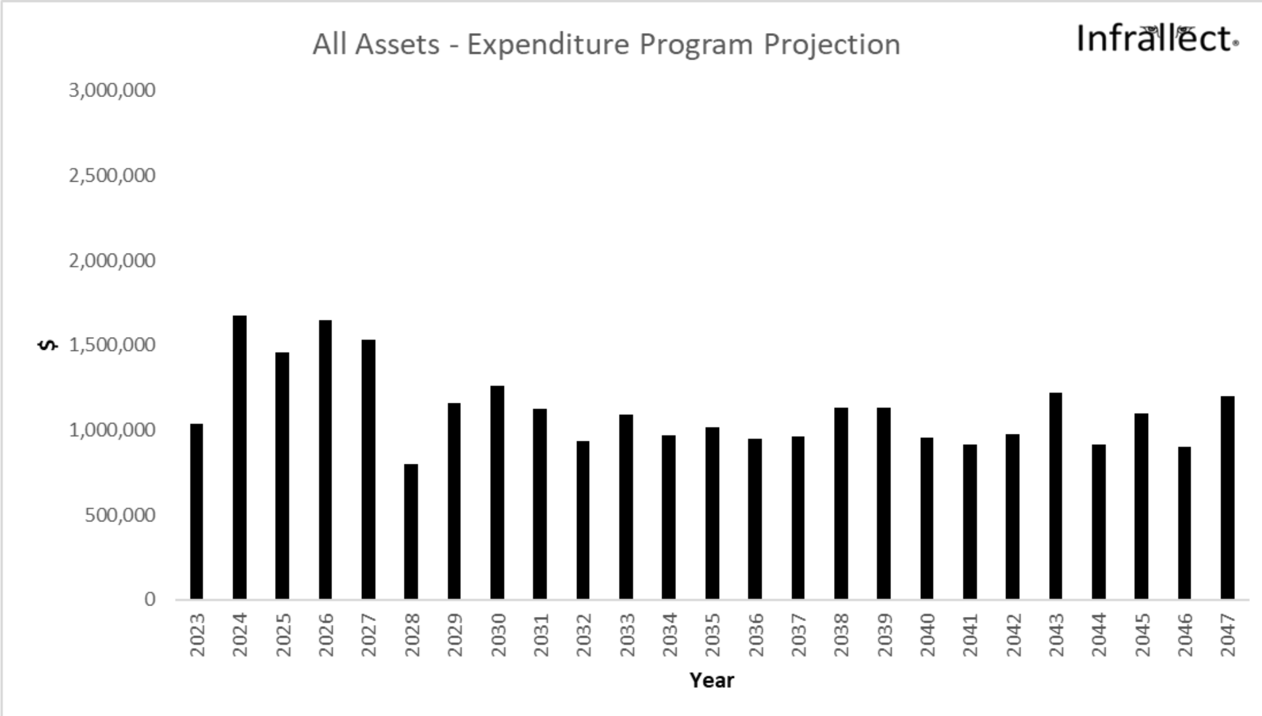

Figure 3: Corresponding Expenditure Forecast of All Infrastructure for the Budget Scenario

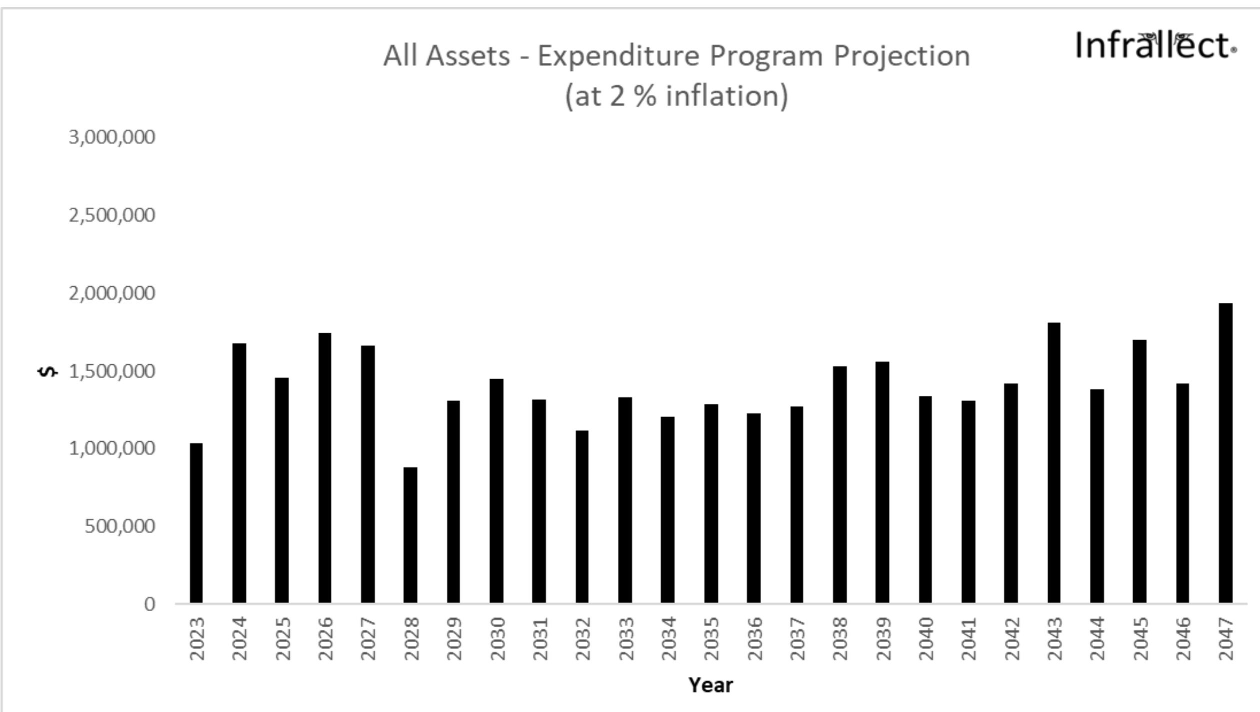

Figure 4: Corresponding Expenditure Forecast of All Infrastructure for the Budget Scenario at 2% Inflation

3.4.2 Target Scenario

The target scenario is used to generate a list of infrastructure expenditure needs to achieve the target levels of service that have been established for each asset class. The target scenario is designed to maintain a target proportion of assets in each asset class in good, fair, and poor.

Target levels of service have been established with collaboration from asset class SMEs and through this process, it is estimated that the additional average annual capital expenditure required for the target scenario is $374,991. Performance distribution with target funding is shown in **Figure 5**. Analysis suggests this level of funding would result in a proportion of assets in each performance category that is anticipated to be acceptable to most stakeholders.

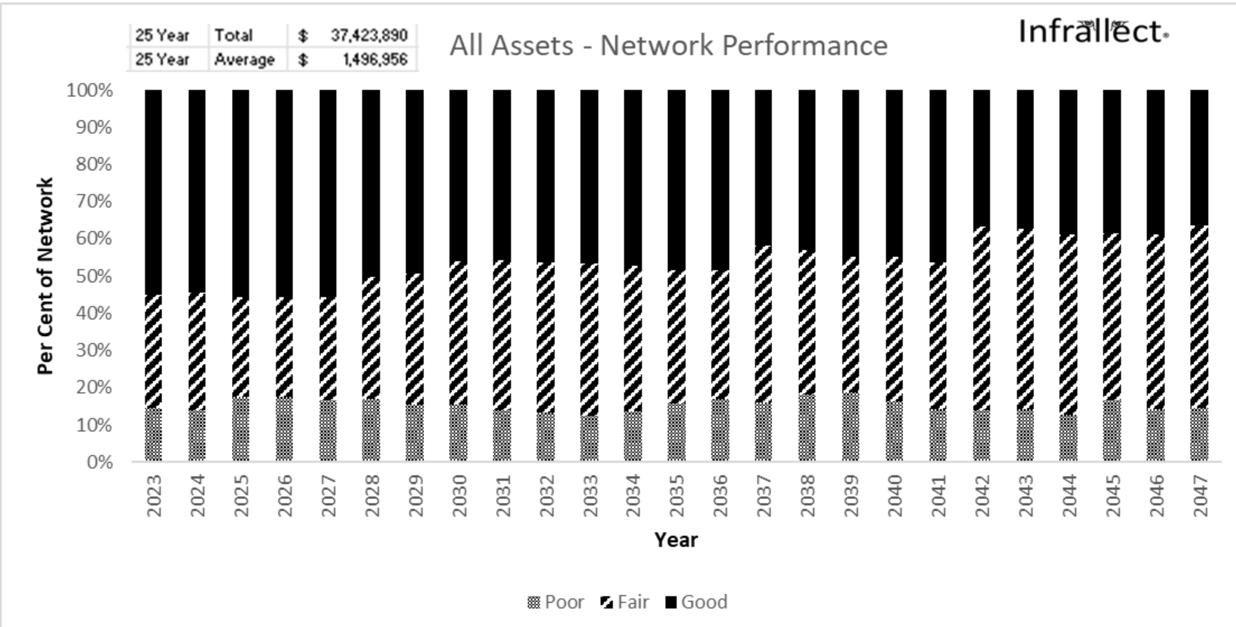

Figure 5: Performance Distribution of All Infrastructure for the Target Scenario

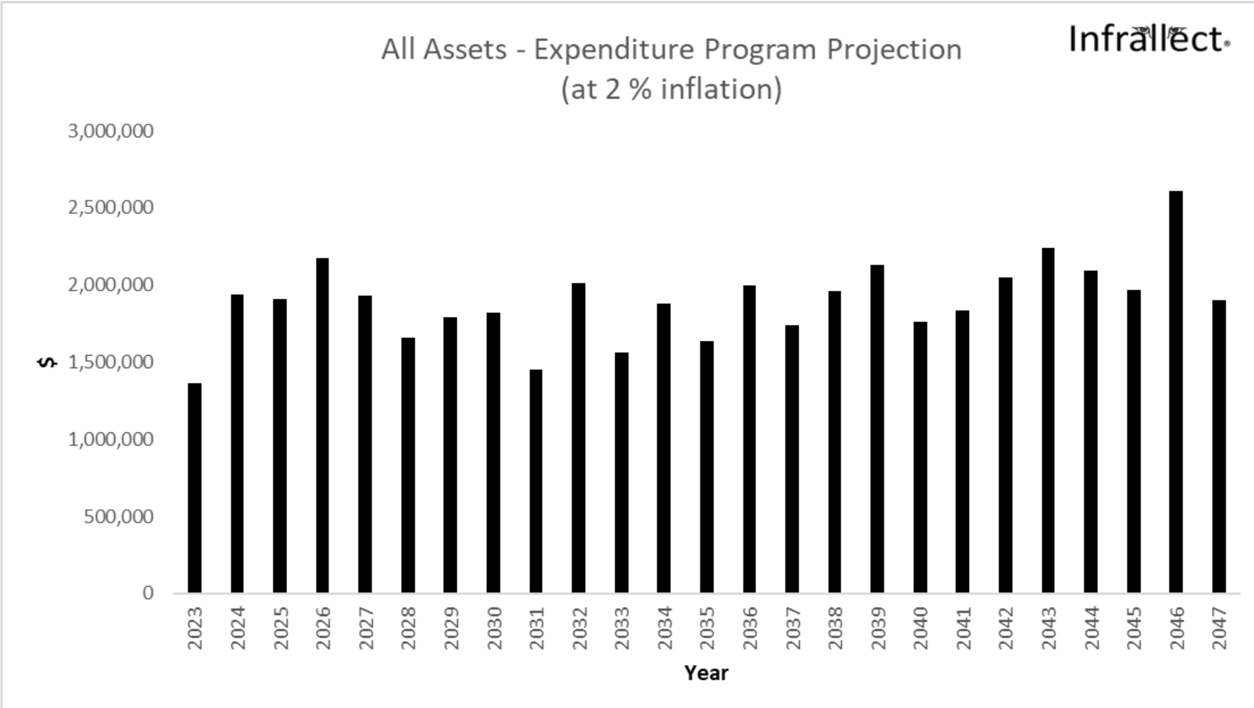

Figure 6: Corresponding Expenditure Forecast of All Infrastructure for the Budget Scenario

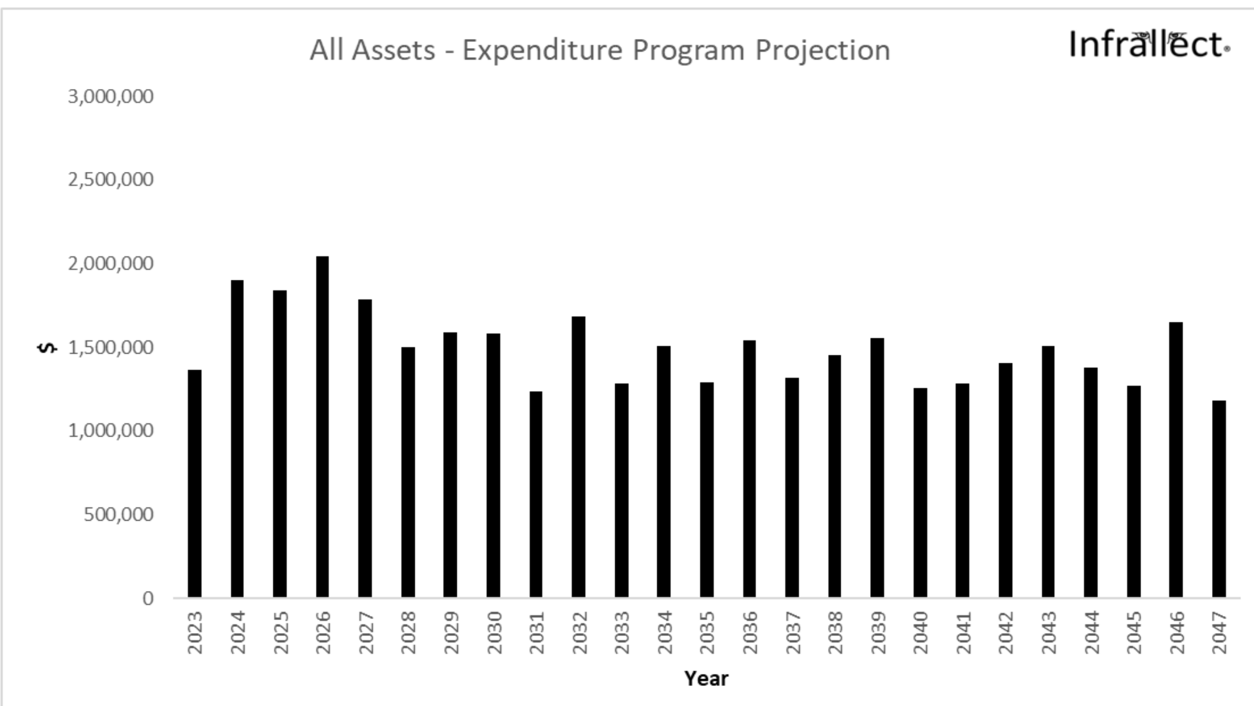

Figure 7: Corresponding Expenditure Forecast of All Infrastructure for the Budget Scenario at 2% Inflation

3.4.3 Scenario Capabilities

The Municipality's SMEs and infrastructure professionals are able to generate a range of scenarios for individual asset classes. The individual analysis at the operational and tactical levels can then be consolidated to obtain a strategic perspective on the overall suite of assets. The analyses of these "what-if" scenarios will be the key to addressing the infrastructure challenges over the coming years.

Using Brooke-Alvinston Infrallect will position the Municipality to leverage operational level asset management processes. This will help prioritize the specific assets requiring renewal activities. In addition, the Brooke-Alvinston Infrallect will support the evaluation of alternative practices, strategies, or construction techniques that will reduce the expenditures that are required to achieve the target performance of the assets. This approach will enable the Municipality (over time) to work toward the goal of having sufficient resources to help ensure that the services provided by the Municipality's infrastructure systems can be sustained over the long term.

3.5 Infrastructure Gap

Additional infrastructure expenditures are required to achieve a level of service that is anticipated to be acceptable to most stakeholders. The required expenditures have been established based on an analysis of the most granular asset data available in the Municipality combined with operational level decision making strategies about when and how each different type of asset is renewed. **Table 4** identifies the additional annual contributions needed to fund the target scenario for each asset class.

Table 4: Infrastructure Funding Gap – All Assets

Asset Class	*Average Annual Funding*	*Annual Funding Needed to Meet Target Performance*	*Average Annual Funding Gap**
Roads	$497,409	$748,515	$251,106
Sidewalks	$19,989	$19,989	$0
Bridges and Culverts	$116,850	$116,850	$0
Sanitary	$0	$0	$0
Water	$14,542	$14,542	$0
Storm	$24,954	$49,867	$24,912
Fleet	$104,183	$150,996	$46,813
Facilities	$83,799	$110,387	$26,588
Road Illumination	$12,397	$12,397	$0
Equipment and Furnishings	$224,848	$224,848	$0
Land Improvements	$22,993	$48,565	$25,572
Total Municipality of Brooke-Alvinston Funding Gap	***$1,121,964***	***$1,496,956***	***$374,991***

4 Financial Strategy

Compared to the private sector municipalities are in general severely constrained with respect to financial strategy options, when it comes to treating existing and delivering new infrastructure. The main source of funds are typically property taxes and/or levies. Followed by grants from provincial and federal sources, which, against all to date efforts, are still subject to a certain degree of subjectivism. Finally, the option of borrowing from provincial sources is severely underused by municipalities, likely due to the process involved or their projects not reaching the minimum threshold necessary to borrow. As such, the Municipality of Brooke-Alvinston will use its developed asset management capacities and tools to make an objective – repeatable at all Canadian municipalities – scientific, evidence-based, case before relevant authorities in order to close the infrastructure gap.

5 Tactical and Operational Practice

In order to realize strategic asset management objectives, it is necessary to apply appropriate tactical and operational practices. These require employing detailed knowledge of the following:

- What do we own and what is it worth?
- Treatment Strategies
- Current Performance and Projected Impact on Budgeted Capital Expenditures
- Target Performance and Required Expenditures
- Lifecycle Management Activities
- Levels of Service
- Demand Management Plan
- Allocation of Infrastructure Funding
- Risk

The following sections explain the details of the above items that are applicable to every asset class.

5.1 Tactical and Operational Details

5.1.1 What do we own and what is it worth?

Before determining the worth of an asset, it is important to note that the question applies to the entire asset class rather than a component of it.

For example, a sanitary section pipe, depending on the community's geographical location, may be worth $500-$800 per metre. However, a section by itself, not connected to other sections (i.e. the network), is not serving a purpose to the community, and therefore cannot be considered an asset. Once connected to other pipes it becomes part of an asset class typically referred to as the "sanitary collection network." Its replacement worth is typically determined by multiplying its length by the unit cost. As per municipalities' purchasing bylaws that ensure procurement decisions are fair, open, transparent and non-discriminatory, the current year's unit cost is based on pricing received from contractors in a competitive bidding environment. Subsequently, the asset class's worth can fluctuate from year to year, depending on various market forces. While replacement value is dependent on market forces, its treatment cost of individual sections ranges from $500-$800 per metre treated (i.e., pipe replacement). The median rate of annual treatment for sanitary networks as a portion of their entire length is 0.48% across Canada; this demonstrates the theoretical significance of the asset's worth compared to its treatment cost.

Please refer to corresponding sections in **Appendix B: Core Assets** and **Appendix C: Non-Core Assets** for quantity and replacement value information of each asset class.

5.1.2 Allocation of Infrastructure Funding

Typical capital budget allocation categorizations include:

- *Replacing Assets*. Replacing Assets indicates that existing assets are being "replaced." However, at the SME level, the actual treatment may include maintenance, rehabilitation, or replacement/reconstruction. For example, a roof replacement is actually a rehabilitative treatment when considering the entire facility, since the facility as a whole is not replaced.
- *Combination of New/Replacement of Assets*. This category indicates a mix of treating existing assets and adding new assets. An example would be the reconstruction of a two-lane road into a four-lane road; the additional two lanes are new.
- *New Assets*. New Assets indicates construction or procurement of infrastructure assets in locations where there were previously none.
- *Decommissioning Assets*. Decommissioning Assets is a relatively rare category, as municipal assets are necessary for a community's socioeconomic wellness, especially in growing communities.

Please refer to the corresponding sections in **Appendix B: Core Assets** and **Appendix C: Non-Core Assets** for the infrastructure allocation funding per asset class.

5.1.3 Rehabilitation or Replacement Strategies

In terms of infrastructure improvement activities, there are a number of terms that appear to be used interchangeably in the industry. These include, but are not limited to:

- Maintenance
- Betterment
- Renewal
- Treatment
- Rehabilitation
- Reconstruction
- Replacement
- Lifecycle management activity
- Extension of service or economic life

The three dominant activities used by SMEs for improvement are maintenance, rehabilitation, and reconstruction. With respect to mechanical assets, such as fleet and equipment, "rehabilitation" is typically replaced by "repair" and "reconstruction" is typically replaced by "replacement."

Municipalities have been executing infrastructure maintenance, rehabilitation, and reconstruction strategies for decades. Corresponding decisions are usually based on the availability of potential treatments for each of the categories, whether in-house or contracted out. For example, the optimal treatment according to an engineering and/or academic point of view may be crack sealing of a certain road section, due to its current performance. However, if in reality market suppliers cannot provide this service as a sustainable business practice (i.e., at a reasonable cost), then it cannot objectively be considered the optimal treatment. In that case, a public works manager may choose a selective resurfacing treatment as the most cost-effective treatment, although it is theoretically more expensive than crack sealing.

AMPs are "a snapshot in time" and cannot reliably prescribe specific treatments (within one of the main treatment categories mentioned above) for assets at explicit costs in the future. Such projections are not scientifically feasible and do not take into account other factors such as political influences or nearby development. As a result, AMPs are constrained to describing the local treatment options available and projecting their average cost and split between the three categories. However, it is the SME's responsibility to professionally manage the assets and decide on the most appropriate treatment with the highest cost/benefit ratio at the time the specific project moves forward. In the above example, both crack sealing and selective resurfacing are typically considered maintenance treatments in road construction terminology. For this reason, it is scientifically feasible to forecast future expenditure at the level of the aggregate treatment categories of maintenance, rehabilitation, and reconstruction, but not at the level of single specific treatments available within each of the categories. These are project specific decisions for which there is typically sufficient information only one to three years out (at most) from the planned year of project execution.

In the municipal context, civil engineered assets (e.g., roads, water collection pipes, trails) are constructed as unique projects, while mechanical assets generally require informed purchase of manufactured assets (e.g., fleet, heating, ventilation and air conditioning (HVAC) units). For example, identical vehicles from a single manufacturer can serve many municipalities across the globe. However, roads, trails, parks, facilities etc., have to be designed for the unique circumstances of each community and the unique project location within that community. This results in a number of possibilities for the project's dimensions, materials to be used, designer skill set requirements, constructor skill set requirements, duration, impact on surrounding environment, etc. The unique aspects of each project are considered by municipal SMEs in determining the optimal specific treatment for the specific asset(s). However, this can only be done close to the time the general maintenance, rehabilitation, or reconstruction treatment was forecasted in the AMP.

Please refer to the corresponding sections in **Appendix B: Core Assets** and **Appendix C: Non-Core Assets** for the treatment strategy options for each asset class.

5.1.4 Lifecycle Management Activities

As described in section 5.1.3, the three main categories of lifecycle management activities are maintenance, rehabilitation, and reconstruction. Formal asset management practices were introduced to management of public infrastructure in the late 2000s, thereby providing sufficient time for trial and error of its application, and subsequent study of required improvements. According to the latest research from the University of Waterloo, the following elements are required in order to apply asset management practice properly to lifecycle management activities for public infrastructure:

- Understanding that lifecycle management activity thinking for mechanical engineered assets cannot be applied to civil engineered assets.
- Understanding that typical Tangible Capital Asset Valuation or Amortization cannot be used for planning lifecycle management activities for civil engineered assets.

Mechanical engineered assets include fleet, HVAC, pumps, and mechanized equipment. They represent a minority of a typical municipal asset portfolio's value; the majority of all other assets are typically civil assets.

Unlike civil assets, mechanical engineered assets are tested under typical working conditions before being introduced to market and available for purchase. Manufacturers are able to develop a relatively reliable schedule of treatments (i.e., preventive and reactive maintenance, repair, and replacement) for mechanical assets. In addition, manufacturers are able to develop treatments of varying magnitude, such that a specific desired Level of Service can be achieved. For example, when a snowplow is in need of treatment, SMEs will apply maintenance, repair, or replacement of its parts or as a whole in response to the assessed wear and tear to ensure the desired Level of Service is provided. In this case, the desired Level of Service is the length of time that the snowplow remains in service after treatment. Forecasting future asset performance and corresponding expenditure according to prescribed or scheduled lifecycle management activities is relatively reliable, with exceptions, for mechanical engineered assets.

Over the past decade, the majority of literature attempting to help municipalities implement asset management assumed that the same approach of scheduled lifecycle management activities can be applied to civil assets. Unfortunately, this is not the case, as these assets are planned, designed, and constructed for very specific and unique circumstances applicable to each community and project. Whereas mechanical lifecycle management activity thinking is primarily concerned with the number of kilometers on a vehicle, or the number of operating hours on equipment, regardless of which community the asset is being used in, civil lifecycle management activity thinking is concerned with the unique circumstances of the community and location the particular asset is serving. Therefore, asset management for civil engineered assets cannot be practiced through a prescribed, scheduled set of lifecycle management activities. The approach needs to be constant asset management analysis of the pressures/stresses/consumption the community is exerting on its infrastructure (please refer to sections 5.1.1 and 5.1.5.2 for details of such analysis). The prescribed, scheduled lifecycle management activities for mechanical assets simply do not account for the vast majority of unique factors impacting lifecycle management activities for civil assets. These include an equal mix of Standard Established Performance Measures (SEPMs) and Corporate Decision Factors. **Table 5** and **Table 6** list and provide examples of each, respectively.

Table 5: Standard (non-age based) SEPMs[1]

Asset class	Standard SEPM other than age – accounting for conditional asset performance[a]	Standard SEPM other than age – accounting for conditional asset performance example	Standard SEPM other than age – accounting for functional asset performance[a]	Standard SEPM other than age – accounting for functional asset performance example
Roads	x	Pavement condition index	x	Average annual daily traffic
Sidewalks		Frequency of surface distresses	x	Trip hazards
Trails		Frequency of surface distresses	x	Trip hazards
Sanitary	x	PACP score	x	Flow capacity
Water	x	Break frequency	x	Flow pressure
Storm	x	PACP score	x	Flow capacity
Storm water management	x	Sediment volume	x	Storage volume
Facilities	x	Facility condition index	x	Disability access
Fleet	x	Distance travelled	x	Capacity to address demand
Parks		Mix of other asset classes	x	Variety of activities available
Forestry	x	Tree health	x	Canopy spread
Parking	x	Pavement condition index	x	Capacity to address demand
Fire		See fleet, facilities and equipment	x	Response time
Equipment		Extent of wear and tear	x	Capacity to address demand
Information technology		Extent of wear and tear	x	Capacity to address demand
Cemeteries		Mix of other asset classes	x	Capacity to address demand

[a] x = established
PACP, pipeline assessment certification program

[1] **Posavljak M, Tighe SL, Larson N and Rapp C, "A different kind of partnership: an infrastructure performance stock exchange", Infrastructure Asset Management, https://doi.org/10.1680/jinam.18.0039, page 4**

Table 6: Corporate Decision Factors - Not Accounted for by SEPMs[2]

Corporate decision factors directly affecting past, present and future asset performance	Asset class applicability	Examples of questions/comments considered by public administrations making infrastructure asset management decisions
Economies of scale	All asset classes	'In order to group projects in proximity, we have to delay or move up treatment of certain assets.'
Level of service – community category	All asset classes	'"Good" asset performance category for our small town and "good" for a larger city is not the same, nor should it be.'
Funding capacity	All asset classes	'We have maxed out all possible funding means; this is the best we can do without exponentially raising taxes.'
Project delivery capacity	All asset classes	'Even if we had the funds to address all needs according to SEPMs, we would have to expand drastically our project management team and then decrease it once the backlog needs are addressed.'
Specific funding accommodation	All asset classes	'The global green infrastructure fund is providing funding only for these specific assets; therefore, we are moving up their treatment.'
Cost-sharing potential	All asset classes	'The regional government is treating this regional road in year X; we should wait or move up our underground work to line up with their timing.'
New design standards' accommodation	All asset classes	'If we go with the replacement of the asset as planned, the like-for-like replacement does not meet the new standard; therefore, let us push it out until we have the funds for the option that does meet the new standards.'
Portion of asset network expressed by SEPMs	All asset classes	'Do we know what sort of overall impact this project will have on the overall performance of the network? Perhaps another project should go forward first.'
Timeliness of SEPMs' information	All asset classes	'How up to date is our SEPMs information which we are taking into account for decision-making?'

Due to the uniqueness of each community; the Budget (5.1.5.1) and Target Performance (5.1.5.2) projections account for all of the factors in the above tables. Then, in any scenario, lifecycle management activities are tailored to the Municipality's civil engineered assets. Specifically, timing and type of treatment can be applied to individual assets lifecycles, which collectively contribute to the overall condition/performance of the asset class in serving the community. Section 5.1.3 identifies why forecasting more specific categories of treatment, other than maintenance, rehabilitation, or replacement for lifecycle management activities is inadequate. Similarly, section 5.1.1 recognizes the reasons why individual infrastructure components (e.g., a pipe section) cannot technically be considered assets unless they are connected to the larger asset class and providing value to the community.

Please refer to the corresponding sections in **Appendix B: Core Assets** and **Appendix C: Non-Core Assets** for lifecycle management activities available per asset class.

5.1.5 Levels of Service

The term "Levels of Service" migrated to public infrastructure management from sectors incurring expenditures related to person-to-person services, rather than consumer goods. The majority of expenditure related to public infrastructure management is concentrated on providing the end user (i.e., public) with a physical product (i.e., infrastructure). As such, the Levels of

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[2] Posavljak M, Tighe SL, Larson N and Rapp C, "A different kind of partnership: an infrastructure performance stock exchange", Infrastructure Asset Management, https://doi.org/10.1680/jinam.18.0039, page 4

Service provided by public infrastructure is directly proportional to the performance of that infrastructure.

The Budget Scenario and Target Scenario performance graphs in sections 5.1.5.1and 5.1.5.2 quantify and illustrate the Levels of Service provided by an asset class to the public. As explained in section 5.1.5.1, individual assets (e.g., pavement sections, pipe section, etc.) cannot serve the public unless they are connected to other individual assets, where they together make up an asset class which serves the public. From an SME, engineering, and academic point of view, this is the primary and objective Level of Service quantification for public infrastructure. As such, according to the latest asset management research at the University of Waterloo, it is the only perspective within asset management practice that answers the question “What Level of Service (i.e., infrastructure performance) is the public receiving for the expended funds?”

Please refer to the corresponding sections in **Appendix B: Core Assets** and **Appendix C: Non-Core Assets** for Levels of Service (i.e. performance) provided by each asset class.

5.1.5.1 *Current Performance and Projected Impact of Budgeted Capital Expenditures*

The degree to which an asset is able to fulfill its intended purpose is the performance level at which it performs. When discussing asset performance, it is important to note that the term "asset class" or "asset group" is typically used interchangeably with "asset." At the most granular level of an asset class inventory are the individual assets making up that class. Individual assets cannot fulfill their intended purpose unless they are connected to other individual assets in the physical environment. For example, a road section which is not connected to the rest of the road network (i.e., the Roads asset class) has no value to the community and is therefore not an asset. Similarly, a pipe which is not connected to the rest of the sanitary collection network (i.e., the Sanitary asset class) has no value to the community and is therefore not an asset, and so on. It is therefore only when the individual assets are arranged together to create a network that they realize their full potential of being an asset to the community. This realization manifests itself in the form of an asset class, and then typically the "class" part is dropped for communication convenience.

Subsequently, when looking at asset performance, it is important to always forecast at the asset class level, as it is at this level that the community is served. Even when an administration is not projected to spend funds on individual assets for decades, by being a part of their respective asset classes, their performance is still serving the community.

The same logic applies to naturally "disconnected" individual assets. For example, a Municipality of 100,000+ residents cannot be served adequately with one park or one recreational facility; a group of facilities making up an asset class is necessary.

The following are the general steps in determining current asset (class) performance:

A1. Analyze past (previous years) and current (current year and planned work) asset performance and spending information
A2. Fill in information gaps with professional knowledge/assumptions
A3. Analyze past and current inspection information (note: in its absence, information from A1. is a proxy for this information)
A4. Derive modelling parameters: current performance, deterioration rate, treatment trigger value, replacement value, and average cost
A5. Forecast current performance by deteriorating asset performance from its last year of treatment to current year
A6. Apply performance value ranges for poor, fair, and good performance categories
A7. Create asset class graph of current performance distribution (e.g., 20% poor, 20% fair, 60% good) weighted according to replacement cost of each individual item with the asset class

Note: Steps A1 to A5 are performed on individual assets at the most granular level of asset inventory, Step A7 is the aggregation of individual assets' performances to create the overall performance of the asset class.

To show the projected impact of the budgeted capital expenditures:

B1. Resulting information from steps A1-A8 is loaded into Brooke-Alvinston Infrallect
B2. Capital project sheet information is cross-referenced to specific assets at the most granular level of the asset inventory within the Brooke-Alvinston Infrallect
B3. Annual funding limits are set as per the annual capital budget total expenditures
B4. The Brooke-Alvinston Infrallect runs a "Budget Scenario" by forecasting asset class annual performance distribution for the next 25 years

It is important to be aware that future forecasts are scientifically reliable only at the aggregate level of expenditure. Specifically, how much in a particular year is forecast to be spent in total will then drive the corresponding annual performance of the asset class (i.e., the distribution of assets in poor, fair, and good performance categories). SME’s adjustments to actual treatment costs and selections regarding the individual assets to be treated within the one to three year outlook are always necessary, for reasons discussed in previous sections. However, these adjustments will not upset the aggregate forecast.

5.1.5.2 Target Performance and Required Expenditures

In order to understand the complete context of the Target Performance discussion, the reader should review the previous section (Current and Budget Performance).

Once a Budget Scenario has been run in Brooke-Alvinston Infrallect, it is reviewed by the SMEs and fine tuning is performed as necessary. Should the Budget Scenario’s 25-year forecast show significant portions of the asset class exhibiting poor and very poor performance, a Target Scenario is then run in the Brooke-Alvinston Infrallect by increasing the available funding. I. In the Target Scenario, unlimited funding is assumed to be available and is redistributed accordingly across the 25-year span to mimic typical cash flow patterns, rather than significant fluctuations.

5.1.5.3 Ontario Regulation 588/17

The Province of Ontario recognized the importance of asset management planning when Ontario Regulation 588/17: Asset Management Planning for Municipal Infrastructure (O. Reg. 588/17) was enacted on January 1, 2018. O. Reg. 588/17 outlines guidelines and expectations for the application of asset management principles for municipalities. In O. Reg. 588/17, the Province introduced specific metrics of interest (from a provincial point of view) that are to be reported for core assets. Municipalities are responsible for introducing and reporting on metrics for non-core assets. **Appendix B: Core Assets** and **Appendix C: Non-Core Assets** contain the metrics required under O. Reg. 588/17 and where applicable, metrics established by the Municipality.

5.1.6 Demand Management Plan

An important function of the Municipality's Asset Management Section is to help the organization at all levels visualize the projected performance of the Municipality's infrastructure, from various angles of interest for an asset class. Increasing demand on infrastructure is a theme that affects all asset classes. Examples of demand drivers are included below in **Table 7**.

Table 7: Sample Demand Drivers

Demand Driver	*Present Position*	*Projection*	*Impact on Services*	*Demand Management Plan*
Climate Change	Future Corporate Climate Adaptation Plan to identify actions to help the Municipality adapt our assets, operations and services to address the impacts of climate change.	More freeze/thaw winter events are anticipated as are more extreme summer temperatures.	Additional stress on road surface & underground infrastructure resulting in the potential for more repairs.	Monitor and adapt as per recommendations identified in the Climate Adaptation Plan.
Autonomous Vehicles	Autonomous vehicles are in the infancy stage and the Municipality is considering potential impacts.	Users of road infrastructure will require that the Municipality anticipates and responds to the needs of autonomous vehicles.	Additional technological advancements may be required in traffic signals and/or streetlights to transmit GPS information. Potential need for additional roadway features.	Monitor and adapt rehabilitation activities as necessary.

Demand Driver	Present Position	Projection	Impact on Services	Demand Management Plan
Infill Infrastructure Requirements	Opportunity to capitalize on lessons learned from "more developed" municipalities.	The Municipality can through application of latest infrastructure processes ensure that its development avoids traffic congestion, climate impact, and citizen inconvenience.	Increased demand for renewed and enhanced transportation networks to accommodate more users.	Monitor and adapt as necessary.

Brooke-Alvinston Infrallect asset management system can be used to perform sensitivity analysis for climate change drivers. For example, a graph can be generated to show infrastructure performance, in terms of those portions of the network that would be flooded during 10-year, 50-year, and 100-year storm events. For infill infrastructure requirements, Brooke-Alvinston Infrallect can be used to project the level of treatments and corresponding performance that would be necessary to accommodate different rates of infill developments.

In conclusion, demand management planning is another organizational process that can be supported by Brooke-Alvinston Infrallect.

5.1.7 Risk

In general, risk (as an organizational phenomena) is any factor that could potentially mitigate the organization's ability to attain its goals. In the case of municipalities, the overarching goal is to provide safe and adequate public infrastructure for the community's socioeconomic wellness.

Asset management research conducted at the University of Waterloo has identified that the concept of the risk related to public infrastructure requires more analysis. The current approach is to transpose risk methodologies used for private industries over to public infrastructure. This is difficult, if not impossible to do as the private sector is based on a for-profit model, and municipalities are not. Typical assets (e.g., machinery) owned by private industries are designed to last for a specific purpose and for a certain length of time. When the asset fails or becomes obsolete in its purpose (e.g., more efficient technology becomes available), it is replaced. The majority of public infrastructure (e.g. civil engineered) is designed differently, to survive certain one-off events, for example a once in 50 or 75 years natural disaster (e.g. storm, earthquake, flood, etc.). Public assets are not designed to fail, per se, rather their performance (level of service) declines over time to a level unacceptable to most stakeholders.

The asset management industry is gradually realizing that private sector framing of risk cannot simply be transposed onto the public sector, and prioritization of projects cannot occur under the assumption that engineers design infrastructure to fail. It is our belief that the Municipality of Brooke-Alvinston is one of the first municipalities in the world to minimize actual public infrastructure management risk by being able to quantify the performance of its entire infrastructure portfolio through The Brooke-Alvinston Infrallect asset management system, on an ongoing basis. Consequences of failure include under or overspending on infrastructure, which ultimately leads to suboptimal socioeconomic wellness of the community. Subsequently, according to asset management academics and professionals, the Municipality is ahead of the curve in understanding and managing public infrastructure risk.

In conclusion, the approach to risk concepts and application do not translate between established practice in the private sector and the public sector. This would require the changing of public sector logic all the way to and including linking risk to profit. Since municipalities are governmental, non-profit organizations, underpinning our society and standard of living, it is the application of risk mitigation that requires adjustment to meet municipal purposes. In collaboration with academic and private sector partners, the Municipality has done and continues to do this successfully.

6 Conclusion

In order to practice effective asset management as it applies to management of public infrastructure, building on top of existing organizational processes (rather than changing them) is necessary. The Municipality has risen to the challenge by putting forth the effort necessary to bridge gaps in asset management practices. Through collaboration with academic and private sector partners and based on feedback received, it is our belief that the Municipality of Brooke-Alvinston is a leader in asset management. Our success is due to our efforts to operationalize asset management and applying private sector asset management principles –not practice- to a public sector environment. The industry standard and approach has been to change the processes of the public sector in order to fit within the private sector's for-profit templates for lifecycle management activities, levels of service, and risk. However, in our experience, the path to success involves changing these preconceived templates through scientific research and professional knowledge, so that they are applicable to the public sector, without requiring the sector to change its nature.

According to the latest asset management research at the University of Waterloo, the Municipality has set a new industry standard for effective (i.e., scientific) asset management practice as it applies to the provision of public infrastructure. The key factors leading to this conclusion include, but are not limited to, the Municipality's:

- Level of information transparency prior to embarking on comprehensive asset management journey;
- Ability to absorb and apply the latest technologies and methods in asset management, as well as develop them;
- Ability to build on top of existing organizational processes;
- Ability to forecast short, mid, and long-term effects of decisions being contemplated today; and,
- Willingness to lead.

According to five years of asset management research at the University of Waterloo, the Municipality of Brooke-Alvinston is part of a handful of administrations globally – along with other partner municipalities - that is able to forecast performance of all of its infrastructure asset classes consistently and in a standardized manner. This is comparable to other industries such as banking, insurance, and consumer goods.

As is illustrated within this plan, the Municipality of Brooke-Alvinston is continuing to manage its assets in a responsible manner, notwithstanding typical municipal resource constraints and available funding sources. Decades of data collection and integrated planning for asset rehabilitation and replacement have resulted in systems that are well managed. The Municipality plans to continue this approach with ongoing improvements of infrastructure assets and updates to Brooke-Alvinston Infrallect.

7 Recommendations

For several years, the Municipality has built momentum in advancing municipal asset management principles and practices. It is recommended that the Municipality sustain this momentum along its charted path and continue to build on top of existing processes, as outlined in the 2023 AMP.

There are two general categories of activity to focus on:

- Improving efficiency of information flow from staff to the Brooke-Alvinston Infrallect by minimizing the necessary effort of staff that are already serving existing processes
- Improving sophistication of infrastructure performance and corresponding expenditure forecasts

Both will increase decision making effectiveness with respect to selecting the most appropriate infrastructure improvements and their timing. They will also contribute to solving one of the most difficult challenges for organizations in general, which is minimizing previously anticipated costs while achieving the same anticipated performance.

The Municipality is already working on further advancement of its asset management practice, by ensuring current processes are leveraged, rather than changed, in supporting new ones. This approach continues to be an essential strategy to success.

Advanced asset management practice is an equal partnership between SMEs (operation and maintenance staff), engineering, finance, senior management, and elected officials. The ability of the Municipality's staff to work together in cross-functional teams will continue to be the key to success.

8 Appendices

8.1 Appendix A: Strategic Asset Management Policy

Strategic Asset Management Policy

Purpose:

The purpose of the policy is to guide the municipal process of infrastructure asset management planning.

Goal:
The goal of the policy is to help the Municipality of Brooke-Alvinston provide an optimal environment for the community's socio-economic well-being, by allowing the municipal administration to allocate infrastructure funding according to expected infrastructure asset performance (level of service) over time.
Articles:

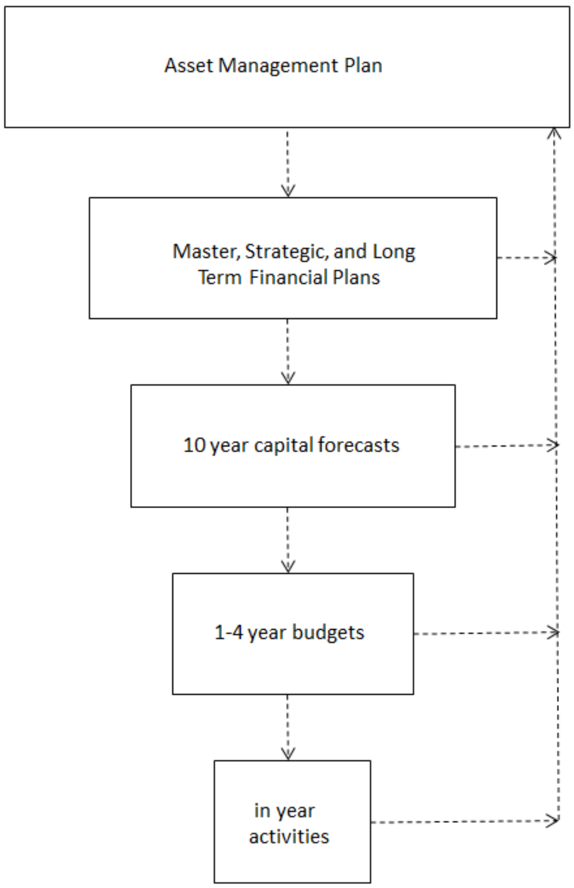
1. The Asset Management Plan is to be the starting and terminal point of financial, engineering, and administrative activities regarding municipal infrastructure assets needs and allocations. This includes, but is not limited to, the development and maintenance of: master plans, strategic plans, long-term financial plans, policies, capital and operational budgets, and multi-year forecasts. Schedule 1 provides a schematic of the relationship between the documents.
2. The Asset Management Plan development process is to be built on top of the existing organizational processes. This will minimize the necessary time and effort to full asset management implementation (operationalization) within the Municipality. Schedule 2 provides the Operationalizing Asset Management Framework.
3. Upon exhausting internal capacities, the Municipality will pro-actively seek assistance from appropriate academic, private, public, and non-profit service providers in order to continuously improve and adopt appropriate asset management planning practices.
4. The following principles are to be considered in practicing asset management planning:
    a. 25 – year performance (level of service) and corresponding expenditure graphs are to be created for each asset class (category), as well as, for all asset classes (categories) aggregated into one.
    b. Performance (level of service) measures break down into four main categories,
        i. conditional - defined by professionals
        ii. conditional - defined by public (e.g. citizenry)
        iii. functional - defined by professionals
        iv. functional - defined by public (e.g. citizenry)
    c. Performance measure (level of service indicator) development and future projections are to be based upon the following methods:
        i. Application of reliability (risk) theory to financial, engineering, and administrative information, and / or,
        ii. Application of asset inspection information, and / or,

        iii. Application of industry averages, and / or,
        iv. Application of asset age.
    d. Over time, the goal is to have performance (level of service) of all asset classes (categories) based upon the method in section c.i.
    e. An Asset Management System composed of the interaction between the organization (staff) and its technology (computer applications) is to be developed, implemented, and maintained.
    f. The Asset Management System is to be used to:
        i. Model assets' service cycles (life cycles)
        ii. Model 25 – year deterioration of all asset classes (categories) at the most granular (detailed) level of asset information inventory
        iii. Program 25 – year scenario(s) of improvement activities at the most granular (detailed) level of asset information inventory
        iv. Generate multi-year work plans
        v. Generate improvement activity – project sheets
    g. Infrastructure planning principles as per applicable provincial and federal legislation.
5. Asset management planning will consider climate change aspects as they relate to the management of infrastructure assets. This includes, but is not limited to:
    a. Identifying vulnerable assets at the most granular (detailed) level of asset information inventory
    b. Capturing climate change items (e.g., greenhouse gas emission scenarios) in 25 – year programming of infrastructure improvement activities
    c. Developing infrastructure performance (level of service) vs. expenditure scenarios, which include sensitivity analysis of disaster planning items, and climate change mitigation and adaptation factors.
6. As per Article 4, asset management planning will address Municipality relevant information provided in any of the following:
    a. Applicable land-use planning framework,
    b. *Municipal Government Act,*
    c. Provincial plans as defined by the *Municipal Government Act*, and
    d. Municipality's official plan.
7. Each asset class (category) is composed of numerous more granular components or aggregates of municipal infrastructure assets that provide the same type of service attributed to the defined asset classes (categories). Should the replacement value of a new asset class (category), of a different type of service other than of already established ones, surpass a capitalization threshold of $ 10,000, the new asset class (category) is to be included within the municipal asset management plan.
8. As per Article 4, asset management planning will address Brooke-Alvinston relevant information of connected or interrelated public infrastructure assets of other communities, public organizations, and levels of government.
9. All positions with the organization are responsible for asset management planning to varying extents. The Chief Administrative Officer, Treasurer, and Public Works Manager are the leaders of this team effort, or their functional equivalents depending on size of organization.
10. Council's role is to increase asset management awareness at the elected officials' level of the organization and collaborate with municipal staff through already established

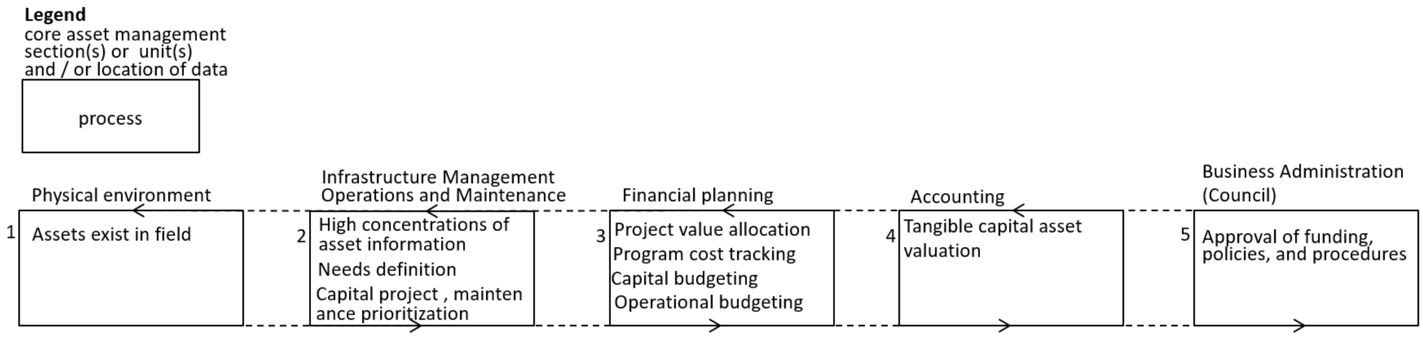
communicative and authoritative responsibilities of respective departments and positions.

11. Public input is to be obtained through a public engagement effort on asset management. The results of which should readily be incorporated through Article 4.

Schedule 1 – Documental Asset Management Framework



Schedule 2 – Operationalizing Asset Management Framework



8.2 Appendix B: Core Assets

O. Reg. 588/17 has identified five asset groups that are considered to be core assets and requires municipalities to make informed decisions based on standard and consistent data. For the Municipality, these asset groups include roads, sanitary collection, water distribution, stormwater collection, bridges, and culverts.

8.2.1 Roads

8.2.1.1 What do we own and what is it worth?

Please refer to section 5.1.1 for general context and appropriate asset management interpretation of this section's specifics.

The Municipality's road network is comprised of approximately 88 lane-km of paved roads (44 center line km), and 452 lane-km of gravel roads (226 center line km). The combined replacement value of these assets is estimated to be $83,904,280; $35,163,721 paved and $48,740,559 gravel roads.

8.2.1.2 Allocation of Infrastructure Funding

Please refer to section 5.1.2 for general context and appropriate asset management interpretation of this section's specifics.

The estimated distribution of the funding is shown in **Figure 8**, with an annual average of approximately $497,409.

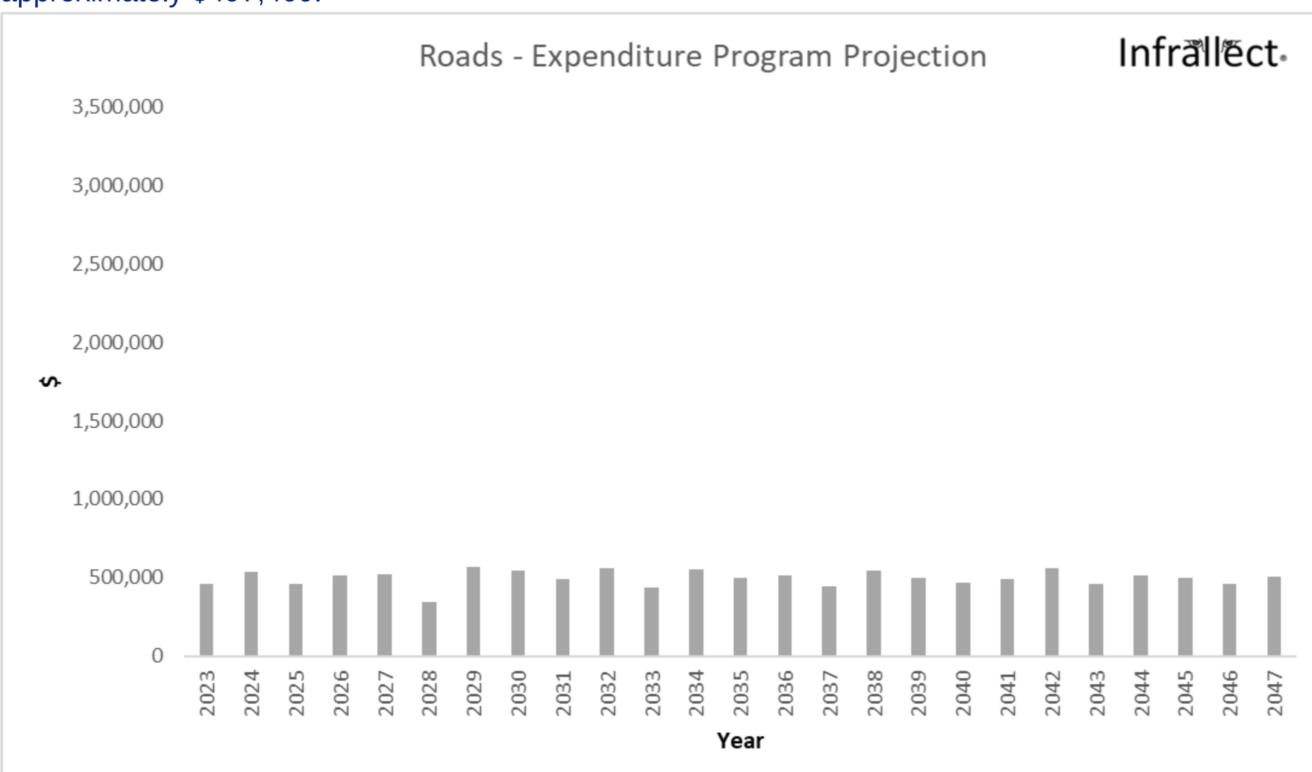


Figure 8: Capital Funding Distribution for Roads

8.2.1.3 Rehabilitation or Replacement Strategies

Please refer to section 5.1.3 for general context and appropriate asset management interpretation of this section's specifics.

In order to maximize spending effectiveness, the Municipality's current strategy is to replace roads in coordination with the replacement of other subsurface infrastructure, such as sanitary or storm sewers. Roads are typically rehabilitated (rather than replaced) when there are no other subsurface infrastructure assets that require replacement. Other considerations are also incorporated into the decisions to replace or rehabilitate a road, such as the timing of proposed developments.

8.2.1.4 Lifecycle Management Activities

Please refer to section 5.1.4 for general context and appropriate asset management interpretation of this section's specifics.

Roads are civil and environmental engineered assets; they have unique factors that inform their lifecycle management activities. Examples include surface distresses, pavement condition, traffic, trip hazards, active transportation considerations, etc. which influence the timing and type of treatment utilized. These various types of treatments have been incorporated into both the budget scenario and target scenario.

For Road maintenance the following lifecycle management activity options exist, but are not limited to:

- Pothole repair
- Crack sealing
- Slurry seal
- Surface asphalt layer removal and replacement (resurfacing)

For Road rehabilitation the following lifecycle management activity options exist, but are not limited to:

- Surface layer and portion of underlying asphalt layer removal and replacement (resurfacing)
- All asphalt layers removal and replacement
- Cold-in-place asphalt recycling
- Hot-in-place asphalt recycling
- Full depth pavement (asphalt and granular) reclamation

For road reconstruction or replacement scenarios, the following lifecycle management activity options exist, but are not limited to:

- Removal of all existing asphalt and granular layers and replacement with new layers

Sidewalks:

The Municipality's sidewalk network is approximately three (3) km long. The combined replacement value of these assets is estimated to be $488,393.

For Sidewalk maintenance the following lifecycle management activity options exist, but are not limited to:

- Elimination of "step-ups" or "step-downs" between sidewalk sections
- Crack sealing

For Sidewalk rehabilitation the following lifecycle management activity options exist, but are not limited to:

- Replacing a few sections within a sidewalk segment

For Sidewalk reconstruction or replacement, the following lifecycle management activity options exist, but are not limited to:

- Removal of sidewalk segments and replacement with new ones, typically done in conjunction with Road improvement projects

Road Illumination:

The Municipality's road illumination network contains more than 156 poles and associated fixtures. The combined replacement value of these assets is estimated to be $407,500.

For Road Illumination maintenance the following lifecycle management activity options exist, but are not limited to:

- Illumination replacements as necessary

For Road Illumination rehabilitation the following lifecycle management activity options exist, but are not limited to:

- Illumination and arm replacements

For Road Illumination reconstruction or replacement, the following lifecycle management activity options exist, but are not limited to:

- Illumination, arm, pole, and/or base replacement

Brooke-Alvinston's Infrallect is used to forecast the Roads, Sidewalks, and Road Illumination asset class performance and corresponding expenditure over a 25-year span. Once the forecast activities are within the one to three year span, SMEs determine the appropriate treatment within the forecasted general categories above. In doing so, all available information relating to the items listed in **Table 5** and **Table 6** is considered by the SMEs in order to determine the treatment of optimal cost/benefit to the community. It is not atypical to adjust treatments and costs from the original forecast. This is because more information becomes available closer to the start of the project (i.e., through surveying, detailed design, etc.). However, the total projected performance and expenditure for the year are not impacted, because the limits of scientific forecasting occur at the aggregate level of asset class performance and spending.

8.2.1.5 Levels of Service

Please refer to section 5.1.5 for general context and appropriate asset management interpretation of this section's specifics.

8.2.1.5.1 Current Performance and Projected Impact of Budgeted Capital Expenditures

Figure 9 illustrates the anticipated performance distribution of road assets based on current information, deterioration rates and funding over the next 25 years. There are currently approximately 25% of roads assets within the poor performance category (i.e., a performance less than 0). The average annual budgeted capital expenditures of approximately $497,409 million will result in a degraded performance profile over the next 25 years that is anticipated to be unacceptable to most stakeholders.

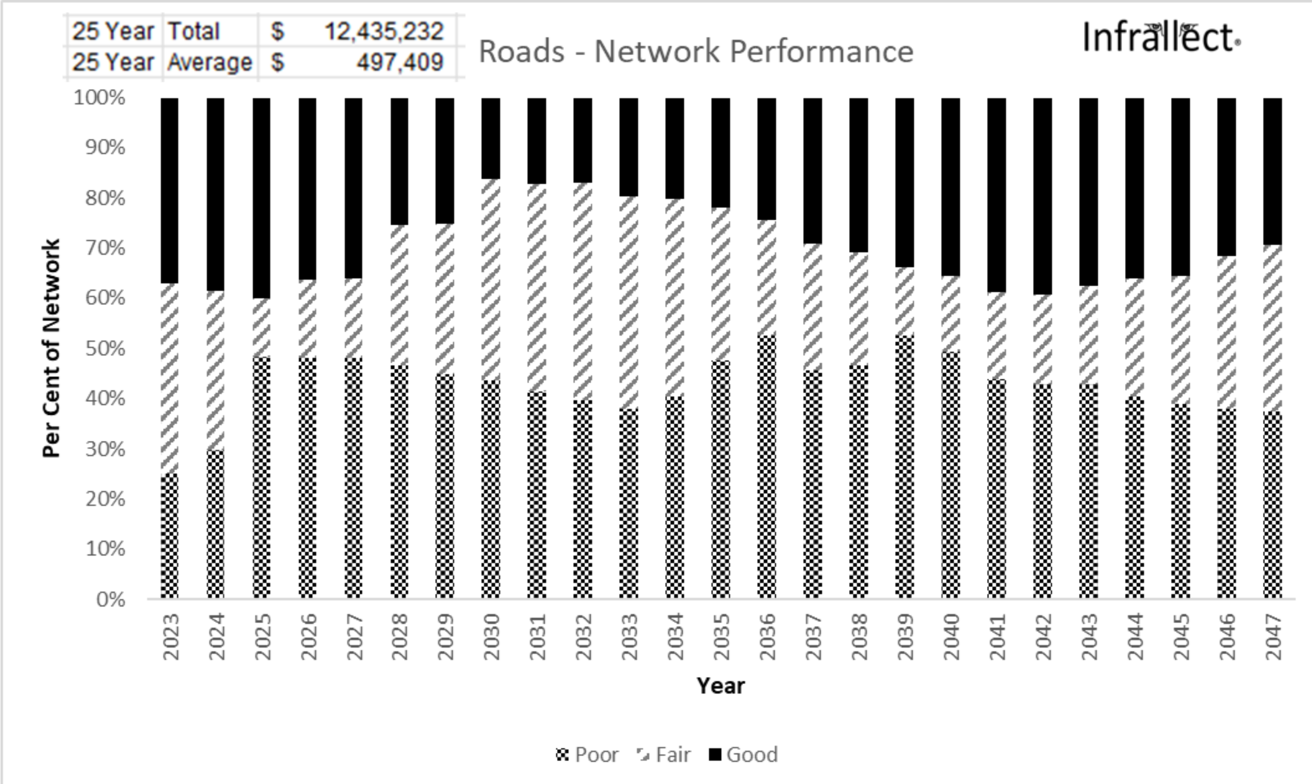


Figure 9: Annual Performance Distribution of Roads Assets in the Budget Scenario

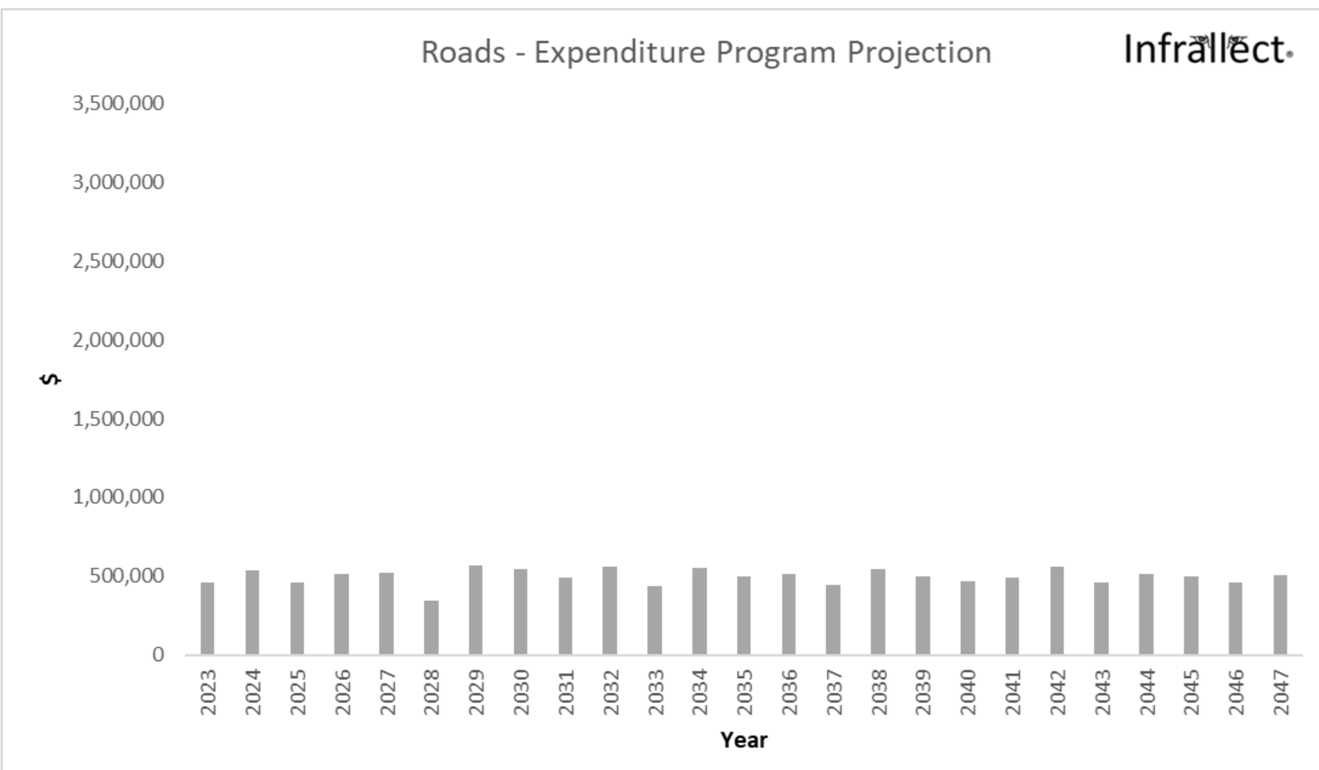


Figure 10: Corresponding Expenditure Forecast of Roads Assets in the Budget Scenario

Figure 11 illustrates the anticipated performance distribution of sidewalk assets based on current information, deterioration rates and funding over the next 25 years. There are currently approximately 20% of sidewalk assets within the poor performance category (i.e., a performance less than 0). The average annual budgeted capital expenditures of approximately $19,989 million will result in an improvement in the performance profile over the next 25 years that is anticipated to be acceptable to most stakeholders.

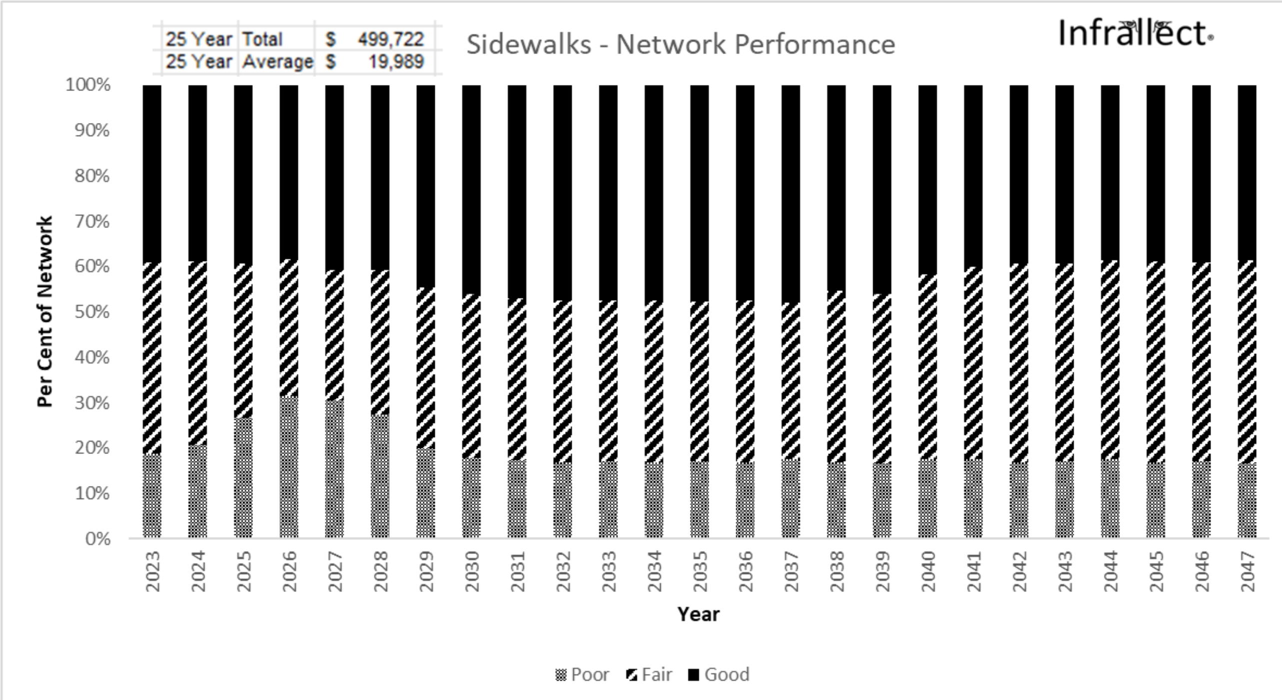


Figure 11: Annual Performance Distribution of Sidewalks Assets in the Budget Scenario

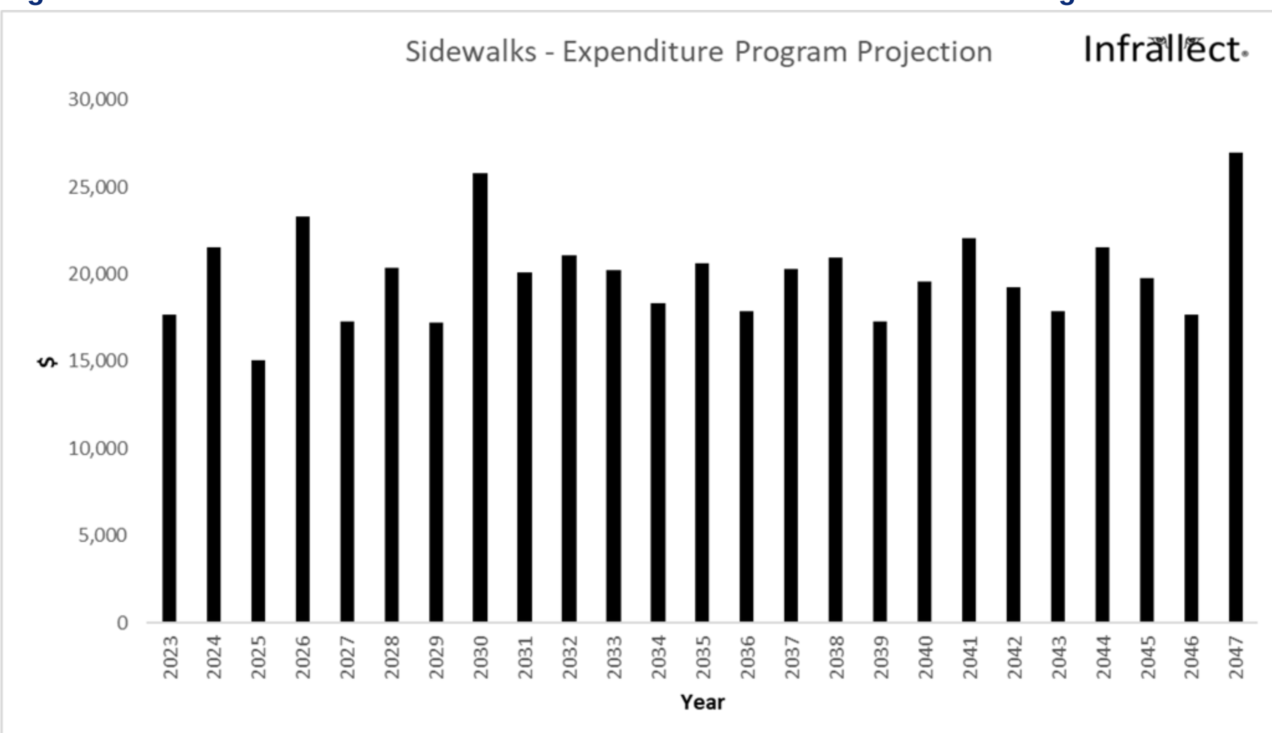


Figure 12: Corresponding Expenditure Forecast of Sidewalks Assets in the Budget Scenario

Figure 13: Annual Performance Distribution of Road Illumination Assets in the Budget Scenario illustrates the anticipated performance distribution of road illumination assets based on current information, deterioration rates and funding over the next 25 years. There are currently approximately 0% of road illumination assets within the poor performance category (i.e., a performance less than 0). The average annual budgeted capital expenditures of approximately $12,397 million will result in an improvement in the performance profile over the next 25 years that is anticipated to be acceptable to most stakeholders.

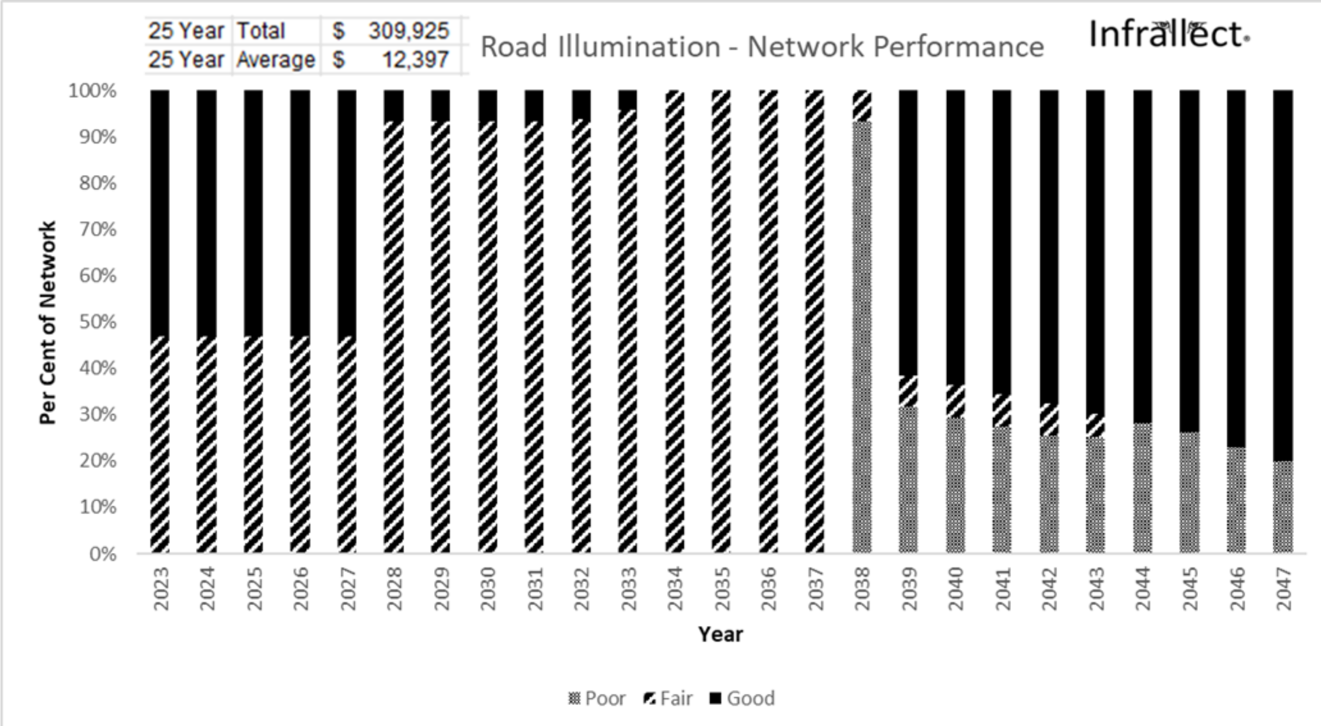


Figure 13: Annual Performance Distribution of Road Illumination Assets in the Budget Scenario

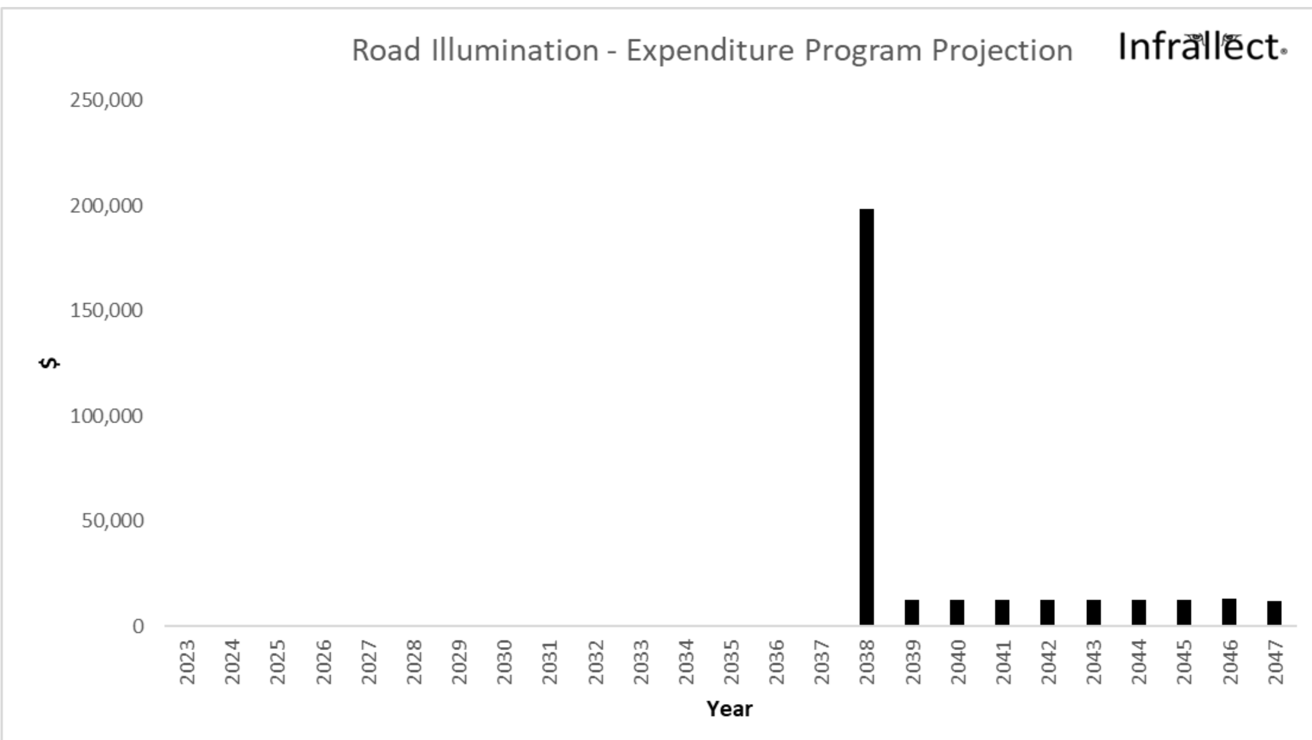


Figure 14: Corresponding Expenditure Forecast of Road Illumination Assets in the Budget Scenario

8.2.1.5.2 Target Performance and Required Expenditures

Roads:
In the target scenario, the proportion of the road assets exhibiting poor performance averages out to approximately 30% over the 25-year span as shown **Figure 15**. It is anticipated this level of performance will be acceptable to most stakeholders. The target scenario is an approximate 50% increase in forecast expenditure over the budget scenario, or $251,106 per annum. The Sidewalk and Road Illumination target scenarios are as per the budget scenario.

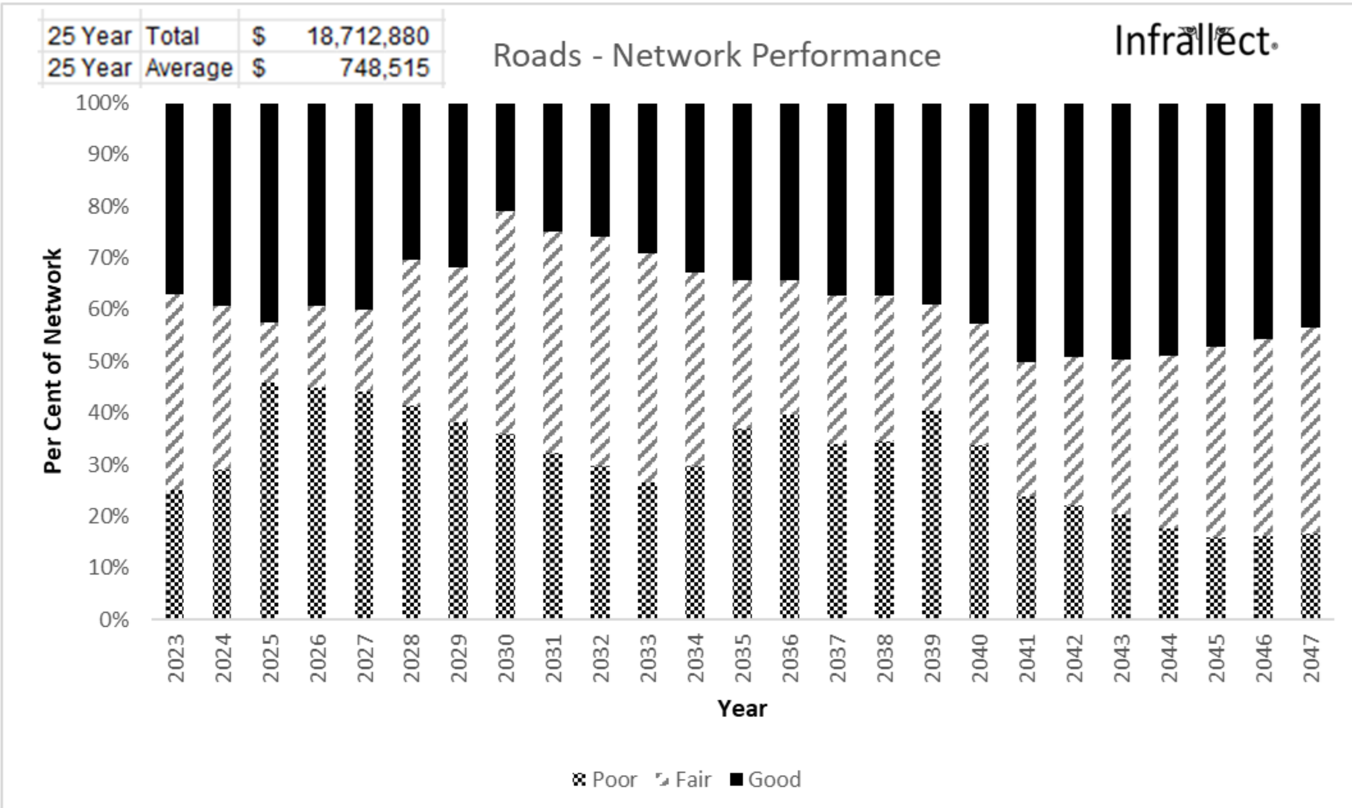


Figure 15: Annual Performance and Corresponding Expenditure of Roads Assets in the Target Scenario

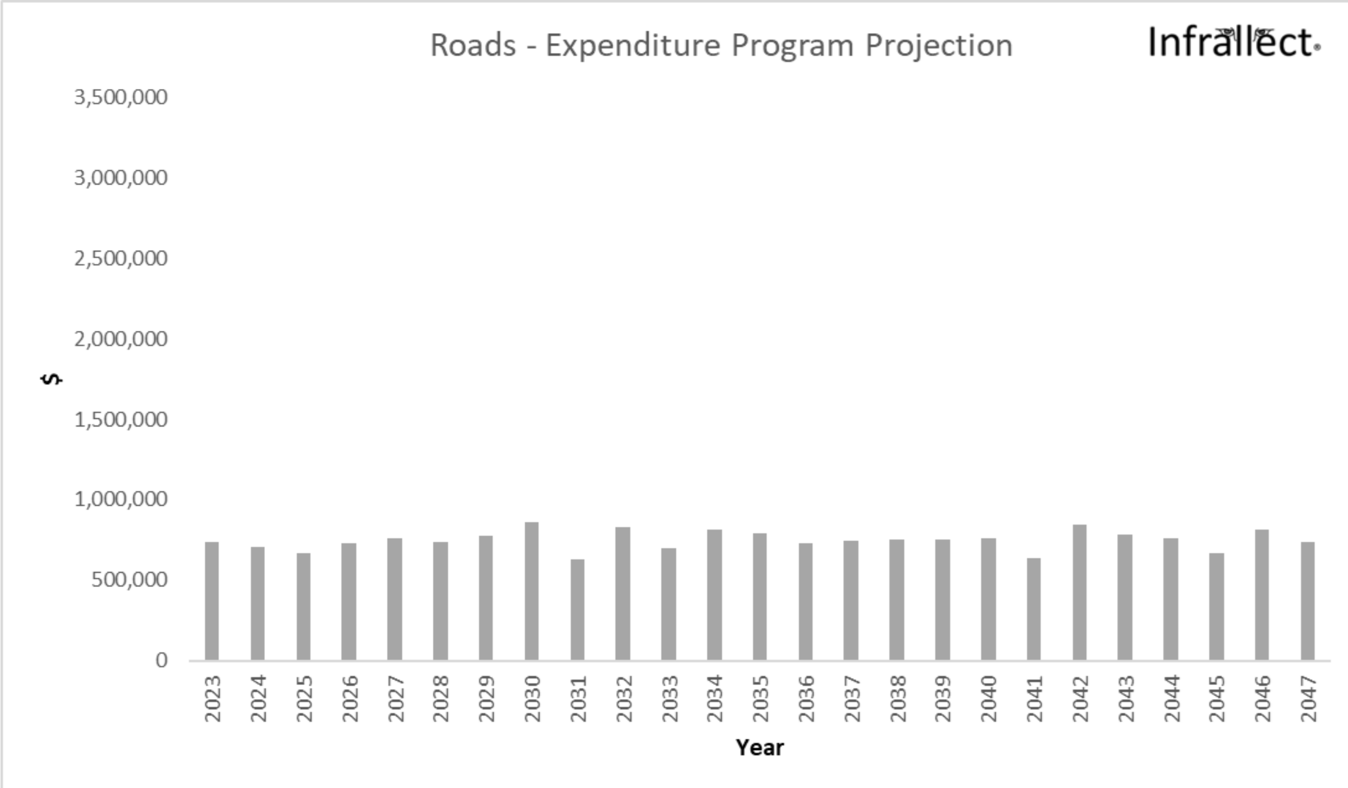


Figure 16: Corresponding Expenditure Forecast of Roads Assets in the Target Scenario

8.2.1.5.3 Ontario Regulation 588/17

A requirement for O. Reg. 588/17 is the reporting of the average age of assets. The following figures show the average age by road type.

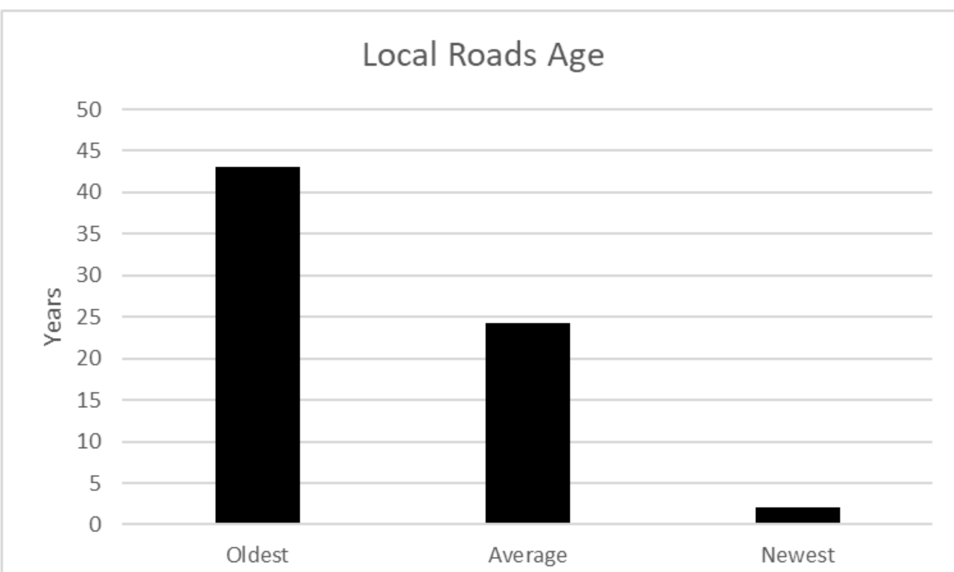


Figure 17: Average Age of Local Roads

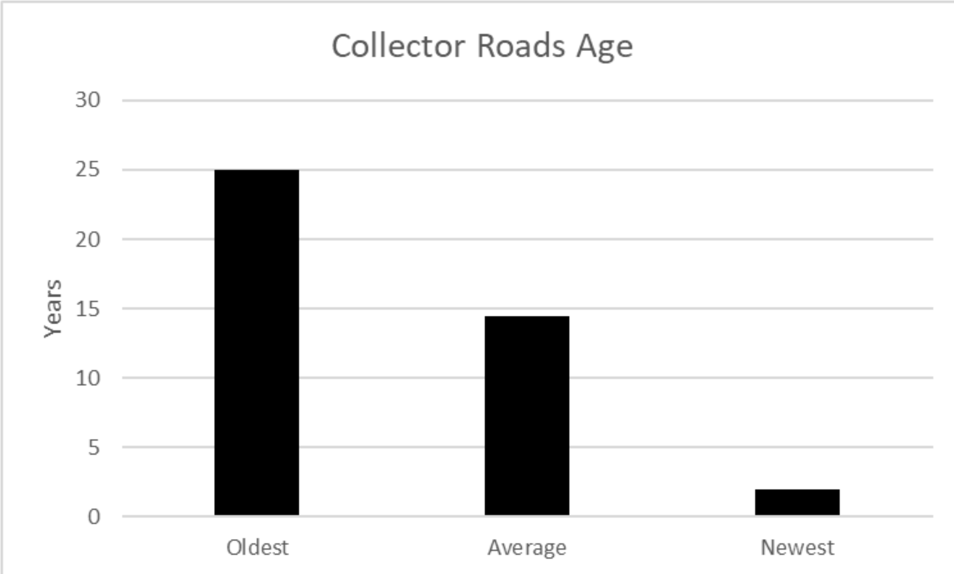


Figure 18: Average Age of Collector Roads

Service levels are defined in two terms, community levels of service and technical levels of service. O. Reg. 588/17 identifies specific metrics for core assets that municipalities must report on. As a core asset, road metrics are identified below in **Table 8** and **Table 9**.

Table 8: Roads Community Levels of Service Metrics

Service Attribute	*Community Levels of Service Measure*	*Community LOS Performance*
Scope	Description, which may include maps, of the road network in the municipality and its level of connectivity.	The Municipality of Brooke-Alvinston is a local-tier municipality within the County of Lambton and is interconnected by a network of Regional, Collector and Local roads, which facilitate travel between all areas of the Municipality.
Quality	Description or images that illustrate the different levels of road class pavement performance.	See **Table 10** for details.

Table 9: Roads Technical Levels of Service Metrics

Service Attribute	*Technical Level of Service Measure*	*2022*	*2023*
Scope	# of lane-kilometres of arterial roads as a proportion of square kilometres of land area of the municipality.	0.0	0.0
	# of lane-kilometres of collector roads as a proportion of square kilometres of land area of the municipality.	1.6	1.6
	# of lane-kilometres of local roads as a proportion of square kilometres of land area of the municipality.	0.08	0.08

Service Attribute	Technical Level of Service Measure	2022	2023
Quality	For paved roads in the municipality, the average pavement condition index value.	0.35 (fair)	0.30 (fair)
	For unpaved roads in the municipality, the average surface condition.	0.49 (fair)	0.49 (fair)

Table 10: Images of Pavement Performance

Pavement Performance	Description	Example
	• Offers a smooth ride • Is aesthetically pleasing • Has no cracks/minor cracks • Has good drainage • Has no patching • Performance value of 0.75-1	
Good	• Offers a smooth ride • Is aesthetically pleasing • Has minor cracks • Has good drainage • Has no patching • Performance of 0.5-0.74	
Fair	• Offers a decent ride • Has some cracks • Has patches • Repairs made but smooth • Has started to deteriorate • Resurfacing candidate • Performance of 0-0.49	

Pavement Performance	Description	Example
Poor	• Provides a bumpy ride • Has several patches • Has sunken manhole covers • Many cracks • Requires reconstruction • Performance of negative 0.01 to negative 0.24	
	• Provides a bumpy ride • Has several patches • Has sunken manhole covers • Many cracks • Has poor drainage • Top layer of asphalt is crumbling • Requires reconstruction • Performance less than or equal to negative 0.25	

8.2.1.6 Demand Management Plan

Please refer to section 5.1.6 for general context and appropriate asset management interpretation of this section’s specifics.

Demand for new services is driven by various factors such as population change, regulatory requirements, changes in demographics, seasonal factors, vehicle ownership rates, consumer preferences and expectations, technological changes, economic factors, and environmental awareness.

Demand will be managed through a combination of managing existing assets, upgrading existing assets, providing new assets, and demand forecasting. Demand management practices can include non-asset solutions, insuring against risks and managing performance.

The Brooke-Alvinston Infrallect will be used to assist Road SMEs in demand management planning.

8.2.1.7 Risk

Please refer to section 5.1.7 for general context and appropriate asset management interpretation of this section’s specifics.

Risk related to the Transportation asset class is managed through:

- SME knowledge and expertise

- Data-driven decision making
- Performance and expenditure forecasting

This three-pronged approach ensures that Roads' Level of Service (i.e. performance) supports the community's socioeconomic growth over the short and long term. The Brooke-Alvinston Infrallect asset management system allows staff to ensure that the future probability of underperforming infrastructure and its consequences is minimized.

In addition to their inherent SME expertise, in order to minimize risk, SMEs always consider a wide range of factors during infrastructure decision-making processes, the core of which are included in **Table 6**. All corporate information related to Roads asset management is centralized within Brooke-Alvinston Infrallect, allowing staff to make comprehensive and informed decisions. The ability to forecast the effects of contemplated decisions increases the reliability of the infrastructure's future performance.

8.2.1.8 Conclusion and Next Steps

The difference between Budget (existing) and Target Levels of Service (i.e., infrastructure performance) over the next 25 years is relatively high when compared to other asset classes. In order to remedy the performance gap, it is estimated that an additional $251,106 per annum is required. **Table 11** contains a further breakdown.

Table 11: Summary of Roads Assets

Asset Group	*Average Annual Planned Expenditures*	*Expenditures Required to Achieve the Target Performance*	*Average Annual Funding Gap*
Roads	$497,409	$748,515	$251,106
Sidewalks	$19,898	$19,898	$0
Road Illumination	$12,397	$12,397	$0

*Note: Values may not add exactly due to rounding.

In order to ensure management of Roads assets continues to be optimal, future asset management steps will aim to find the most efficient means of working towards remedying the performance gap.

Strategic steps will include:

- Continuous effort in increasing performance data collection capabilities
- Continuous improvement of Brooke-Alvinston Infrallect analysis capabilities
- Continuous improvement of forecasting logic
- Corporate awareness and training

Tactical steps will include:

- Minimizing impact on staff time with respect to sharing information required for the Brooke-Alvinston Infrallect
- Increasing awareness of the difference between project level (most granular asset inventory) and network (asset class) level application of asset management principles
- Increasing awareness of general forecasting principles

Operational steps will include:

- Where applicable, developing data collection templates and means
- Continuous engagement with SMEs on progress
- Improving consumer-based modelling parameters

8.2.2 Sanitary Sewer

8.2.2.1 What do we own and what is it worth?

Please refer to section 5.1.1 for general context and appropriate asset management interpretation of this section's specifics.

The sanitary sewer collection network is comprised of approximately 27 km of pipes and three (3) sanitary wastewater pumping stations. The total replacement value of the sanitary network is approximately $20,932,200. The pipe network accounts for 92% of the replacement value of the sanitary sewer collection network; the sanitary wastewater pumping stations account for the other 8% of the replacement value. The pumping stations, and wastewater treatment plan are captured under the Facilities assets class.

8.2.2.2 Allocation of Infrastructure Funding

Please refer to section 5.1.2 for general context and appropriate asset management interpretation of this section's specifics.

Existing sanitary sewers budget and target scenarios do not currently include capital expenditure requirements.

8.2.2.3 Rehabilitation or Replacement Strategies

Please refer to section 5.1.3 general context and appropriate asset management interpretation of this section's specifics.

- Sanitary sewers
  Can be either rehabilitated or replaced. The current strategy in Brooke-Alvinston is to replace sanitary sewers that are in poor (i.e., a forecasted performance less than zero (0), with confirmed deterioration information) in coordination with the replacement of the road surface and other subsurface infrastructure, such as watermains or storm sewers.

- Sanitary wastewater pumping stations
  Are rehabilitated on an as-needed basis as components in each facility reach the end of their useful life (i.e., reach a performance of zero (0)).

8.2.2.4 Lifecycle Management Activities

Please refer to section 5.1.4 for general context and appropriate asset management interpretation of this section's specifics.

For Sanitary pipe maintenance the following lifecycle management activity options exist, but are not limited to:

- Flushing
- Spot repair

For Sanitary pipe rehabilitation the following lifecycle management activity options exist, but are not limited to:

- Lining

For Sanitary pipe reconstruction or replacement, the following lifecycle management activity options exist, but are not limited to:

- Replacement

For Sanitary Pumping Station maintenance, the following lifecycle management activity options exist, but are not limited to:

- Scheduled maintenance (Inspect, clean, lubricate)

- Unclogging pump

For Sanitary Pumping Stations rehabilitation, the following lifecycle management activity options exist, but are not limited to:

- Pump parts refurbishment
- Pump parts replacement

For Sanitary Pumping Station replacement, the following lifecycle management activity options exist, but are not limited to:

- Pump replacement

The Brooke-Alvinston Infrallect is used to forecast the Sanitary asset class performance and corresponding expenditure over a 25-year span. Once the forecast activities are within the one to three year span, SMEs determine the appropriate treatment within the forecasted general categories above. In doing so, all available information relating to the items listed in **Table 5** and **Table 6** is considered by the SMEs in order to determine the treatment of optimal cost/benefit to the community. It is not atypical to adjust treatments and costs from the original forecast. This is because more information becomes available closer to the start of the project (i.e., through surveying, detailed design, etc.). However, the total projected performance and expenditure for the year are not impacted. This is because the limits of scientific forecasting occur at the aggregate level of asset class performance and spending.

8.2.2.5 Levels of Service

Please refer to section 5.1.5 for general context and appropriate asset management interpretation of this section's specifics.

8.2.2.5.1 Current Performance and Projected impact of Budgeted Capital Expenditures

There are currently zero (0) sanitary sewer collection assets exhibiting poor performance profiles as shown in **Figure 19**. Maintenance as necessary is to be expected, however, capital treatment of existing pipes is currently not in the forecast.

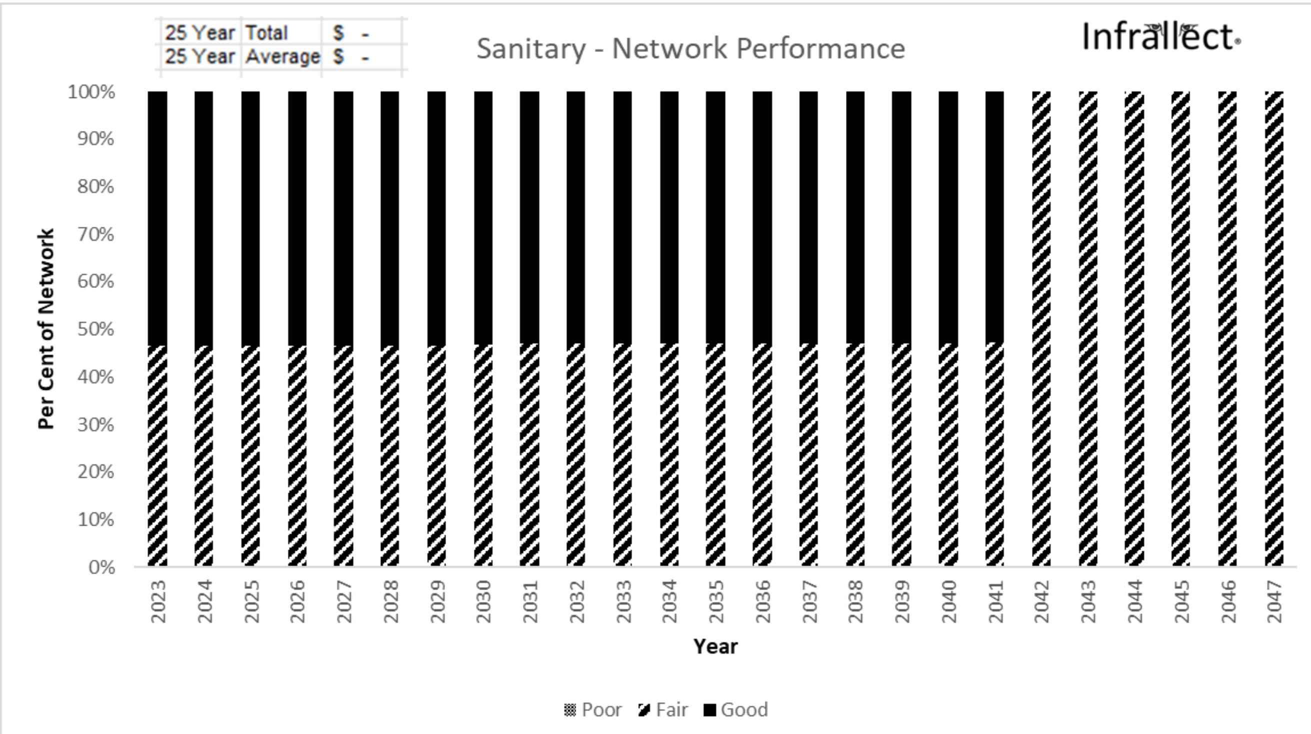


Figure 19: Annual Performance of Sanitary Pipe Assets in the Budget Scenario

8.2.2.5.2 Target Performance and Required Expenditures

As per budget scenario.

8.2.2.5.3 Ontario Regulation 588/17

A requirement for O. Reg. 588/17 is the reporting of the average age of assets. The following figures show the average age of the pipe network and pumping stations, respectively.

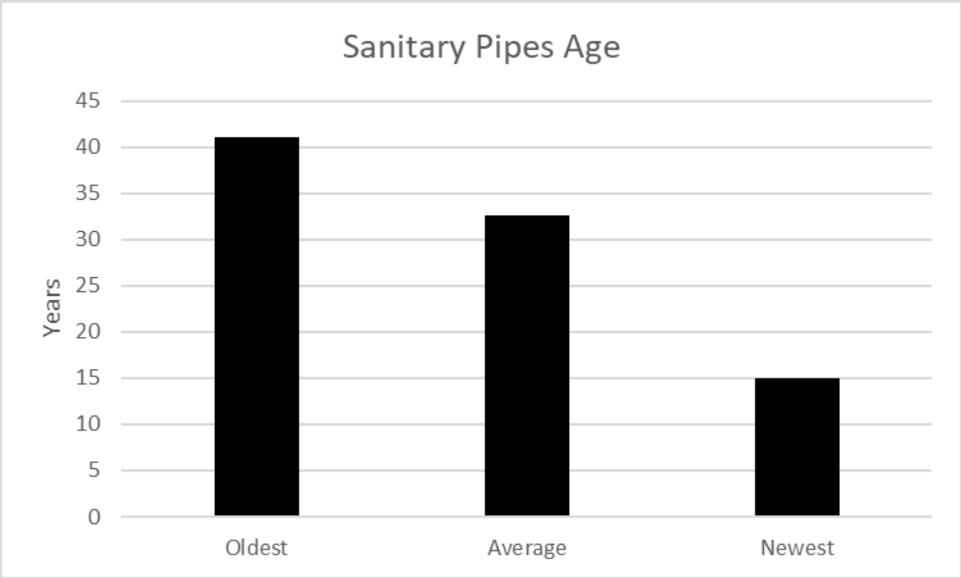


Figure 20: Average Age of Sanitary Pipes

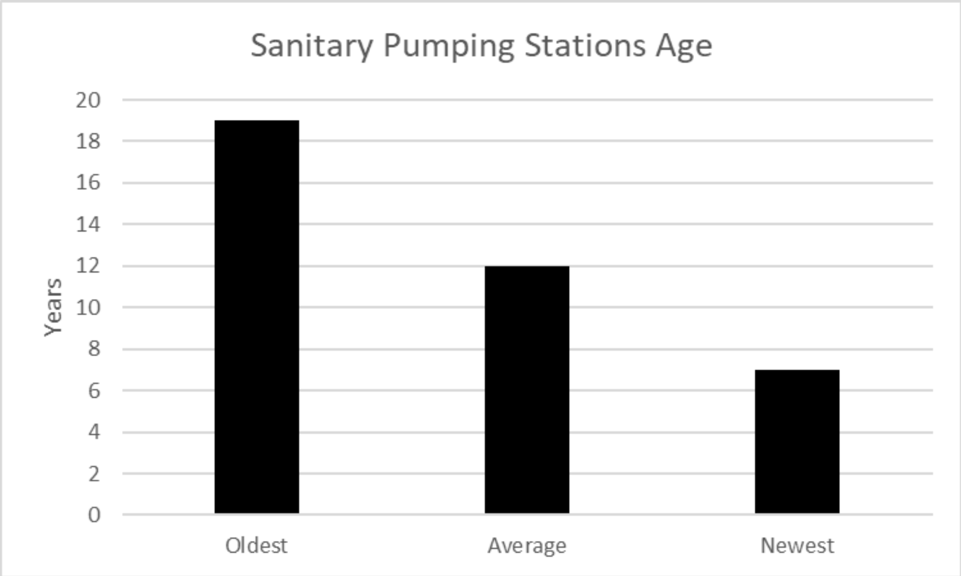


Figure 21: Average Age of Sanitary Pumping Stations

Service levels are defined in two terms, community levels of service and technical levels of service. O. Reg. 588/17 identifies specific metrics for core assets that municipalities must report on. As a core asset, sanitary metrics are identified below in **Table 12** and **Table 13.**

Table 12: Sanitary Sewer Community Levels of Service Metrics

Service Attribute	Community Level of Service Measure	Community LOS Performance
Scope	Description, which may include maps, of the user groups or areas of the municipality that are connected to the municipal wastewater system.	The Municipality of Brooke-Alvinston provides wastewater collection to most properties within the urban areas while all rural areas are serviced by private septic systems except for the public school.
Reliability	Description of how stormwater can get into sanitary sewers in the municipal wastewater system, causing sewage to overflow into streets or homes.	Stormwater may enter the sanitary sewer through multiple sources: • Groundwater may enter sanitary sewers through defective pipe joints; • Broken pipes in areas with high groundwater elevation; • Through sump pump or roof drain connections All of the aforementioned sources could lead to an increased flow to the wastewater treatment plant.
	Description of how sanitary sewers in the municipal wastewater system are designed to be resilient to avoid events described above.	Brooke-Alvinston has a separate sanitary sewer system to prevent stormwater entering the wastewater system.

Table 13: Sanitary Sewer Technical Levels of Service Metrics

Service Attribute	Technical Level of Service Measure	2022	2023
Scope	% of properties connected to the municipal wastewater system	27.0% (74% of urban properties)	27.0% (74% of urban properties)
Reliability	# of connection days per year due to wastewater backups compared to the total # of properties connected to the municipal wastewater system	0.0%	0.0%
	# of effluent violations per year due to wastewater discharge compared to the total # of properties connected to the municipal wastewater system	0.0%	0.0%

8.2.2.6 Demand Management Plan

Please refer to section 5.1.6 for general context and appropriate asset management interpretation of this section’s specifics.

Demand for new services is driven by various factors, such as population change, regulatory requirements, changes in demographics, seasonal factors, consumer preferences and expectations, technological changes, economic factors, and environmental awareness.

Demand will be managed through a combination of managing existing assets, upgrading existing assets, providing new assets, and demand forecasting. Demand management practices can include non-asset solutions, insuring against risks and managing performance.

The Brooke-Alvinston Infrallect will be used to assist Sanitary SMEs in demand management planning.

8.2.2.7 Risk

Please refer to section 5.1.7 for general context and appropriate asset management interpretation of this section's specifics.

Risk related to the Sanitary asset class is managed through:

- SME knowledge and expertise
- Data-driven decision making
- Performance and expenditure forecasting

This three-pronged approach ensures that the Sanitary Sewer's Level of Service (i.e., performance) supports the community's socioeconomic growth over the short and long term. The Brooke-Alvinston Infrallect allows staff to ensure that the future probability of underperforming infrastructure and its consequences is minimized.

In addition to their inherent expertise, in order to minimize risk, SMEs always consider a wide range of factors during infrastructure decision-making processes, the core of which are included in **Table 6**. All corporate information related to Sanitary asset management is centralized within the Brooke-Alvinston Infrallect, allowing staff to make comprehensive and informed decisions. The ability to forecast the effects of contemplated decisions increases the reliability of the infrastructure's future performance.

8.2.2.8 Conclusion and Next Steps

Currently, there are no differences between Budget (existing) and Target Levels of Service (i.e., infrastructure performance) over the next 25 years.

In order to ensure management of Sanitary assets continues to be optimal, future asset management steps will aim to find the most efficient means of working towards remedying the performance gap.

Strategic steps will include:

- Continuous effort in increasing performance data collection capabilities
- Continuous improvement of the Brooke-Alvinston Infrallect analysis capabilities
- Continuous improvement of forecasting logic
- Corporate awareness and training

Tactical steps will include:

- Minimizing impact on staff time with respect to sharing information required for the Brooke-Alvinston Infrallect
- Increasing awareness of the difference between project level (most granular asset inventory) and network (asset class level) application of asset management principles
- Increasing awareness of general forecasting principles

Operational steps will include:

- Where applicable, developing data collection templates and means
- Continuous engagement with SMEs on progress
- Improving consumer-based modelling parameters

8.2.3 Water Distribution

8.2.3.1 What do we own and what is it worth?

Please refer to section 5.1.1 for general context and appropriate asset management interpretation of this section's specifics.

The water distribution network is comprised of 27 km of pipes with associated valves and appurtenances. The total replacement value of the water distribution network is approximately $19,250,700.

8.2.3.2 Allocation of Infrastructure Funding

Please refer to section 5.1.2 for general context and appropriate asset management interpretation of this section's specifics.

The estimated distribution of the funding is shown in **Figure 22**, with an annual average of $14,542.

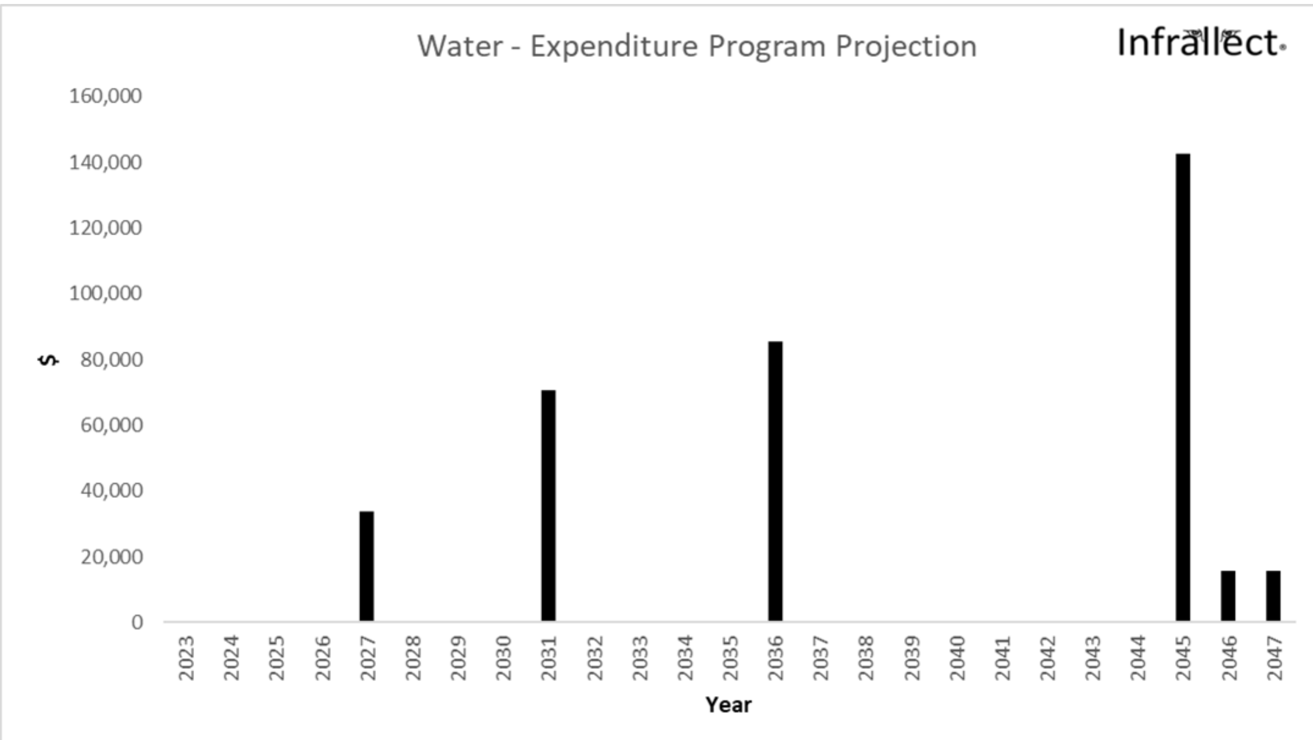


Figure 22: Capital Funding Distribution for Water Pipe Assets

8.2.3.3 Rehabilitation or Replacement Strategies

Please refer to section 5.1.3 for general context and appropriate asset management interpretation of this section's specifics.

- Watermains
  Can be either rehabilitated or replaced. The current strategy in Brooke-Alvinston is to replace watermains that experience a high number of breaks or that have a forecasted performance of zero (0), with confirmed deterioration information. The rehabilitation of watermains through the installation of a cured in place liner is not routinely practiced.

8.2.3.4 Lifecycle Management Activities

Please refer to section 5.1.4 for general context and appropriate asset management interpretation of this section's specifics.

For Water pipe maintenance the following lifecycle management activity options exist, but are not limited to:

- Flushing
- Spot repair

For Water pipe rehabilitation the following lifecycle management activity options exist, but are not limited to:

- Lining

For Water pipe reconstruction or replacement, the following lifecycle management activity options exist, but are not limited to:

- Replacement

The Brooke-Alvinston Infrallect is used to forecast the Water Distribution asset class performance and corresponding expenditure over a 25-year span. Once the forecast activities are within the one to three year span, SMEs determine the appropriate treatment within the forecasted general categories above. In doing so, all available information relating to the items listed in **Table 5** and **Table 6** is considered by the SMEs in order to determine the treatment of optimal cost/benefit to the community. It is not atypical to adjust treatments and costs from the original forecast. This is because more information becomes available closer to the start of the project (i.e., through surveying, detailed design, etc.). However, the total projected performance and expenditure for the year are not impacted. This is because the limits of scientific forecasting occur at the aggregate level of asset class performance and spending.

8.2.3.5 Levels of Service

Please refer to section 5.1.5 for general context and appropriate asset management interpretation of this section's specifics.

8.2.3.5.1 Current Performance and Projected impact of Budgeted Capital Expenditures

There are currently zero (0) water distribution assets exhibiting poor performance profiles as illustrated in **Figure 23**Error! Reference source not found.. The average annual budgeted capital expenditures of approximately $14,542 will maintain the performance profile over the next 25 years that is anticipated to be acceptable to most stakeholders.

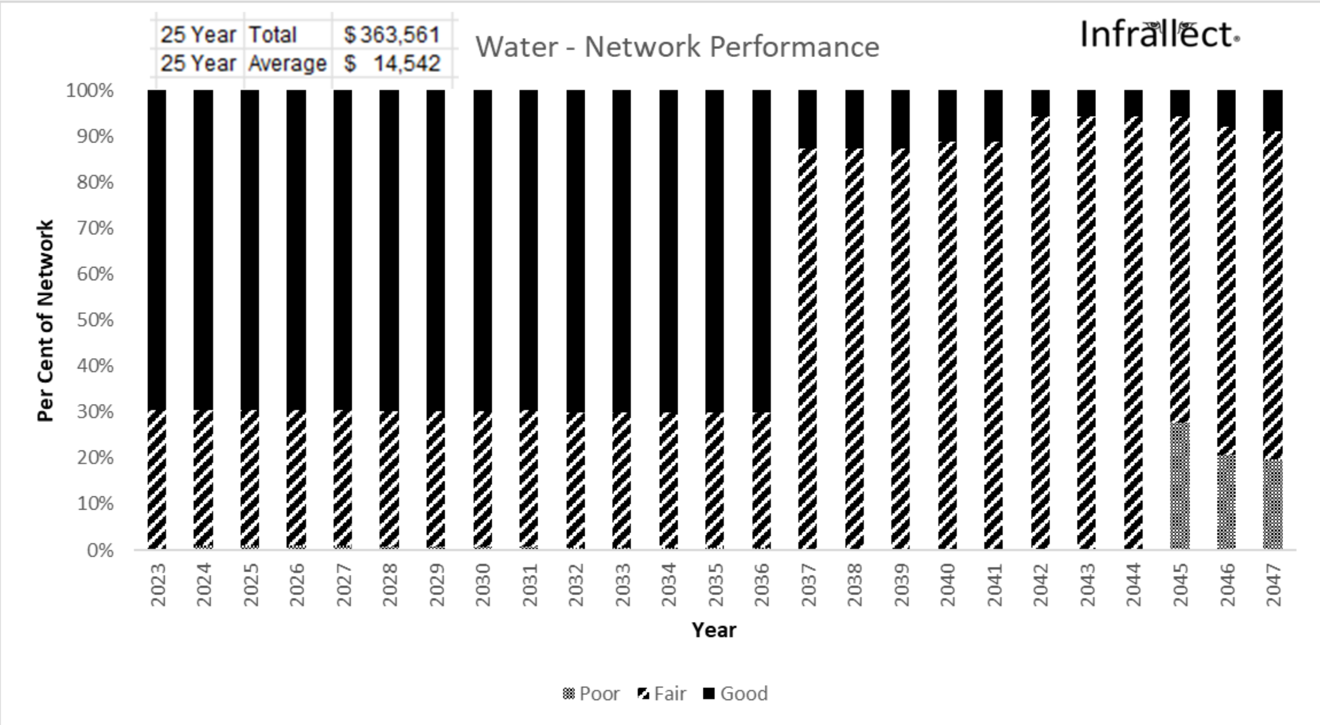


Figure 23: Annual Performance and Corresponding Expenditure of Water Assets in the Budget Scenario

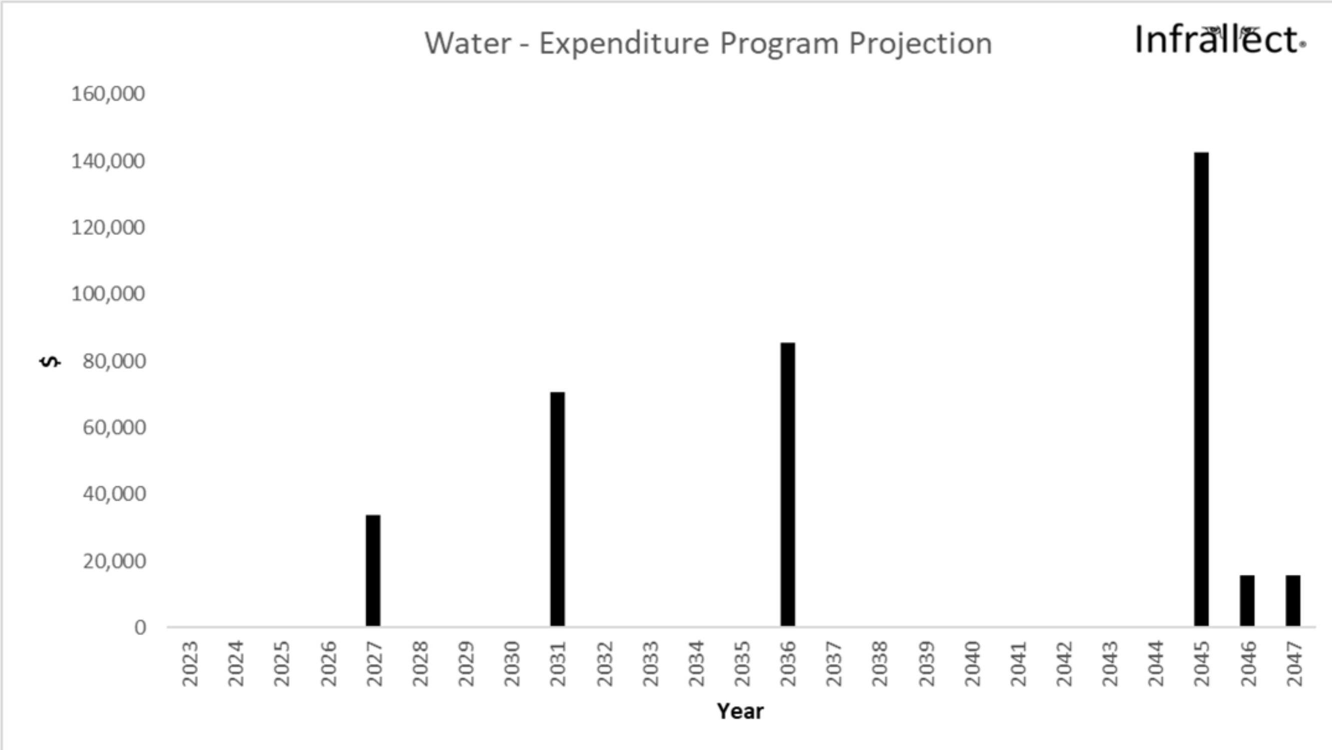


Figure 24: Corresponding Expenditure Forecast of Water Pipe Assets in the Budget Scenario

8.2.3.5.2 Target Performance and Required Expenditures

As per budget scenario.

8.2.3.5.3 Ontario Regulation 588/17

A requirement for O. Reg. 588/17 is the reporting of the average age of assets. **Figure 25** shows the average age for the water distribution pipe network.

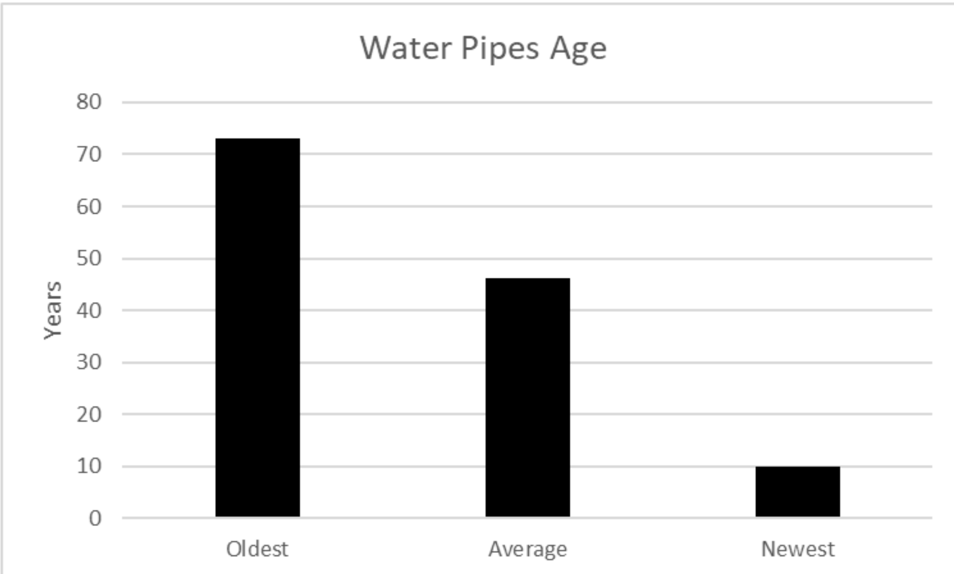


Figure 25: Average Age of Water Pipes Age

Service levels are defined in two terms, community levels of service and technical levels of service. O. Reg. 588/17 identifies specific metrics for core assets that municipalities must report on. As a core asset, water metrics are identified below in **Table 14** and **Table 15**.

Table 14: Water Community Level of Service Metrics

Service Attribute	Community Level of Service Measure	Community LOS Performance
Scope	Description, which may include maps, of the user groups or areas of the municipality that are connected to the municipal water system.	The Municipality provides drinking water to most properties within the urban areas while a small portion of the rural areas are serviced as well, but the majority rely on private wells.
Reliability	Description, which may include maps, of the user groups or areas of the municipality that have fire flow.	The majority of the Alvinston urban community has access to municipal drinking water and in turn adequate fire flow.
	Description of boil water advisories and service interruptions.	A boil water advisory is issued when contaminants are detected in the water supply and present an immediate public health threat. This excludes precautionary advisories due to operational activities to maintain service. A service interruption is a result of a failure in the Municipality managed water distribution system and excludes planned interruptions.

Table 15: Water Technical Levels of Service Metrics

Service Attribute	Technical Level of Service Measure	2022	2023
Scope	% of properties connected to the municipal water system.	23.40% (77% urban Alvinston)	23.40% (77% urban Alvinston)
	% of properties where fire flow is available	23.40%	23.40%
Reliability	# of connection days per year where a boil water advisory notice is in place compared to the total # of properties connected to the municipal water system.	0	0
	# of connection days per year due to water main breaks compared to the total # of properties connected to the municipal water system.	0	0

8.2.3.6 Demand Management Plan

Please refer to section 5.1.6 for general context and appropriate asset management interpretation of this section's specifics.

Demand for new services is driven by various factors such as population change, regulatory requirements, changes in demographics, seasonal factors, consumer preferences and expectations, technological changes, economic factors, and environmental awareness.

Demand will be managed through a combination of managing existing assets, upgrading existing assets, providing new assets, and demand forecasting. Demand management practices can include non-asset solutions, insuring against risks and managing performance.

The Brooke-Alvinston Infrallect will be used to assist Water SMEs in demand management planning.

8.2.3.7 Risk

Please refer to section 5.1.7 for general context and appropriate asset management interpretation of this section's specifics.

Risk related to the Water asset class is managed through:

- SME knowledge and expertise
- Data-driven decision making
- Performance and expenditure forecasting

This three-pronged approach ensures that Water's Level of Service (i.e. performance) supports the community's socioeconomic growth over the short and long term. The Brooke-Alvinston Infrallect allows staff to ensure that the future probability of underperforming infrastructure and its consequences is minimized.

In addition to their inherent expertise, in order to minimize risk, SMEs always consider a wide range of factors during infrastructure decision-making processes, the core of which are included in **Table 6**. All corporate information related to Water asset management is centralized within the Brooke-Alvinston Infrallect, allowing staff to make comprehensive and informed decisions. The ability to forecast the effects of contemplated decisions increases the reliability of the infrastructure's future performance.

8.2.3.8 Conclusion and Next Steps

Currently, there are no differences between Budget (existing) and Target Levels of Service (i.e., infrastructure performance) over the next 25 years.

In order to ensure management of Water assets continues to be optimal, future asset management steps will aim to find the most efficient means of working towards remedying the performance gap.

Strategic steps will include:

- Continuous effort in increasing performance data collection capabilities
- Continuous improvement of the Brooke-Alvinston Infrallect analysis capabilities
- Continuous improvement of forecasting logic
- Corporate awareness and training

Tactical steps will include:

- Minimizing impact on staff time with respect to sharing information required for the Brooke-Alvinston Infrallect
- Increasing awareness of the difference between project level (most granular asset inventory) and network (asset class) level application of asset management principles
- Increasing awareness of general forecasting principles

Operational steps will include:

- Where applicable, developing data collection templates and means
- Continuous engagement with SMEs on progress
- Improving consumer-based modelling parameters

8.2.4 Stormwater Management

8.2.4.1 What do we own and what is it worth?

Please refer to section 5.1.1 for general context and appropriate asset management interpretation of this section's specifics.

The Municipality's stormwater infrastructure consists of a sewer network that is approximately 15 km long, with an estimated replacement value of $10,666,728.

8.2.4.2 Allocation of Infrastructure Funding

Please refer to section 5.1.2 for general context and appropriate asset management interpretation of this section's specifics.

The forecast distribution of the funding is shown in **Figure 26**, averaging $24,954 per annum.

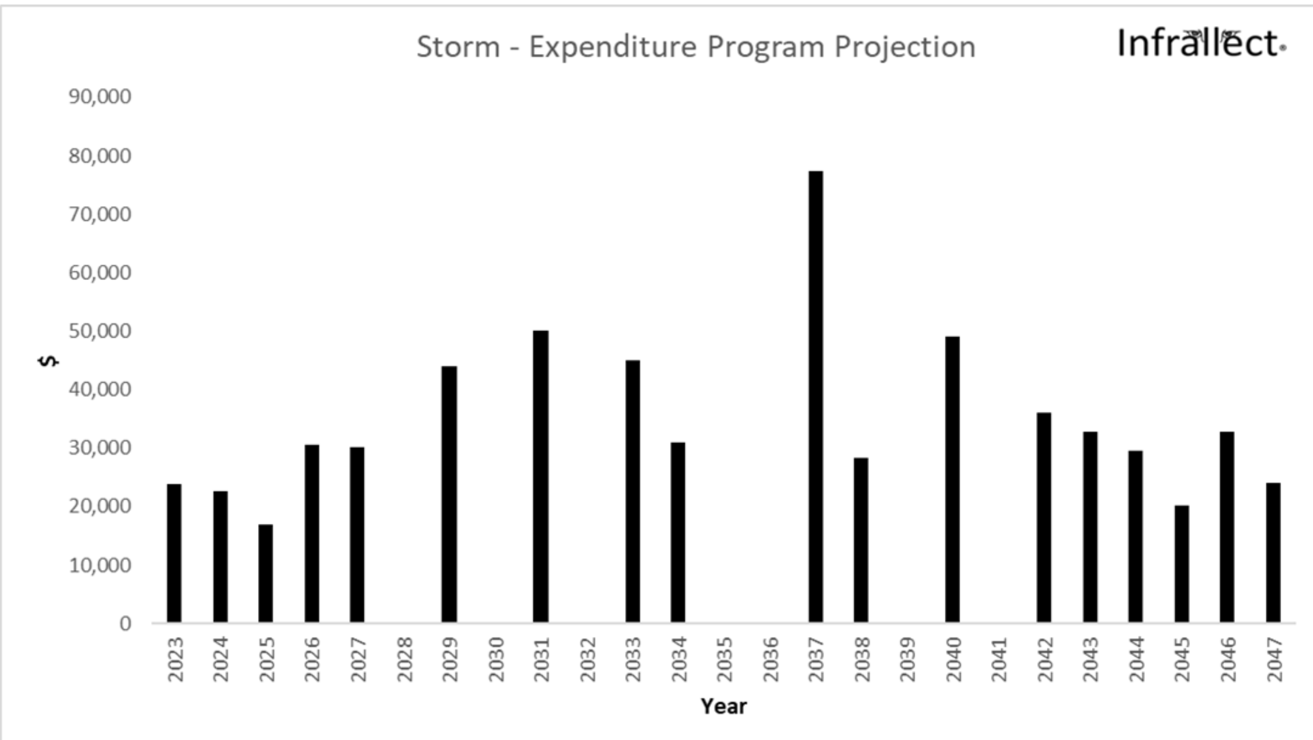


Figure 26: Capital Funding Distribution for Storm Pipes

8.2.4.3 Rehabilitation or Replacement Strategies

Please refer to section 5.1.3 for general context and appropriate asset management interpretation of this section's specifics.

- Storm sewers

  Can be either rehabilitated or replaced. The current strategy in Brooke-Alvinston is to replace storm sewers that have a forecasted performance of zero (0), with confirmed deterioration information. They are generally replaced during road reconstruction works. As work to rehabilitate roads is undertaken, linear storm needs to be addressed as necessary. Storm sewers are not typically rehabilitated in Brooke-Alvinston, as there is currently limited in-situ condition information to help decide when this renewal strategy is appropriate.

8.2.4.4 Lifecycle Management Activities

Please refer to section 5.1.4 for general context and appropriate asset management interpretation of this section's specifics.

For Stormwater pipe maintenance the following lifecycle management activity options exist, but are not limited to:

- Flushing
- Spot repair

For Stormwater pipe rehabilitation the following lifecycle management activity options exist, but are not limited to:

- Lining

For Stormwater pipe reconstruction or replacement, the following lifecycle management activity options exist, but are not limited to:

- Replacement

Brooke-Alvinston's Infrallect is used to forecast the Stormwater asset class performance and corresponding expenditure over a 25-year span. Once the forecast activities are within the one to three year span, SMEs determine the appropriate treatment within the forecasted general categories above. In doing so, all available information relating to the items listed in **Table 5 and Table 6** is considered by the SMEs in order to determine the treatment of optimal cost/benefit to the community. It is not atypical to adjust treatments and costs from the original forecast. This is because more information becomes available closer to the start of the project (i.e., through surveying, detailed design, etc.). However, the total projected performance and expenditure for the year are not impacted. This is because the limits of scientific forecasting occur at the aggregate level of asset class performance and spending.

8.2.4.5 Levels of Service

Please refer to section 5.1.5 for general context and appropriate asset management interpretation of this section's specifics.

8.2.4.5.1 Current Performance and Projected impact of Budgeted Capital Expenditures

There are currently about 25% of linear storm collection assets exhibiting poor performance. The average annual budgeted capital expenditures of approximately $24,954 will result in a performance profile over the next 25 years that is anticipated to be unacceptable to most stakeholders. **Figure 27** shows the performance profile.

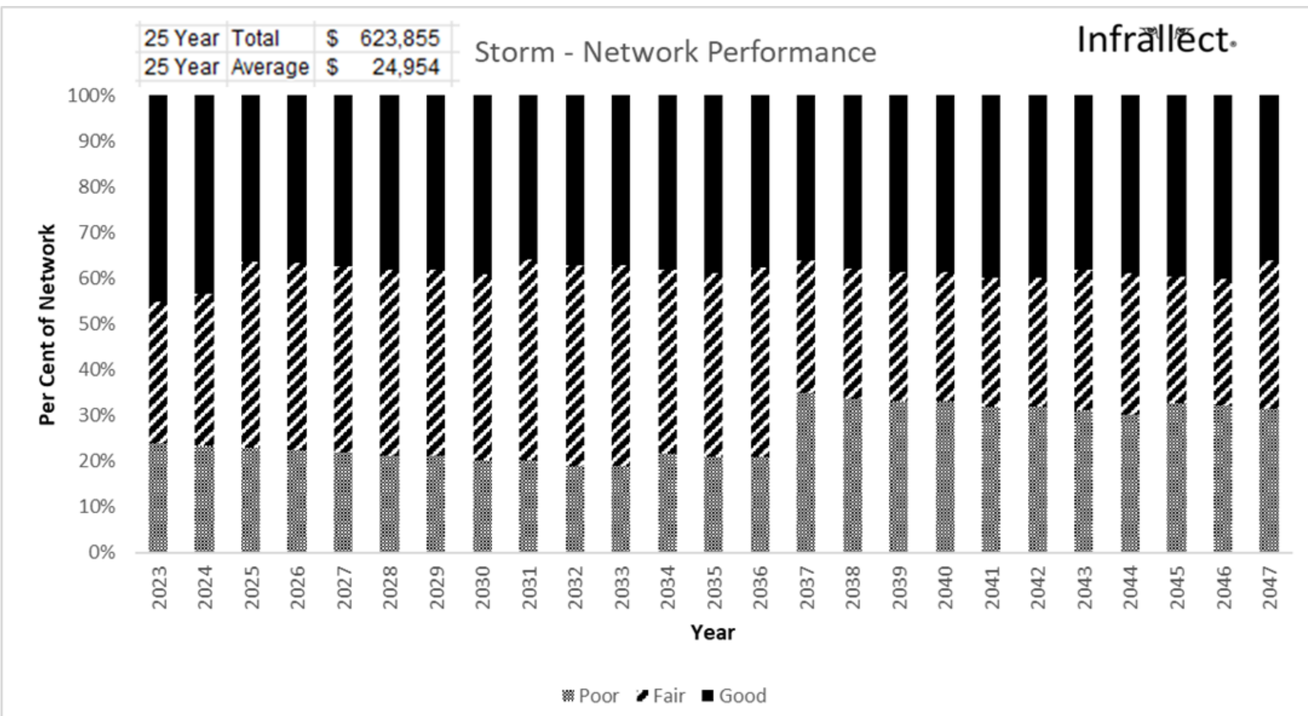


Figure 27: Annual Performance of Linear Stormwater Collection Assets in the Budget Scenario

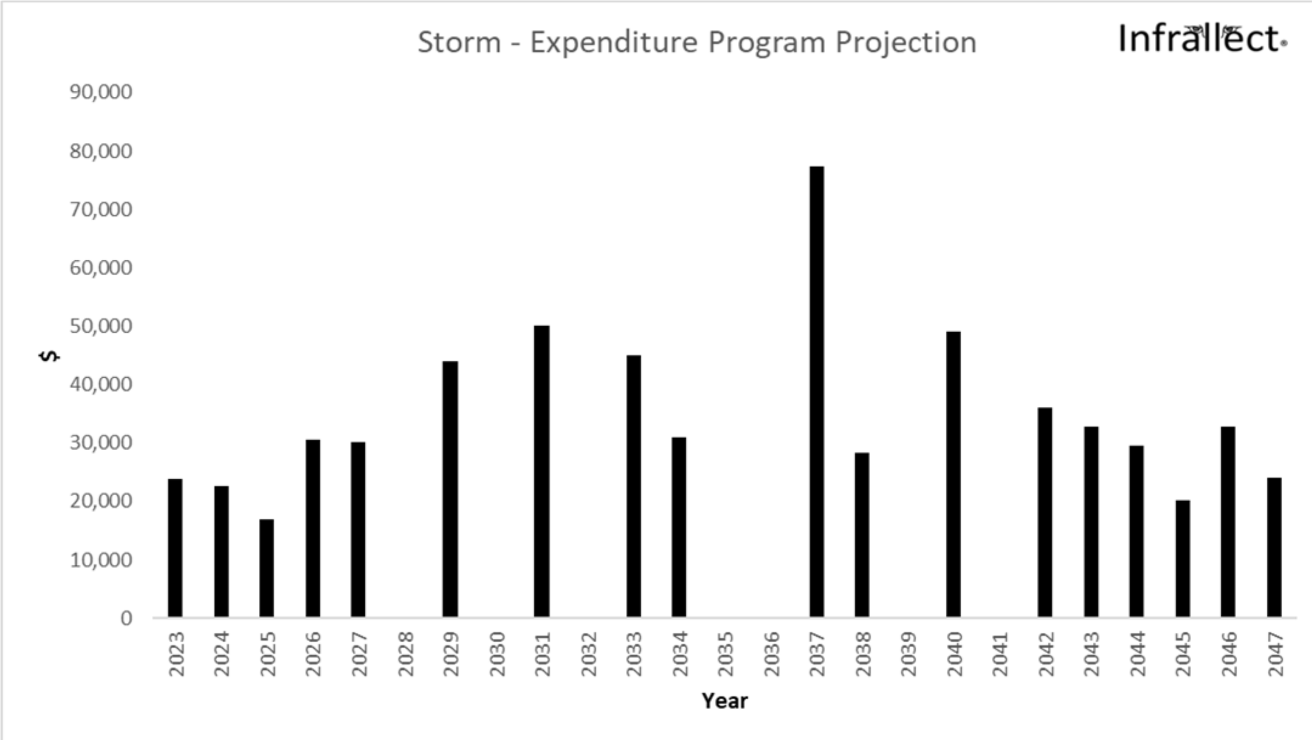


Figure 28: Corresponding Expenditure Forecast of Storm Pipe Assets in the Budget Scenario

8.2.4.5.2 Target Performance and Required Expenditures

In the target scenario, the proportion of the storm assets exhibiting poor performance averages out to approximately 20% over the 25-year span as shown in **Figure 29**. It is anticipated this level of performance will be acceptable to most stakeholders. The target scenario is an approximate 100% increase in forecast expenditure over the budget scenario, or $24,912 per annum.

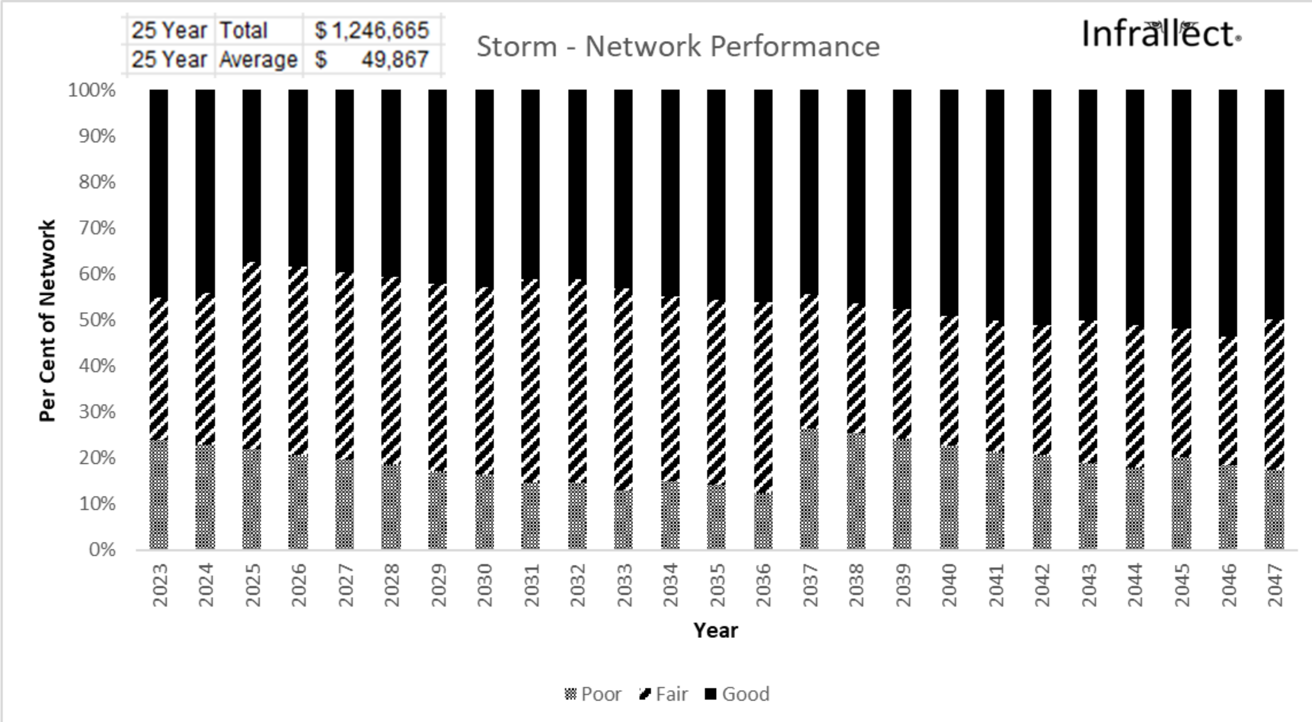


Figure 29: Annual Performance of Storm Assets in the Target Scenario

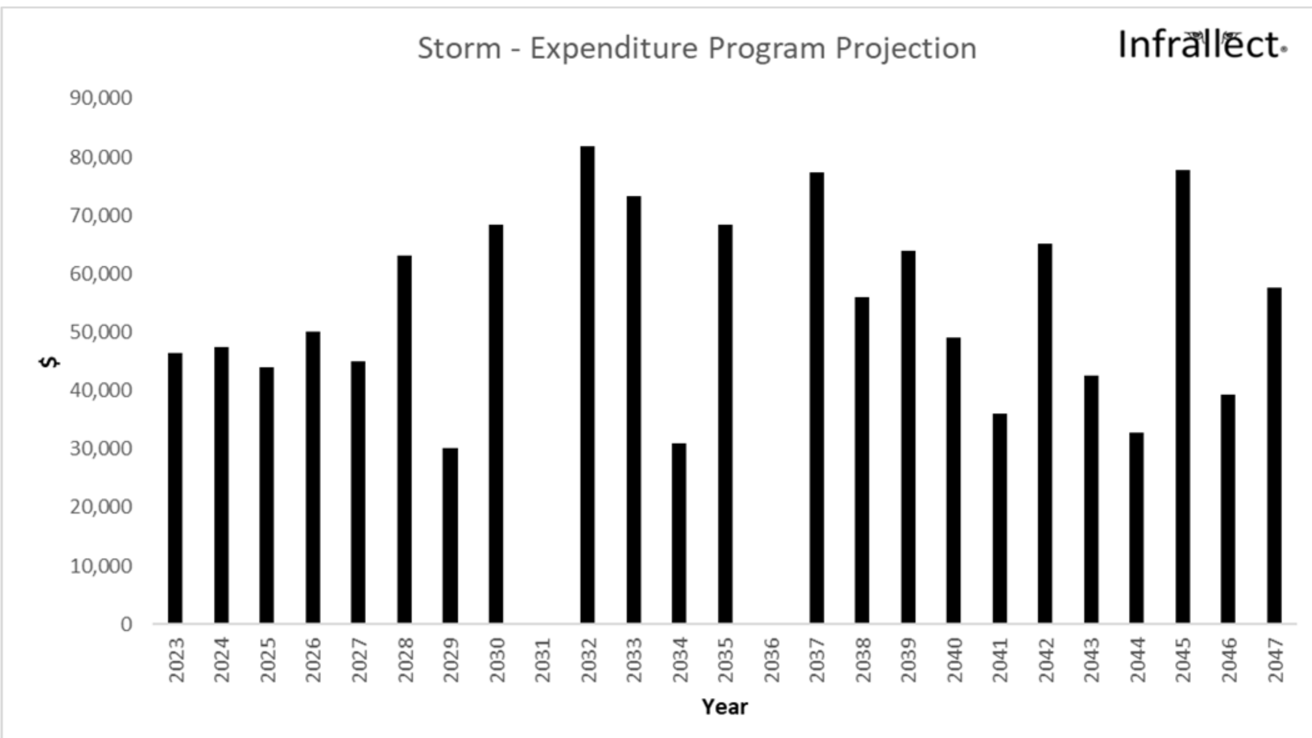


Figure 30: Corresponding Expenditure Forecast of Storm Assets in the Target Scenario

8.2.4.5.3 Ontario Regulation 588/17

A requirement for O. Reg. 588/17 is the reporting of the average age of assets. **Figure 31** identifies the average age for stormwater pipes.

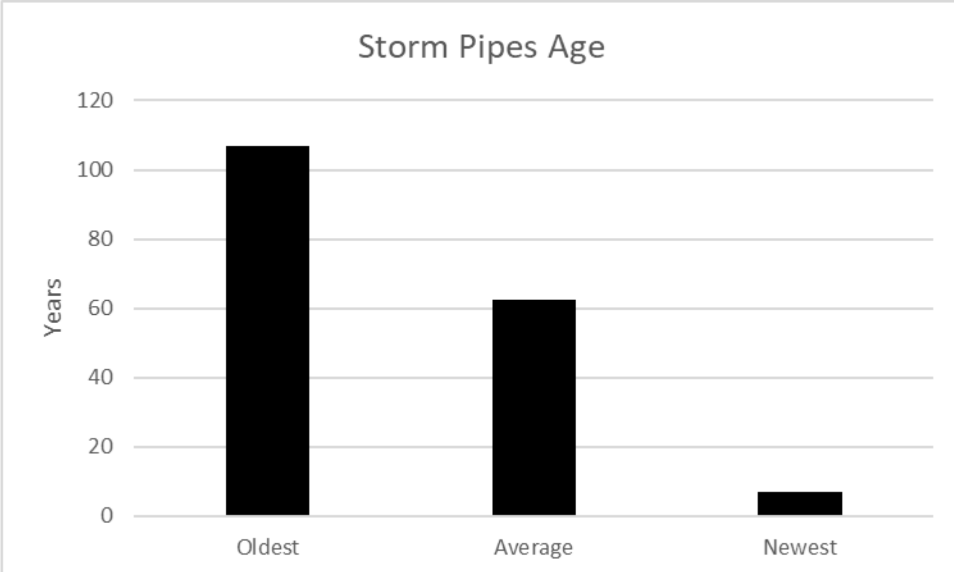


Figure 31: Average Age of Stormwater Pipes

Service levels are defined in two terms, community levels of service and technical levels of service. O. Reg. 588/17 identifies specific metrics for core assets that municipalities must report on. As a core asset, stormwater metrics are identified below in **Table 16** and **Table 17**.

Table 16: Stormwater Community Level of Service Metrics

Service Attribute	*Community Level of Service Measure*	*Community LOS Performance*
Scope	Description, which may include maps, of the user groups or areas of the municipality that are protected from flooding, including the extent of the protection provided by the municipal stormwater management system.	A majority of the developed area within the Municipality is protected from flooding, either through surface (creeks) or subsurface infrastructure (storm pipe), while the majority of rural area, specifically pastureland is subject to annual flooding via spring thaw and during heavy rain falls. No structures are allowed to be built in or around these flood plains. The map included in **Figure 32** shows the density of the watershed features throughout the Municipality.

Table 17: Stormwater Technical Levels of Service Metrics

Service Attribute	*Technical Level of Service Measure*	*2022*	*2023*
Scope	% of properties in the municipality resilient to a 100 year storm	36.3%	36.3%
	% of properties in the municipality resilient to a 5 year storm	99.0%	99.0%

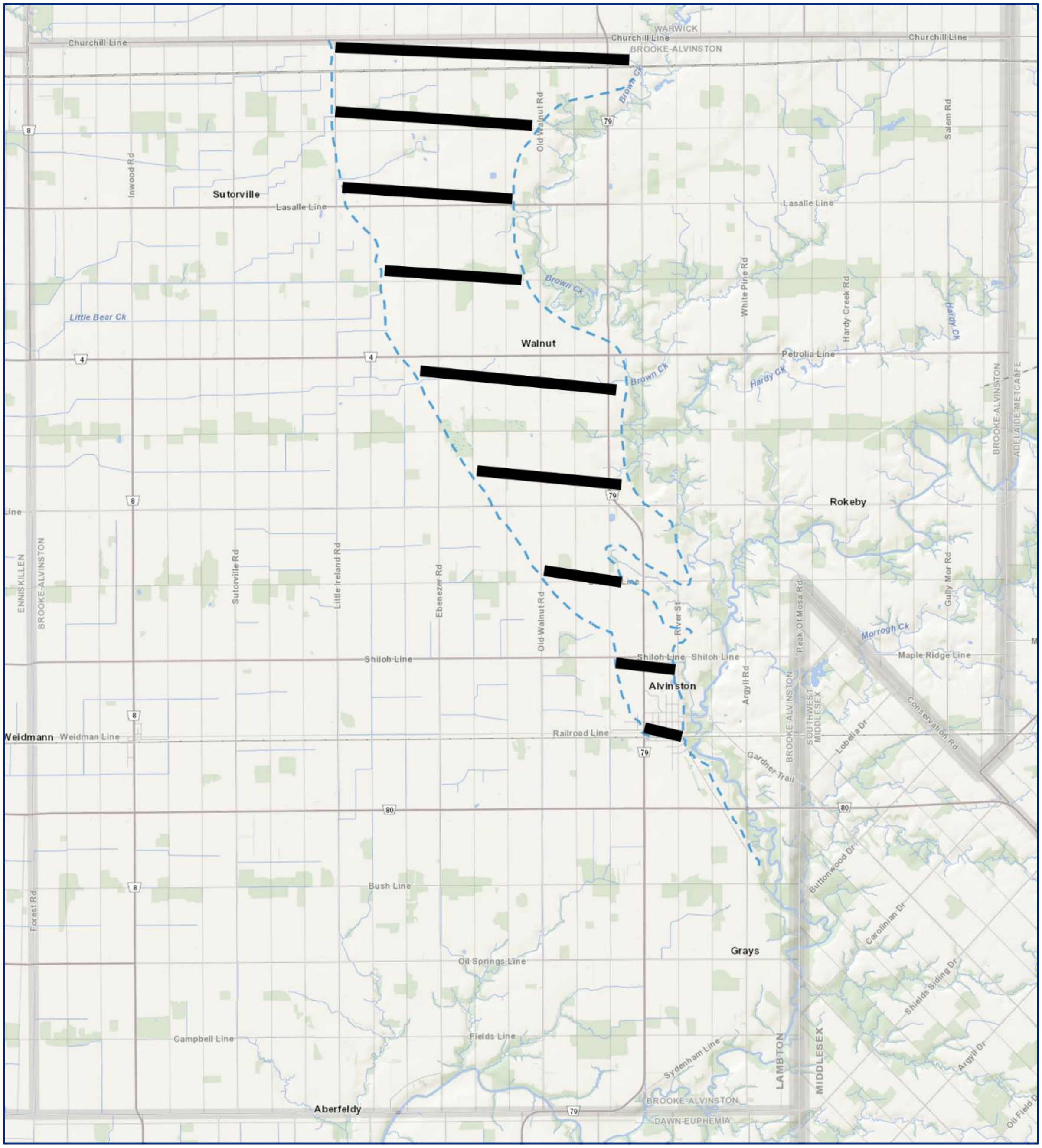


Figure 32: Brooke-Alvinston Topography - https://www.lioapplications.lrc.gov.on.ca/

The majority of the Municipality's land mass includes water features such as a river, creeks and farmland drainage channels. The river's elevation is 200m, while the local predominant plane (hatched area) with the highest elevation contours at 220m. The southern pinnacle of this plane includes the urban community of Alvinston. From this plane the topography typically stratospheres in 5-10m increments down to the river's elevation. It is assumed that a 100-year storm precipitation rate would exceed the soils discharge rate to natural water bodies in all areas of the municipality other than that serviced by storm pipes and in the relative immediate proximity of the main body of water (i.e., the river); which is only the urban community of Alvinston. Provided that structures are not permitted in regularly flooded plains, it is assumed that the discharge rate of the soil is sufficient to prevent the flooding of properties outside the flood plains during a 5-year storm.

8.2.4.6 Demand Management Plan

Please refer to section 5.1.6 for general context and appropriate asset management interpretation of this section's specifics.

Demand for new services is driven by various factors such as climate change, population change, regulatory requirements, changes in demographics, seasonal factors, consumer preferences and expectations, technological changes, economic factors, and environmental awareness.

Demand will be managed through a combination of managing existing assets, upgrading existing assets, providing new assets, and demand forecasting. Demand management practices can include non-asset solutions, insuring against risks and managing performance.

The Brooke-Alvinston Infrallect will be used to assist Stormwater SMEs in demand management planning.

8.2.4.7 Risk

Please refer to section 5.1.7 for general context and appropriate asset management interpretation of this section's specifics.

Risk related to the Stormwater asset class is managed through:

- SME knowledge and expertise
- Data-driven decision making
- Performance and expenditure forecasting

This three-pronged approach ensures that Stormwater's Level of Service (i.e., performance) supports the community's socioeconomic growth over the short and long term. Brooke-Alvinston Infrallect allows staff to ensure that the future probability of underperforming infrastructure and its consequences is minimized.

In addition to their inherent expertise, in order to minimize risk, SMEs always consider a wide range of factors during infrastructure decision-making processes, the core of which are included in **Table 6**. All corporate information related to Stormwater asset management is centralized within the Brooke-Alvinston Infrallect asset management system, allowing staff to make comprehensive and informed decisions. The ability to forecast the effects of contemplated decisions increases the reliability of the infrastructure's future performance.

8.2.4.8 Conclusion and Next Steps

The difference between Budget (existing) and Target Levels of Service (i.e., infrastructure performance) over the next 25 years is relatively low when compared to other asset classes. In order to remedy the performance gap, it is estimated that an additional $24,912 per annum is required.

In order to ensure management of Stormwater assets continues to be optimal, future asset management steps will aim to find the most efficient means of working towards remedying the performance gap.

Strategic steps will include:

- Continuous effort in increasing performance data collection capabilities
- Continuous improvement of the Brooke-Alvinston Infrallect analysis capabilities
- Continuous improvement of forecasting logic
- Corporate awareness and training

Tactical steps will include:

- Minimizing impact on staff time with respect to sharing information required for the Brooke-Alvinston Infrallect
- Increasing awareness of the difference between project level (most granular asset inventory) and network (asset class) level application of asset management principles
- Increasing awareness of general forecasting principles

Operational steps will include:

- Where applicable, developing data collection templates and means
- Continuous engagement with SMEs on progress
- Improving consumer-based modelling parameters

8.2.5 Bridges and Culverts

8.2.5.1 What do we own and what is it worth?

Please refer to section 5.1.1 for general context and appropriate asset management interpretation of this section's specifics.

The replacement value of the Municipality's bridges and culverts is estimated at $22,522,314. This includes 11 bridges, and 49 culverts.

8.2.5.2 Allocation of Infrastructure Funding

Please refer to section 5.1.2 for general context and appropriate asset management interpretation of this section's specifics.

The estimated distribution of the funding is shown in **Figure 33**, with an annual average of approximately $116,850. This includes recommended bridge and culvert treatments by a third-party consultant in the 1-5 year span.

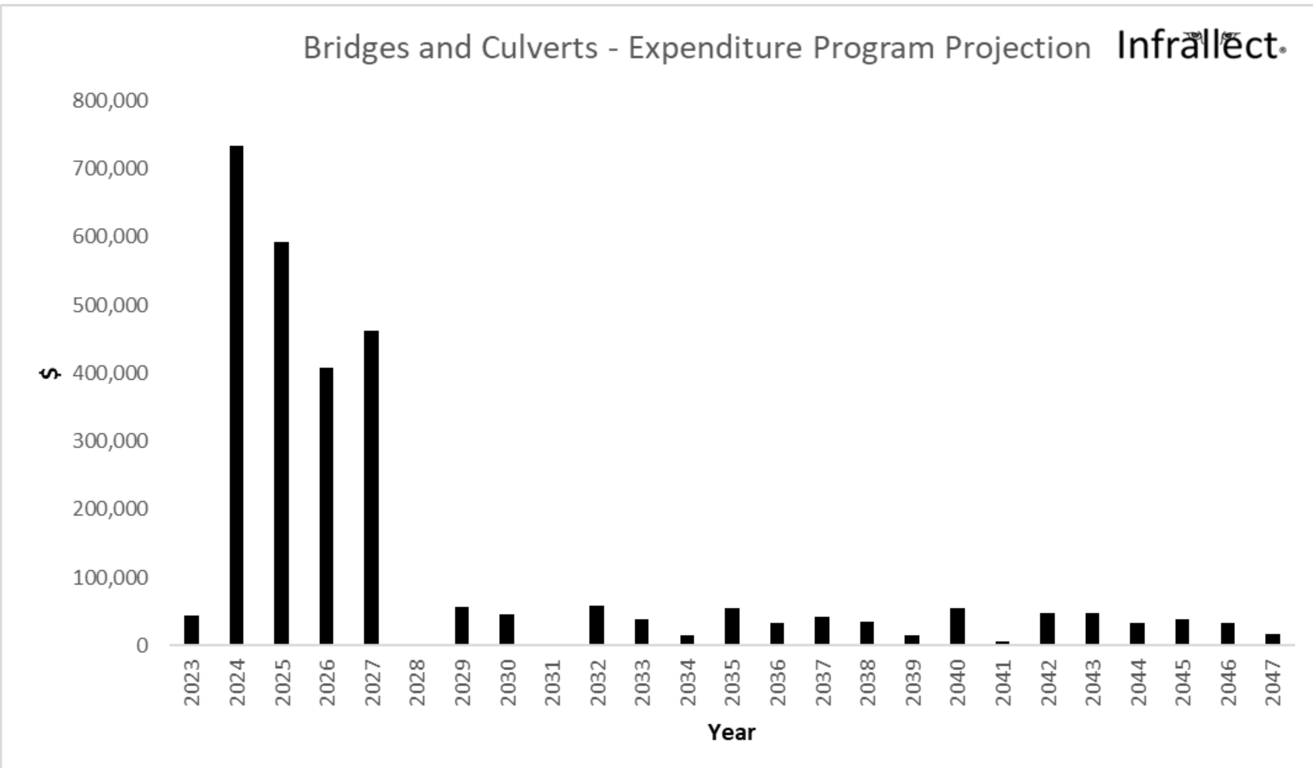


Figure 33: Capital Funding Distribution for Bridges and Culverts

8.2.5.3 Rehabilitation or Replacement Strategies

Please refer to section 5.1.3 for general context and appropriate asset management interpretation of this section's specifics.

- Bridges
  Are inspected every two (2) years and treated accordingly. Those with a forecast performance of zero (0) are addressed as well, after in-field confirmation of deterioration.

- Culverts
  Are inspected every two (2) years and treated accordingly. Those with a forecast performance of zero (0) are addressed as well, after in-field confirmation of deterioration.

8.2.5.4 Lifecycle Management Activities

Please refer to section 5.1.4 for general context and appropriate asset management interpretation of this section's specifics.

For Bridge maintenance the following lifecycle management activity options exist, but are not limited to:

- Painting
- Protective coating

For Bridge rehabilitation the following lifecycle management activity options exist, but are not limited to:

- Repair of components (deck, railing, abutment walls, etc.)

For Bridge replacement the following lifecycle management activity options exist, but are not limited to:

- Replacement

For Culvert maintenance the following lifecycle management activity options exist, but are not limited to:

- Debris removal
- Spot repairs

For Culvert rehabilitation the following lifecycle management activity options exist, but are not limited to:

- Full length repair
- Lining

For Culvert replacement the following lifecycle management activity options exist, but are not limited to:

- Replacement
- Twinning

Brooke-Alvinston's Infrallect asset management system is used to forecast the Bridges and Culverts asset class performance and corresponding expenditure over a 25-year span. Once the forecast activities are within the one to three year span, SMEs determine the appropriate treatment within the forecasted general categories above. In doing so, all available information relating to the items listed in **Table 5** and **Table 6: Corporate Decision Factors - Not Accounted for by SEPMs** is considered by the SMEs in order to determine the treatment of optimal cost/benefit to the community. It is not atypical to adjust treatments and costs from the original forecast. This is because more information becomes available closer to the start of the project (i.e., through surveying, detailed design, etc.). However, the total projected performance and expenditure for the year are not impacted. This is because the limits of scientific forecasting occur at the aggregate level of asset class performance and spending.

8.2.5.5 Levels of Service

Please refer to section 5.1.5 for general context and appropriate asset management interpretation of this section's specifics.

8.2.5.5.1 Current Performance and Projected impact of Budgeted Capital Expenditures

The proportion of Bridges and Culverts assets exhibiting poor performance is currently about 15% as illustrated in **Figure 34**. The average annual budgeted capital expenditures of approximately $116,850 will result in a decline in the performance profile over the next 25 years, which is anticipated to be acceptable to most stakeholders. The proportion of Bridge and Culverts assets with good performance fluctuates from approximately 70% to 45% in 2033 and increases to 50% at the end of the 25-year span.

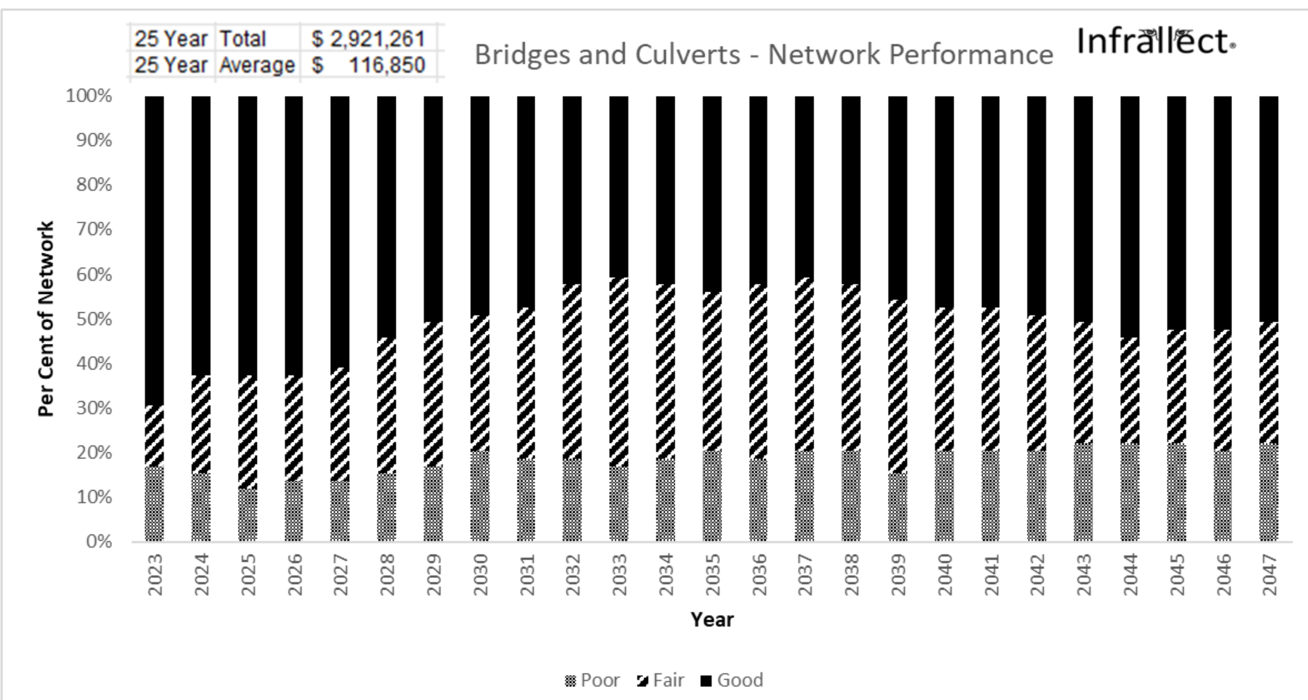


Figure 34: Annual Performance of Bridges and Culverts in the Budget Scenario

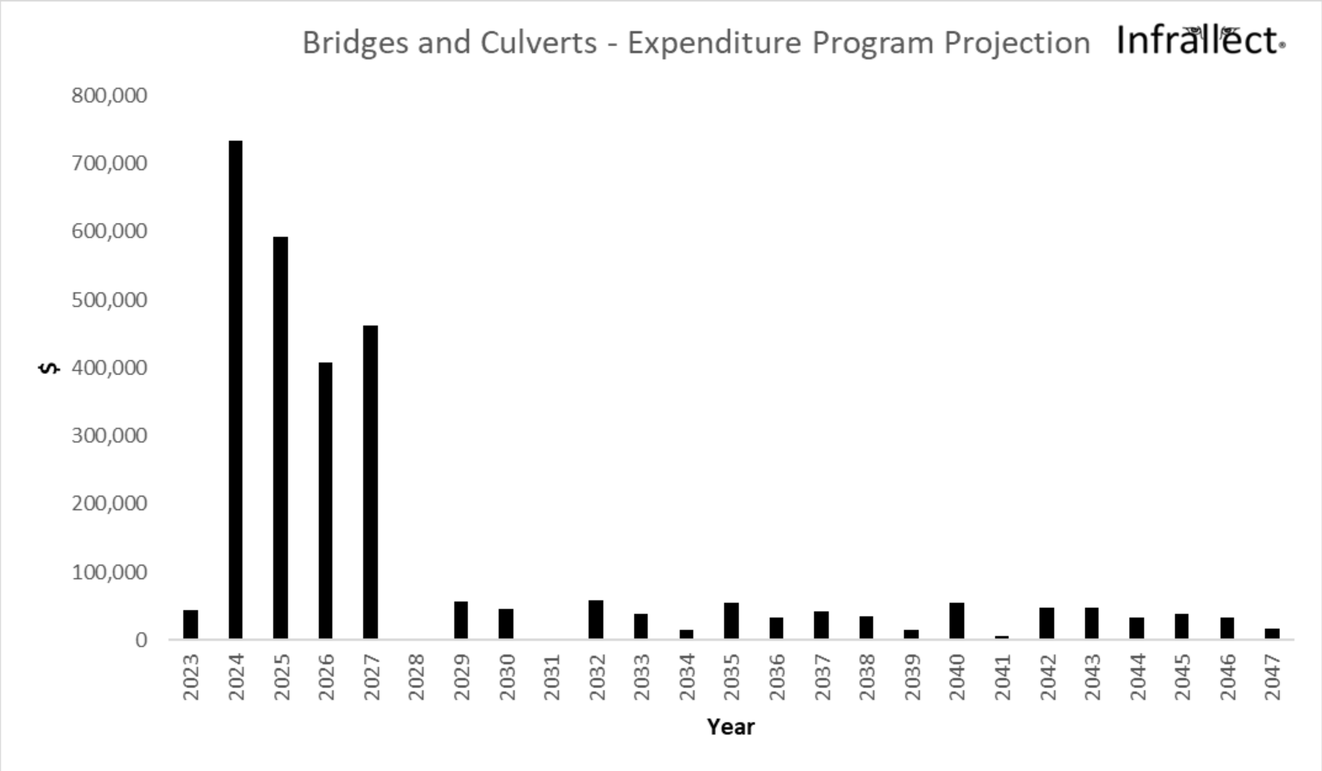


Figure 35: Corresponding Expenditure Forecast of Bridges and Culverts Assets in the Budget Scenario

8.2.5.5.2 Target Performance and Required Expenditures

As per budget scenario.

8.2.5.5.3 Ontario Regulation 588/17

A requirement for O. Reg. 588/17 is the reporting of the average age of assets. The following figures show the age profile of Bridges and Culverts, respectively.

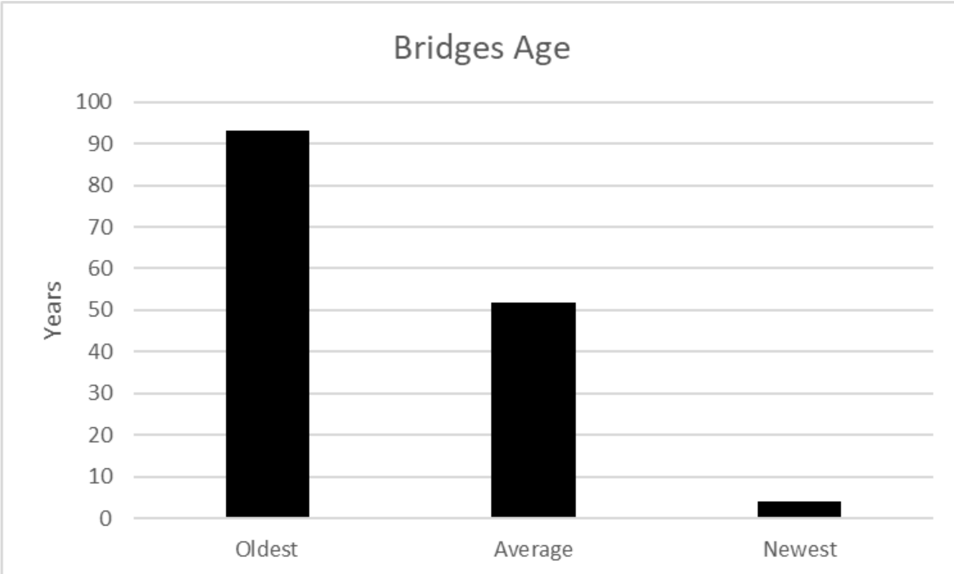


Figure 36: Average Age of Bridges

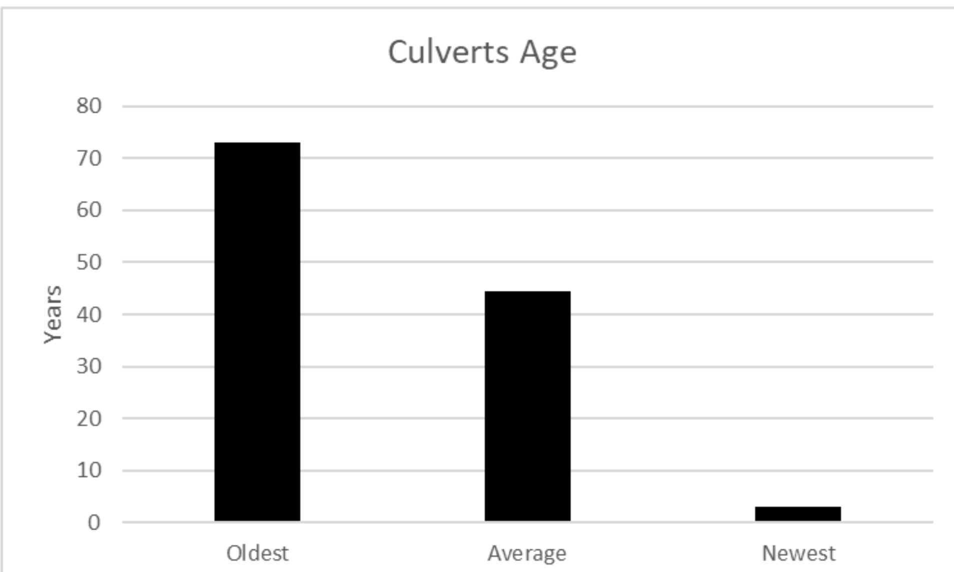


Figure 37: Average Age of Culverts

Service levels are defined in two terms, community levels of service and technical levels of service. O. Reg. 588/17 identifies specific metrics for core assets that municipalities must report on. As a core asset, bridge metrics are identified below in **Table 18** and **Table 19**.

Table 18: Bridges and Culverts Community Level of Service Metrics

Service Attribute	*Community Level of Service Measure*	*Community LOS Performance*
Scope	Description of the traffic that is supported by municipal bridges (e.g., heavy transport, motor vehicles, emergency vehicles, pedestrians, cyclists).	Within the Municipality, bridges fall into two categories, bridges and culverts. They support heavy transport, motor

Service Attribute	Community Level of Service Measure	Community LOS Performance
		vehicles, emergency vehicles, pedestrians and cyclists.
Quality	Description or images of the condition of bridges and how this would affect use of the bridges.	A number of factors related to the various elements that comprise a bridge structure can affect the condition and use of a bridge. Elements of a bridge include substructures such as foundations and abutments, primary components and secondary components. The elements may be composed of the varying materials which may display ranging levels of defect. Bridges where the severity and extent of any one defect is high, or bridges with a high proportion of elements in a poor condition state and structures with load limits all affect the use of a bridge structure from a public safety, comfort and convenience perspective.
	Description or image of the condition of culverts and how this would affect use of the culverts.	A number of factors related to the various elements that comprise culverts can affect the condition and their use. Elements of a culvert include barrels, barriers, headwalls, foundations, embankments and streams, etc. The culvert barrels themselves may be made of concrete, or corrugated steel pipe and may be constructed in several shapes: namely, round, ellipses, pipe arches or rectangular. The other elements that make up the bridge structure may be composed of the varying materials which may display ranging levels of defect. Culverts where the severity and extent of any one defect is high, or bridges with a high proportion of elements in a poor condition state and structures with load limits all affect the use of a bridge structure from a public safety, comfort and convenience perspective.

Table 19: Bridges and Culverts Technical Levels of Service Metrics

Service Attribute	Technical Level of Service Measure	2022	2023
Scope	% of bridges in the municipality with loading or dimensional restrictions	18%	18%
Quality	For bridges in the municipality, the average bridge condition index value.	0.07 (fair)	0.02 (fair)
	For culverts in the municipality, the average bridge condition index value.	0.49 (fair)	0.44 (fair)

8.2.5.6 Demand Management Plan

Please refer to section 5.1.6 for general context and appropriate asset management interpretation of this section's specifics.

Demand for new services is driven by various factors such as climate change, population change, regulatory requirements, changes in demographics, seasonal factors, consumer preferences and expectations, technological changes, economic factors, and environmental awareness.

Demand will be managed through a combination of managing existing assets, upgrading existing assets, providing new assets, and demand forecasting. Demand management practices can include non-asset solutions, insuring against risks and managing performance.

The Brooke-Alvinston Infrallect will be used to assist Bridges and Culverts SMEs in demand management planning.

8.2.5.7 Risk

Please refer to section 5.1.7 for general context and appropriate asset management interpretation of this section's specifics.

Risk related to the Bridges and Culverts asset class is managed through:

- SME knowledge and expertise
- Data-driven decision making
- Performance and expenditure forecasting

This three-pronged approach ensures that the Bridges and Culverts' Level of Service (i.e., performance) supports the community's socioeconomic growth over the short and long term. Brooke-Alvinston Infrallect allows staff to ensure that the future probability of underperforming infrastructure and its consequences is minimized.

In addition to their inherent expertise, in order to minimize risk, SMEs always consider a wide range of factors during infrastructure decision-making processes, the core of which are included in **Table 6**. All corporate information related to Bridges and Culverts asset management is centralized within the Brooke-Alvinston Infrallect asset management system, allowing staff to make comprehensive and informed decisions. The ability to forecast the effects of contemplated decisions increases the reliability of the infrastructure's future performance.

8.2.5.8 Conclusion and Next Steps

Currently, there are no differences between Budget (existing) and Target Levels of Service (i.e., infrastructure performance) over the next 25 years.

In order to ensure management of Bridges and Culverts assets continues to be optimal, future asset management steps will aim to find the most efficient means of working towards remedying the performance gap.

Strategic steps will include:

- Continuous effort in increasing performance data collection capabilities
- Continuous improvement of the Brooke-Alvinston Infrallect system’s analysis capabilities
- Continuous improvement of forecasting logic
- Corporate awareness and training

Tactical steps will include:

- Minimizing impact on staff time with respect to sharing information required for the Brooke-Alvinston Infrallect system
- Increasing awareness of the difference between project level (most granular asset inventory) and network (asset class) level application of asset management principles
- Increasing awareness of general forecasting principles

Operational steps will include:

- Where applicable, developing data collection templates and means
- Continuous engagement with SMEs on progress
- Improving consumer-based modelling parameters

8.3 Appendix C: Non-Core Assets

For O. Reg. 588/17, non-core assets are those that each municipality has and that are not included as a Core Asset. For the next AMP update, the Municipality has asset groups that are considered non-core and will be reported upon in this section.

8.3.1 Facilities

8.3.1.1 What do we own and what is it worth?

Please refer to section 5.1.1 for general context and appropriate asset management interpretation of this section's specifics.

The Municipality's facilities network is comprised of more than 20 structures ranging from sheds to large recreation facilities. The total replacement value of the facilities is approximately $22,883,818 and represents 16.6% of the total replacement value of the Municipality's assets. Facilities include, however, are not limited to municipal offices, recreation facilities, libraries, fire stations and various structures within Parks.

8.3.1.2 Allocation of Infrastructure Funding

Please refer to section 5.1.2 for general context and appropriate asset management interpretation of this section's specifics.

The distribution of the funding is shown in **Figure 38**, averaging $83,799 per annum. This includes recommended Water and Wastewater Plant treatments by a third-party consultant in the 1-10 year span.

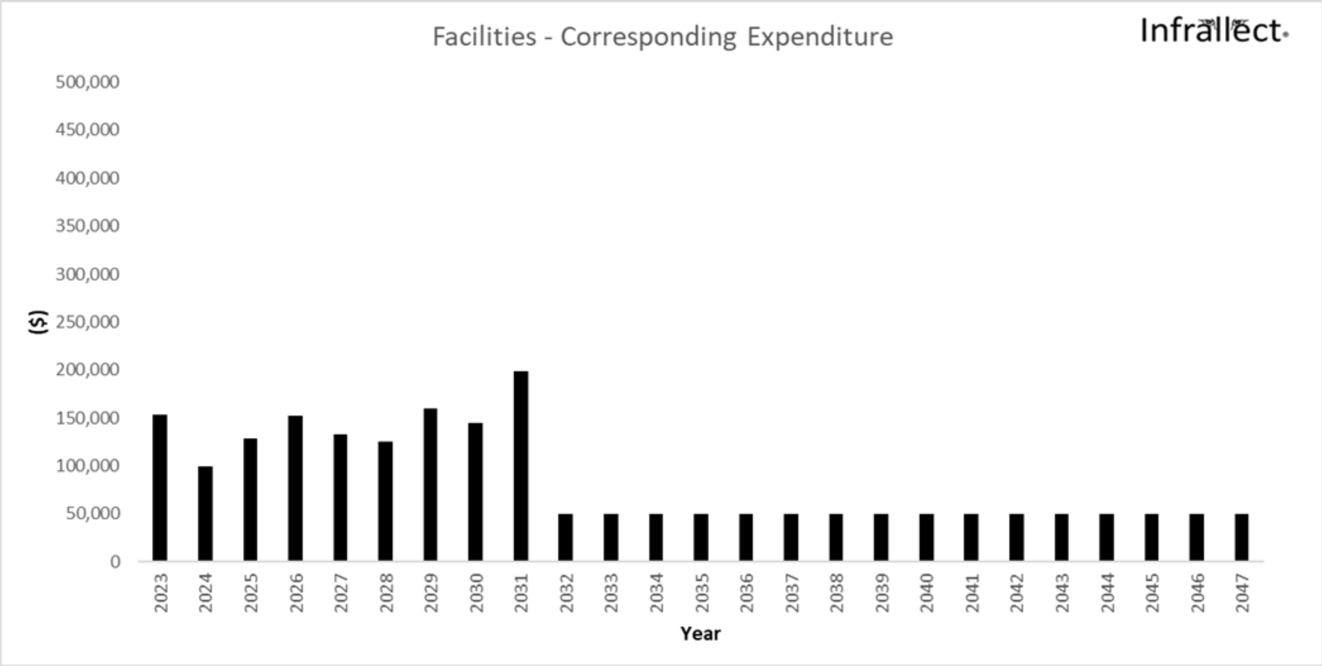


Figure 38: Capital Funding Distribution for Facilities

8.3.1.3 Rehabilitation or Replacement Strategies

Please refer to section 5.1.3 for general context and appropriate asset management interpretation of this section's specifics.

Facilities are typically rehabilitated through the replacement or refurbishment of individual components or groups of components. Each component has an estimated service life that is combined with observations of the condition of each component during site investigations and a target performance for the respective component to project the required expenditures. Individual components are treated when they reach a performance of zero (0), with confirmed deterioration.

8.3.1.4 Lifecycle Management Activities

Please refer to section 5.1.4 for general context and appropriate asset management interpretation of this section's specifics.

For Facility maintenance the following lifecycle management activity options exist, but are not limited to:

- Localized repairs (e.g., floor tile replacement, painting, broken fixtures etc.)

For Facility maintenance the following lifecycle management activity options exist, but are not limited to:

- Programmed/grouped repairs (e.g., roof replacement program)
- Component replacements (e.g., windows, doors)
- Interior and exterior renovation

For Facility replacement the following lifecycle management activity options exist, but are not limited to:

- Complete facility replacement (very rare)

The Brooke-Alvinston Infrallect is used to forecast the Facilities asset class performance and corresponding expenditure over a 25-year span. Once the forecast activities are within the one to three year span, SMEs determine the appropriate treatment within the forecasted general categories above. In doing so, all available information relating to the items listed in **Table 5 and Table 6** is considered by the SMEs in order to determine the treatment of optimal cost/benefit to the community. It is not atypical to adjust treatments and costs from the original forecast. This is because more information becomes available closer to the start of the project (i.e., through surveying, detailed design, etc.). However, the total projected performance and expenditure for the year are not impacted. This is because the limits of scientific forecasting occur at the aggregate level of asset class performance and spending.

8.3.1.5 Level of Service

Please refer to section 5.1.5 for general context and appropriate asset management interpretation of this section's specifics.

8.3.1.5.1 Current Performance and Projected impact of Budgeted Capital Expenditures

Currently about 10% of Facilities assets are in the poor performance category. The average annual budgeted capital expenditures of approximately $83,799 will result in an improvement in the performance distribution of Facilities assets over the next 25 years shown in **Figure 39.** However, it is anticipated that this level of service will not be acceptable to most stakeholders. The primary reason being backlogged expansion pressures.

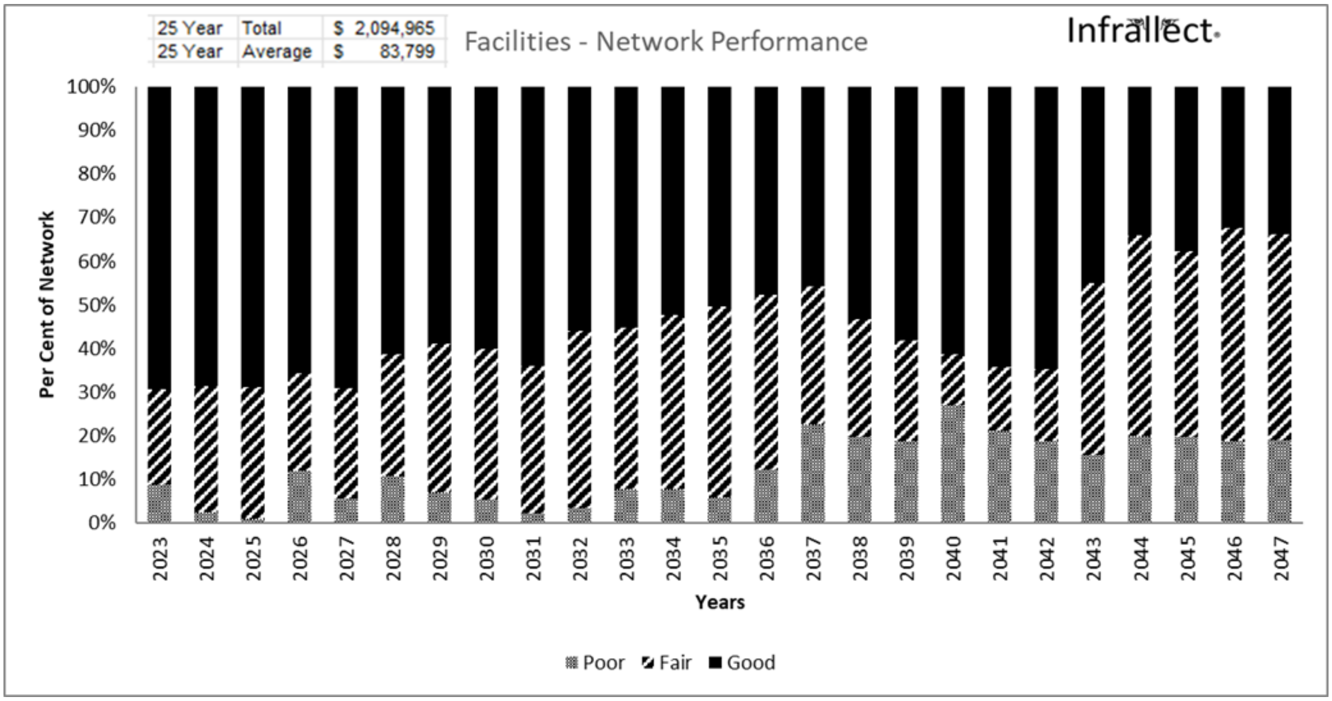


Figure 39: Annual Performance of Facilities in the Budget Scenario

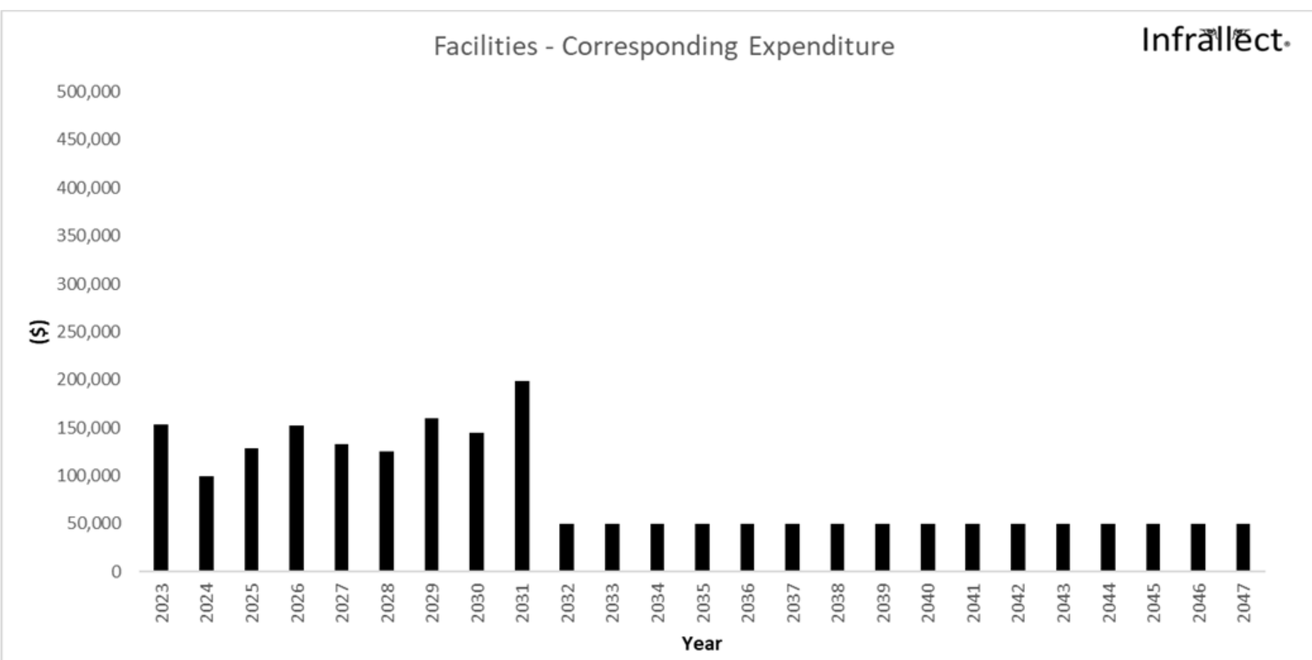


Figure 40: Corresponding Expenditure Forecast of Facilities Assets in the Budget Scenario

8.3.1.5.2 Target Performance and Required Expenditures

An average annual expenditure of approximately $110,387 over the next 25 years is required to achieve the target performance profile of the Facilities asset class. In the target scenario, the proportion of the asset class with poor performance averages out to approximately 2.5% as illustrated in **Figure 41**.

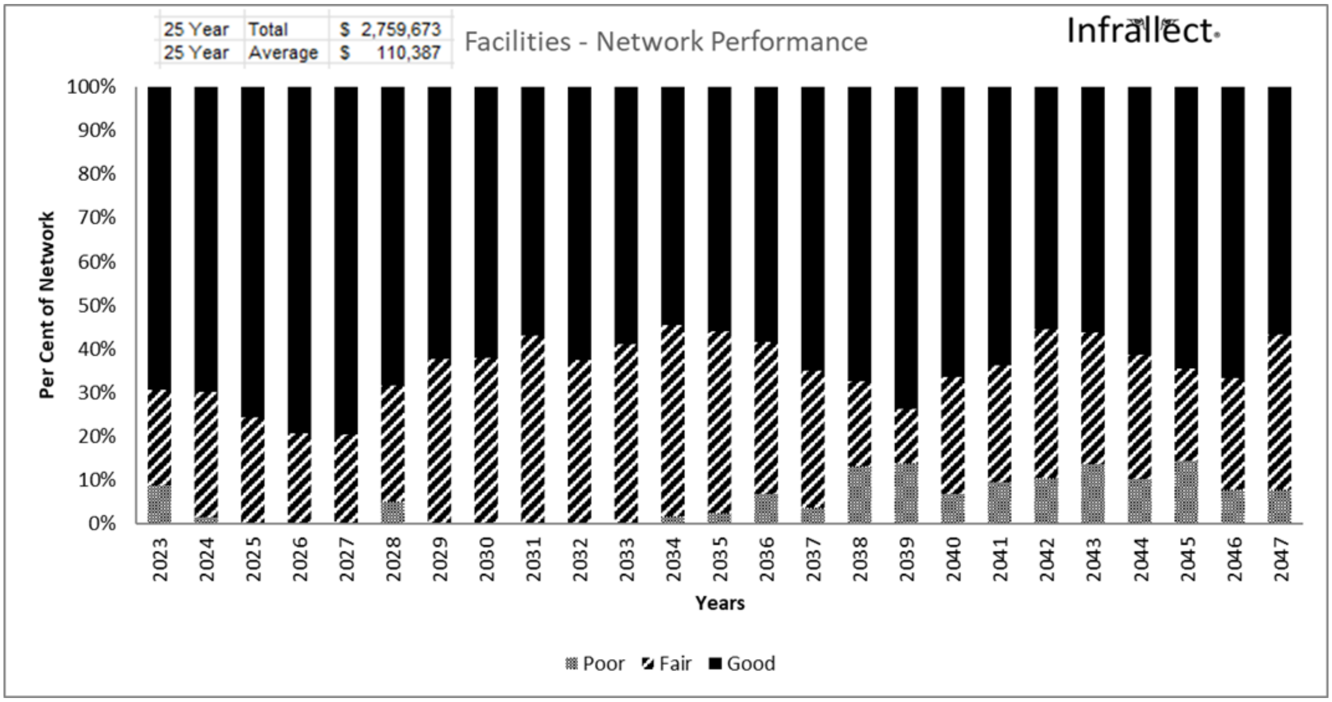


Figure 41: Annual Performance of Facilities Assets in the Target Scenario

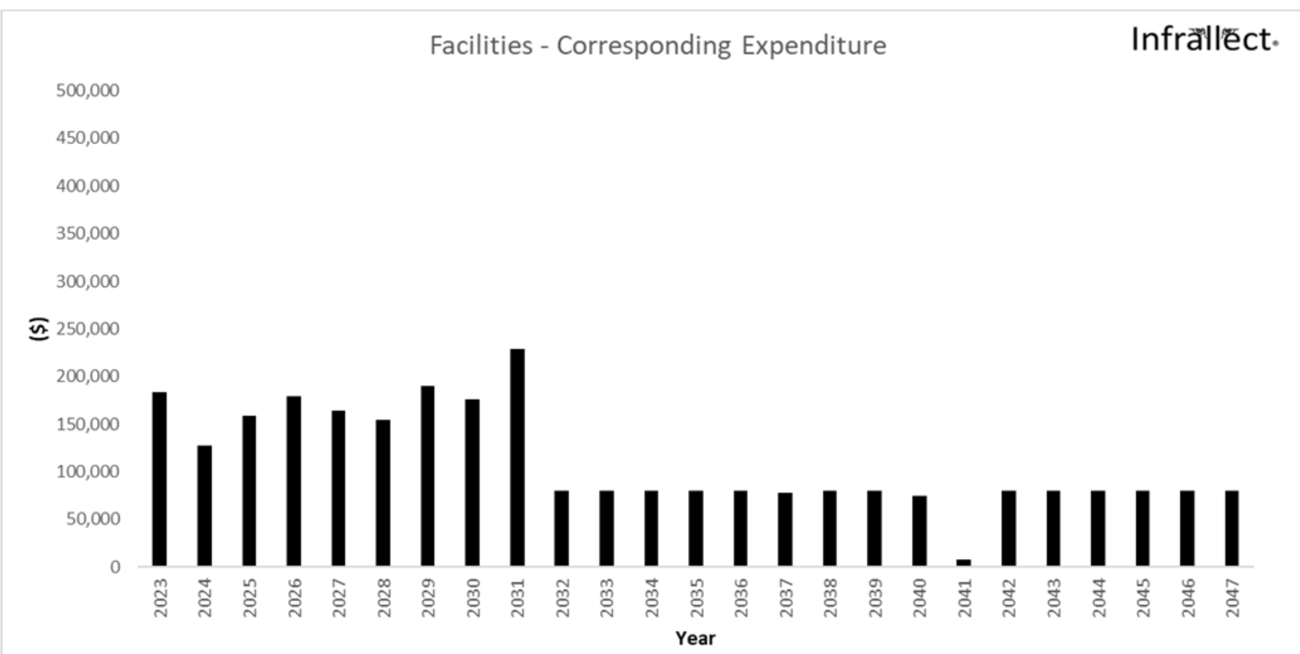


Figure 42: Corresponding Expenditure of Facilities Assets in the Target Scenario


MUNICIPALITY OF BROOKE-ALVINSTON
1842
1880
2001
WE ARE
IN THIS
TOGETHER
#Thanks
HEALTH
HEROES

8.3.1.5.3 Ontario Regulation 588/17

Service levels are defined in two terms, community levels of service and technical levels of service. O. Reg. 588/17 identifies specific metrics for core assets that municipalities must report on however metrics for non-core assets are to be developed by each municipality. As a non-core asset, Facilities metrics will be developed and included in the 2024 AMP. These will be as necessary, sub-sets of the comprehensive Level of Service already developed by the Municipality, as shown in the previous two sections.

8.3.1.6 Demand Management Plan

Please refer to section 5.1.6 for general context and appropriate asset management interpretation of this section's specifics.

Demand for new services is driven by various factors such as climate change, population change, regulatory requirements, changes in demographics, seasonal factors, consumer preferences and expectations, technological changes, economic factors, and environmental awareness.

Demand will be managed through a combination of managing existing assets, upgrading existing assets, providing new assets, and demand forecasting. Demand management practices can include non-asset solutions, insuring against risks and managing performance.

The Brooke-Alvinston Infrallect will be used to assist Facilities SMEs in demand management planning.

8.3.1.7 Risk

Please refer to section 5.1.7 for general context and appropriate asset management interpretation of this section's specifics.

Risk related to the Facilities asset class is managed through:

- SME knowledge and expertise
- Data-driven decision making
- Performance and expenditure forecasting

This three-pronged approach ensures that Facilities' Level of Service (i.e., performance) supports the community's socioeconomic growth over the short and long term. The Brooke-Alvinston Infrallect allows staff to ensure that the future probability of underperforming infrastructure and its consequences is minimized.

In addition to their inherent expertise, in order to minimize risk, SMEs always consider a wide range of factors during infrastructure decision-making processes, the core of which are included in **Table 6**. All corporate information related to Facilities asset management is centralized within the Brooke-Alvinston Infrallect, allowing staff to make comprehensive and informed decisions. The ability to forecast the effects of contemplated decisions increases the reliability of the infrastructure's future performance.

8.3.1.8 Conclusion and Next Steps

The difference between Budget (existing) and Target Levels of Service (i.e., infrastructure performance) over the next 25 years is relatively low when compared to other asset classes. In order to remedy the performance gap, it is estimated that an additional $26,588 per annum is required. This excludes the potential replacement of the ice rink piping system, which is expected to cost above $1M.

In order to ensure management of Facilities assets continues to be optimal, future asset management steps will aim to find the most efficient means of working towards remedying the performance gap.

Strategic steps will include:

- Continuous effort in increasing performance data collection capabilities
- Continuous improvement of the Brooke-Alvinston Infrallect analysis capabilities
- Continuous improvement of forecasting logic
- Corporate awareness and training

Tactical steps will include:

- Minimizing impact on staff time with respect to sharing information required for the Brooke-Alvinston Infrallect
- Increasing awareness of the difference between project level (most granular asset inventory) and network (asset class) level application of asset management principles
- Increasing awareness of general forecasting principles

Operational steps will include:

- Where applicable, developing data collection templates and means
- Continuous engagement with SMEs on progress
- Improving consumer-based modelling parameters

8.3.2 Land Improvements and Parks

8.3.2.1 What do we own and what is it worth?

Please refer to section 5.1.1 for general context and appropriate asset management interpretation of this section's specifics.

There are more than 40 assets under the Land Improvements and Parks, ranging from small parkettes to large neighbourhood parks. It is important to note that buildings with Parks are captured under the Facilities asset class. The estimated replacement value of Land Improvements and Parks is $1,713,148 million which represents approximately 1.26% of the total replacement value of the Municipality's assets.

8.3.2.2 Allocation of Infrastructure Funding

Please refer to section 5.1.2 for general context and appropriate asset management interpretation of this section's specifics.

The distribution of the funding is shown in **Figure 43** averaging $22,993 per annum.

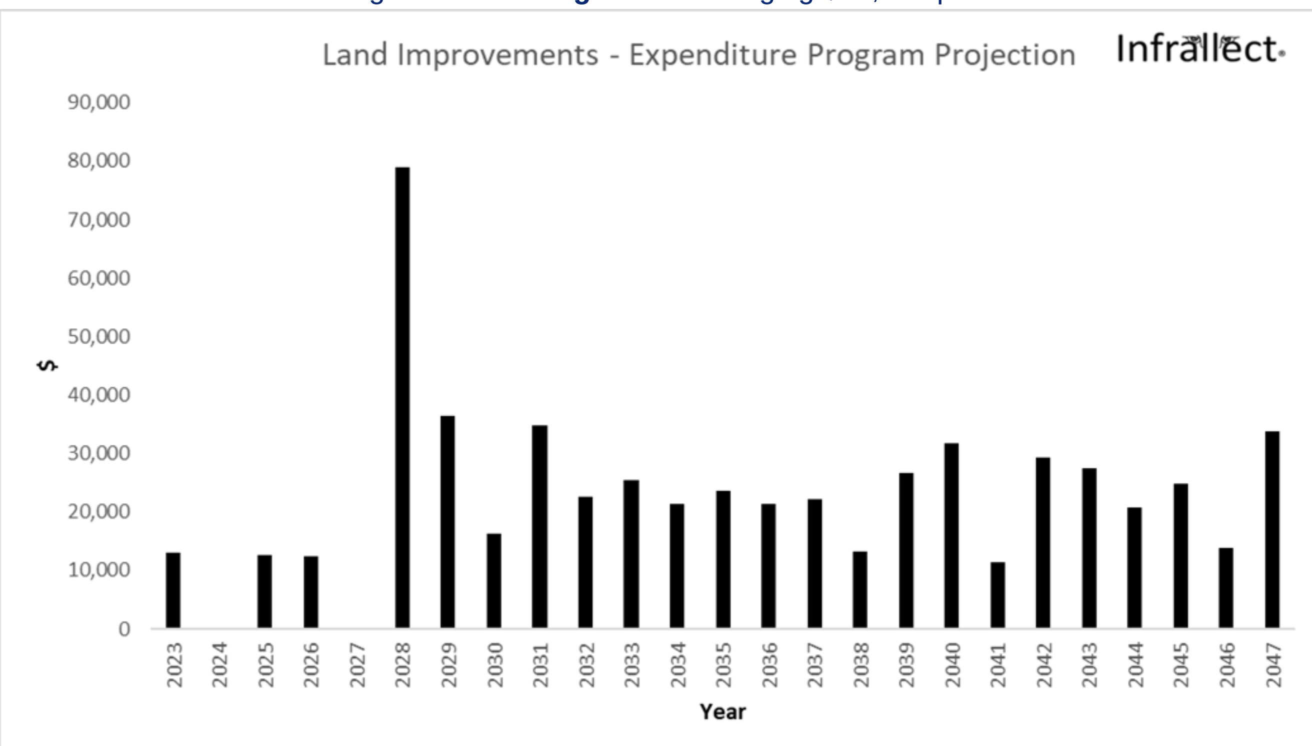


Figure 43: Capital Funding Distribution for Land Improvements and Parks

8.3.2.3 Rehabilitation or Replacement Strategies

Please refer to section 5.1.3 for general context and appropriate asset management interpretation of this section's specifics.

Land Improvement and Park assets are treated when they fall below the target performance for the respective component. In general, components with a higher consequence of underperformance (playgrounds, structures, etc.) have a higher target performance than those with a lower consequence of underperformance (i.e., benches, fields, etc.).

8.3.2.4 Lifecycle Management Activities

Please refer to section 5.1.4 for general context and appropriate asset management interpretation of this section's specifics.

For Land Improvements and Park maintenance the following lifecycle management activity options exist, but are not limited to:

- Localized repairs

For Land Improvements and Park rehabilitation the following lifecycle management activity options exist, but are not limited to:

- Components replacements (e.g., benches, signs, playgrounds, etc.)

For Land Improvements and Park reconstruction the following lifecycle management activity options exist, but are not limited to:

- Park reconstruction

The Brooke-Alvinston Infrallect is used to forecast the Land Improvements and Parks asset class performance and corresponding expenditure over a 25-year span. Once the forecast activities are within the one to three year span, SMEs determine the appropriate treatment within the forecasted general categories above. In doing so, all available information relating to the items listed in **Table 5 and Table 6** is considered by the SMEs in order to determine the treatment of optimal cost/benefit to the community. It is not atypical to adjust treatments and costs from the original forecast. This is because more information becomes available closer to the start of the project (i.e., through surveying, detailed design, etc.). However, the total projected performance and expenditure for the year are not impacted. This is because the limits of scientific forecasting occur at the aggregate level of asset class performance and spending.

8.3.2.5 Level of Service

Please refer to section 5.1.5 for general context and appropriate asset management interpretation of this section's specifics.

8.3.2.5.1 Current Performance and Projected impact of Budgeted Capital Expenditures

Currently about 15% of Parks assets have poor performance profiles. The average annual budgeted capital expenditure of approximately $22,993 will result in a decline in the performance profile over the next 25 years, which is anticipated to be unacceptable to most stakeholders. **Figure 44** contains the performance distribution.

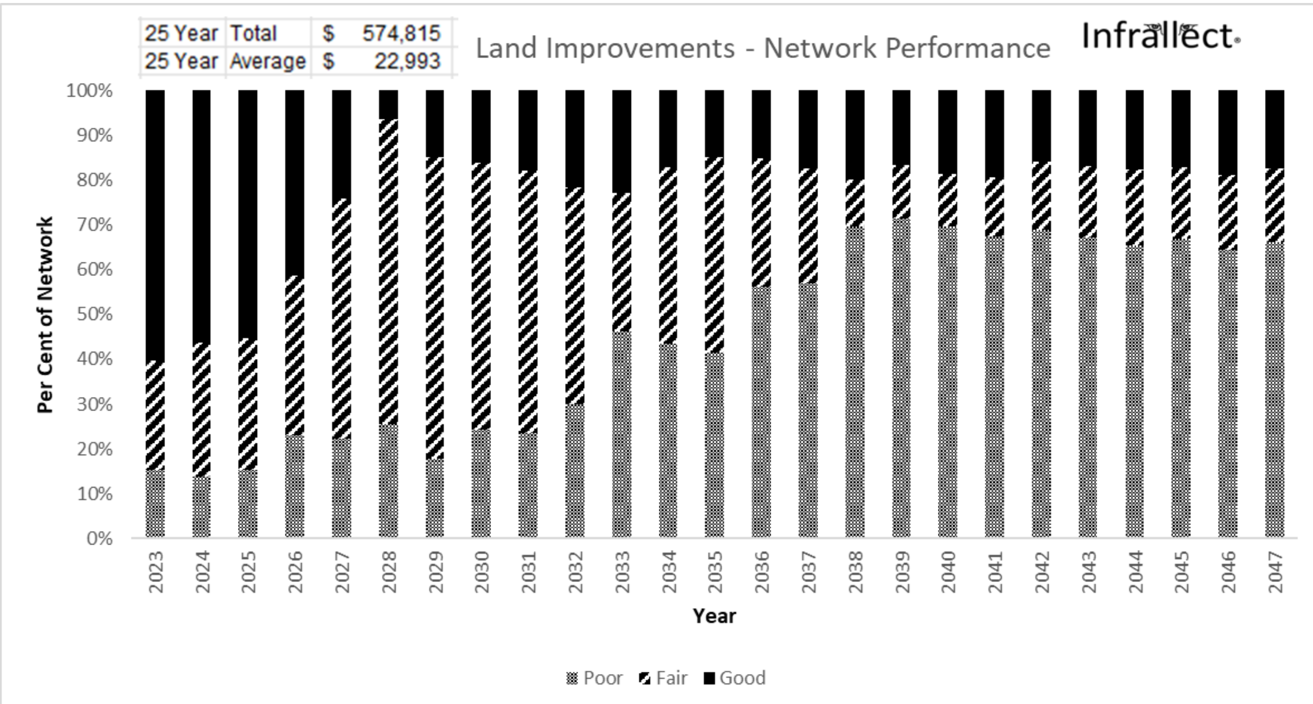


Figure 44: Annual Performance of Park assets in the Budget Scenario

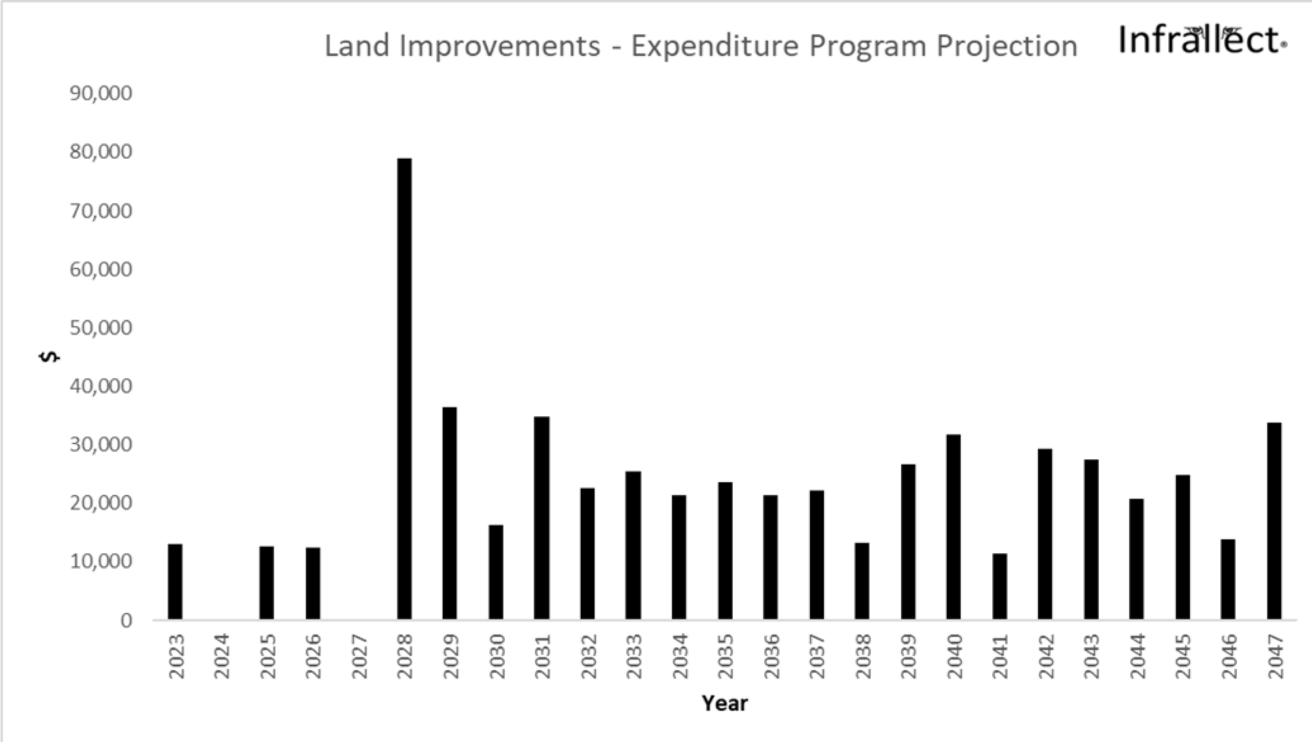


Figure 45: Corresponding Expenditure Forecast of Land Improvements and Parks Assets in the Budget Scenario

8.3.2.5.2 Target Performance and Required Expenditures

An average annual expenditure of $48,565 over the next 25 years is required to achieve the target performance profile of the Land Improvements and Parks asset class. The portion of asset class with poor performance averages to approximately 15% over the 25-year span as illustrated in **Figure 46**.

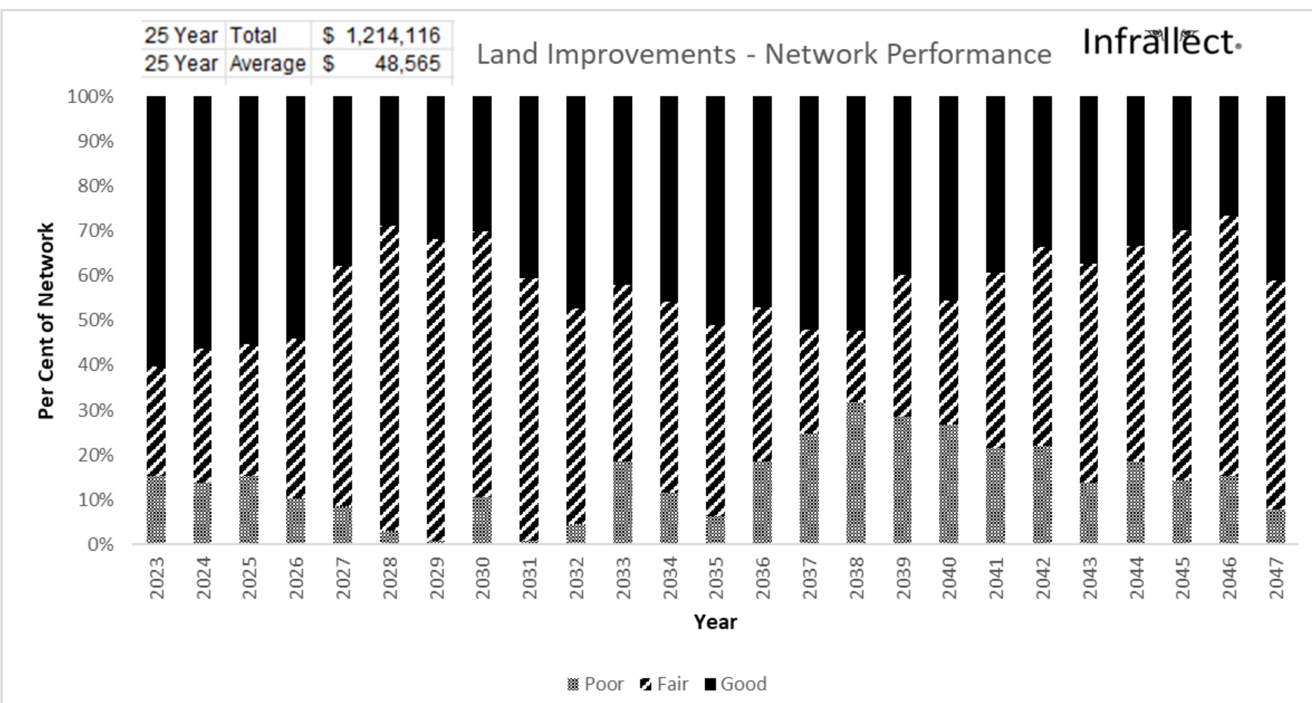


Figure 46: Annual Performance of Land Improvements and Parks Assets in the Target Scenario

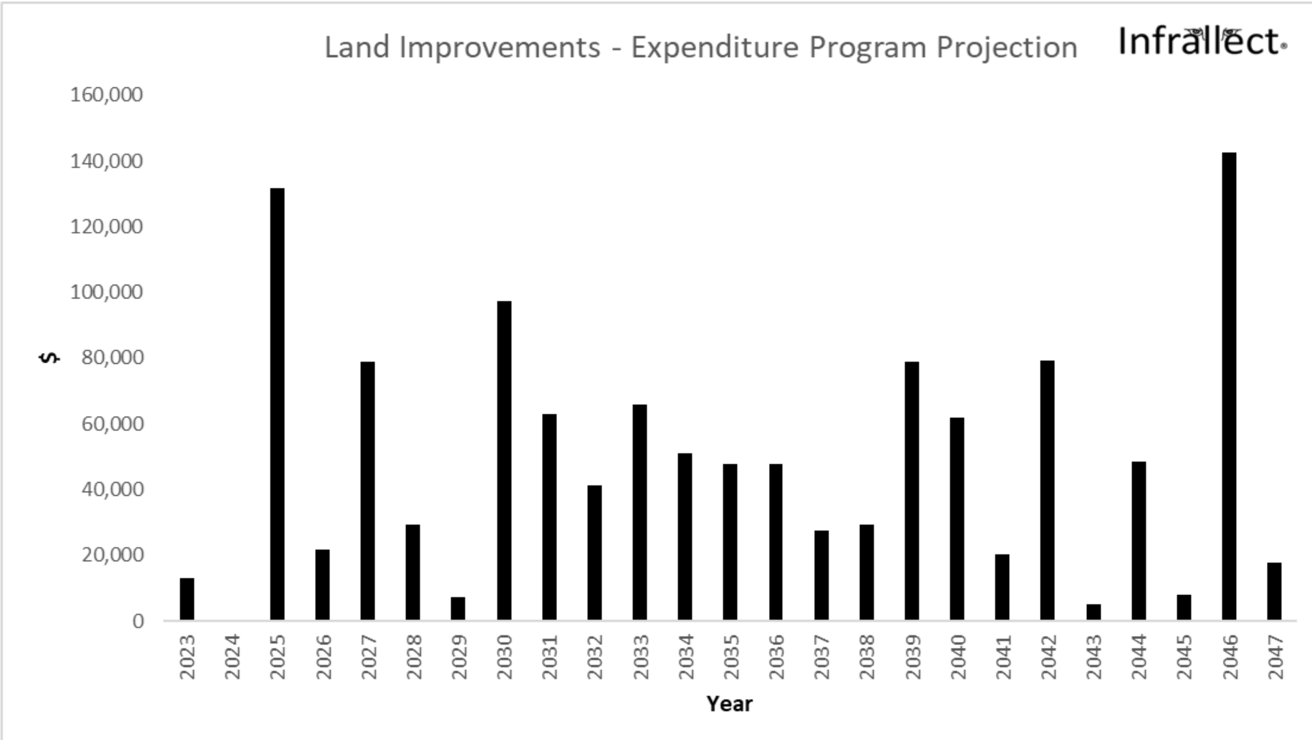
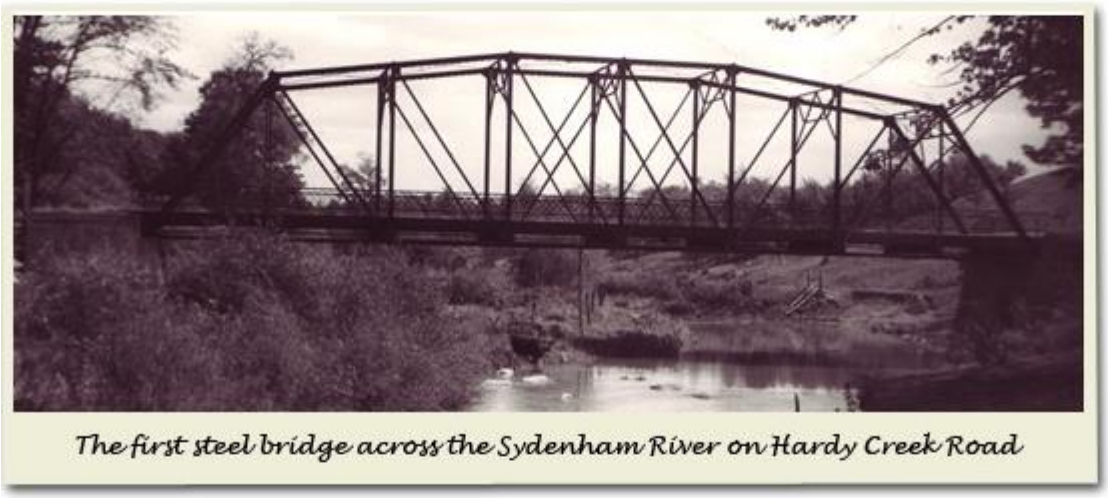


Figure 47: Corresponding Expenditure of Land Improvements and Parks Assets in the Target Scenario

8.3.2.5.3 Ontario Regulation 588/17

Service levels are defined in two terms, community levels of service and technical levels of service. O. Reg. 588/17 identifies specific metrics for core assets that municipalities must report on however metrics for non-core assets are to be developed by each municipality. As a non-core asset, Land Improvements and Parks metrics will be developed and included in the 2024 AMP. These will be, as necessary, sub-sets of the comprehensive Level of Service already developed by the Municipality, as shown in the previous two sections.



8.3.2.6 Demand Management Plan

Please refer to section 5.1.6 for general context and appropriate asset management interpretation of this section's specifics.

Demand for new services is driven by various factors such as climate change, population change, regulatory requirements, changes in demographics, seasonal factors, consumer preferences and expectations, technological changes, economic factors, and environmental awareness.

Demand will be managed through a combination of managing existing assets, upgrading existing assets, providing new assets, and demand forecasting. Demand management practices can include non-asset solutions, insuring against risks and managing performance.

The Brooke-Alvinston Infrallect will be used to assist Land Improvements and Parks SMEs in demand management planning.

8.3.2.7 Risk

Please refer to section 5.1.7 for general context and appropriate asset management interpretation of this section's specifics.

Risk related to the Land Improvements and Parks asset class is managed through:

- SME knowledge and expertise
- Data-driven decision making
- Performance and expenditure forecasting

This three-pronged approach ensures that Land Improvements and Parks' Level of Service (i.e., performance) supports the community's socioeconomic growth over the short and long term. The Brooke-Alvinston Infrallect allows staff to ensure that the future probability of underperforming infrastructure and its consequences is minimized.

In addition to their inherent expertise, in order to minimize risk, SMEs always consider a wide range of factors during infrastructure decision-making processes, the core of which are included in **Table 6**. All corporate information related to Land Improvements and Parks asset management is centralized within the Brooke-Alvinston Infrallect, allowing staff to make comprehensive and informed decisions. The ability to forecast the effects of contemplated decisions increases the reliability of the infrastructure's future performance.

8.3.2.8 Conclusion and Next Steps

The difference between Budget (existing) and Target Levels of Service (i.e., infrastructure performance) over the next 25 years is relatively low when compared to other asset classes. In order to remedy the performance gap, it is estimated that an additional $25,572 per annum is required.

In order to ensure management of Land Improvements and Parks assets continues to be optimal, future asset management steps will aim to find the most efficient means of working towards remedying the performance gap.

Strategic steps will include:

- Continuous effort in increasing performance data collection capabilities
- Continuous improvement of the Brooke-Alvinston Infrallect analysis capabilities
- Continuous improvement of forecasting logic
- Corporate awareness and training

Tactical steps will include:

- Minimizing impact on staff time with respect to sharing information required for the Brooke-Alvinston Infrallect
- Increasing awareness of the difference between project level (most granular asset inventory) and network (asset class) level application of asset management principles
- Increasing awareness of general forecasting principles

Operational steps will include:

- Where applicable, developing data collection templates and means
- Continuous engagement with SMEs on progress
- Improving consumer-based modelling parameters

8.3.3 Fleet

8.3.3.1 What do we own and what is it worth?

Please refer to section 5.1.1 for general context and appropriate asset management interpretation of this section's specifics.

The Municipality owns 16 fleet assets, ranging from small vehicles to large winter maintenance vehicles. The total replacement value of fleet assets is approximately $2,411,923 million which represents 1.8% of the total replacement value of the Municipality's assets.

8.3.3.2 Allocation of Infrastructure Funding

Please refer to section 5.1.2 for general context and appropriate asset management interpretation of this section's specifics.

The distribution of the funding is shown in **Figure 48**, averaging $104,183 per annum.

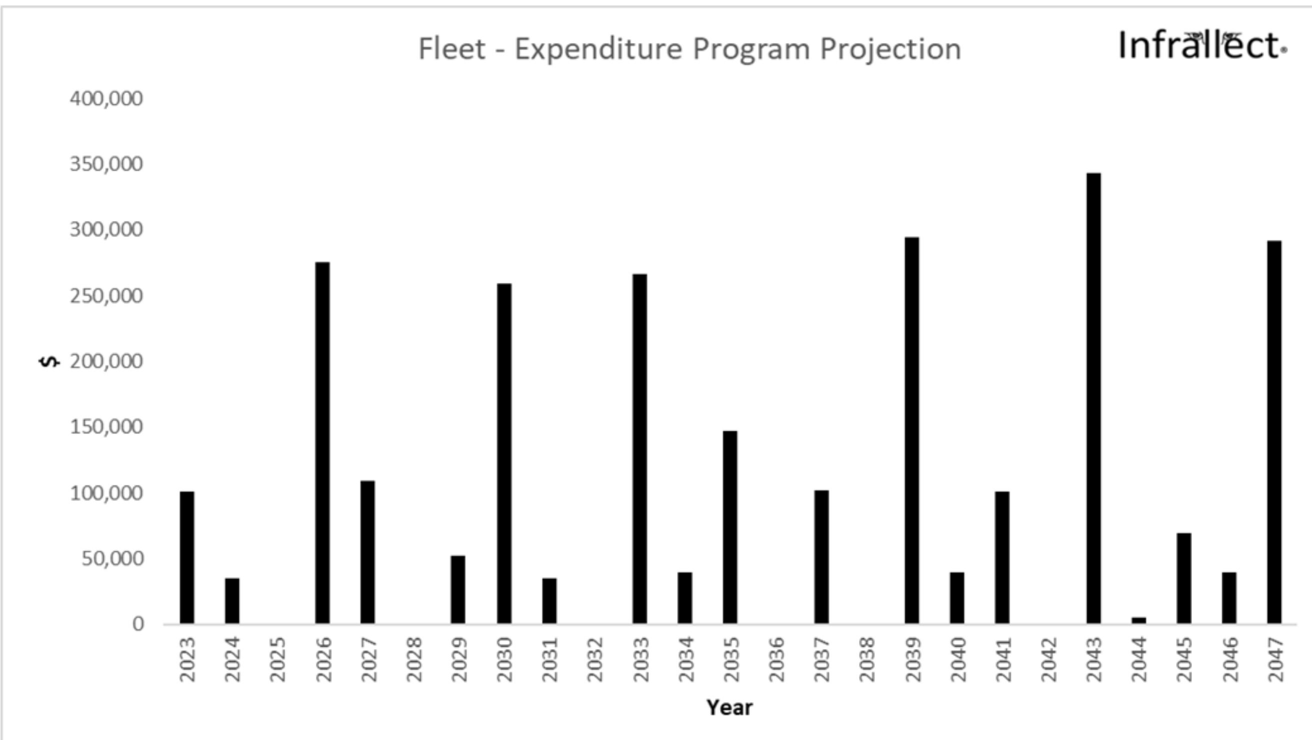


Figure 48: Capital Funding Distribution for Fleet Assets

8.3.3.3 Rehabilitation or Replacement Strategies

Please refer to section 5.1.3 for general context and appropriate asset management interpretation of this section's specifics.

Fleet assets are replaced when they reach the end of their useful life [i.e., reach a performance of zero (0)].

8.3.3.4 Lifecycle Management Activities

Please refer to section 5.1.4 for general context and appropriate asset management interpretation of this section's specifics.

For Fleet maintenance the following lifecycle management activity options exist, but are not limited to:

- Preventative maintenance activities and inspections are undertaken at predetermined intervals or according to prescribed criteria, aimed at reducing the failure, risk or performance degradation of the equipment.

For Fleet rehabilitation the following lifecycle management activity options exist, but are not limited to:

- Unscheduled maintenance (repairs) to correct deficiencies that occur between scheduled services to maintain fleet in a safe, operable condition.

For Fleet reconstruction the following lifecycle management activity options exist, but are not limited to:

- Replacement

The Brooke-Alvinston Infrallect is used to forecast Fleet asset class performance and corresponding expenditure over a 25-year span. Fleet is a unique asset class as maintenance and rehabilitation activities are ongoing throughout the year to ensure that the equipment can provide an acceptable level of service. Once the forecast activities are within the one to three year span, SMEs determine the appropriate replacement needs. In doing so, all available information relating to items listed in **Table 5 and Table 6** is considered by SMEs in order to determine the treatment of highest /benefit to the community. It is not atypical to adjust treatments and costs from the original forecast. This is because more information (e.g., functional and conditional needs are identified each year). However, the total projected performance and expenditure for the year are not impacted. This is because the limits of scientific forecasting occur at the aggregate level of asset class performance and spending.

8.3.3.5 Level of Services

Please refer to section 5.1.5 for general context and appropriate asset management interpretation of this section's specifics.

8.3.3.5.1 Current Performance and Projected impact of Budgeted Capital Expenditures

There are currently around 50% of fleet assets in the poor performance category. The average annual budgeted capital expenditures of approximately $104,183 will result in a performance profile that is anticipated to be unacceptable to most stakeholders. The portion of asset class in poor performance fluctuates around 55% over the 25-year span as illustrated in **Figure 49**.

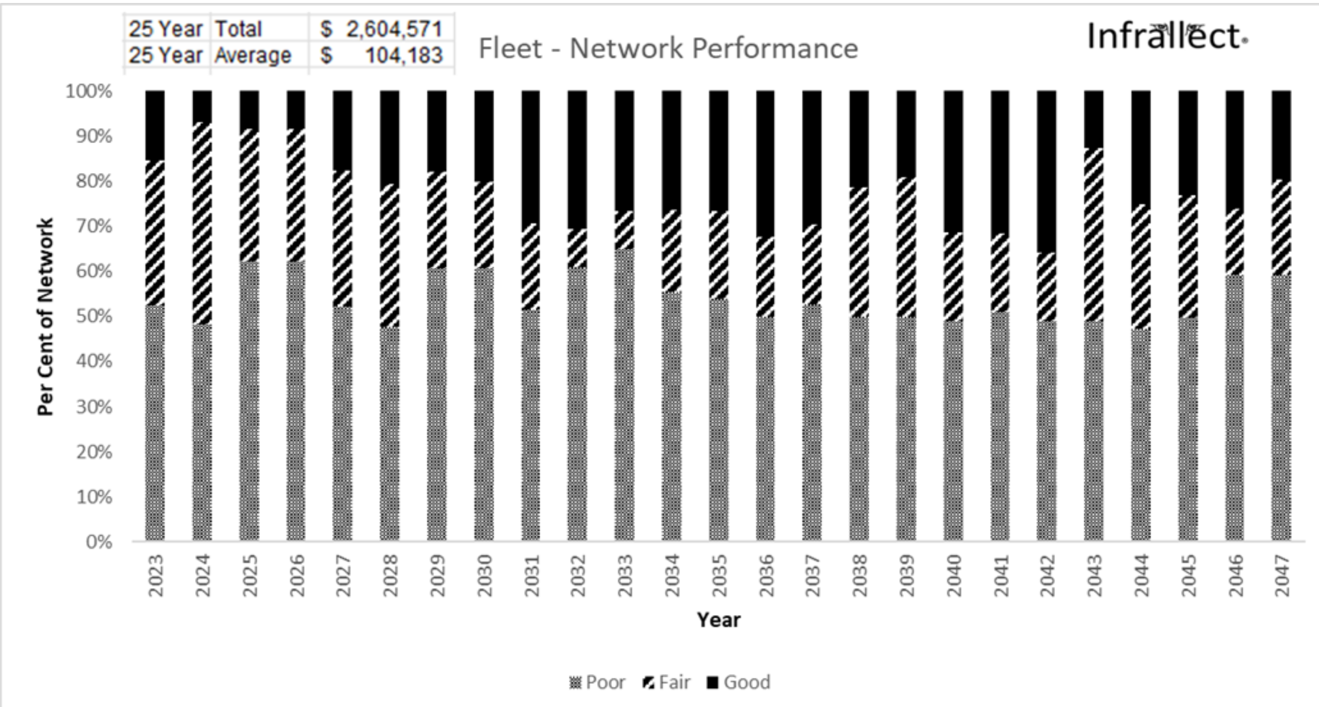


Figure 49: Annual Performance of Fleet Assets in the Budget Scenario

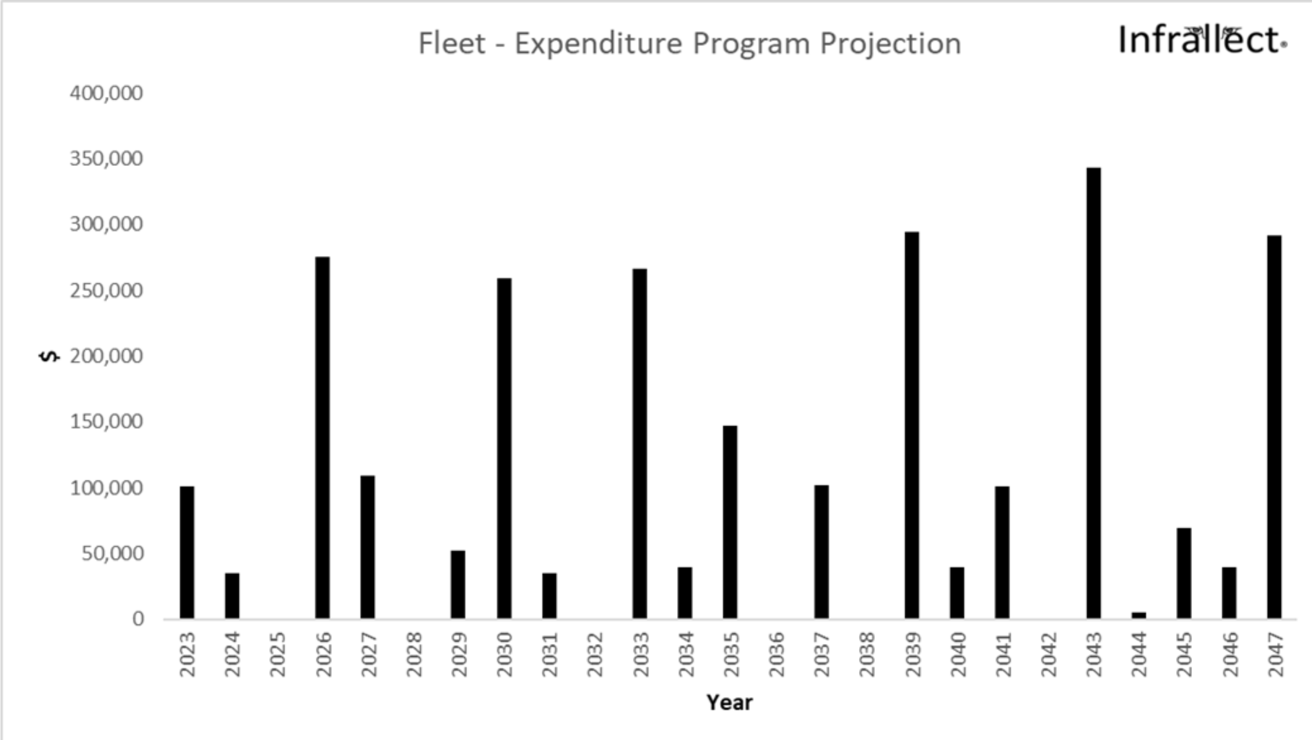


Figure 50: Corresponding Expenditure Forecast of Fleet Assets in the Budget Scenario

8.3.3.5.2 Target Performance and Required Expenditures

An average annual expenditure of $150,996 over the next 25 years is required to achieve the target performance profile of the Fleet asset class. The portion of asset class with poor performance averages to approximately 34% over the 25-year span as illustrated in **Figure 51**.

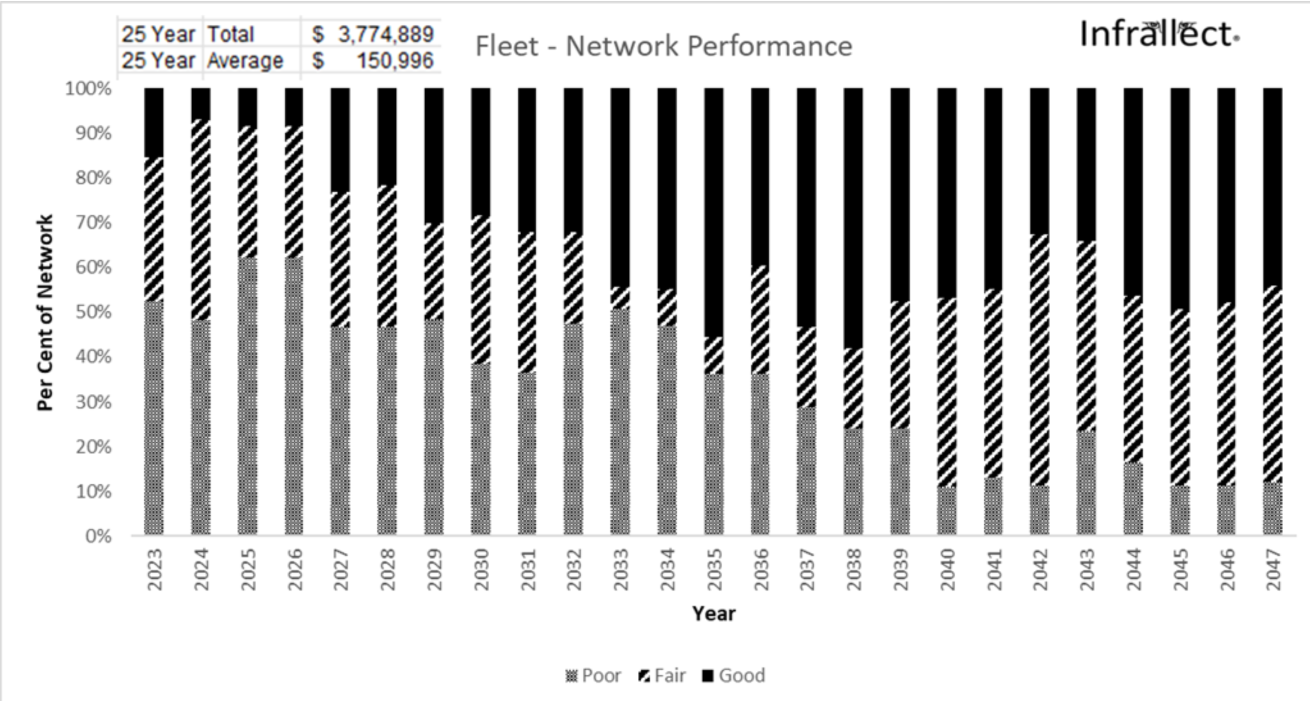


Figure 51: Annual Performance of Fleet Assets in the Target Scenario

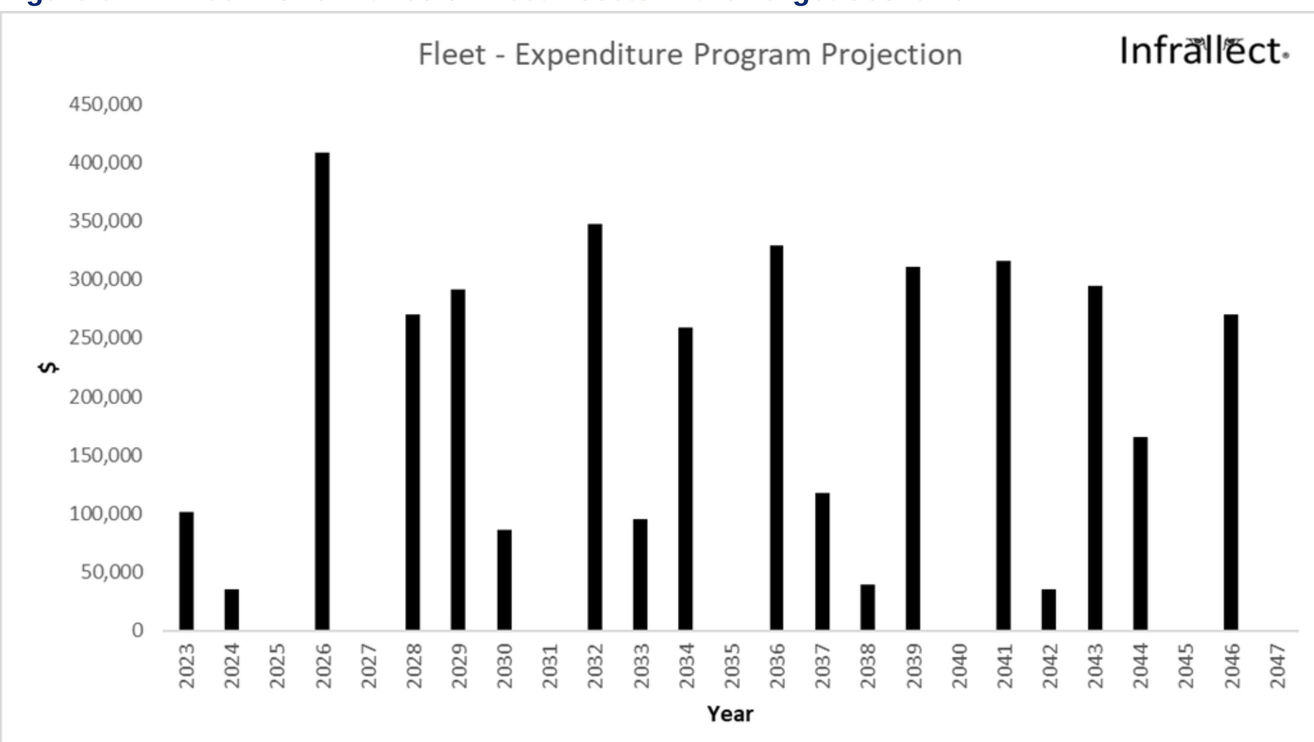


Figure 52: Corresponding Expenditure of Fleet Assets in the Target Scenario

8.3.3.5.3 Ontario Regulation 588/17

A requirement for O. Reg. 588/17 is the reporting of the average age of assets. The average age for Fleet equipment is 13 years.

Service levels are defined in two terms, community levels of service and technical levels of service. O. Reg. 588/17 identifies specific metrics for core assets that municipalities must report on however metrics for non-core assets are to be developed by each municipality. As a non-core asset, Fleet metrics will be developed and included in the 2024 AMP. These will be as necessary, sub-sets of the comprehensive Level of Service already developed by the Municipality, as shown in the previous two sections.

8.3.3.6 Demand Management Plan

Please refer to section 5.1.6 for general context and appropriate asset management interpretation of this section's specifics.

Demand for new services impact fleet assets. These demands can include the impacts of climate change, population change, regulatory requirements, changes in demographics, seasonal factors, consumer preferences and expectations, technological changes, economic factors, and environmental awareness.

Demand will be managed through a combination of managing existing assets, upgrading existing assets, providing new assets, and demand forecasting. Demand management practices can include non-asset solutions, insuring against risks and managing performance.

The Brooke-Alvinston Infrallect will be used to assist SMEs in other asset classes (e.g., Transportation, Water Distribution) in demand management planning. The demand management planning in those areas has the potential to impact Fleet and the equipment the Municipality purchases and maintains.

8.3.3.7 Risk

Please refer to section 5.1.7 for general context and appropriate asset management interpretation of this section's specifics.

Risk related to the Fleet asset class is managed through:

- SME knowledge and expertise
- Data-driven decision making
- Performance and expenditure forecasting

This three-pronged approach ensures that Fleet's Level of Service (i.e., performance) supports the community's socioeconomic growth over the short and long term. The Brooke-Alvinston Infrallect allows staff to ensure that the future probability of underperforming infrastructure and its consequences is minimized.

In addition to their inherit SME expertise, in order to minimize risk, SMEs always consider a wide range of factors during infrastructure decision making processes, the core of which are included in **Table 6**. The available asset inventory data, deterioration rates and funding related to Fleet is centralized within the Brooke-Alvinston Infrallect. This along with fleet equipment assessments and professional management allow staff to make comprehensive and informed decisions. The ability to forecast effects of contemplated decisions increases the reliability of infrastructure's future performance.

8.3.3.8 Conclusion and Next Steps

The difference between Budget (existing) and Target Levels of Service (i.e., infrastructure performance) over the next 25 years is medium by magnitude when compared to other asset classes. In order to remedy the performance gap, it is estimated that an additional $46,813 per annum is required.

In order to ensure management of Fleet assets continues to be optimal, future asset management steps will aim to find the most efficient means of maintaining the performance forecast.

Strategic steps will include:

- Continuous effort in increasing performance data collection capabilities
- Continuous improvement of the Brooke-Alvinston Infrallect analysis capabilities
- Continuous improvement of forecasting logic
- Corporate awareness and training

Tactical steps will include:

- Minimizing impact on staff time with respect to sharing information required for the Brooke-Alvinston Infrallect
- Increasing awareness of the difference between project level (most granular asset inventory) and network (asset class) level application of asset management principles
- Increasing awareness of general forecasting principles

Operational steps will include:

- Where applicable, developing data collection templates and means
- Continuous engagement with SMEs on progress
- Improving consumer-based modelling parameters

8.3.4 Equipment and Furnishings

8.3.4.1 What do we own and what is it worth?

Please refer to section 5.1.1 for general context and appropriate asset management interpretation of this section's specifics.

The Municipality manages more than 170 individual and/or grouped Equipment and Furnishing assets, ranging from information technology to small construction equipment. The total replacement value of Equipment and Furnishings assets is approximately $3,192,975 which represents 2.3% of the total replacement value of the Municipality's assets.

8.3.4.2 Allocation of Infrastructure Funding

Please refer to section 5.1.2 for general context and appropriate asset management interpretation of this section's specifics.

The distribution of the funding is shown in **Figure 53**, averaging $224,848 per annum.

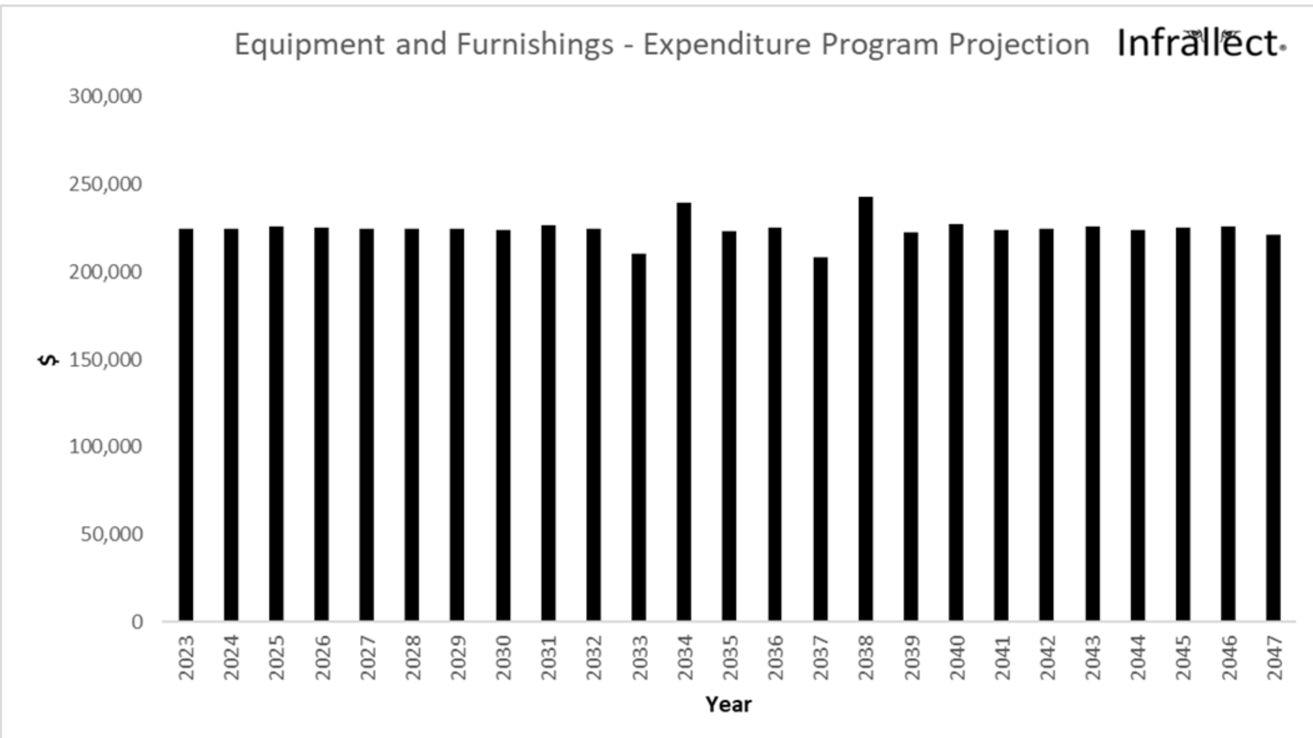


Figure 53: Capital Funding Distribution for Equipment and Furnishings Assets

8.3.4.3 Rehabilitation or Replacement Strategies

Please refer to section 5.1.3 for general context and appropriate asset management interpretation of this section's specifics.

Equipment and Furnishings assets are replaced when they reach the end of their useful life [i.e., reach a performance of zero (0)%].

8.3.4.4 Lifecycle Management Activities

Please refer to section 5.1.4 for general context and appropriate asset management interpretation of this section's specifics.

For Equipment and Furnishings maintenance the following lifecycle management activity options exist, but are not limited to:

- Preventative maintenance activities and inspections are undertaken at predetermined intervals or according to prescribed criteria, aimed at reducing the failure, risk or performance degradation of the equipment.

For Equipment and Furnishings rehabilitation the following lifecycle management activity options exist, but are not limited to:

- Unscheduled maintenance (repairs) to correct deficiencies that occur between scheduled services to maintain equipment in a safe, operable condition.

For Equipment and Furnishings reconstruction the following lifecycle management activity options exist, but are not limited to:

- Replacement

The Brooke-Alvinston Infrallect is used to forecast Fleet asset class performance and corresponding expenditure over a 25-year span. Fleet is a unique asset class as maintenance and rehabilitation activities are ongoing throughout the year to ensure that the equipment can provide an acceptable level of service. Once the forecast activities are within the one to three year span, SMEs determine the appropriate replacement needs. In doing so, all available information relating to items listed in **Table 5 and Table 6** is considered by SMEs in order to determine the treatment of highest /benefit to the community. It is not atypical to adjust treatments and costs from the original forecast. This is because more information (e.g., functional and conditional needs are identified each year). However, the total projected performance and expenditure for the year are not impacted. This is because the limits of scientific forecasting occur at the aggregate level of asset class performance and spending.

8.3.4.5 Level of Services

Please refer to section 5.1.5 for general context and appropriate asset management interpretation of this section's specifics.

8.3.4.5.1 Current Performance and Projected impact of Budgeted Capital Expenditures

There are currently around 35% of fleet assets in poor performance. The average annual budgeted capital expenditures of approximately $224,848 will result in a performance profile that is anticipated to be acceptable to most stakeholders. **Figure 49** contains the performance distribution.

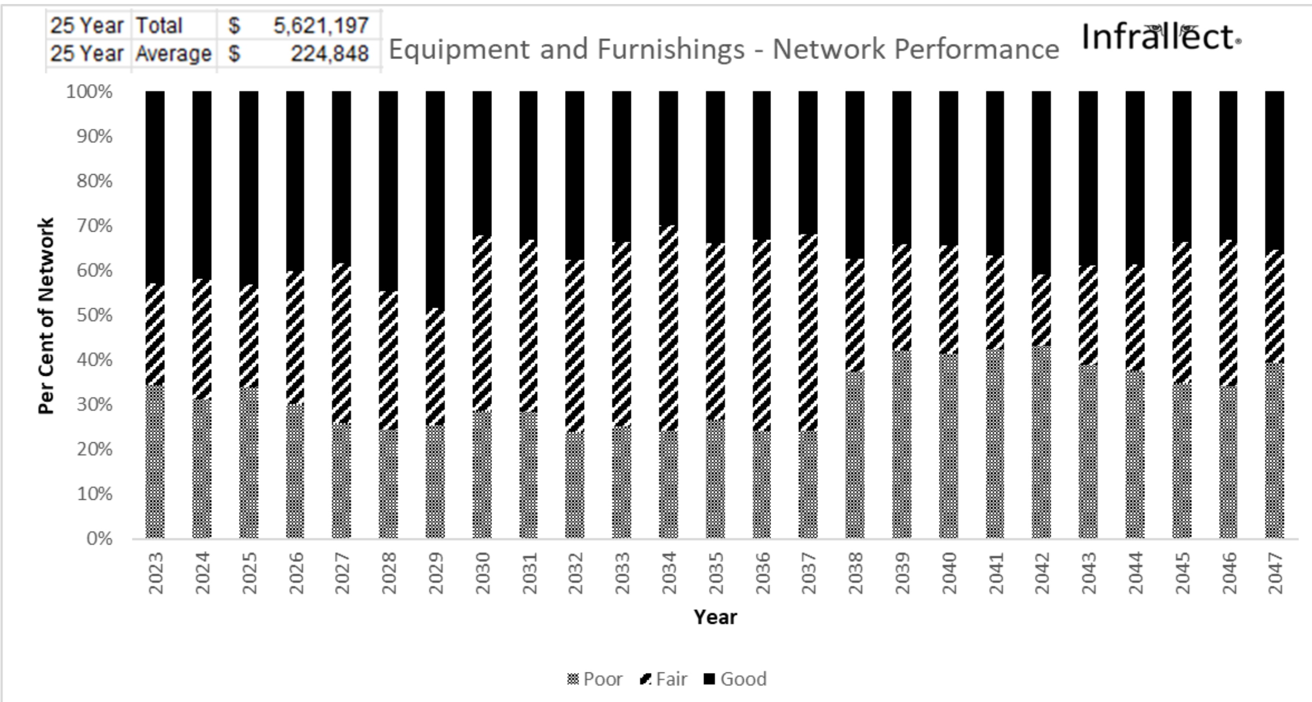


Figure 54: Annual Performance of Fleet Assets in the Budget Scenario

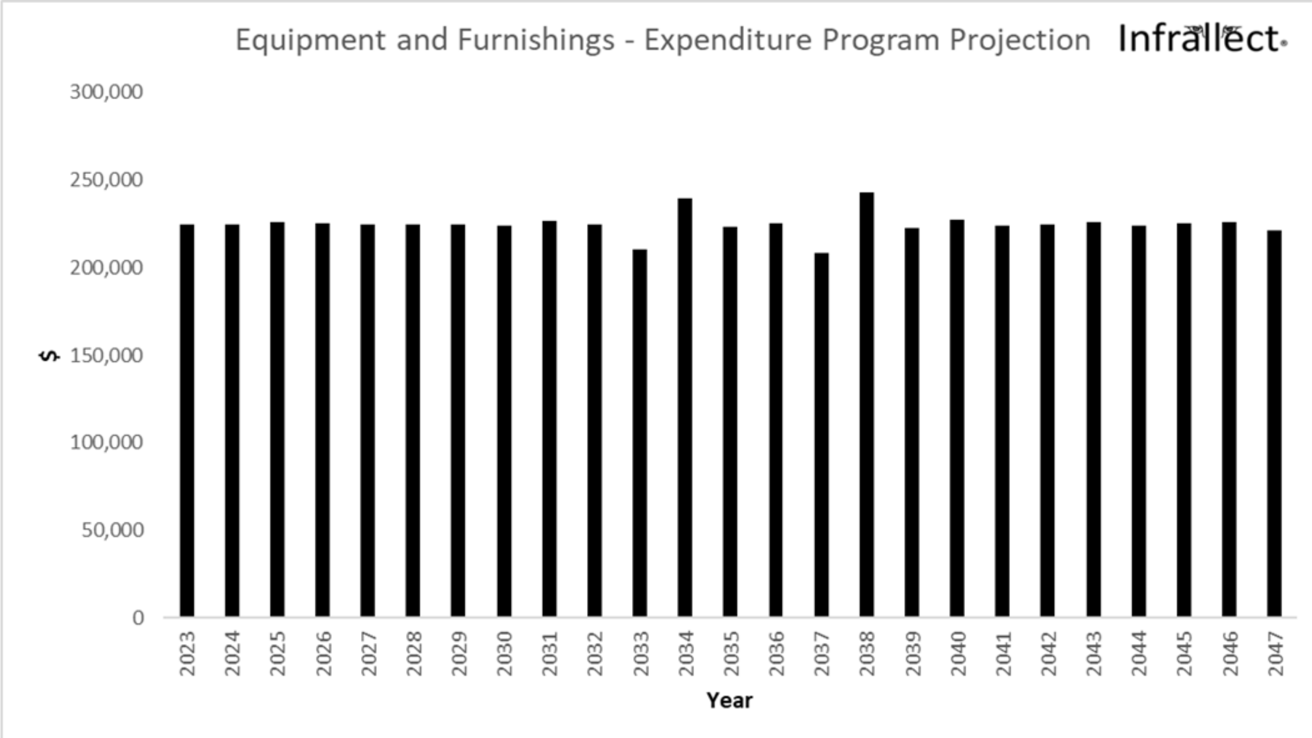


Figure 55: Corresponding Expenditure Forecast of Land Improvements and Parks Assets in the Budget Scenario

8.3.4.5.2 Target Performance and Required Expenditures

As described above, the current budgeted expenditures are expected to be in the general range that is required to achieve the target performance for Fleet assets.

8.3.4.5.3 Ontario Regulation 588/17

A requirement for O. Reg. 588/17 is the reporting of the average age of assets. The average age of Equipment and Furnishings is 10 years.

Service levels are defined in two terms, community levels of service and technical levels of service. O. Reg. 588/17 identifies specific metrics for core assets that municipalities must report on however metrics for non-core assets are to be developed by each municipality. As a non-core asset, Fleet metrics will be developed and included in the 2024 AMP. These will be, as necessary, sub-sets of the comprehensive Level of Service already developed by the Municipality, as shown in the previous two sections.

8.3.4.6 Demand Management Plan

Please refer to section 5.1.6 for general context and appropriate asset management interpretation of this section's specifics.

Demand for new services impact fleet assets. These demands can include the impacts of climate change, population change, regulatory requirements, changes in demographics, seasonal factors, consumer preferences and expectations, technological changes, economic factors, and environmental awareness.

Demand will be managed through a combination of managing existing assets, upgrading existing assets, providing new assets, and demand forecasting. Demand management practices can include non-asset solutions, insuring against risks and managing performance.

The Brooke-Alvinston will be used to assist SMEs in other asset classes (e.g., Transportation, Water Distribution) in demand management planning. The demand management planning in those areas has the potential to impact the equipment and furnishings the Municipality purchases and maintains.

8.3.4.7 Risk

Please refer to section 5.1.7 for general context and appropriate asset management interpretation of this section's specifics.

Risk related to the Fleet asset class is managed through:

- SME knowledge and expertise
- Data-driven decision making
- Performance and expenditure forecasting

This three-pronged approach ensures that Fleet's Level of Service (i.e., performance) supports the community's socioeconomic growth over the short and long term. The Brooke-Alvinston Infrallect allows staff to ensure that the future probability of underperforming infrastructure and its consequences is minimized.

In addition to their inherit SME expertise, in order to minimize risk, SMEs always consider a wide range of factors during infrastructure decision making processes, the core of which are included in **Table 6**. The available asset inventory data, deterioration rates and funding related to Fleet is centralized within the Brooke-Alvinston Infrallect. This along with fleet equipment assessments and professional management allow staff to make comprehensive and informed decisions. The ability to forecast effects of contemplated decisions increases the reliability of infrastructure's future performance.

8.3.4.8 Conclusion and Next Steps

Based on available information, a difference between Budget (existing) and Target Levels of Service (i.e., infrastructure performance) over the next 25 years is not expected at this time.

In order to ensure management of Fleet assets continues to be optimal, future asset management steps will aim to find the most efficient means of maintaining the performance forecast.

Strategic steps will include:

- Continuous effort in increasing performance data collection capabilities
- Continuous improvement of the Brooke-Alvinston Infrallect analysis capabilities
- Continuous improvement of forecasting logic
- Corporate awareness and training

Tactical steps will include:

- Minimizing impact on staff time with respect to sharing information required for the Brooke-Alvinston Infrallect
- Increasing awareness of the difference between project level (most granular asset inventory) and network (asset class) level application of asset management principles
- Increasing awareness of general forecasting principles

Operational steps will include:

- Where applicable, developing data collection templates and means
- Continuous engagement with SMEs on progress
- Improving consumer-based modelling parameters

8.3.5 Forestry

Not applicable.

8.3.6 Parking

Under Land Improvements and Parks.

8.3.7 Fire

Under Facilities and Fleet.

8.3.8 Information Technology

Under Equipment and Furnishings.

8.3.9 Cemeteries

Under Land Improvements and Parks.

8.3.10 Public Art

Not applicable.

8.3.11 Land

Not applicable.

8.4 Appendix D: Application of Risk

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Memorandum

From: Milos Posavljak, PhD Cndt, P Eng, University of Waterloo

To: Cassandra Pacey, CPA, CGA, Asset Management Manager, City of Waterloo

Date: 3-Jul-2020

Re: Application of Risk and Reliability to Provision of Public Infrastructure

Risk management is a central theme for all successful organizations. Since the introduction of asset management principles to provision of public infrastructure just over a decade ago, risk based prioritization has become a key term of focus.

According to the latest asset management research at the University of Waterloo, unfortunately, risk has not yet been properly formulated in the context of public infrastructure management. The issue stems from current industry practice attempting to conform public infrastructure management risk assessment to private sector risk assessment. Typically the engineering definition of risk is used to start-off the assessment, that is "risk = probability of asset failure x consequence of failure." Then subjective and arbitrary scores or qualitative categories are used, rather than continuing with actual statistical calculations that are necessary for the assessment to satisfy the engineering definition of risk (with which the assessment started-off). Furthermore, the professional engineering industry's goal is to ensure that infrastructure does not fail at all. In fact, civil engineering infrastructure is designed with a 0.99999 reliability (i.e. probability of not failing) resulting in 0.00001 probability of failure. The term "failure" is not lightly used in engineering, if at all; the proper term is "reliability" which is the opposite of failure. There have been a very limited number of failures in the developed world, however, compared to the volume of built infrastructure, its actual working (i.e.in the field) reliability is significantly higher than 0.99999 or another way to consider it, the probability of failure is less than 1/10,000.

Mechanical engineered assets typically make up less than 5% of a municipal infrastructure portfolio, this includes fleet, heating, ventilation and air conditioning (HVAC), and mechanized equipment. Assuming manufacturer's schedule of pre-planned treatments is adhered to, once its lifecycle comes to an end, it is not considered "failure" as it has fulfilled its designed lifecycle.

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Civil engineered assets typically make up 95% of a municipal infrastructure portfolio. Unless the magnitude of the forces experienced once constructed, are significantly greater (i.e. natural disaster) than those that the infrastructure was designed for, civil engineered assets will continue to stand (i.e. not fail) in perpetuity. The assets will deteriorate over time, however the infrastructure is not designed to physically fail, rather the performance or level of service will decline. As mentioned above, the rarity of such failures does not justify focusing entire asset management risk assessments on the probability of infrastructure failure, especially not with subjective and arbitrary risk scoring for "probability of failure".

According to latest asset management research from the University of Waterloo, the only risk which can practically be managed by a municipality is the risk of failing to meet infrastructure performance targets thereby negatively impacting the community's socioeconomic wellness. In order to assess whether performance targets are being met or not, their quantification and visualization (i.e. graphing) is necessary. Therefore, the appropriate definition of risk as it applies to public infrastructure management is:

public infrastructure asset management risk

=

probability of failure to quantify infrastructure performance according to decisions being contemplated

X

consequence of failure

Where probability of failure is inversely proportional to asset management system's capabilities and consequence of failure is directly proportional to over or under spending on infrastructure.

Further details on this item and public infrastructure management in general can be found in the attached paper titled: "A Different Kind of Partnership – An Infrastructure Performance Stock Exchange".

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A different kind of partnership: an infrastructure performance stock exchange

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Typically, public–private partnerships are constrained to be 'mega' construction projects and long-term arrangements. This paper introduces a practical mechanism for a novel public–private partnership modelled on the concepts of market trading (i.e. stock exchange). The ultimate mega project is the management of an entire infrastructure asset network by a government agency (federal, provincial, local, etc.). Hundreds of billions of dollars are spent each year in North America on the upkeep of public infrastructure (roads, underground, buildings, parks, etc.). Yet, according to current projections, this is still far short of the funding that is required to achieve acceptable levels of performance or service. A transparent, evidence-based and auditable process for deriving a universal infrastructure asset performance stock measure is introduced. Rather than being based on asset age, as the current 'old infrastructure order' is, the 'new infrastructure order' of asset management is based on the principles of reliability (risk) engineering as applied to corporate information.

Notation

AAD_{iPS}	average annual deterioration of the infrastructure asset performance stock (iPS)
c_i	cost of treatment or improvement activity
$iPS_{t_{Ti}}$	asset performance after last asset treatment or inspection (1 to 0)
iPS_{t_o}	asset performance in the current or any future year (1 to $-\infty$)
m_{tt}	asset's mean time to treatment or improvement activity
n	number of treatments or improvement activities
r_i	cost of asset replacement
$SEPM_s$	value of the subject matter expert established performance measure as inspected, but scaled to a range of 1 to 0
TT_{iPS}	asset's treatment trigger or improvement activity iPS threshold value
t_a	year of treatment or improvement activity
t_o	current or future year for which performance is being calculated
t_{pa}	year of the previous improvement activity
t_{Ti}	year of last asset treatment or inspection

Introduction

In order to remedy the funding gap to maintain the services provided by twentieth-century infrastructure and construct the infrastructure necessary to implement technological advances of the twenty-first, a different kind of public–private partnership is necessary, one that is not constrained to 'mega' construction projects and long-term leases whose values are miniscule when compared to that which is necessary for continuous provision of all public infrastructure.

This paper recommends the establishment of an exchange for infrastructure asset performance stock (iPSx). As such, a derivation of a universal infrastructure asset performance stock (iPS) measure is developed. iPS development took 10 years to complete and is currently, since its introduction in 2017, being applied to 15+ infrastructure managing agencies across Canada.

After analysing the North American infrastructure gap and limitations of traditional subject matter expert (e.g. engineering) established performance measures (SEPMs) for infrastructure assets, the applicability and advantages of iPS are explained.

Purpose

The purpose of this paper is to

- analyse remedies for the North American infrastructure gap
- analyse limitations of traditional SEPMs for infrastructure assets
- provide the essential elements for establishing an iPSx.

The purpose is to be achieved by applying reliability (risk) engineering onto subject matter expert (e.g. engineering), finance and administrative corporate information, available within managing agencies.

Scope

The scope includes four unique aspects to contribute to the advancement of the current state of the art of infrastructure asset management

- approaching the problem from a strictly corporate point of view of a public agency
- addressing all infrastructure asset classes owned by managing agencies
- developing a universal performance measure for all infrastructure
- providing a direct link between infrastructure asset performance and expenditure that is readily auditable by existing corporate audit standards.

The pillars of the presented material include

- 8 years of academic research on infrastructure asset management
- 10 years of public agency experience covering the full vertical and horizontal spectrums of the corporation
- 13 corporate case studies demonstrating uptake by corporate structures of the arguments herein.

North American infrastructure funding gap

Existing literature varies in the type and detail captured of actual public sector spending and related financial information and the time span to which it corresponds. It ranges from qualitative assertions to quantitative lump sums and overall asset-centric (i.e. single asset class out of an entire portfolio that an agency manages) replacement values. The figures themselves are typically referenced from other publications (e.g. government reports). It is important to note that both the annual capital and replacement values are subject to competitive construction bidding. As such, future projections are subject to market fluctuations. Annual capital expenditures are of significantly greater concern to asset management than the replacement value. The asset replacement value – overall or asset-centric – is theoretical and, other than giving an idea of the asset's size, has minimal asset management process implications.

The Canadian Infrastructure Report Card (CIRC, 2016) and the US Infrastructure Report Card (ASCE, 2017) annual expenditure and infrastructure replacement values are shown in Table 1.

Table 1. North American infrastructure gap

Information type	Canada[a]	USA[b]	North America
Total existing annual expenditure: C$ billions	20	130	150
Overall infrastructure replacement value: C$ billions	1100	7074[c]	8174
Annual (2016–2025) funding gap: C$ billions	10	170	180
Annual funding gap as a per cent of existing annual expenditure: %	47	131	120

[a] Includes CIRC asset class categorisation: potable water, waste water, storm water, roads, bridges, buildings, sport and recreation facilities, transit
[b] Includes US Infrastructure Report Card asset class categorisation: surface transportation, water/waste water infrastructure, public parks and recreation (excludes electricity, airports, inland waterways and marine ports, dams, hazardous and solid waste, levees, rail, schools)
[c] Not readily available, extrapolated from Canada ratio of 20/1100
C$1 = £0·592

The North American infrastructure replacement value is estimated at C$8·2 trillion. This is 42% of the annual gross domestic product (GDP) of C$19·6 trillion (Trading Economics, 2018). The annual capital expended on renewing infrastructure is 0·8% of the GDP. Hence, the annual value of the means (public infrastructure) to that of the ends (socio-economic growth – GDP) is at a ratio of 1 to 131. It is argued that the replacement value and its ratio of 1 to 2·4 cannot be used in the same context, as the term 'replacement' typically refers to project-level improvement activities, which are funded through annual capital expenditure and, to a lesser extent, through operating expenditure. Replacement of entire asset-centric networks through lump sums equal to their replacement value is not practiced.

The predominant modes of funding infrastructure needs are taxes and user fees. Figure 1 shows the 25-year infrastructure gap scenarios. In order to close the gap by 2027, all administrations managing public infrastructure would need to increase taxes and user fees by 8·30% year on year. This is double the maximum recorded inflation value (4·15%) in North America from 1993 to 2017, weighted according to existing annual expenditures of Canada and the USA (BOC, 2018; The Balance, 2018). This is neither practical nor sustainable, as barring any special circumstances (e.g. major expansion of communities' recreation facilities), elected officials typically aim to keep rates at or below inflation. Such an approach would see the gap closed in 2057, while a sustained increase of 4·15% would see the gap closed in 2037. However, the presented timing of all three scenarios is questionable – as the gap exists now – and the longer it takes to address it, the larger its actual value will be than the ones projected today.

The only scenario which attempts to address the gap in a timely manner, so that there is no 'gap creep', is the iPSx.

Provided that the information for the derivation of the instrument of trade (iPS) is readily available at municipalities, there are no uptake issues expected from this angle. The time frame shown is optimistic provided that the logistics for facilitating market trading will take years to establish. However, it is argued that this is a significantly less cumbersome undertaking than attempting to sustain tax rate increases at unprecedented levels across all relevant agencies. Hence, the scenario is realistic, and perhaps conservative, when comparing the alternative's curves across time.

In 2017, the global value of stocks traded was C$101 trillion (C$1 = £0·592). Providing access to only 0·18% of such value

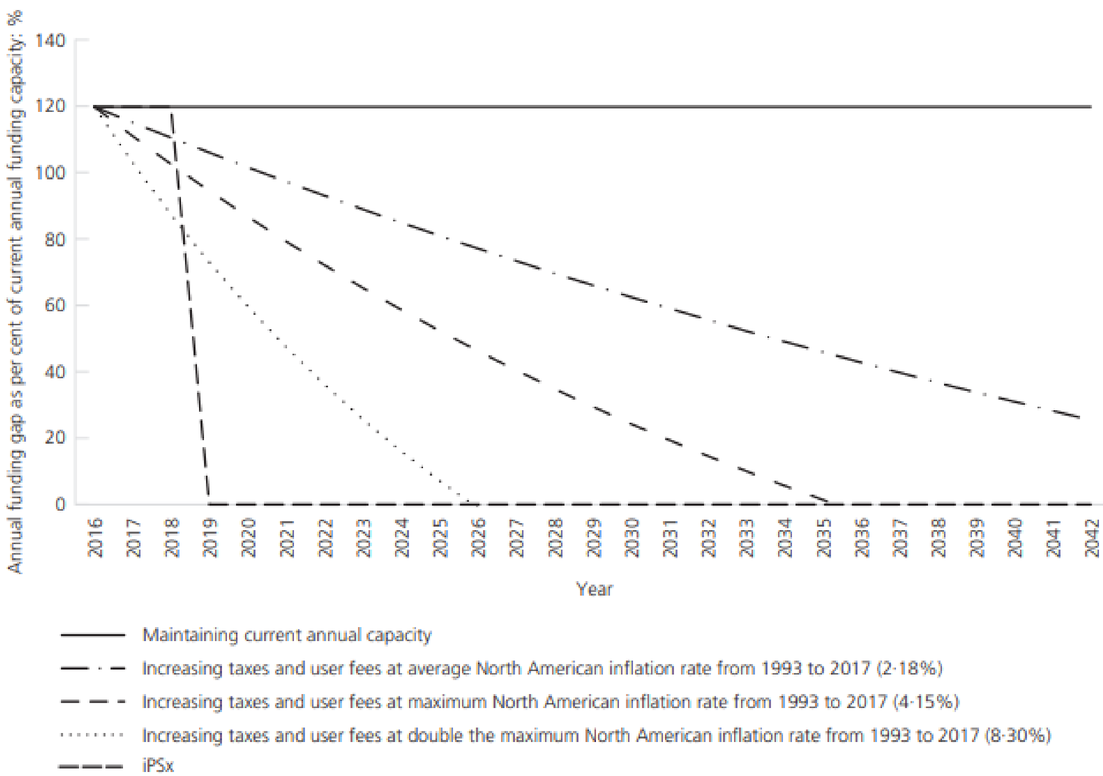

Figure 1. North American infrastructure gap projections

to the infrastructure needs would bridge the gap (World Bank, 2018). It should be noted that there is already an established infrastructure exchange called the West Coast Infrastructure Exchange (WCX, 2018). However, its focus appears to be concentrated on training, education and a project-by-project basis of assistance to public administrations. On the other hand, the iPSx is to be an actual market exchange.

As with any market, consumer confidence is a necessity for its initialisation, growth and sustainability. The minimum bar for creating an environment where such confidence can come about is ensuring that the science and engineering behind the concept is transparent and evidence based. The following section explains the current related limitations of the industry.

Limitations of traditional SEPMs

The results of analysed SEPMs across different asset classes and public managing agencies is presented in this section. As each can be a research topic in itself, background details about previously conducted research on individual asset classes or parts thereof are outside the scope of the paper. The main reason being is that, practically, within a managing agency, all asset classes and their associate metadata (e.g. performance measures) are considered by the administrators – at the same time – during decision-making processes. Therefore, study of such information on an individual basis does not represent the actual conditions under which they are typically used during infrastructure asset management decision-making processes. Table 2 shows a non-exhaustive list of asset classes and their conditional and functional SEPMs as seen through the corporate lens. Asset age is the industry-wide 'fallback' SEPM in the absence of others. While this may to an extent be appropriate for relatively homogenous and small asset stocks (e.g. personal vehicle and machinery), it is not for extremely heterogeneous and large asset stocks such as societal infrastructure. The reasoning for this argument will be discussed later on in the paper.

There appears to be an industry-wide confusion with respect to defining what the term 'level of service' practically means with respect to provision of public infrastructure. There should be no such compulsion. The public uses a physical product (i.e. the infrastructure); therefore, the 'level of infrastructure performance' is synonymous with the 'level of service' that a public administration provides to its community, barring the 'customer level of service', which is not related to infrastructure, but rather to services provided by public servants, such as snowploughing. While an asset-centric perspective may disagree, under corporate perspective, top categories of SEPMs' taxonomy include only two: conditional and functional. The next immediate level is a one will see competition within the public (e.g. municipalities) and private (e.g. manufacturers) sectors of who will be the first to address their infrastructure gap and ensure that the benefits of new technologies reach the society in a timely manner.

It is argued that public infrastructure needs to be viewed as a commodity whose cultivation and subsequent allocation is necessary to achieve visions of future civilisations. At the very least, this includes the integration of twentieth-century public infrastructure with twenty-first-century technologies (e.g. information technologies). Furthermore, it is argued that the current, widespread application bottlenecking of such technologies (e.g. self-driving cars, hyperloops and smart communities) is the lack of capacity (i.e. funding) on the public administration side, specifically, first, to remedy the infrastructure gap; second, to ensure a steady flow of funds to minimise its reoccurrence; and then to focus resources on administrative and construction solutions for cultivation and allocation of public infrastructure tailored with latest technologies.

A study by the American Society of Civil Engineers (ASCE, 2017) found that '[f]ailure to close the gap carries an estimated $3.9T USD loss to United States GDP, and a $7T loss in business sales, by 2025. 2.5 M jobs will be lost in 2025, and families will lose annually upwards of $3,400USD of disposable income or $9 USD each day'.

Figure 2 shows the sources of iPS's investment returns.

In addition to projected tax and user fee revenues (without iPSx), the expected sources include the value derived from preserved socio-economic activity and new value generated from economic development opportunities not possible today due to technological limitations currently associated with public infrastructure. Conceptually, a 1:2:3 proportion of yield value is expected from tax, preserved activity and generated activity, respectively.

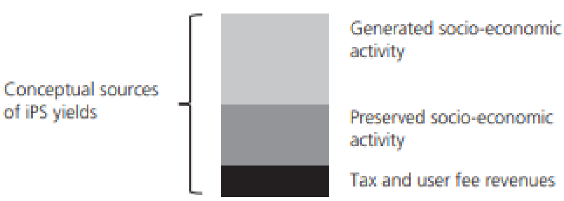

Figure 2. Sources of iPS's investment returns

In terms of iPSx establishment, perhaps integration into the existing municipal bond mechanism would be more efficient than starting from scratch. In any case, in order to deliver timely value to public administrations and in turn to society, iPSx structure should aim to minimise the necessary paperwork for issuance of iPS. Public administrations are already at capacity with respect to available staff time. A good portion, if not a majority, of all infrastructure is administered by 'small' municipalities. These administrations include staff sizes of less than ten, sometimes five, full-time positions. Preparation of lengthy applications is not an option for them. As such, the iPSx should strive to facilitate direct iPS issuance by public administrations to the market without third-party involvement. This will provide maximised accessibility to a wide range of issuers and keep the cost of issuance down. Given that public administrations are already subject to rigorous audit programmes, their detailed financial information is generally already available on their websites, and internal financial professionals prepare such information; the issuance of iPS should not take more than a week of staff's time.

To achieve this efficiency, the derivation of iPS must be transparent, evidence based and auditable. The following section addresses these items.

Universal iPS measure

In contrast to the old infrastructure order (Table 4), Table 5 shows the proposed new infrastructure order.

The steps numbered in the table have already been or are in the process of being applied by 15+ local governments across Canada. The concept was first applied by the City of Waterloo in 2016, during the development of their first comprehensive asset management plan. Since then, there has been an uptake by others.

Table 5. New infrastructure order – asset performance and expenditure projections

Step	New infrastructure order of projecting future infrastructure asset performance and required expenditure according to reliability (risk) theory (forecasting includes corporate decision factors)
1	Analyse existing subject matter expert, finance and administrative information across the entire corporation
2	Derive annual asset deterioration, mean time to treatment, treatment trigger and starting performance
3	Derive the average treatment cost
4	Deteriorate performance over a long-term span (e.g. 25 years)
5	Apply average treatment costs at asset performance values equating to treatment trigger values
6	Repeat steps 1 to 5 for all assets owned
7	Set unique qualitative performance ranges (e.g. good, fair, poor) for values in step 4
8	Add up costs of all assets from step 5, and present values as infrastructure funding needs over the long term
9	Weigh overall asset network performance according to the replacement cost of each single asset, and project expected long-term good, fair and poor performance assuming needs from step 8 are going to be addressed

it was maintenance, it will be decreased. Hence, SEPM's treatment-dependent performance variations are also accounted for in iPS's calculation. Scaling maximum performance to a value of 1 is representative of 100%. Percentages are widely used as performance measures throughout society (e.g. stock price increase/decrease and student performance) for a variety of different phenomena. Acceptance by public administrations should not be an issue. The approach objectively and practically, without prescription, accounts for uniqueness of all communities, but still provides a standardised performance scale for iPS across all municipalities. If a SEPM inspection rather than a treatment is performed on the asset, the iPS is adjusted as per the inspection results, but scaled from the SEPM range of performance values (e.g. 10 to 0) to iPS's scale.

Finally, Equation 5 is a combination of previous ones and provides the calculation for the exact iPS value

$$5.\quad \mathrm{iPS}_{t_o} = \mathrm{iPS}_{t_{Ti}} - \mathrm{AAD}_{\mathrm{iPS}}(t_o - t_{Ti})$$

where iPS_{t_o} is the asset performance in the current or any future year (1 to $-\infty$); $\mathrm{iPS}_{t_{Ti}}$ is the asset performance after the last asset treatment or inspection (1 to 0); $\mathrm{AAD}_{\mathrm{iPS}}$ is the annual asset deterioration (1 to 0); t_o is the current or future year for which performance is being calculated; and t_{Ti} is the year of last asset treatment or inspection.

It should be noted that iPS values can go negative during modelling. Table 6 provides qualitative iPS performance ranges.

The top half between 1 and the treatment trigger value is considered good; the bottom half, fair; and below is considered poor. These can further be divided to provide the 'very' categories, if necessary.

In terms of issuing iPS onto the iPSx, the public administration would specify the current iPS value, cost and return rate. All other information is already subject to audit programmes. It is anticipated that market forces will stabilise any initial issuance anomalies.

In order to eliminate bottlenecking of information technology integration into infrastructure, it is anticipated that the tech sector will be a major player in the market share, while the corporate decision factor of new design standard accommodation (Table 3) will drive the initial public offerings.

Table 6. iPS' qualitative performance ranges and corresponding quantitative values

Performance ranges	
Good	$1 \geq \mathrm{iPS} > (1 - \mathrm{TT}_{\mathrm{iPS}})/2$
Fair	$(1 - \mathrm{TT}_{\mathrm{iPS}})/2 \geq \mathrm{iPS} > \mathrm{TT}_{\mathrm{iPS}}$
Poor	$\mathrm{TT}_{\mathrm{iPS}} > \mathrm{iPS}$

Conclusions

The practical relevance and potential application of the new infrastructure order proposed in this paper rivals that of the recent developments of blockchain technology. The 'decentralized' public–private partnership enabled by the iPSx is the key to leverage private-sector capital and is the only practical mechanism proposed to date that will enable the management of infrastructure systems in a manner that achieves current and future societal objectives. The proposed approach is scalable in terms of both the quantity/value of infrastructure being managed and the sophistication of the calculation of the universal iPS used to operationalise the iPSx. This scalability provides the opportunity for accelerated accessibility to all infrastructure management agencies in a matter of years, not decades, when facilitated through twenty-first-century information technology capabilities.

Acknowledgements

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