2017 Asset Management Plan
Municipality of Brooke-Alvinston
Case Study – University of Waterloo

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March 17, 2017

Dear Mr. Ikert,

Please find attached the Asset Management Plan report for the Municipality of Brooke-Alvinston for your consideration. Thank you for the case-study opportunity and subsequent efficient and effective collaboration.

Yours truly,

Milos Posavljak, P.Eng.
PhD Candidate

cc: Dr. Susan L. Tighe

Acknowledgments

Four organizations have been instrumental in making this project possible: the Municipality of Brooke-Alvinston, the City of Waterloo, GM Blueplan Engineering, and the University of Waterloo.

Credit is due to the Mayor of Brook – Alvinston, Mr. Don McGugan, who initiated the effort and gathered council support for the project. His effective leadership is echoed in the professionalism of municipal staff members. Their flexibility, sharing of knowledge and expertise allowed for unhindered project progress. In no particular order, a special thank you to: Ms. Janet Denkers, Mr. Stephen Ikert, Ms. Connie Swan, Ms. Sandra Dale, Mr. Randy Hills, Ms. Darlene Paolucci, and other team members of the municipality.

Brooke-Alvinston is the first small municipality to apply an asset management approach pioneered at the City of Waterloo. The Commissioner of Integrated Planning and Public Works - Mr. Cameron Rapp - championed the creation of the City's first comprehensive Corporate Asset Management Plan. The project was directed by the Executive Operations Officer - Mr. Bill Garibaldi. The success of which could not have been possible without the time, effort, and support of subject matter experts, engineering, finance, senior administration, and Council. In no particular order, a special thank you to: Ms. Cassandra Pacey, Mr. Jeff Little, Ms. Denise McGoldrick, Mr. Sunda Siva, Mr. Eckhard Pastrik, Ms. Roslyn Lusk, Councilor Jeff Henry, Mr. Tim Anderson, Ms. Keshwer Patel, Mr. Mark Dykstra, Mr. Steve Heldman, Ms. Filipa Reynolds, Mr. Brad Witzel, Ms. Andrea Bazler, Ms. Jean Starchuk, Mr. Kevin Van Ooteghem, Mr. Mike Lupsa.… and the many more professionals serving the citizens of Waterloo. On the project's private sector partner side, credit is due to the GM Blue Plan Engineering Team: Mr. Nick Larson, Mr. Philip Balt, Ms. Amanda Beattie, Mr. James Burn, Mr. Terry Martins, Mr. David Watt, Mr. Chris Hamel and the rest of the team members. Their willingness to take the traditional engineering consultant – client relationship and adhere it to the needs of effective asset management planning was crucial.

Credit is due to Professor Susan Tighe from the University of Waterloo, for guidance and support, without which the concepts of integrated infrastructure asset management planning would have not seen development or application. Also, a special thank you to Professor Mahesh Pandey for entertaining the application of traditional engineering risk and reliability concepts for corporate infrastructure asset management.

Finally, recognition to the Ministry of Infrastructure for conducting municipal consultations on asset management planning where initial contact with Mayor McGugan was made.

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Executive Summary

The Municipality of Brooke-Alvinston teamed up with the University of Waterloo to push the existing boundary of municipal infrastructure asset management planning. The plan was developed as part of an academic research study focused on the institutionalization/operationalization of asset management practice and cross-asset trade-off analysis.

The approach taken was pioneered at the City of Waterloo and focuses on exhausting existing organizational information in creating corporate-data-drive performance measures. Subsequently, an asset management plan is produced which can readily be updated with nominal increases in resources or within the existing depending on the agency. Special attention is paid to existing processes and ensuring the project builds on top of them, thereby minimizing their disturbance.

The plan covers 11 asset classes from underground infrastructure to facilities. Current state, asset management strategy, financing strategy, and the resulting asset performance (level of service) over 25 years was developed for each asset class. The sequence of the mentioned items is representative of the horizontal information flow taking place in infrastructure managing agencies, and is slightly rearranged compared to the order provided in the provincial Asset Management Guide available online.

As the asset management practice maturity for each asset class varies industry wide, deterioration rates and treatment trigger development was based upon three categories: established engineering / subject matter expert performance measures, engineering risk and reliability, and asset age. Examples include the pavement condition rating for roads, a comprehensive performance measure for facilities based upon improvement activity frequency and costing data, and age based analysis for underground water infrastructure, respectively.

An attempt has been made for each asset class section of the report to be self-contained without the need to cross-reference. Each contains four sub-sections as per the provincial Asset Management Guide.

State of Local Infrastructure - all infrastructure assets

The total replacement value of all infrastructure is \$ 95,764,088. When the gravel roads value of \$ 47,806,629 is included, the figure is \$ 143,570,717. Asset classes' replacement values are shown in Table 1.

The overall current infrastructure performance weighted according to replacement value of each asset class is 53 % good, 33 % fair, and 13 % poor.

Table 1: Infrastructure Asset Class Replacement Values

Asset Class	Replacement Value ($)	Portion of Total Replacement Value ($)
Facilities	22,280,396	23.27%
Roads (paved)	21,296,000	22.24%
Bridges and Culverts	15,400,507	16.08%
Storm Sewer	10,633,955	11.10%
Water Distribution	10,068,107	10.51%
Sanitary Sewer	7,863,524	8.21%
Equipment & Furnishings	3,945,460	4.12%
Fleet	2,975,612	3.11%
Land Improvements	701,481	0.73%
Sidewalks	301,067	0.31%
Road Illumintaion	297,979	0.31%
Total*	95,764,088	

* *the gravel road network is in good condition and is addressed separately due to its size relative to other asset classes.*

Asset Management Strategy - all infrastructure assets

The asset management strategies for each asset class depend upon the ability to model network deterioration, lifecycle improvement activities, associated costs, and resulting asset performance levels or levels of service over the 25 year span. Varying any of the four factors produces different scenarios of asset performance levels. Subsequently, the recommended asset management strategies are the ones which yield appropriate levels of asset performance. This is an iterative process where conditional and functional performance measures from public and professional perspectives are taken into consideration.

Financing Strategy - all infrastructure assets

The iterative process of asset management strategy vs. asset performance is gauged via their pivot -- being the financing strategy. Aggregate funding needs by asset class are compared to existing financial capacities derived from the last six (6) years. A recommendation is made whether to maintain existing, or increase funding levels in order to achieve the expected level of asset performance, and is accompanied by a recommendation on the potential fund raising approach. Figure 1 shows the 25 year capital expenditure profile necessary for achieving acceptable asset performance (level of service) over the planning horizon for all infrastructure owned by the municipality.

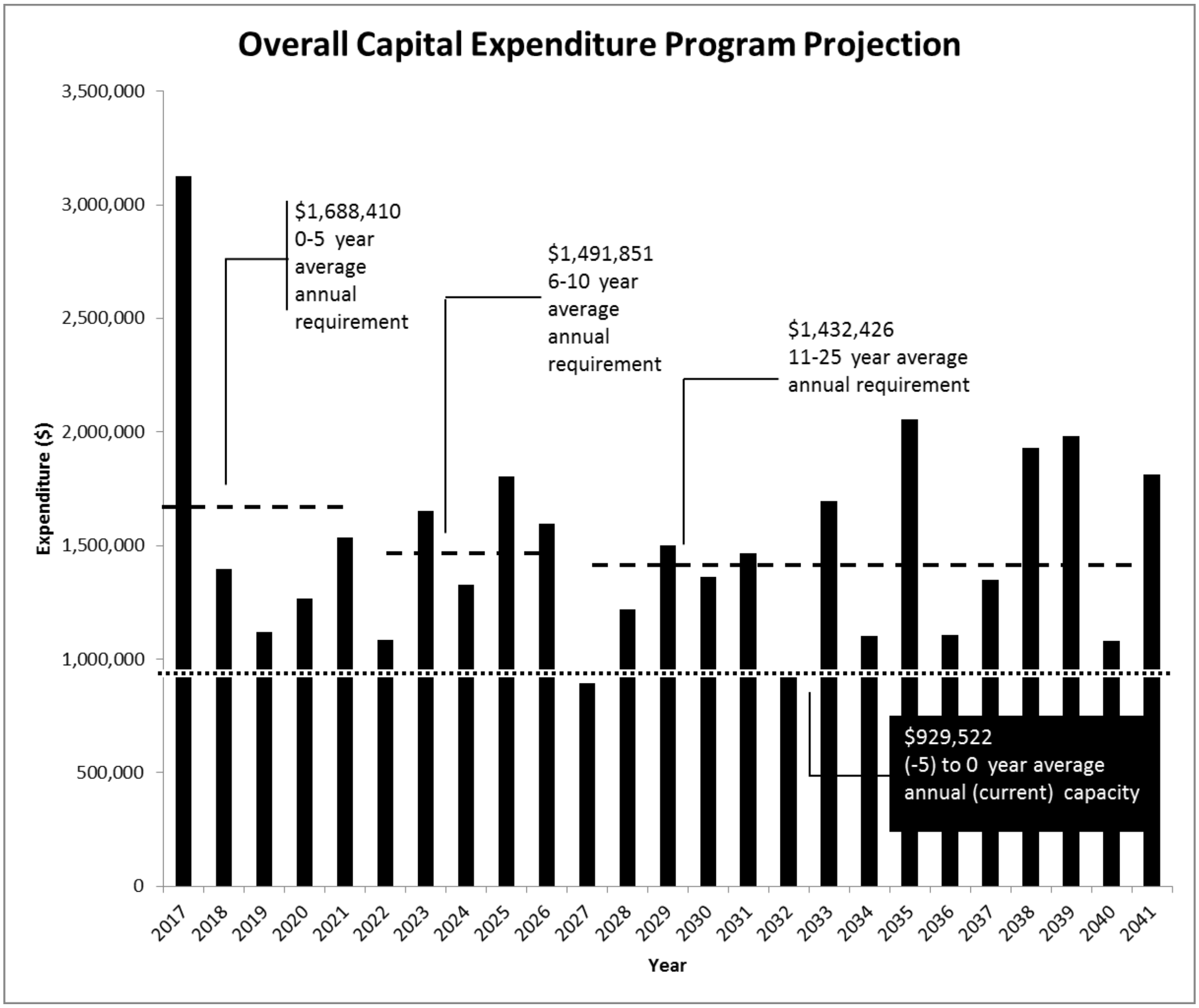

Figure 1: 25 Year Overall Capital Expenditure Program Projection

Review of Financial Information Returns indicated an annual six (6) year average of $ 929,522 of capital expended on municipal infrastructure. It is important to note that all projected values are estimates based upon the best available information and professional expertise, actual costs are subject to market forces invoked through the competitive bidding process associated with capital works. All values are in today's dollars. RS Means' Historical Construction Index is used for inflating the value of all civil works other than roads, as the current Asphalt Cement Price Index is in the range of that when the road study was completed – from which unit costs are used. Bank of Canada inflation rates are used for mechanical infrastructure (e.g. fleet). One-time large influxes for the expansion of the water distribution network and roadside costs were excluded from the calculation, as they would have artificially inflated the average capital capacity.

The average annual short (0-5 years), mid (6-10), and long term (11-25) funding gaps are, $ 758,888, $ 562,329, and $ 502,904, respectively. The theoretical overall 25 year average annual gap is $ 572,124. It is theoretical because to achieve the expected asset performance level, the short term requires greater capital. Lack of such short term capacity would see sub optimal asset performance, which would need to be addressed at some point in the future, and would therefore result in a greater mid and long term, and overall funding gap. This would be more than the shortfalls presented under the currently expected level of asset performance or level of service. Financing options for the scenario should explore the possibility of tax, fees, and debt instruments as funding generators; however, due to the relatively small size of the municipality, the majority of the initial effort should focus on grants.

Brooke-Alvinston's tax rates are already among the highest of all townships in the county. Borrowing to finance average capital expenditures of over $1.5 million a year - for the next 25 years - is not an affordable strategy. It does not have the luxury of exploring road tolling options such as the City of Toronto, and is definitely not considered as one of the "rich" communities of Ontario. The resident population is very low and there are very few opportunities to raise funds through user fees.

This report reiterates the need to concentrate administrative efforts on grants, but to date the Municipality's experience has seen governments giving less and less to small, declining communities and more and more to large, growing communities. The municipality has applied for funding for different capital projects, but each time, is turned down. Any funding that it does receive is minimal and in the 10% range of the recommended capital requirements. For example, last year it completed a storm sewer reconstruction. The total cost of the project will be over $ 1 M. The Municipality applied to government funding, but received zero (0) for the project, other than the normal gas tax which is approximately $70,000 per year. This is a very difficult position. They are currently starting their 2017 budget deliberations. At this time, the proposed capital expenditures are approximately $ 1.6 M, with estimated government (grant) funding of approximately $150,000, excluding the base gas tax and base OCIF funding it receives ($140,000 combined). Their application for OCIF top up funding was declined for the second year in a row. At the present time, the municipality would require over a 30% tax rate increase to accommodate the required capital asset expenditures.

A 30 % tax rate increase is not implementable; even if it was, it would severely deter from the overall goal of fostering the community's economic growth and social accessibility. In order to have the tax rate increase below 10 %, a $500,000 to $600,000 funding gap would be incurred. This equates to over 10% of total annual budgeted expenditures or 30 % of the required capital expenditures. While the first option would exert unsustainable fiscal pressure on the community, the second fails to provide adequate infrastructure asset performance (levels of service) necessary for sustained economic growth and social accessibility. Grant funding from higher government levels is therefore necessary to achieve this goal by helping the Municipality attain the required expenditure levels shown previously in Figure 1; which yield adequate infrastructure asset performance levels, as presented in the following section.

Asset Performance - all infrastructure assets (Expected levels of service)

Figure 2 shows the overall infrastructure performance distribution weighted according to the replacement value of each respective asset class.

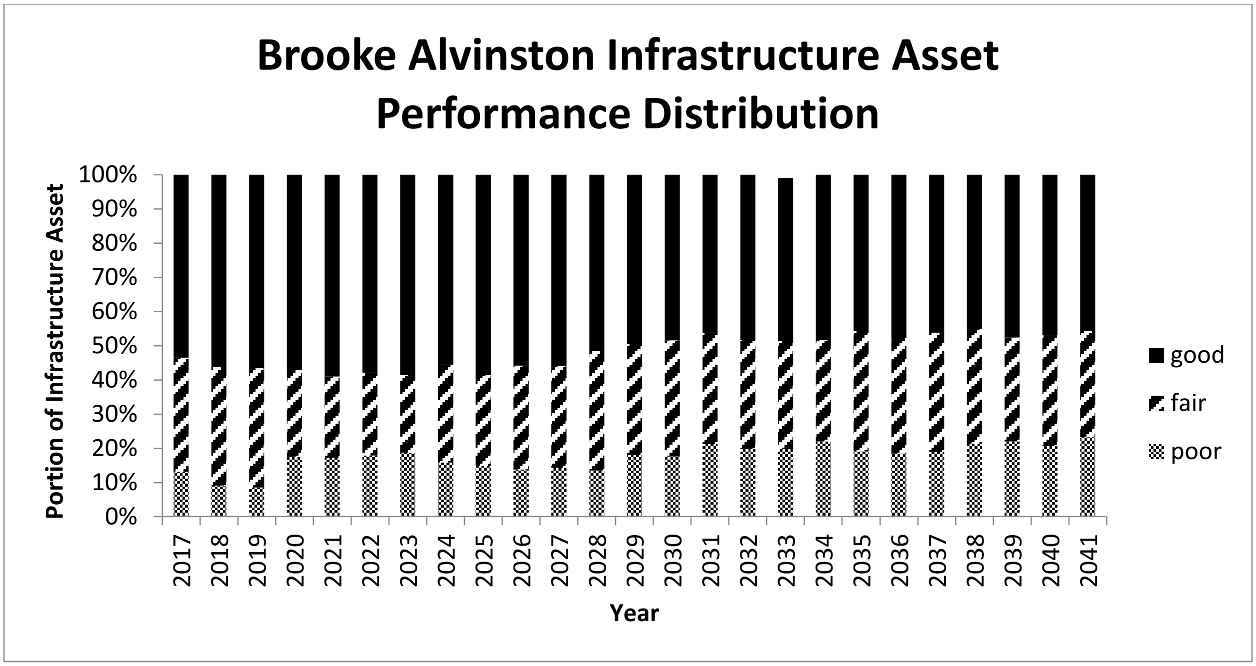

Figure 2: Overall Infrastructure Asset Performance (Expected Level of Service)

Unpaved roads are not included in the figure, as their replacement value is greater than 50 % of all other infrastructure combined. Provided that 100 % of the unpaved road network is in good condition, and current funding levels are sufficient, their inclusion would skew the graph in a way which would minimize the poor and fair portions of the other, more complex and challenging to manage asset classes.

The average poor asset performance for the first five (5) years is 13 %, increasing in the six (6) to ten year span to 16 %, and further increasing to 19 % in the 11-25 year span. The average fair asset performance for the first five (5) years is 30 %, decreasing in the six (6) to ten year span to 26 %, and averaging 33 % in the 11-25 year span. The average good asset performance for the first five (5) years is 56 %, slightly increasing in the six (6) to ten year span to 57 %, and decreasing by nine (9) per cent to 48 % in the 11-25 year span. As can also be seen from Figure 2, the performance categories share of the network are relatively stable over time. The poor and fair categories gain six (6) and three (3) per cent at the expense of the good category going from a 57 % average in the first ten years to an average of 48 % for the remainder of the planning horizon . Other scenarios were modeled; this is the recommended one for implementation according to professional input and corporate-data-driven infrastructure asset performance measures. Furthermore, it is necessary in order for the Municipality of Brooke-Alvinston to be contributing positively to the provincial and federal goals of social accessibility and economic growth.

1 Background

Compared to approximately a century of modern infrastructure construction, asset management planning is a relatively new addition to the field of public infrastructure. Conceptualized in the late eighties with the beginning of wide spread computer technology use, the last 15 years have seen an exponential increase in explicit use of “asset” management terminology. The last five (5) years include further intensification with the academics aiming to formalize the field within the educational system, and public governance looking to introduce potential regulation to further increase transparency for public infrastructure spending.

The general asset management planning challenges include, but are not limited to:

- determining key performance indicators;
- projecting network performance;
- prioritizing / optimizing infrastructure improvement activity;
- minimizing impact on existing processes; and,
- ensuring plan is a living document.

This Case Study report aims to address the challenges by applying the latest academic research findings in providing the Municipality of Brooke-Alvinston with an updated Asset Management Plan.

The approach taken was pioneered by the City of Waterloo in its completion of a comprehensive Corporate Asset Management Plan in 2016. A balance of engineering and finance expertise supported by private sector consulting, lead to a novel result with respect to the “how to” of asset management planning. The City of Waterloo Approach (CWAp) and its application for the Brooke-Alvinston Asset Management Plan focuses on exhausting existing information sources and minimizing effects on existing organizational processes.

1.1 Introduction

The following provides a concise summary of the community’s socio-economic profile supported by the built infrastructure:

“The Municipality of Brooke-Alvinston, located in eastern Lambton County, is 311 square km in size with a population of approximately 2,600. This quaint rural community is serviced by two small urban areas of Alvinston and Inwood. The municipality is central to the large urban areas of Sarnia, London and Chatham, all joined by major transportation routes.

The village of Alvinston is a fully serviced developing youth friendly community with restaurants, a bank, farm machinery dealership, modern machine shop, plumbing and heating shop as well as several churches, a library, an active legion, post office, recreation centre complex and a modern funeral home. Alvinston is also home to a commercial honey processing facility which produces award winning mead (wine). Ontario’s largest installer of ground source heating and cooling systems is also located in Alvinston.

Our Inwood community is also a fully serviced depressed urban area with several businesses and is home to Brooke Telecom, a publicly owned telephone system company offering regular and cell phone service as well as high speed internet and cable television services. Brooke Telecom has installed fiber optics throughout the Towns of Alvinston and Watford and has plans to do the same for Inwood, making services available to residents and businesses. The newly renovated Inwood library provides all the services of an urban library and a meeting space for local quilters and other community groups.

The Brooke – Alvinston – Inwood Community Centre Complex (BAICCC) is located in Alvinston. This modern facility contains an arena, auditorium with banquet facilities for 500 and several meeting rooms. Many sports teams gather year round at the BAICCC bringing visitors from surrounding areas. Brooke-Alvinston is known for its many sports teams which include: the Brooke-Alvinston Figure Skating & Synchro club, the East Lambton minor hockey teams, Alvinston Atom Silverstick tournaments, Alvinston minor ball teams and the Alvinston Aces Men's Fastball team. We are proud to say that some teams have been provincial champions.

Located nearby is the A.W. Campbell Conservation Area that offers camping and includes walking trails and picnic / playground / swimming facilities for families. It is generally booked to full capacity during the summer with seasonal and local recreational campers.

The rural agricultural area surrounding these centres has productive soils, managed by innovative food producers. Crops include wheat, soybeans, corn and specialty beans such as edamame and azuki. As well the many extensive livestock operations, our farmers are becomingly increasingly innovative with solar panel placement and other alternative energy initiatives.

Recent business additions include: Riverstone Pizza, Armor's Ale House, Alvinston Pharmacy, a hair salon, and new business space/ apartments on Centre Street planned for next year.

The local elementary school is host to the French Immersion Program as well as a Best Start Hub which also provides the Early Years Program.

We are further, very fortunate to have a very active Community Group who were recognized for their accomplishments in the village of Alvinston as one of the 2013 recipients of the June Callwood Award." (Municipality of Brooke Alvinston, 2017)

The goal of the asset management plan is to increase the municipality's administrative capacity in analyzing infrastructure performance and corresponding funding needs. Parallel implementation of asset management processes will allow for optimal balancing of available resources between infrastructure needs and corresponding socio-economic growth and stability. The following section explains the relationship between the asset management plan, municipal planning and financial documents.

The City of Waterloo approach views asset management planning as an equal partnership between engineering or subject matter experts and finance, fused together by administrative policies and procedures. Hence, the asset management plan is designed to resonate with and yield further value from existing organizational processes. The goal is to produce a living document which can readily be updated with nominal (if any) increases in existing resources.

In terms of the plan's relationship to other documentation, Figure 3 provides an illustration.

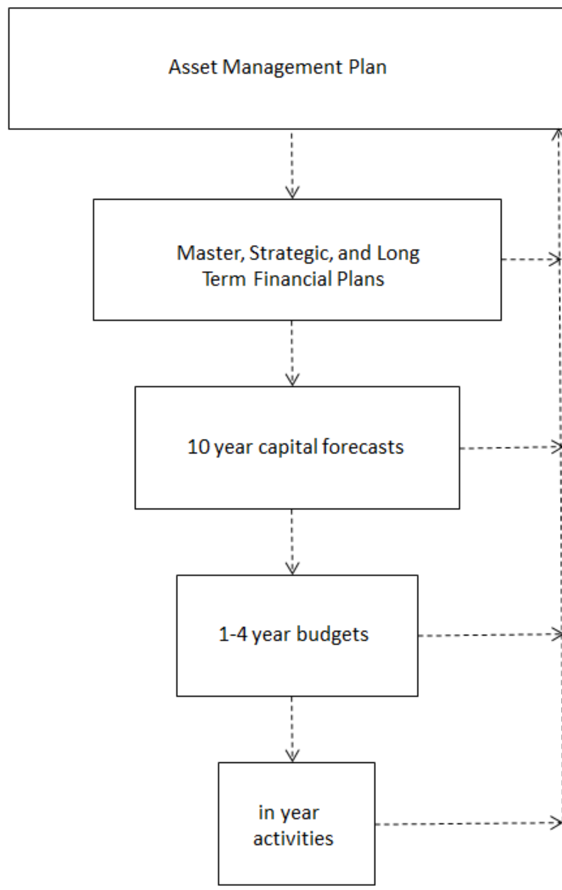

Figure 3: Documental Asset Management Framework

The Asset Management Plan is to be the starting and final point of all planning related activity regarding tangible capital asset needs and allocations. Including the addressing of any relevant information from existing Master, Strategic, and Long Term Financial plans. Any available capital and operational budgets, and 10 year forecasts create the initial backbone of the plan, but will in subsequent years be derived from the Asset Management Plan.

The plan's purpose is to allow the municipal administration to allocate infrastructure funding according to the expected infrastructure asset performance (expected level of service) over time. There are two overarching categories of performance measures, one defined by professionals or the industry, and the others defined by public stakeholder input. Each is further broken down into two sub categories: conditional and functional performance measures.

Professionally defined functional examples include frequency of watermain breaks per kilometer of watermain, frequency of sewer blockages, frequency of valve failures, frequency of pumping station concerns, volume to capacity traffic ratios, per cent of roadway network cleared after snow fall within specified time duration, number of recreational program adjustments due to facility malfunction, number of visits to recreational facilities per capita, level of grass cutting at parks, etc. This group also includes internal maintenance metrics typically derived from maintenance protocols practiced by the managing organization. Examples include catch basin cleaning programs, water valve turning programs, etc. The functional key performance indicators defined by public stakeholder input include the levels of service perceived and expected by the public. Examples include public perception with respect to services provided by the municipality. Depending on the type of input requested during public input, the key performance measure may also fall under the conditional performance measure category. An example of this is the public's perception of the poor, fair, and good qualitative ratings of infrastructure.

The plan allows for more efficient and effective internal communication between the engineering (subject matter expert), financial, and administrative professionals when it comes to infrastructure planning. The same efficiencies are then projected onto external municipal communication with the public, other levels of government, etc.

The plan spans the next 25 years, covering respective entire lifecycles of assets within the time window. The following asset classes are included in the plan: roads, sidewalks, road illumination, bridges and culverts, sanitary sewer collection, water distribution, storm sewer collection, facilities, fleet, equipment and furnishings, and land improvements.

The project team included the professional staff of Brooke-Alvinston, a doctoral candidate from the University of Waterloo, and a research assistant. The Brooke-Alvinston project steering committee is chaired by the Mayor and includes the Council. Professional staff include: the Clerk-Administrator, Treasurer, Administrative Assistants, Treasury Assistant, and Public Works Manager. It is important to note that all other municipal positions, which have not been explicitly noted above, are in some manner, to varying extents, involved in the corporate asset management processes.

The plan will periodically be evaluated according to:

- necessary updating effort
- interoperability of associated asset management planning processes and existing organizational processes
- increased internal and external communication effectiveness with respect to infrastructure performance and investment planning
- timely accommodation of strategic, tactical, and operational staff information inquiries ranging from individual engineering, finance, and administrative perspectives to a mix of two or more
- degree to which most granular / detailed infrastructure performance / investment data is captured in creating respective asset class graphs
- application of engineering risk and reliability theory as thought at academic institutions

The plan and its associated asset management processes will be improved in the short term through:

- municipal staff exposure to latest research findings via University of Waterloo (spring 2017 – implementation)
- Brooke-Alvinston potentially being the first small municipality to join the upcoming Infrastructure Asset Management Exchange project at the University of Waterloo (spring 2017- implementation)
- internal plan update with latest information generated since current submission (fall 2017 – implementation)
- inclusion of cross-asset trade –off investment analysis (fall 2017 – implementation)
- official plan update (fall 2017 – implementation)
- continuous improvement of the asset management processes (ongoing)

The following sections describe the purpose, scope, and methodology used in the plan's development followed by a breakdown of each asset class according to:

1) Current state of infrastructure;
2) Financing strategy;
3) Asset management strategy; and,
4) Asset performance (Expected level of service)

1.2 Purpose

The goal of the report is to develop an Asset Management Plan for the Municipality of Brooke-Alvinston to:

- exceed provincial requirements for asset management plans;
- provide a means of satisfying potential future asset management planning regulation; and,
- advance academic research.

1.3 Scope

In collaboration with municipal staff the project team developed the Asset Management Plan through the following methodology:

1- Inventory of asset information analysis
2- Asset performance derivation
3- Analysis of maintenance programs
4- Documentation of deterioration rates for key performance indicators
5- Quantifying operating and capital budget infrastructure improvements
6- 25 – year asset investment and performance projections

The methodology is based upon the pioneering approach taken by the City of Waterloo in developing its comprehensive Corporate Asset Management Plan in 2016. The effort was aided by an academic and private sector partner.

The Building together – Guide for municipal asset management plans was used for categorizing the results of the methodology.

All infrastructure assets owned by the Brooke-Alvinston Municipality were included within the Asset Management Plan.

In addition to supporting the future infrastructure management efforts of the municipal administration, the intent of the plan is to be a case-study for doctoral research, on the topic of comprehensive infrastructure asset management planning at the University of Waterloo.

The next section describes the methodology in further detail.

2 Methodology

The methodology used in generating the Asset Management Plan followed the City of Waterloo Approach. The strategy focuses on the following items:

- Exhausting existing information;
- Concentrating effort on tactical and operational organizational levels; and,
- Yielding value from existing processes.

The methodology's goal is to ensure that the asset management plan is a living document, thereby providing a timely means for institutionalizing or operationalizing asset management processes.

The approach builds on the strategic and tactical literature within existing guides (e.g. International Infrastructure Management Manual, InfraGuide, ISO 55000, Building Together: Asset Management Guide for Municipalities) and provides an Operationalizing Asset Management Framework.

The framework's goal is to accommodate the coordinated asset management activities that take place within a managing agency, as shown in the figure below.

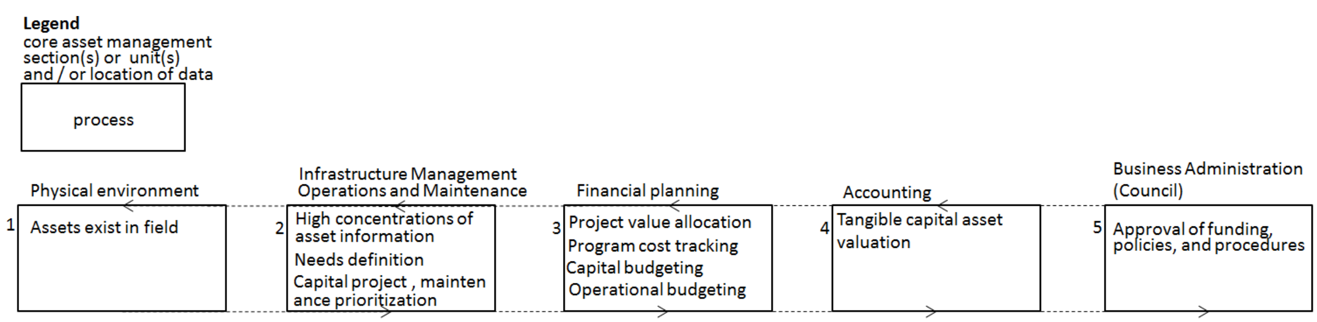

Figure 4: Operationalizing Asset Management Framework

The framework describes the *general* horizontal information flow which takes place across an infrastructure agency, thereby providing an additional perspective on the organizational structure which is typically constrained to illustrative authoritative lines of reporting or the “silo” structure view.

Box 1 represents the physical environment within which the tangible capital assets exist. Box 2 indicates the flow of information from the assets to “Infrastructure Management” sections/units/positions. These typically contain nodes (e.g. excel spreadsheets, databases, etc.) of high information concentration, such as project lists, maintenance prioritizations, asset performance data, etc. In general, asset needs are generally converted into capital projects through collaboration with “Financial Planning”. Maintenance programs are developed and carried out by “Operational Maintenance” sections/units/positions. Box 3 indicates the flow of information from “Infrastructure Management” positions to the “Financial Planning” positions. Information from across the organization is aggregated as per financing policies and procedures, and used in the budget cycle process. Box 4 indicates the carrying out of tangible capital valuation and reporting as per the PSAB 3150, while box 5 shows an example of the overall business administration examples which govern the first four boxes. For example, yearly budgets and forecasts which are created through the efforts described in boxes 1-4 are approved by Council. Once approval is obtained, the flow is reversed as allocations reach the necessary points within the organization until necessary improvements to infrastructure are carried out.

It is important to note that the Operationalizing Asset Management Framework described shows the general information flow from the assets to the funding approval authority, and back to the assets in the form of improvement treatments; it does not by any means preclude the regular micro information exchanges that may occur outside of the general process lines described within the framework.

The City of Waterloo methodology is broken down into six (6) parts which are explained in the following sub-sections.

2. 1 Inventory of asset information analysis

In order to maximize the degree of eventual asset management plan implementation, analysis of existing data structures was undertaken. This includes subject matter experts or engineering, finance, and administrative data or information sets. The location, format, and quantity of the information were used as guides in the development of asset investment and performance projections.

2.2 Asset performance derivation

One of the key challenges of asset management planning and organizational operational analysis in general is determining appropriate key performance indicators. The difficulty is further escalated when a wide range of different asset classes is part of one portfolio of responsibility. Depending on the asset class - existing, a mix of existing and new, or just new asset performance indicators were used.

In addition to capturing asset performance, the goal was to provide an approach to allow for the ongoing refinement of performance indicators such that their degree of responsiveness to organizational processes increases over time.

2.3 Analysis of maintenance programs

Depending on which perspective one takes (engineering, finance, administrative, or academic), maintenance programs typically included under operational budgets may not be accounted for as having an explicit impact on the improvement of asset performance. The intent of the analysis was to provide a solid foundation to be able to in the future capture the impact of maintenance activities on asset performance.

2.4 Documentation of deterioration rates for key performance indicators

Depending on the asset class, deterioration rates may vary from linear to exponential. This is for those assets where industry effort over the past decades has yielded wide accepted deterioration trends, such examples can be found for the road and fleet asset classes. In the absence of - or in addition to such efforts - deterioration is typically monitored via inspection programs, upon which improvement activities are planned. Challenges may arise in projecting future asset performance based upon current or historical asset-centric inspection data. Arguably, relatively arbitrary age based asset performance is typically used in such cases.

Where applicable, existing industry standards were used for deterioration rate documentation. In their absence an engineering risk and reliability approach was applied. Based upon historical improvement activity information, a deterministic model approach was used in allocating appropriate deterioration rate(s) for each asset.

2.5 Quantify operating and capital budget improvement impacts on assets' key performance indicators

In order to determine the current level of service or asset performance, existing planned budgets and associate improvement activities were analyzed. In addition to providing the base scenario for asset investment and performance projections, the approach ensured maximized value yield from existing processes.

2.6 25 year asset investment and performance projections (Asset Management Strategy and Financing Strategy)

The ability to quantify and visualize the effects of contemplated infrastructure investment decisions on future asset performance is pivotal to an effective asset management plan. Varying levels of investment and performance were considered in providing future asset management planning scenarios. The optimal ones with respect to engineering, finance, and administrative perspectives are shown in the following sections.

The presentation of results is based upon the *Building Together: Asset Management Guide for Municipalities*, provided by the province in 2011 or its current online version. The four general categories are:

1) Current state of infrastructure;

2) Expected level of service;

3) Asset management strategy; and,

4) Financing strategy.

It is important to briefly mention the categories' interdependency. Specifically, financing provides for infrastructure asset management strategies (i.e. improvement activities) which allow for states of infrastructure to yield eventual levels of service over time.

The following section provides a 25 year program projection by each asset class, and the accompanying results/conclusions/recommendations according to the four categories noted in the provincial guide. It is important to note that the sequence of the categories has been altered. Specifically, current state of infrastructure is followed by asset management strategy, then financing strategy, ending with the expected level of service. This sequence is more representative of the horizontal information flow taking place in managing agencies.

3 Results

A system modeled after the City of Waterloo's Asset Management System was created to produce a variety of graphs showing scenarios with varying asset investments and performances. Given that roads typically require the highest relative continuous investment, multiple scenarios are shown, and one optimal, is recommended. In order to minimize the environmental footprint of the Asset Management Plan hard copy report, only optimal scenarios are shown for other asset classes.

3.1 Roads

3.1.1 State of local infrastructure – Paved Roads

The roadway network is composed of paved and unpaved sections. The current state of the paved portion is 19 %, 78 %, and 3 %, in good, fair, and poor condition, respectively. The unpaved roads are in good condition. The network has a total of 270 km, 64 km paved, and 206 km unpaved. The replacement values are $ 21,296,000, and $ 47,806,629, respectively.

3.1.2. Asset management strategy – Paved Roads

Deterioration modeling was applied according to a previous engineering report, where for high class bitumen (HCB) pavements a single lift hot mix pavement and a double lift of hot mix pavement would yield a life cycle of 10 and 20 years, respectively. While a single lift treatment for low class bitumen (LCB) road surfaces yields an eight (8) year life cycle. A Ministry of Transportation Ontario rating scale from 0 to 10, results in 0.5 units / year and 0.625 units / year deterioration rates for HCB and LCB pavements, respectively.

Table 2 shows the treatment categories and corresponding treatment triggers for ranges of pavement condition.

Table 2: Pavement Treatment Triggers

Treatment Category	Pavement Rating Range of Treatmant Trigger
Routine Maintenance	5.4 to 6.4
Rehabilitation	3.5 to 5.3
Reconstruction	less than 3.4

It is important to note that the boundaries for treatment categories can vary across agencies, as a variety of specific treatments are available under each category. There are possibilities where one treatment due to different positional perspectives (e.g. public vs. private vs. academic) may be referred to in two or more different terms. Furthermore, recent advancements in the study of pavement life cycle costing use the term “preservation” for rehabilitative treatments that are applied earlier in the life cycle rather than delaying treatment until the sections experience serious failure, where more costly rehabilitative treatments are required or complete reconstruction. Academic research has established that a strategy of pavement network preservation where sections are treated earlier with relatively higher pavement ratings is more effective than allowing them to deteriorate further and then having to apply a “worst first” approach. By earlier treatments the preservation strategy has a minimizing effect on the frequency of high cost rehabilitative treatments and reconstructions.

Table 2 triggers are set for such a preservation strategy adjusted for a predominantly rural environment with a maximum average annual daily traffic range of 400-999. Routine maintenance, rehabilitation, and reconstruction are eligible treatments at the lower end of the good, top of the fair, and midway of the fair rating categories, respectively. Hence, from a pavement specialist / academic perspective, the terms preservation and rehabilitation are more appropriate for Table 2, however, in order to maximize the plan’s resonance with existing organizational processes, including terminology use, rehabilitation and reconstruction terms are included.

3.1.3 Financing strategy – Paved Roads

According to the 2009-2015 Financial Information Returns the average annual capital spent on roads is $ 273, 029, excluding indirect costs. Analysis of the municipality’s latest road studies indicated significant underperformance of the roadway network over the 25 year span. Next, the 95th percentile of a normal distribution with a mean of $ 273, 029 and corresponding standard deviation was used for generating the funding for the first scenario (Scenario 1), which equals to $ 525,256.49 / year. The corresponding performance distribution graph is shown in Figure 6 under the expected levels of service (Asset performance) section. Given that Scenario 1 does not meet the expected levels of performance (service) two more 25 year scenarios were developed at 1.25 the cost of Scenario 1 (Scenario 2, Figure 7, $ 656,570.61 / year) and 1.50 the cost of Scenario 1 (Scenario 3, Figure 8, $ 787,884.74 / year).

Figure 5 shows the 25 year capital expenditure profile for the three scenarios. The fluctuations from the respective averages are due to certain projects exceeding the available funding, and as a result they end up being pushed into the following year.

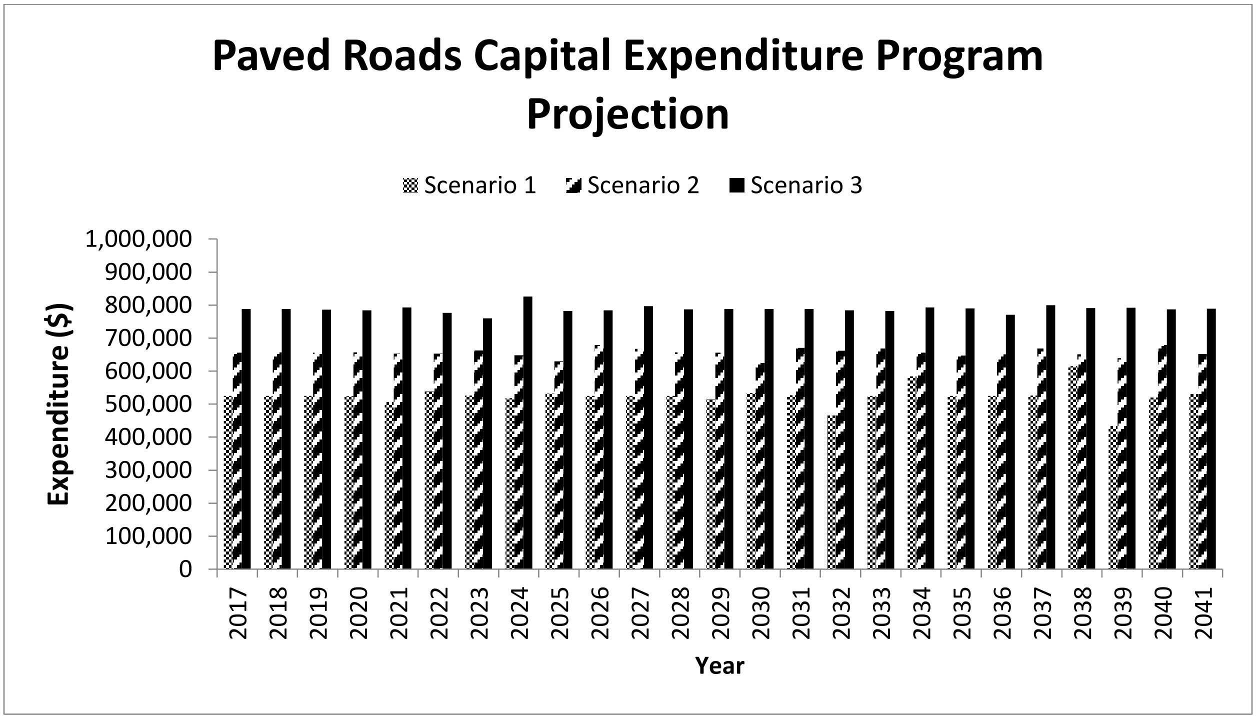

Figure 5: Paved Roads Capital Expenditure Program Projection

Detailed analysis on a section by section basis concluded that Scenario 3 (Figure 8, $ 787,884.74 / year) is the only one which provides a foundation for the municipality to be in a position to within the next decade start applying the asset management strategy of roadway network preservation rather than worst first. This has been deemed deficient with respect to returns on investment when it comes to roadway network management by pavement specialists / academics.

Although Scenario 2 (Figure 7, $ 656,570.61 / year) outperforms Scenario 1 ($ 525,256.49 / year), detailed analysis on a section by section basis concluded that Scenario 2 (Figure 7, $ 656,570.61 / year) does not meet the necessary network performance and does not provide an opportunity to apply the appropriate asset management strategy of network preservation.

Scenario 3 (Figure 8, $ 787,884.74 / year) is recommend for implementation on the paved network (64 km) of roadways. Maintaining existing levels of funding and raising an additional $ 492,211 / year on average is recommend for implementation. The financing options for the scenario should explore the possibility of tax, fees, and debt instruments as funding generators; however, due to the relatively small size of the municipality, the majority of the initial effort should focus on grants.

The unpaved portion (206 km) of the roadway network is sufficiently funded at this time.

3.1.4 Asset performance (Expected levels of service) - Paved Roads

Table 3 contains a cross reference between the quantitative and qualitative performance indicators.

Table 3: Paved Pavement Performance Measures

Performance	Condition Rating
Good	6 to 10
Fair	1 to 6
Poor	less than 1

While pavement ratings typically have two more categories, very poor and excellent (or very good), given the relatively small size of the network, and the goal of presenting common performance graphs across all assets, they have been included within the adjacent categories. More specifically, through an iterative process of varying investments and performance thresholds, the standard Ministry of Transportation Ontario Ride Rating Guide with corresponding performance increments of two (2), from zero (0) to 10, was adjusted according to the corporate infrastructure management experience. This also includes decades of relatively intimate economic and social knowledge of the local community served by the infrastructure. The averages of unit costs were used for planning, as the actual costs are subject to tendering and market forces at a future time of project planning, design, and construction.

Figure 6 illustrates the network paved roadway performance over the next 25 years, under Scenario 1 where the investment requirement is $ 525,256.49 / year.

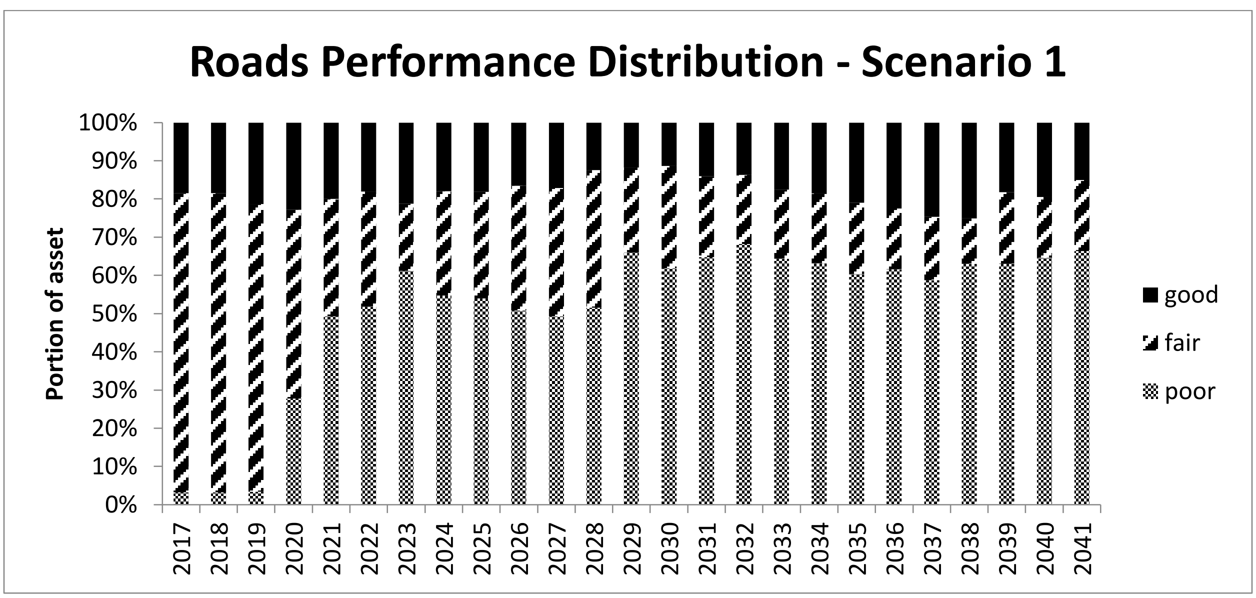

Figure 6: Paved Roads Network Performance - Scenario 1 ($ 525,256 / year)

Given that current planning capacity for specific infrastructure projects is three (3) years, the graph shows the impact of addressing these needs in years one (1) to three (3). During this time, the level of service is maintained around the current, 9 %, 78 %, and 3 %, of good, fair, and poor condition, respectively. During this three (3) year period, approximately 25 % of the network approaches the poor condition threshold, and crosses it in year four (4). In year five (5) approximately another 22 % deteriorates into the poor rating category. Subsequent financing strategy allows for $ 525,256.49 / year, and provides sufficient capacity for an asset management strategy which yields a poor proportion of the network fluctuating between 49 and 68 % for the following twenty years.

Figure 7 illustrates the network paved roadway performance over the next 25 years, under Scenario 2 where the investment requirement is $ 656,570.61 / year.

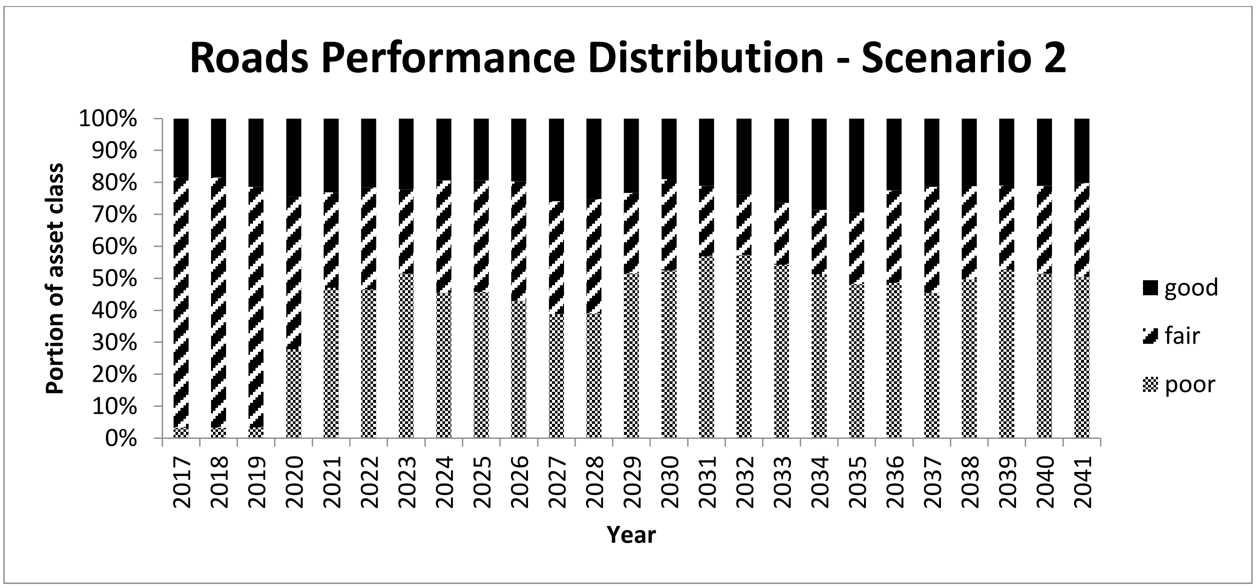

Figure 7: Paved Roads Network Performance - Scenario 2 ($ 656,571 / year)

As in the previous scenario, Scenario 2 executes specific infrastructure projects in the first three (3) years, which have already been planned for by engineering / subject matter experts. The graph shows the impact of addressing these needs in years one (1) to three (3). During this time the level of service is maintained around the current, 9 %, 78 %, and 3 %, of good, fair, and poor condition, respectively. During this three (3) year period, approximately 25 % of the network approaches the poor condition threshold, and crosses it in year four (4). In year five (5) approximately another 19 % deteriorates into the poor rating category. Subsequent financing strategy allows for $ 656,570.61 / year, and provides sufficient capacity for an asset management strategy which yields a poor proportion of the network fluctuating between 39 and 57 % for the following twenty years.

Figure 8 illustrates the network paved roadway performance over the next 25 years, under Scenario 3 where the investment requirement is $ 787,884.75 / year.

As in the previous scenarios, Scenario 3 executes specific infrastructure projects in the first three (3) years, which have already been planned for by engineering / subject matter experts. The graph shows the impact of addressing these needs in years one (1) to three (3). During this time, the level of service is maintained around the current, 9 %, 78 %, and 3 %, of good, fair, and poor condition, respectively. During this three (3) year period, approximately 25 % of the network approaches the poor condition threshold, and crosses it in year four (4). In year five (5) approximately another 16 % deteriorates into the poor rating category. Subsequent financing strategy allows for $ 787,884.74 / year, and provides

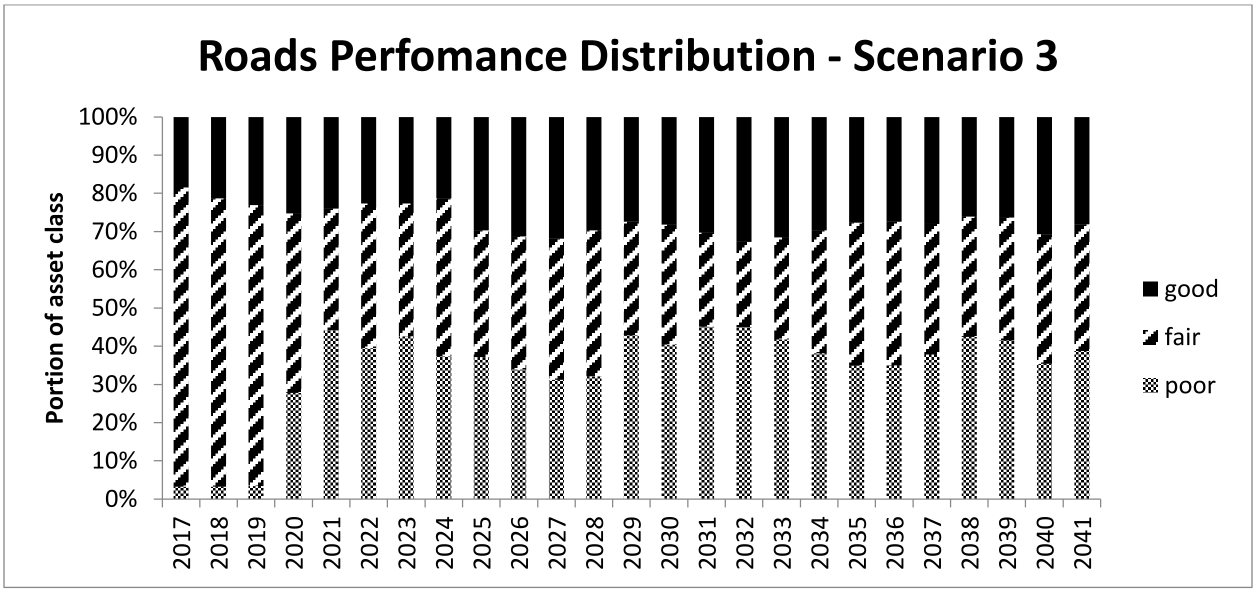

Figure 8: Paved Roads Network Performance 3 ($ 787,885 / year)

sufficient capacity for an asset management strategy which yields a poor proportion of the network fluctuating between 31 and 45 % for the following twenty years.

Scenario 3 is the recommended network performance (level of service) for the paved roadway network. With respect to the unpaved roadway network, maintaining the existing network performance - absolute majority in good - is recommended.

3.2 Sidewalks

3.2.1 State of local infrastructure - Sidewalks

The sidewalk network is long 2.5 km. Currently 100 % of the network is in good condition, and the replacement value is $ 301,067.

3.2.2 Asset management strategy - Sidewalks

The sidewalk section's life cycle is 50 years. Provided that the network was built over the past and current decade, major capital improvements are not expected within the next 25 years. Should minor defects arise (e.g. sectional settlement) it is recommended that they be addressed with current operational and capital capacities. In case of network expansions (e.g. new construction), it is recommended that the works be completed in conjunction with roadworks due to efficiencies such as economies of scale.

3.2.3 Financing strategy - Sidewalks

Maintaining current level of investment through existing means is recommended (e.g. road maintenance budget), no explicit capital expenditures forecasted over the next 25 years at this time.

3.2.4 Asset performance (expected levels of service) - Sidewalks

Table 4 contains a cross reference between the quantitative and qualitative performance indicators.

Table 4: Sidewalk Performance Measures

Perfomance	Remaining Life Cycle %
Good	100 - 33.33
Fair	33 - 16.67
Poor	less than 16.67

As is the case with pavements, pursuit of actual improvements should be based upon previously conducted engineering / subject matter expert inspections. The results of which should be projected over the next 25 years for asset management purposes. In the absence of such inspection information, and potentially the means to perform such a projection, a life cycle of 50 years is used.

The performance (level of service) thresholds are set such that a concrete sidewalk section is in good condition if its remaining life cycle falls within the range of 100 – 33.33 %, or the first two thirds of the life cycle. The fair category is within the 33.33-16.67 % range, and the poor is when the remaining life cycle is less than 16.67 %.

These thresholds reflect the current condition of the asset network according to subject matter experts, and allow for future projections that are conceptually tailored in a non-linear manner to the nature of the asset (i.e. fully supported concrete slab, with typical pedestrian loading). In contrast, another approach is to tailor the performance (level of service) according to asset age in a linear manner, where the different categories of performance are relatively equally spaced out (e.g. thirds of asset age).

Such an approach would indicate that the asset's condition is linearly deteriorating according to age, which is not the case for an absolute majority of civil engineered infrastructure. The corporation's asset management plan would subsequently underestimate the asset performance over the planning horizon, and overestimate the future financial burden to address the “underperformance”. For these reasons a non-linear approach has been taken, one derived from the perspective of existing organizational processes and the exhaustion of existing information. Specifically, allocating the poor category to a range of less than 16.67 % of remaining life cycle (8.33 years), provides ample time for engineering / subject matter expert, finance, and administrative processes to react such that the corporation is in an optimal position to address any underperformance of the asset. The approach also focuses inspection efforts on the portions of the network under the poor category. This does not exclude the regular monitoring of the entire network, but rather provides an opportunity to quickly identify which sidewalk sections may require a closer than the usual look. Practically, should an inspection of any good section according to the asset management model reveal that it is actually in poor condition, the model should be adjusted accordingly, and vice versa with respect to an inspection of a poor section.

Ultimately, for sidewalks, and other assets where the performance currently (level of service) regresses directly back to the age of the asset, engineering risk and reliability approaches as thought at the graduate level at academic institutions should be applied to model the asset deterioration and associated costs and timing of improvement treatments. Figure 9 illustrates the 25 year sidewalk network performance (level of service).

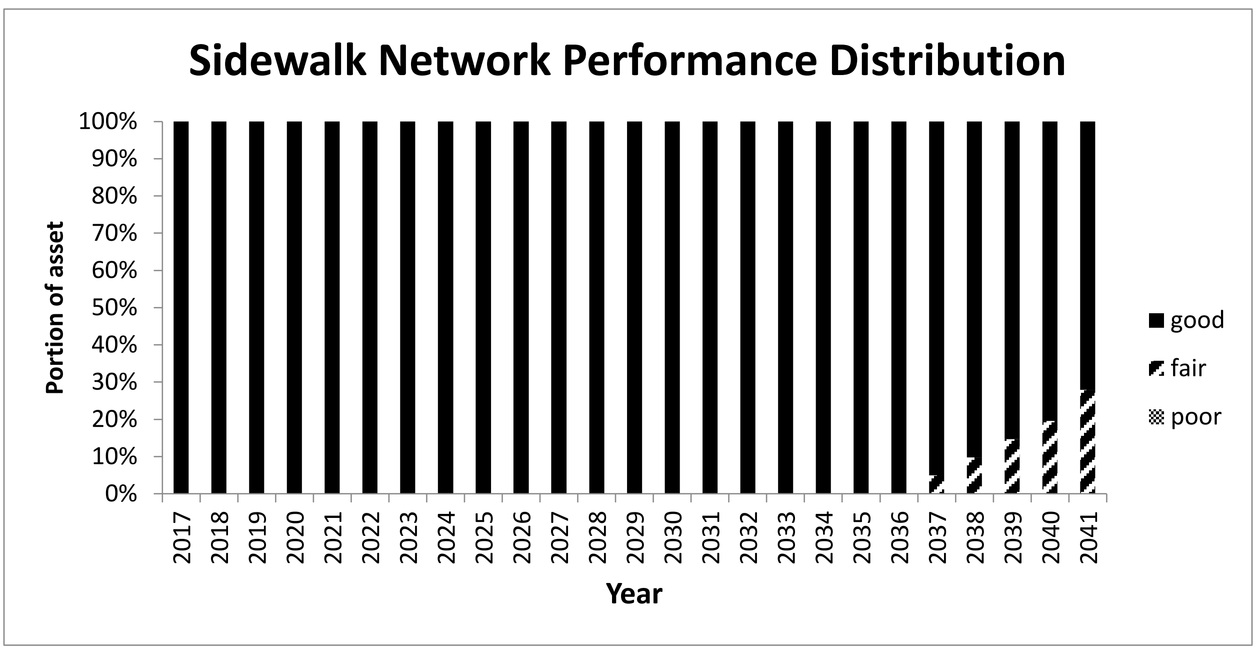

Figure 9: Sidewalk Network Performance Distribution

Provided that the sidewalk network was constructed over the past and current decade, different performance (level of service) threshold scenarios were explored, the one shown is recommended for corporate use.

3.3 Road Illumination

3.3.1 State of local infrastructure – Road Illumination

The road illumination network is made up of 213 streetlights. Currently 100 % of the network is in fair condition, and the replacement value is $ 297,979.

3.3.2 Asset management strategy – Road Illumination

The road illumination asset has two groups, one with a life cycle of 50 years, and another with a lifecycle of 15 years. The former is the original streetlight network construction in the 1980s, while the latter includes the 2015 LED upgrades. Major capital improvements are not expected within the next 10 years, a replacement strategy is encountered in 2030. In case of network expansions (e.g. new construction), it is recommended that the works be completed in conjunction with roadworks due to efficiencies such as economies of scale.

3.3.3 Financing strategy – Road Illumination

Figure 10 shows the 25 year capital expenditure profile necessary for achieving acceptable performance (level of service) over the planning horizon.

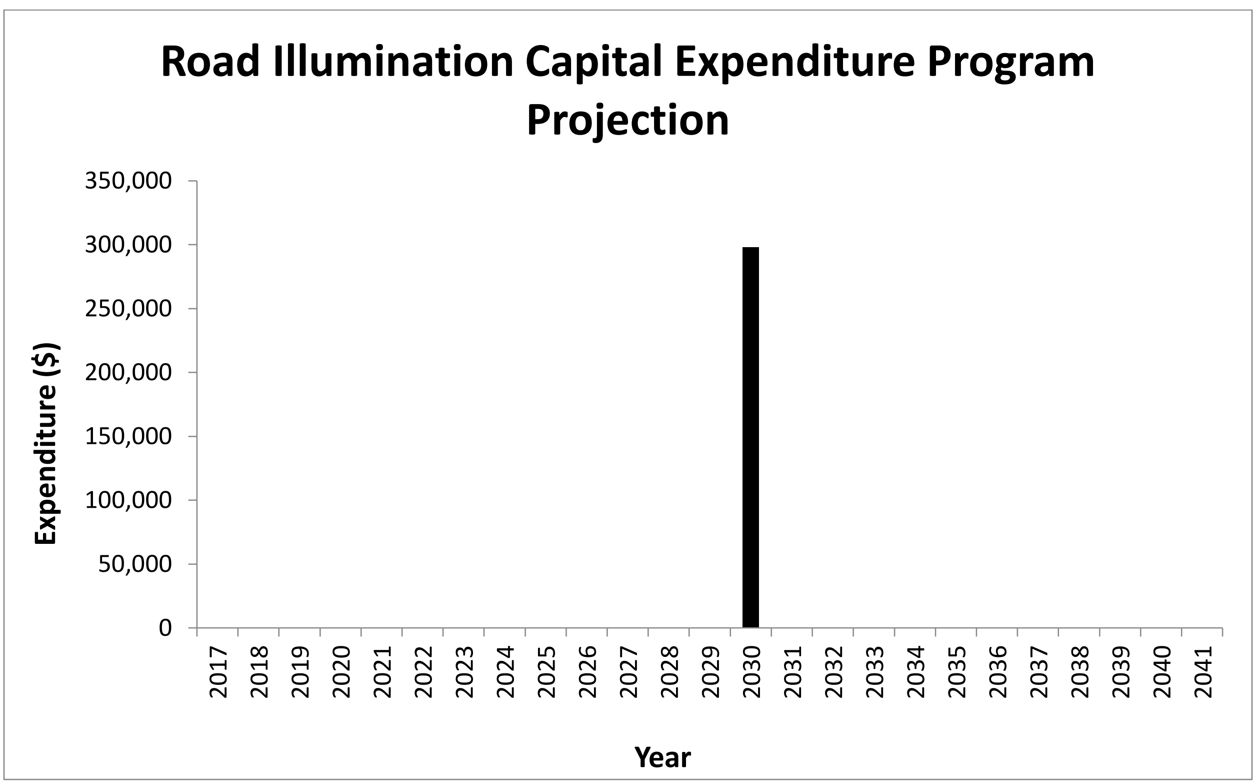

Figure 10: Road Illumination Capital Expenditure Program Projection

Major capital improvements are not expected within the next 10 years. In 2030, as both group's life cycles end, an expenditure of approximately $ 300,000 is encountered. Should minor defects arise prior to, it is recommended that they be addressed with current operational and capital capacities.

3.3.4 Asset performance (expected levels of service) – Road Illumination

Table 5 contains a cross reference between the quantitative and qualitative performance indicators.

Table 5: Road Illumination Performance Measures

Perfomance	Remaining Life Cycle %
Good	100 - 33.33
Fair	33.33 - 16.66
Poor	less than 16.66

Pursuit of actual improvements should be based upon previously conducted engineering / subject matter expert inspections. The results of which should be projected over the next 25 years for asset management purposes. In the absence of such inspection information, and means of projection, the age based life spans are used.

The performance (level of service) thresholds are set such that a streetlight is in good condition if its remaining life cycle falls within the range of 100 – 33.33 %, or the first two thirds of the life cycle. The fair category is within the 33.33-16.66 % range, and the poor is when the remaining life cycle is less than 16.67 %. The categories for the LED upgrade components are slightly adjusted, and use one thirds of the life span for the corresponding performance categories.

Allocating the poor category to a range of less than 16.66 % of remaining life cycle (8.33 years), provides ample time for engineering / subject matter expert, finance, and administrative processes to react such that the corporation is in an optimal position to address any underperformance of the asset. The approach also focuses inspection efforts on the portions of the network under the poor category. This does not exclude the regular monitoring of the entire network, but provides an opportunity to quickly identify which streetlights may require a closer than usual look. Practically, should an inspection of any good streetlight according to the asset management model, reveal that it is actually in poor condition, the model should be adjusted accordingly and vice versa with respect to an inspection of a poor illumination element.

Ultimately, for streetlights, and other assets where the performance currently (level of service) regresses directly back to the age of the asset, engineering risk and reliability approaches as thought at the graduate level at academic institutions should be applied to model the asset deterioration and associated costs and timing of improvement treatments. Figure 11 illustrates the 25 year streetlight network performance (level of service).

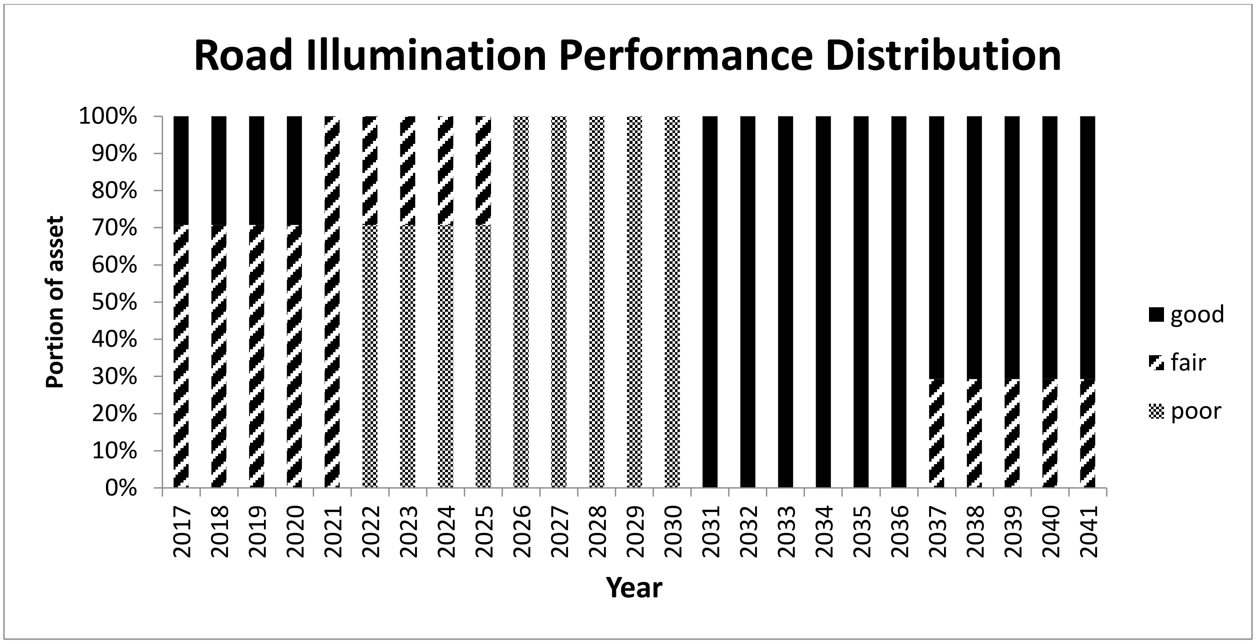

Figure 11: Road Illumination Network Performance

Provided that the roadway illumination network was constructed in the 1980s, and upgraded in 2015, different performance (level of service) threshold scenarios were explored, the one shown is recommended for corporate use. As the network enters the poor category rating in 2026, there is a four (4) year window to plan, design, and implement the appropriate improvement activities.

3.4 Bridges and Culverts

3.4.1 State of local infrastructure – Bridges and Culverts

The Bridges and Culverts asset class numbers 50 structures. Currently 35 %, 43 %, and less than 22 %, of the asset class has good, fair, and poor performance, respectively. The replacement value is $ 15,400,507.

3.4.2 Asset management strategy – Bridges and Culverts

The Bridges and Culverts asset class is one of the more complex within the municipal portfolio in regards to the variety of structural components involved (abutment walls, wing walls, deck, etc.). Information on improvement activities and associated costs, an engineering study, and field inspection records, were used to develop the asset management strategy.

Municipal information on improvement activities and associated costs, spanning back to the 1950s was used to develop deterioration rates, treatment trigger values, and average treatment costs - at an individual level for each bridge and culvert. This approach ensures a uniquely tailored asset management strategy for each site based upon the environment they are in. Furthermore, the developed performance measure considers functional and conditional based indicators according to public and professional perspectives which have guided decisions over the past decades.

The performed mass data analysis is based upon the principles of risk-based life cycle management of engineering systems. The asset degradation rate and average cost of treatments is derived from the rate of interventions and associated costs to date, respectively. This engineering risk and reliability approach provides performance measures that are not necessarily mutually exclusive from the current industry standard for bridges - being the Bridge Condition Index (BCI), but are arguably more flexible in accommodating factors outside the sphere of a professionally assessed asset condition rating. These include functional performance measures, from public and professional perspectives; as well as conditional asset performance from a public perspective, and political commitments.

3.4.3 Financing strategy – Bridges and Culverts

Figure 12 shows the 25 year capital expenditure profile necessary for achieving expected performance (level of service) over the planning horizon.

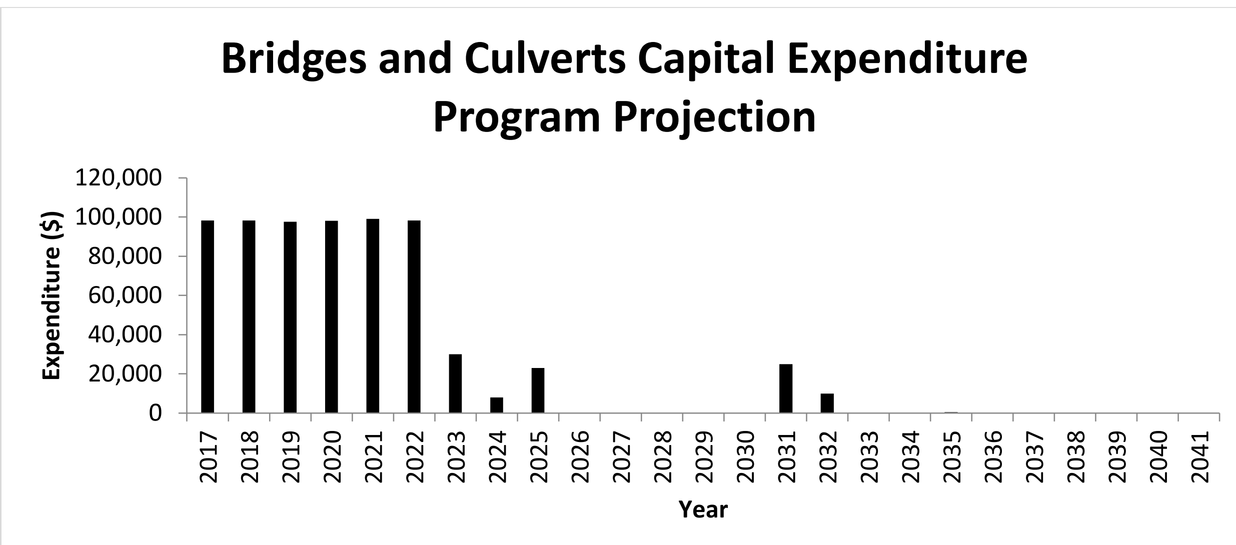

Figure 12: Bridges and Culverts Capital Expenditure Program Projection

The average annual capital expenditure for the first five (5) years is $ 98,272, and $ 31,851 in the six (6) to 10 years span. The 11 – 25 years span has two culvert rehabilitations in 2031, and 2032, with minor bridge maintenance in 2035. The 25 years average is $ 27,444.

Analysis of Financial Information Returns shows that the average operational cost was $ 37,076, and the capital $ 37,401, for a total of $ 74,477 over the past six (6) years. Multiple scenarios were modeled; the preferred one necessary for achieving expected level of performance is shown.

Assuming a portion of the necessary improvements can be completed under the operational budget (e.g. minor/major maintenance) the current capital funding levels are sufficient for accommodating the expected asset performance levels. However, the needs of the first six years require slight redistribution further into the future in order to fit within the operating and capital envelope. Should the next inspection cycle reveal greater bridge and culvert needs, an annual capital funding shortfall can be expected. Subsequently, financing options for such a scenario should explore the possibility of tax, fees, and debt instruments as funding generators; however, due to the relatively small size of the municipality, the majority of the initial effort should focus on grants.

3.4.4 Asset Performance (Expected levels of service) – Bridges and Culverts

The current performance measure typically used in the industry is the Bridge Condition Index (BCI). It is calculated as a ratio of the "cost of required bridge improvements" over the "bridge replacement cost". Bridge inspectors determine the required improvements, while historical construction records are the industry source for unit costs of the assessed requirements. A limitation of the BCI is that it is constrained to the physical condition of the asset only. In cases where agencies lack the capacity (e.g small municipalities) to assess and track the BCI on a regular basis (e.g. every 2-5 years) for all of its bridges and culverts, there does not appear to be a widely accepted means of quantifying and modelling of asset performance.

Irrelevant of whether or not an agency has the capacity to develop the BCI, decades of bridge and culvert management by agencies indicated that the professional staff do possess the knowledge, skill and expertise to make investment decisions based upon the following asset performance categories: public expectations, political commitments, fiscal constraints, and the physical and functional aspects of the asset. The resulting decades of data are an explicit output of such performance measures being accounted for in already established decision making processes within an agency. The data contains the initial construction cost, frequency of treatments, and associated costs; but does not provide the degree of influence of each asset performance category mentioned. None the less, using the concepts of data analysis and reliability computation from risk-based life cycle management of engineering systems research, a Comprehensive Bridge and Culvert Asset Management performance measure (CBAM) was developed.

Figure 13 illustrates the 25 year bridge and culvert performance (level of service).

The graph is based upon the condition of individual structures. Although the graphic shows the overall performance of bridges and culverts combined, the individual graphics are available for the asset management process to support future decision making.

The average poor asset performance for the first five (5) years is 18 %, decreasing in the six (6) to ten year span to 4 %, and averaging out at 15 % in the 11-25 year span. The average fair asset performance for the first five (5) years is 47 %, increasing in the six (6) to ten year span to 63 %, and averaging 52 % in the 11-25 year span. The average good asset performance for the first five (5) years is 35 %, decreasing in the six (6) to ten year span to 34 %, and averaging 34 % in the 11-25 year span. As can also be seen from Figure 13, the performance categories share of the network are relatively stable over time. There

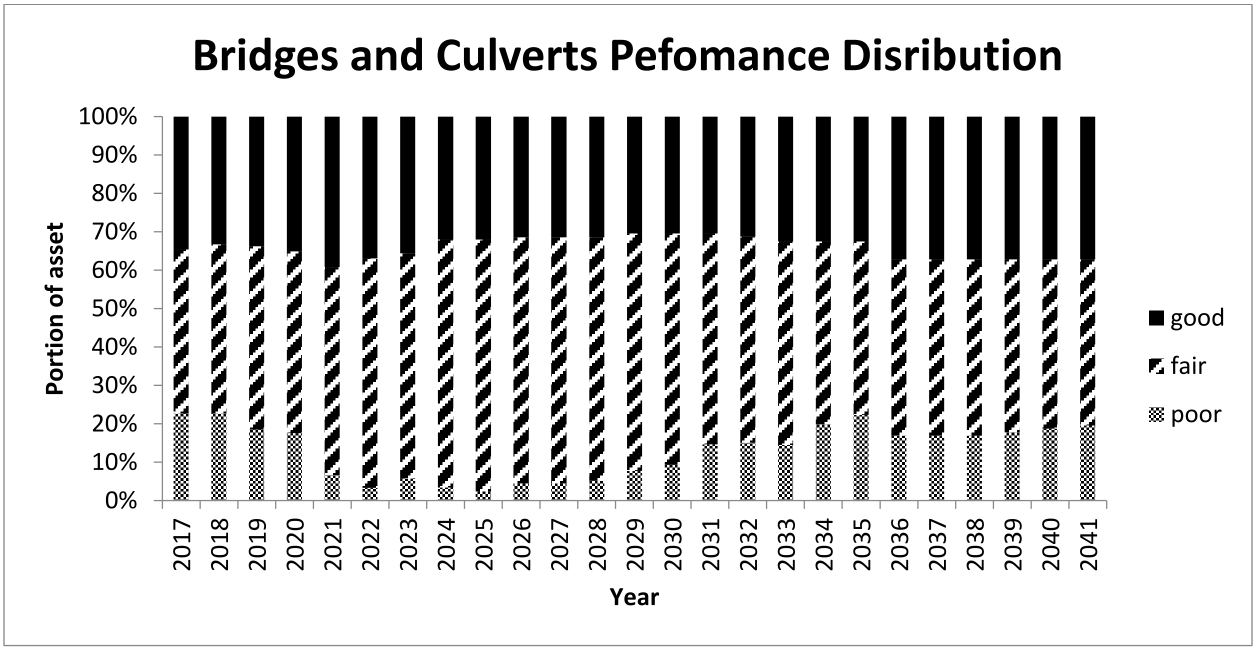

Figure 13: Bridges and Culverts Performance

is a gradual decrease in the poor category from year four (4) to nine (9), followed by a gradual increase to its initial levels in year 18. Other scenarios were modelled; this is the recommended one for implementation according to professional input and corporate-data-driven performance measures.

The use of CBAM is recommended in addition to, or in the absence of a BCI, as a comprehensive performance measure for bridge and culvert asset management. One which accounts for all of the asset performance categories: professionally defined conditional and functional, publicly defined conditional and functional, and political commitments. Future tracking of the degree of influence each category has on decision making is also recommended, as this will provide a foundation for expanding the portfolio of available performance measures according to each category.

3.5 Sanitary Sewer Network

The Sanitary asset class is composed of the sanitary sewer collection systems, including gravity and force mains. The Waste Water Treatment Plant, although practically a part of the sanitary system, can either be shown under the Sanitary or the Facilities asset class. For the hard copy of this Asset Management Plan it is included under the latter.

3.5.1 State of local infrastructure – Sanitary Sewer Network

The sanitary collection network length is 27 km. Currently 100 % of the network is in good condition, and the replacement value is $ 7,863,524.

3.5.2 Asset management strategy – Sanitary Sewer Network

The life cycle of any sanitary pipe section is assumed at 75 years. Provided that the network was predominantly built in the 1980s and over the past decade, major capital improvements are not expected within the next 25 years. Should minor defects arise (e.g. debris build up) it is recommended that they be addressed with current operational and capital capacities. In case of network expansions (e.g. new construction), it is recommended that the works be completed in conjunction with roadworks due to efficiencies such as economies of scale.

3.5.3 Financing strategy – Sanitary Sewer Network

Maintaining the current level of investment through existing means is recommended, no explicit capital expenditures forecasted over the next 25 years at this time.

3.5.4 Asset performance (Expected levels of service) – Sanitary Sewer Network

Table 6 contains a cross reference between the quantitative and qualitative performance indicators.

Table 6: Sanitary Sewer Network Performance Measures

Perfomance	Remaining Life Cycle %
Good	100 - 30
Fair	30 - 15
Poor	less than 15

Pursuit of actual improvements should be based upon previously conducted engineering / subject matter expert inspections. The results of which should be projected over the next 25 years for asset management purposes. In the absence of such inspection information, and means of projection, a life cycle of 75 years is used.

The performance (level of service) thresholds are set such that a sanitary pipe section is in good condition if its remaining life cycle falls within the range of 100 – 30 %. The fair category is within the 30 - 15 % range, and the poor is when the remaining life cycle is less than 15 %.

These thresholds reflect the current condition of the sanitary collection network according to subject matter experts, and allow for future projections that are conceptually tailored in a non-linear manner to the nature of the asset. The details of this approach are previously described under the Sidewalk asset, and apply to all assets whose performance (level of service) currently regresses back to the asset's age. Allocating the poor category to a range of less than 15 % of the remaining life cycle (11.25 years), provides ample time for engineering / subject matter expert, finance, and administrative processes to react such that the corporation is in an optimal position to address any underperformance of the asset. The approach also focuses inspection efforts on the portions of the network under the poor category. This does not exclude the regular monitoring of the entire network, but provides an opportunity to quickly identify which pipe sections may require a closer than usual look. Practically, should an inspection of any good section according to the asset management model reveal that it is actually in poor condition, the model should be adjusted accordingly, and vice versa with respect to an inspection of a poor section.

In addition to the perspective presented, engineering risk and reliability approaches as thought at the graduate level at academic institutions should be applied to model the asset deterioration and associated costs and timing of improvement treatments.

Figure 14 illustrates the 25 year sanitary sewer network performance (level of service).

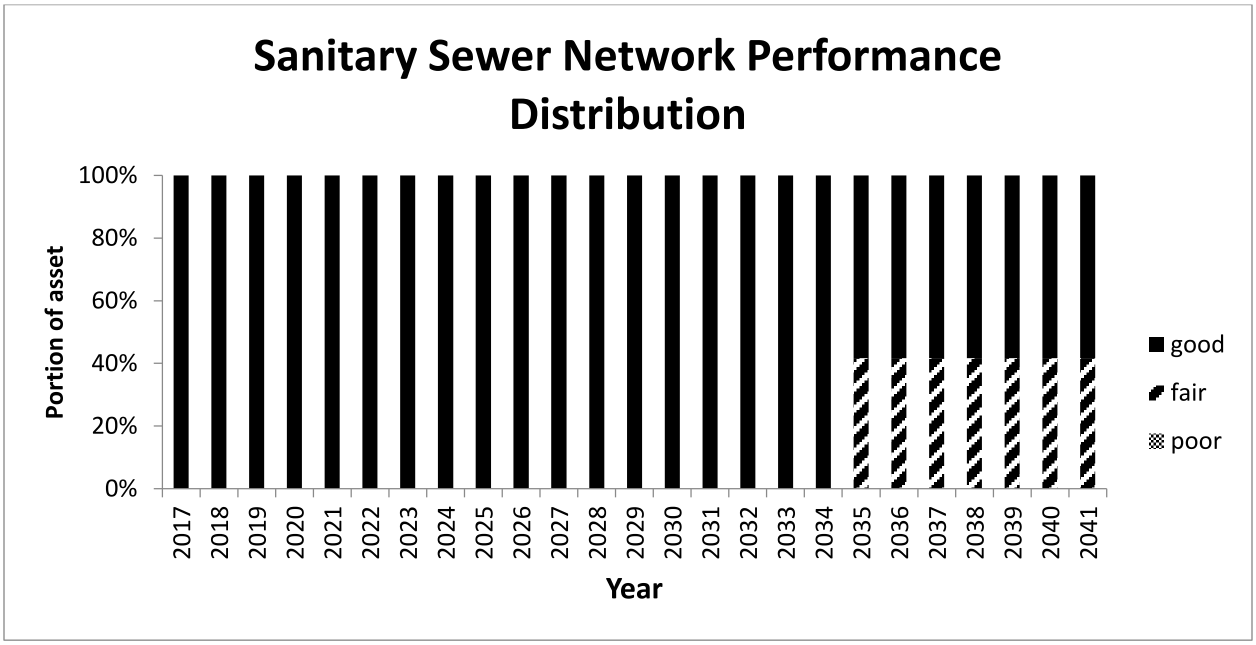

Figure 14: Sanitary Sewer Network Performance

Provided that the sanitary collection network was constructed in the early 1980s and over the past decade, different performance (level of service) threshold scenarios were explored, the one shown is recommended for asset management planning use.

3.6 Water Distribution Network

The Water asset class is composed of the water distribution systems, and the Water Treatment Plant. Although practically a part of the water system, it can be shown under the Water or the Facilities asset class. For the hard copy of this Asset Management Plan it is included under the latter.

3.6.1 State of local infrastructure – Water Distribution Network

The water distribution network length is 29 km. Currently close to 100 % of the network is in good condition. The replacement value is $ 10,068,107.

3.6.2 Asset management strategy – Water Distribution Network

The life cycle of any water distribution pipe section is assumed at 75 years. Provided that the network was predominantly built in the mid 1970s and over the past decade, major capital improvements are not expected within the next 25 years. According to the performance thresholds, capital investment is required in 2025 to address a portion of the network which is projected to fall within the poor category. Other than that projected capital expenditure, should minor defects arise it is recommended that they be addressed with current operational and capital capacities. In case of network expansions (e.g. new construction), it is recommended that the works be completed in conjunction with roadworks due to efficiencies such as economies of scale.

3.6.3 Financing strategy – Water Distribution Network

Capital expenditure of approximately $ 520 k, in 2025 is forecasted over the next 25 years, as shown in Figure 15. Maintaining existing levels of investment and raising funds for an additional $ 2,893 / year is recommend for implementation.

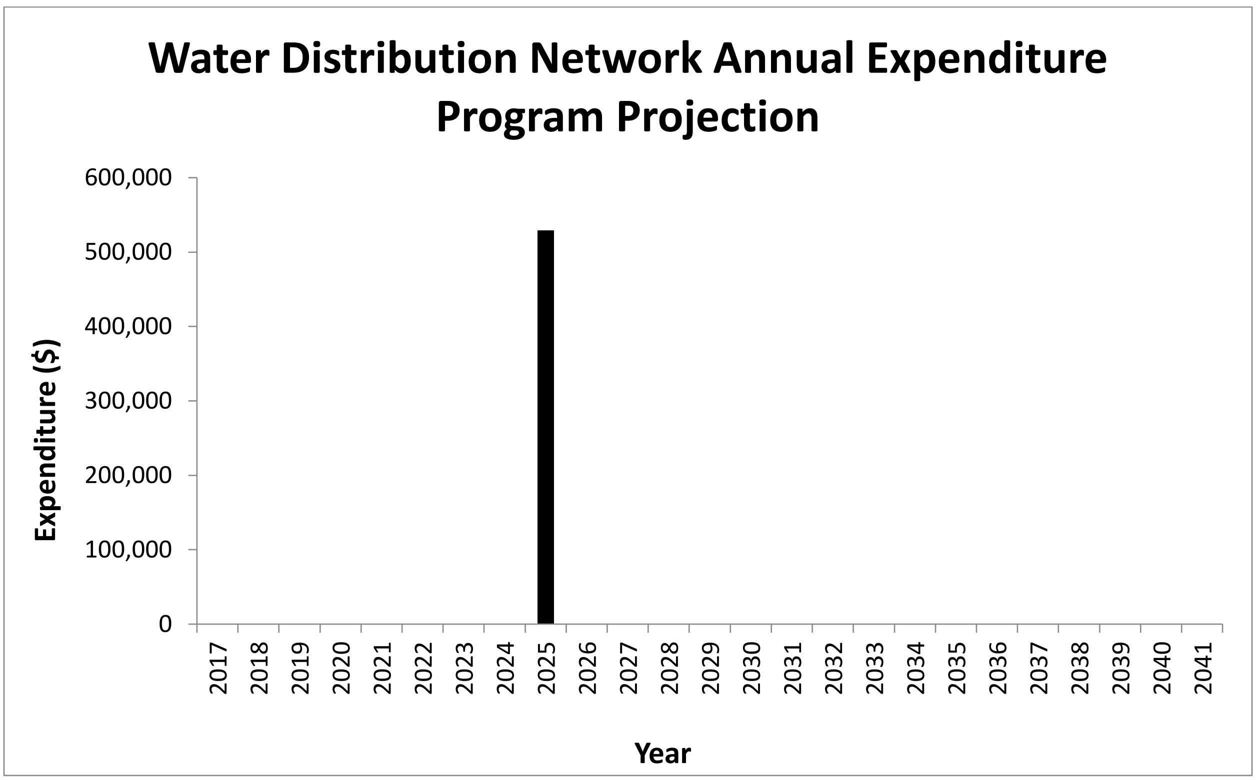

Figure 15: Water Distribution Network Capital Expenditure Program Projection

3.6.4 Asset Performance (Expected levels of service) – Water Distribution Network

Table 7 contains a cross reference between the quantitative and qualitative performance indicators.

Table 7: Water Distribution Network Performance Measures

Perfomance	Remaining Life Cycle %
Good	100 - 30
Fair	30 - 15
Poor	less than 15

Pursuit of actual improvements should be based upon previously conducted engineering / subject matter expert inspections / hydraulic modeling. The results of which should be projected over the next 25 years for asset management purposes. In the absence of such inspection information, and means of projection, a life cycle of 75 years is used.

The performance (level of service) thresholds are set such that a water pipe section is in good condition if its remaining life cycle falls within the range of 100 – 30 %. The fair category is within the 30 - 15 % range, and the poor category is when the remaining life cycle is less than 15 %.

These thresholds reflect the current condition of the water distribution network according to subject matter experts, and allow for future projections that are conceptually tailored in a non-linear manner to the nature of the asset. The details of this approach are previously described under the Sidewalk asset, and apply to all assets whose performance (level of service) currently regresses back to the asset's age. Allocating the poor category to a range of less than 15 % of the remaining life cycle (11.25 years), provides ample time for engineering / subject matter expert, finance, and administrative processes to react such that the corporation is in an optimal position to address any underperformance of the asset. The approach also focuses inspection efforts on the portions of the network under the poor category. Which does not exclude the regular monitoring of the entire network, but provides an opportunity to quickly identify which pipe sections may require a closer than usual look. Practically, should an inspection of any good section according to the asset management model reveal that it is actually in poor condition, the model should be adjusted accordingly, and vice versa with respect to an inspection of a poor section.

In addition to the perspective presented, engineering risk and reliability approaches as thought at the graduate level at academic institutions should be applied to model the asset deterioration and associated costs and timing of improvement treatments.

Figure 16 illustrates the 25 year water distribution network performance (level of service). Provided that the water distribution network was constructed in the mid 1970s and over the past decade, different performance (level of service) threshold scenarios were explored, the one shown is recommended for asset management planning use.

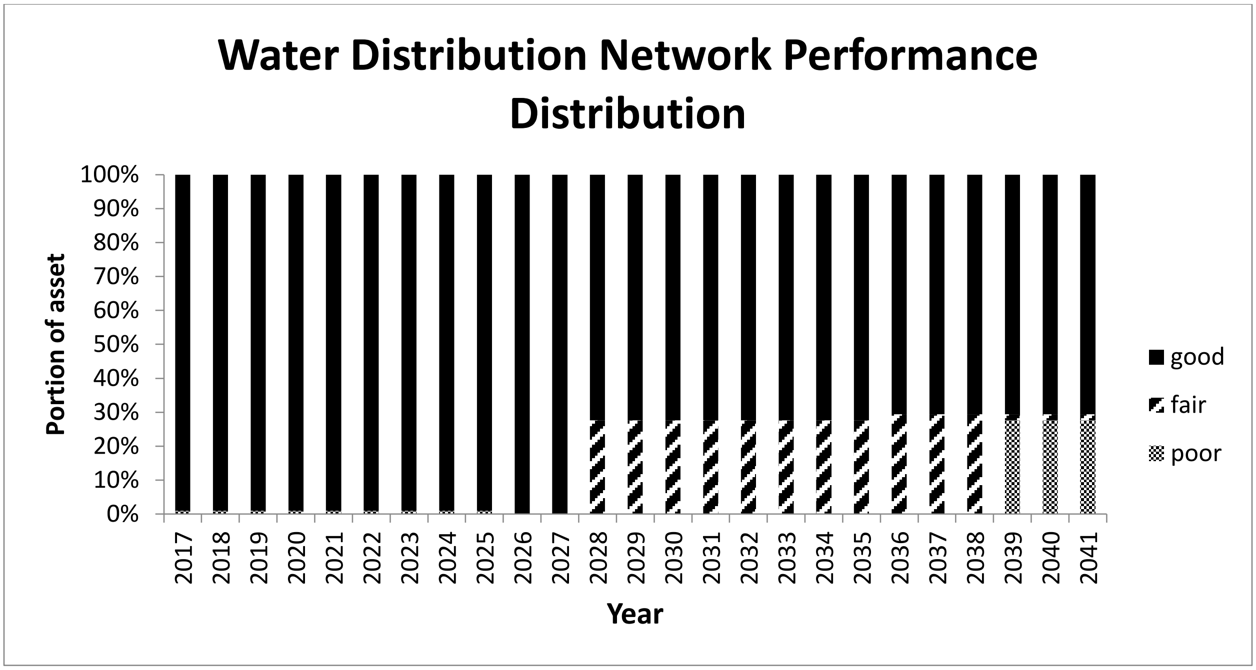

Figure 16: Water Distribution Network Performance

3.7 Storm Sewer Network

3.7.1 State of local infrastructure – Storm Sewer Network

The Storm sewer collection network length is 13 km. Currently 71 %, 5%, and 24%, of the network is in good, fair, and poor condition, respectively. The replacement value is $ 10,633,955.

3.7.2 Asset management strategy – Storm Sewer Network

The life cycle of any storm pipe section is assumed at 75 years. Provided that the network was built throughout the last century, a number of capital improvements are expected within the next 25 years, focused predominantly on the replacement of clay pipes.

In case of network expansions (e.g. new construction), it is recommended that the works be completed in conjunction with road works due to efficiencies such as economies of scale.

3.7.3 Financing strategy – Storm Sewer Network

Figure 17 shows the 25 year capital expenditure profile necessary for achieving acceptable performance (level of service) over the planning horizon.

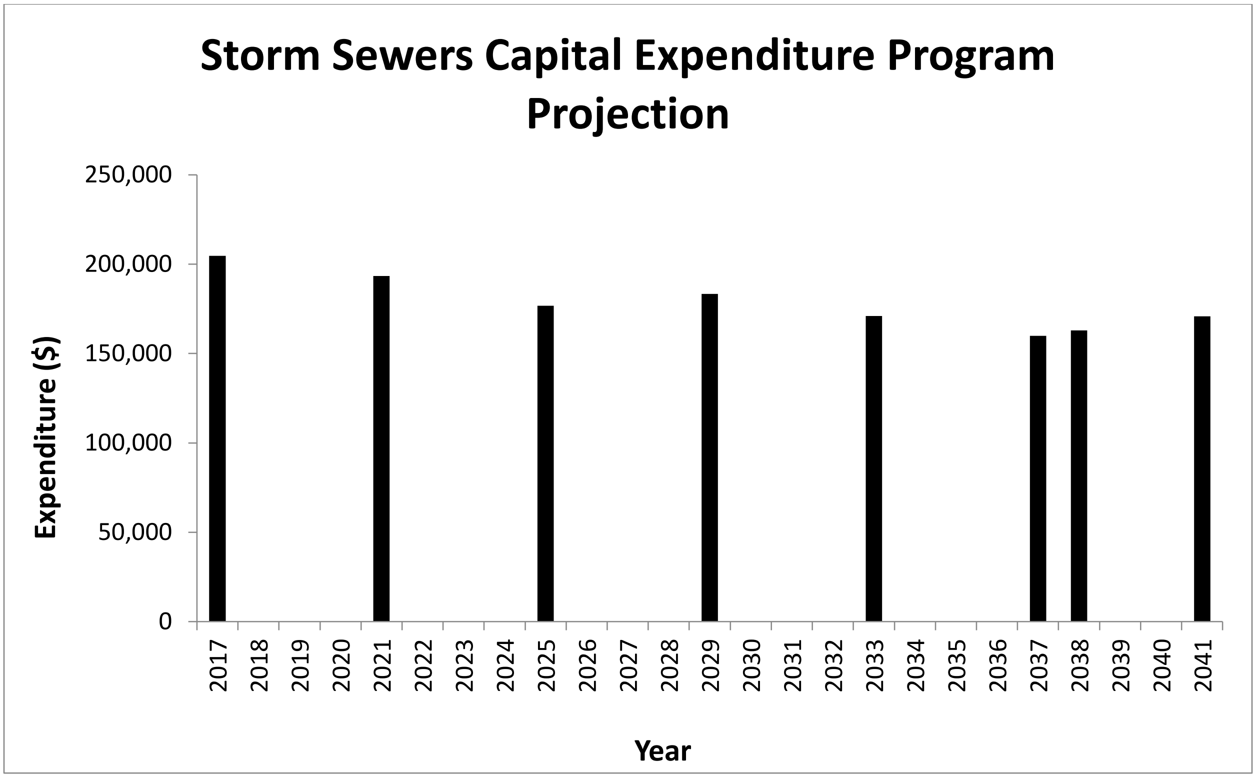

Figure 17: Storm Sewer Network Capital Expenditure Program Projection

The age based modeling along with subject matter expert input yields an almost $ 3 M immediate funding requirement. This is not untypical of modeling networks. However, for any organization to accommodate such a large influx in a short period of time is highly unlikely. Hence, the funding requirement has been distributed across every four years to mimic the average funding requirement and timing observed in the 2009-2015 Financial Information Returns. The scenario yields an approximate four (4) year average of just above $ 175 k. At the end of the 25 years, there is approximately $ 1.4 M of unaddressed funding requirements, which would equal to approximately $ 57,543 / year of additional funding needed – not shown in the graphic above - on top of the periodic $ 175 k. The resulting annual average expenditure is $ 114,458.

Maintaining existing levels of investment and raising funds for an additional $ 36,625 / year is recommend for implementation. Financing options for the scenario should explore the possibility of tax, fees, and debt instruments as funding generators; however, due to the relatively small size of the municipality, the majority of the initial effort should focus on grants.

3.7.4 Asset performance (expected levels of service) – Storm Sewer Network

Table 8 contains a cross reference between the quantitative and qualitative performance indicators.

Pursuit of actual improvements should be based upon previously conducted engineering / subject matter expert inspections. The results of which should be projected over the next 25 years for asset management purposes. In the absence of such inspection information, and potentially, the means of projection, a life cycle of 75 years is used.

Table 8: Storm Sewer Network Performance Measures

Perfomance	Remaining Life Cycle %
Good	100 - 30
Fair	30 - 15
Poor	less than 15

The performance (level of service) thresholds are the same for those of the sanitary collection and water distribution asset networks, set such that the storm sewer pipe section is in good condition if its remaining life cycle falls within the range of 100 – 30 %. The fair category is within the 30 - 15 % range, and the poor category is when the remaining life cycle is less than 15 %.

These thresholds reflect the current condition of the storm sewer network according to subject matter experts, and allow for future projections that are conceptually tailored in a non-linear manner to the nature of the asset. The details of this approach are previously described under the Sidewalk asset, and apply to all assets whose performance (level of service) currently regresses back to the asset's age. Allocating the poor category to a range of less than 15 % of the remaining life cycle (11.25 years), provides ample time for engineering / subject matter expert, finance, and administrative processes to react such that the corporation is in an optimal position to address any underperformance of the asset. The approach also focuses inspection efforts on the portions of the network under the poor category. This does not exclude the regular monitoring of the entire network, but provides an opportunity to quickly identify which pipe sections may require a closer, than the usual, look. Practically, should an inspection of any good section according to the asset management model, reveal that it is actually in poor condition, the model should be adjusted accordingly, and vice versa with respect to an inspection of a poor section.

In addition to the perspective presented, engineering risk and reliability approaches as thought at the graduate level at academic institutions should be applied to model the asset deterioration and associated costs and timing of improvement treatments.

Figure 18 illustrates the 25 year storm sewer network performance (level of service).

The poor network proportion is relatively constant, from 20 % to 26 % over the 25 year span. The fair proportion varies around 5 % for the first 14 years, increasing to around 18 % for the remainder of the planning horizon. The good condition varies slightly around 70 % for the first 14 years, subsequently decreasing to approximately 60 % for the remainder of the planning horizon. Multiple performance vs. investment scenarios were analyzed, the one shown is recommended for implementation.

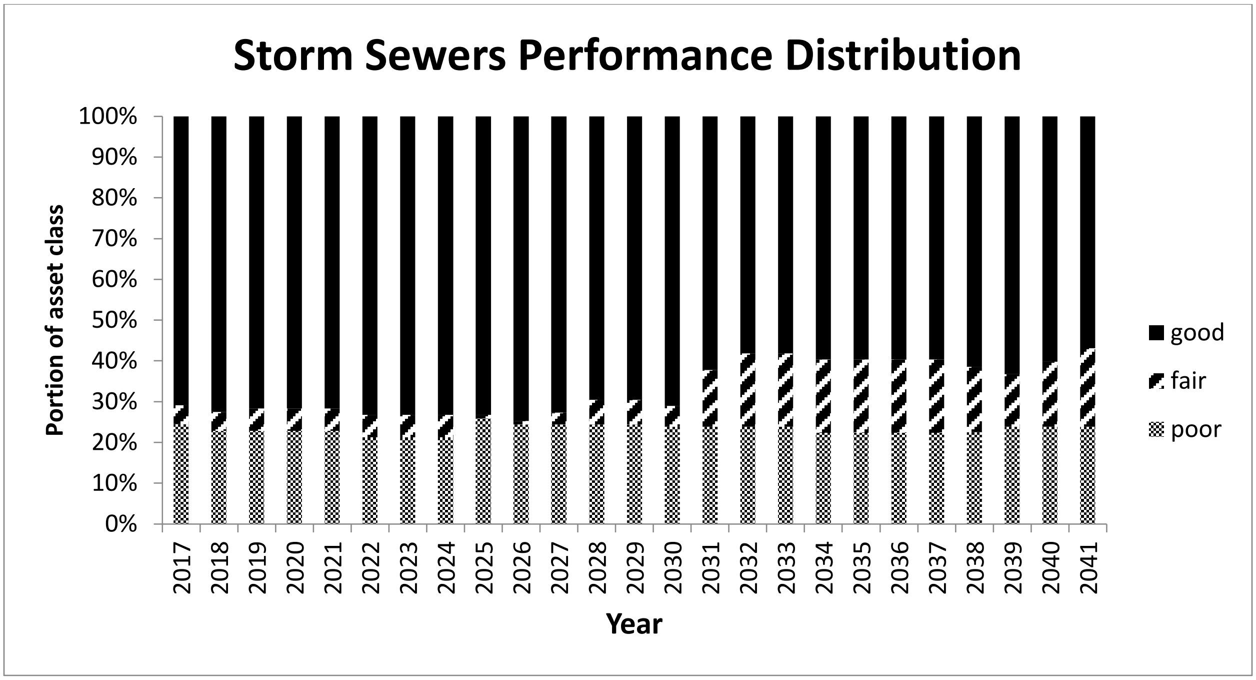

Figure 18: Storm Sewer Network Performance

3.8 Fleet

3.8.1 State of local infrastructure - Fleet

The Fleet asset class numbers 22 items, serving three fire, one public works department, and the community centre. Currently 29 %, 17%, and 54%, of the fleet network is in good, fair, and poor condition, respectively. The replacement value is $ 2,975,612.

3.8.2 Asset management strategy - Fleet

Over a century of motorized vehicle and equipment production allows today's manufacturers to provide relatively precise product maintenance requirements and life cycle information to the consumer. Such information dictates the asset management strategy for the fleet asset class.

However, it is important to note that the product life span information provided by manufacturers is typically an average value that forms part of a probability distribution curve (e.g. normal distribution).

Subsequently, there is potential for scenarios where the product (e.g. individual fleet asset) is performing sufficiently but appears to be past its service life. It is recommended the Fleet asset management strategy increase sensitivity towards such scenarios, and adjust accordingly.

3.8.3 Financing strategy - Fleet

Figure 19 shows the 25 year capital expenditure profile necessary for achieving acceptable performance (level of service) over the planning horizon.

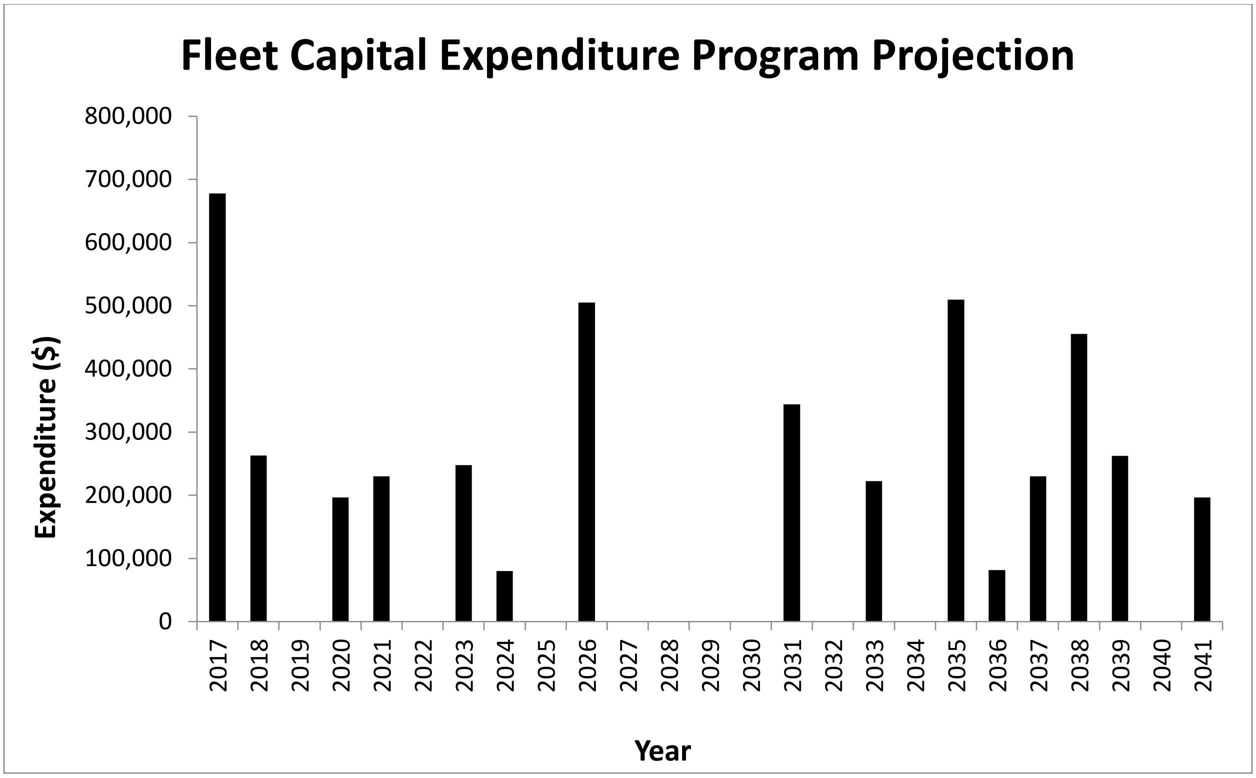

Figure 19: Fleet Capital Expenditure Program Projection

The majority of the projected expenditure is based upon the replacement of large trucks (e.g. tankers, dumpers, rescue, etc.) that are used in public works and fire services. Their cost ranges from $ 200,000 to $ 300,000 per vehicle. It is recommended that the budgeting process for the Fleet assets adhere to the existing individual processes of each respective organizational section, rather than attempting a new "pooled" approach. The reason a separate asset class has been created for fleet in the plan is due to the assets very similar nature, in that they are engineered mechanical products / machines. That subsequently exhibit similar rates of degradation and cost. However, because they are used for different services and managed under separate asset management processes, the cost / benefit

of creating new "engineering/subject matter expert – to – finance – to – administration" information flows, is unsustainably high; when taking into consideration that the existing flows already provide the necessary information (asset condition, improvement treatments, costs, etc.) to create pooled performance graphs and expenditure profiles.

Annual funding of $ 36,510 is required on top of existing capacity in order to achieve the expected level of asset performance. Financing options for the scenario should explore the possibility of tax, fees, and debt instruments as funding generators; however, due to the relatively small size of the municipality, the majority of the initial effort should be focused on grants.

3.8.4 Asset performance (Expected levels of service) - Fleet

Table 9 contains a cross reference between the quantitative and qualitative performance indicators.

Table 9: Fleet Performance Measures

Perfomance	Remaining Life Cycle %
Good	100 - 66.66
Fair	66.66 - 33.33
Poor	less than 33.33

The life span of the Fleet assets ranges from 5 to 25 years. Unlike for the civil engineering infrastructure assets, the direct use of asset age for performance projection is optimal. The thresholds of the performance categories are divided into thirds and depend on the respective individual asset life spans. Compared to civil infrastructure life spans (e.g. 25-50+ years), the Fleet's are relatively shorter, avoiding the need to vary the remaining life cycle ranges in order to minimize potential of needs over estimation. As for ensuring appropriate lead time for the administration to react and address upcoming needs with existing capacities, the performance thresholds are scaled appropriately. For example, a fire truck with a life span of 20 years would "come on the radar" with approximately six (6) and half years of remaining life span. This provides ample time for the existing engineering / subject matter expert-to-finance-to-administration information flow to address the $ 200,000 need in an efficient, effective and transparent manner. Research of new technologies, emerging fire service standards, review of funding options, and preparation of request for proposal, are some of the items that would be addressed within that time period. On the other end, a pick-up truck with a life span of six (6) years, would "come on the radar" with two (2) years of remaining life span. Determining an appropriate replacement, and exploring the trade-in options are a few of the activities that would take place within the two (2) years. This would be ample time for the administration to address the $ 10,000 to $ 40,000 need with existing resources. Necessary time and effort are typically proportional to the value of the need to be addressed.

Figure 20 illustrates the 25 year Fleet performance (level of service).

Compared to other asset classes composed of civil infrastructure, the graphic is more dynamic. This is due to shorter life spans and increased variety of components in mechanical infrastructure. The 25 year average fleet performance is 36 % good, 30 % fair, and 34 % poor. Varying performance vs. investment scenarios were analyzed, the above scenario is recommended for implementation. Considering that the life spans are average values which fall under probability distribution curves, use of engineering risk and reliability methods to fine tune the scenario in future improvements of asset management processing is suggested.

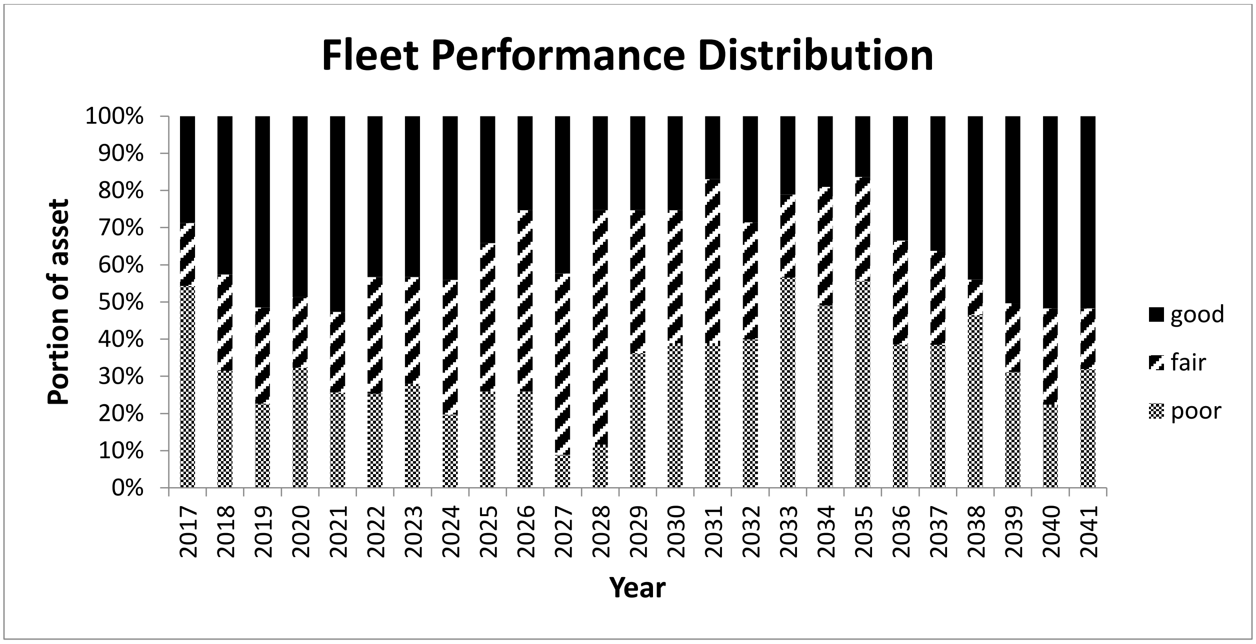

Figure 20: Fleet Performance

3.9 Equipment and Furnishings

3.9.1 State of local infrastructure – Equipment and Furnishings

The Equipment and Furnishings asset class numbers 157 items, serving three fire, one public works department, and the community centre. Currently 14 %, 31%, and 54%, of the equipment and furnishings are in good, fair, and poor condition, respectively. The replacement value is $ 3,945,460.

3.9.2 Asset management strategy – Equipment and Furnishings

Manufacturers provide relatively precise product maintenance requirements and life cycle information to the consumer. Such information dictates the asset management strategy for the equipment and furnishings asset class.

However, it is important to note that the product life span information provided by manufacturers is typically an average value that forms part of a probability distribution curve (e.g. normal distribution).

Subsequently, there is potential for scenarios where the product (e.g. compressor) is performing sufficiently but appears to be past its service life. It is recommended the Equipment and Furnishings asset management strategy increase sensitivity towards such scenarios, and adjust accordingly.

3.9.3 Financing strategy – Equipment and Furnishings

Figure 21 shows the 25 year capital expenditure profile necessary for achieving acceptable performance (level of service) over the planning horizon.

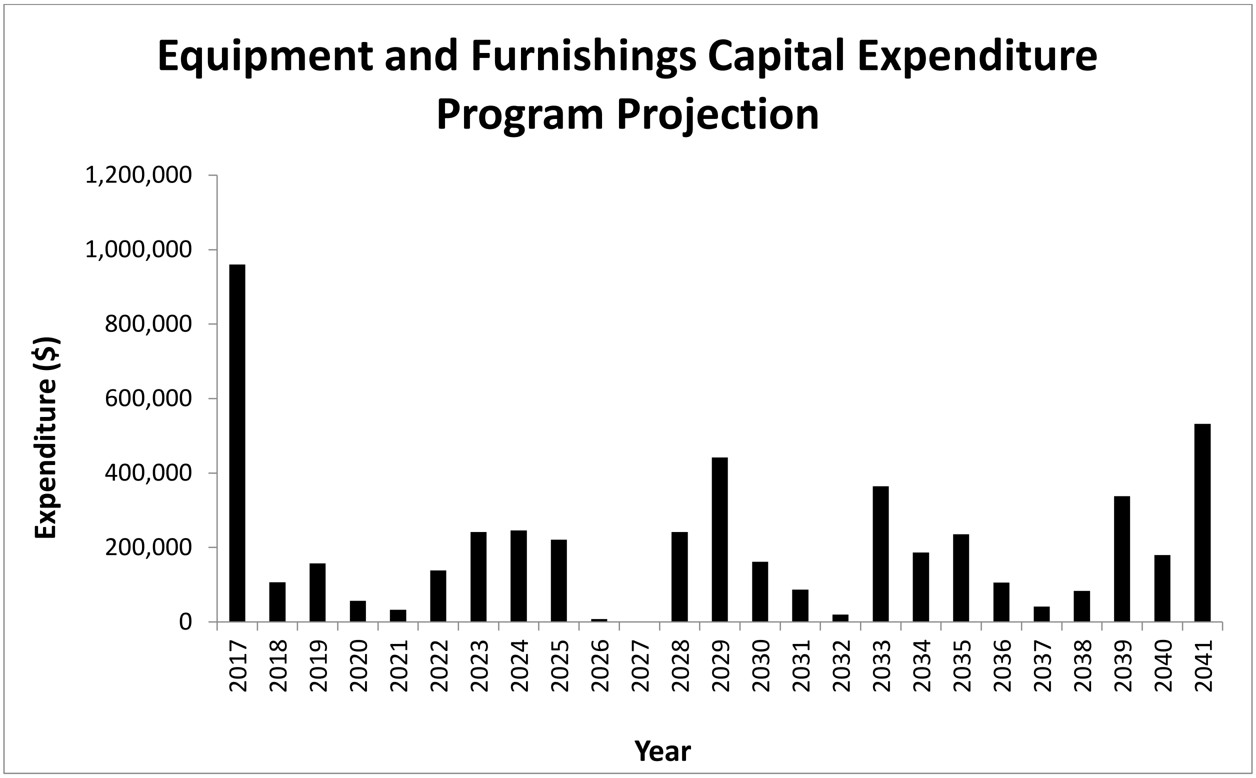

Figure 21: Equipment and Furnishings Capital Expenditure Program Projection

The initial spike of projected expenditure is based upon the replacement of equipment items which have according to an age based analysis reached the replacement threshold. The approximate breakdown according to municipal areas is 40 % fire rescue, 25 % public works, 25 % sewage treatment, and 10 % for the community centre. It is recommended that the budgeting process for the equipment and furnishings assets adhere to the existing individual processes of each respective organizational section, rather than attempting a new “pooled” approach. The reason a separate asset class has been created for equipment and furnishings in the plan is due to the assets similar nature, in that they are typically engineered mechanical products / machines. That subsequently exhibit similar rates of degradation and cost. However, because they are used for different services and managed under separate asset management processes, the cost / benefit of creating new “engineering/subject matter expert – to – finance – to – administration” information flows, is unsustainably high; when taking into consideration that the existing flows already provide the necessary information (asset condition, improvement treatments, costs, etc.) to create pooled performance graphs and expenditure profiles.

Annual funding of $ 100,099 is required on top of existing capacity in order to achieve the expected level of asset performance. Financing options for the scenario should explore the possibility of tax, fees, and debt instruments as funding generators; however, due to the relatively small size of the municipality, the majority of the initial effort should be focused on grants.

3.9.4 Asset performance (expected levels of service) – Equipment and Furnishings

Table 10 contains a cross reference between the quantitative and qualitative performance indicators.

Table 10: Equipment and Furnishings Performance Measures

Perfomance	Remaining Life Cycle %
Good	100 - 66.66
Fair	66.66 - 33.33
Poor	less than 33.33

The life span of the assets ranges from five (5) (e.g. heater) to 20 years (e.g. grader), with the median being five (5), and the average 10 years (e.g. snowblower). Unlike for the civil engineering infrastructure assets, the direct use of asset age for performance projection is optimal. The thresholds of the performance categories are divided into thirds and depend on the respective individual asset life spans.

As previously described under the Fleet asset class, the performance threshold ranges provide appropriate windows of time for the corporation to address the needs with existing organizational processes. Figure 22 illustrates the 25 year Equipment and Furnishings performance (level of service).

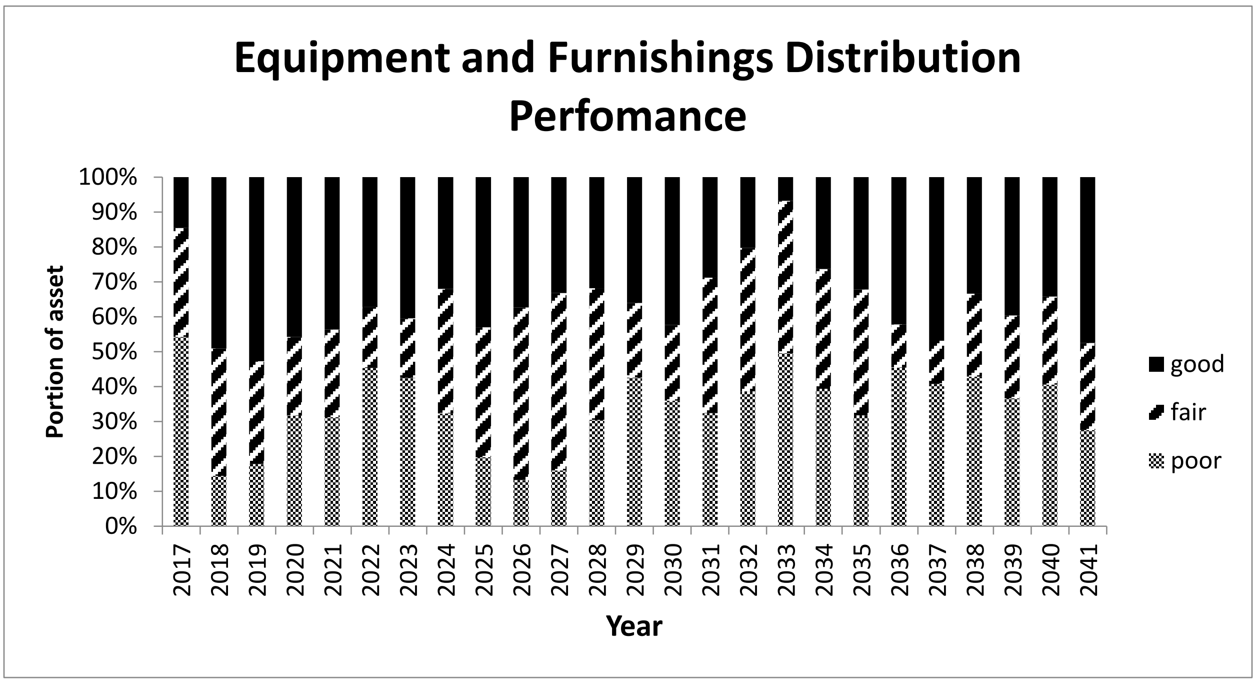

Figure 22: Equipment and Furnishings Performance

Compared to other asset classes composed of civil infrastructure, the graphic is more dynamic. This is due to shorter life spans and increased variety of components in mechanical infrastructure. The 25 year average equipment and furnishings performance is 36 % good, 30 % fair, and 34 % poor. Varying performance vs. investment scenarios were analyzed, the above scenario is recommended for implementation. Considering that the life spans are average values which fall under probability distribution curves, use of engineering risk and reliability methods to fine tune the scenario in future improvements of asset management processing is suggested.

3.10 Facilities

3.10.1 State of local infrastructure - Facilities

The Facilities asset class numbers 16 structures of varying size and complexity; serving three fire departments, a public works department, and the municipal administration. Currently 70 %, 30%, and less than 1 %, of the Facilities asset class is in good, fair, and poor condition, respectively. The replacement value is $ 22,280,396.

3.10.2 Asset management strategy - Facilities

The Facilities asset is the most complex within the municipal portfolio with respect to the variety of engineering systems involved. ASTM's "Uniformat II Elemental Classification for Building Specifications, Cost Estimating, and Cost Analysis" is used to develop the asset management strategy.

The replacement cost of each structure is used to project the value of *Level 1 – general grouping of major elements* (e.g. C Interiors), and subsequent *Level 2 – group elements* (e.g. C Interiors – C20 Stairs) or systems. Municipal information on improvement activities and associated costs spanning back to the 1950s was used to develop deterioration rates, treatment trigger values, and average treatment costs - at a system level for each facility. This approach ensures a uniquely tailored asset management strategy for each facility and the type of use it services. Furthermore, the developed performance measure considers functional and condition based indicators according to public and professional perspectives which have guided decisions over the past decades.

The performed mass data analysis is based upon the principles of risk-based life cycle management of engineering systems. The asset degradation rate and average cost of treatments is derived from the rate of interventions and associated costs to date, respectively. This engineering risk and reliability approach provides performance measures that are not necessarily mutually exclusive from the current industry standard, being the Facility Condition Index (FCI), but are arguably more flexible in accommodating factors outside the sphere of a professionally assessed asset condition rating. These include functional performance measures, from public and professional perspectives; as well as conditional asset performance from a public perspective, and political commitments.

3.10.3 Financing strategy - Facilities

Figure 23 shows the 25 year capital expenditure profile necessary for achieving acceptable performance (level of service) over the planning horizon.

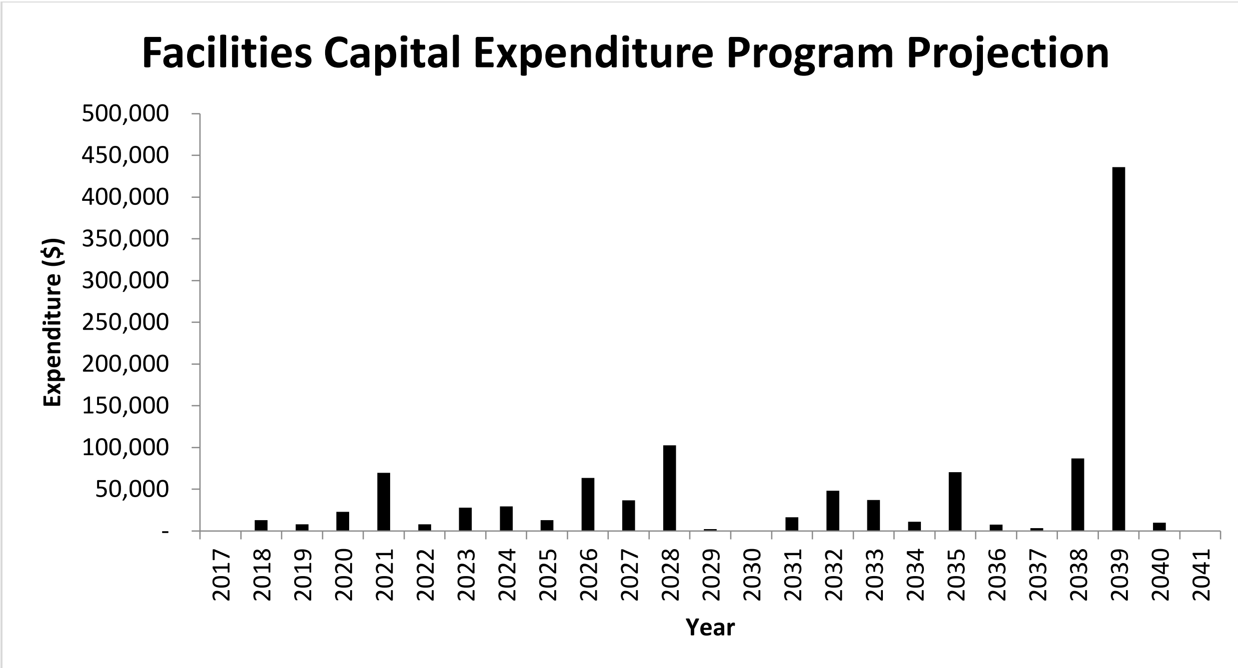

Figure 23: Facilities Capital Expenditure Program Projection

The average annual capital expenditure for the first 10 years is $ 25,621, and $ 32,833 for the remainder of the planning horizon. The large expenditure in 2039 is associated with the replacement of the sludge storage tank at the Waste Water Treatment Plant. Although functionally the Water and Waste Water plants are part of the water distribution and sanitary assets, they are relatively more complex than the pipe networks they serve; and have components similar to typical facilities (e.g. floors, electrical systems, mechanical systems, etc.). For this reason they have been shown under the Facilities asset performance graph, which does not exclude the ability of the asset management system to illustrate their performance under the respective asset classes as required to support decision making processes.

It is recommended that the budgeting process for the Facilities assets adhere to the existing individual processes of each respective organizational section, rather than attempting a new “pooled” approach. They are used for different services and managed under separate asset management processes, the cost / benefit ratio of creating new “engineering/subject matter expert – to – finance – to – administration” information flows is unsustainably high; when taking into consideration that the existing flows already provide the necessary information (asset condition, improvement treatments, costs, etc.) to create pooled performance graphs and the expenditure profile.

The current capital funding levels are sufficient for accommodating the expected asset performance levels.

3.10.4 Asset performance (Expected levels of service) - Facilities

The current performance measure typically used in the industry is the Facilities Condition Index (FCI). It is calculated as a ratio of the “cost of required facility improvements” over the “facility replacement cost”. Facility inspectors determine the required improvements, and RS Means is the industry source for the unit costs of the assessed requirements. A limitation of the FCI is that it is constrained to the physical condition of the asset only. In cases where agencies lack the capacity (e.g. small municipalities) to assess and track the FCI on a regular basis (e.g. every 5 years) for all of its facilities, there does not appear to be a widely accepted means of quantifying and modelling asset performance.

Irrelevant of whether or not an agency has the capacity to develop the FCI, decades of facility management by agencies indicated that the professional staff possess the knowledge, skill and expertise to make investment decisions based upon the following asset performance categories: public expectations, political commitments, fiscal constraints, and the physical and functional aspects of the asset. The resulting decades of data are an explicit output of such performance measures being accounted for in already established decision making processes within an agency. The data contains the initial construction cost, frequency of treatments, and associated costs; but does not provide the degree of influence of each asset performance category mentioned. None the less, using the concepts of data analysis and reliability computation from risk-based life cycle management of engineering systems research, the Comprehensive Facility Asset Management performance measure (CFAM) was developed.

Figure 24 illustrates the 25 year Facilities performance (level of service).

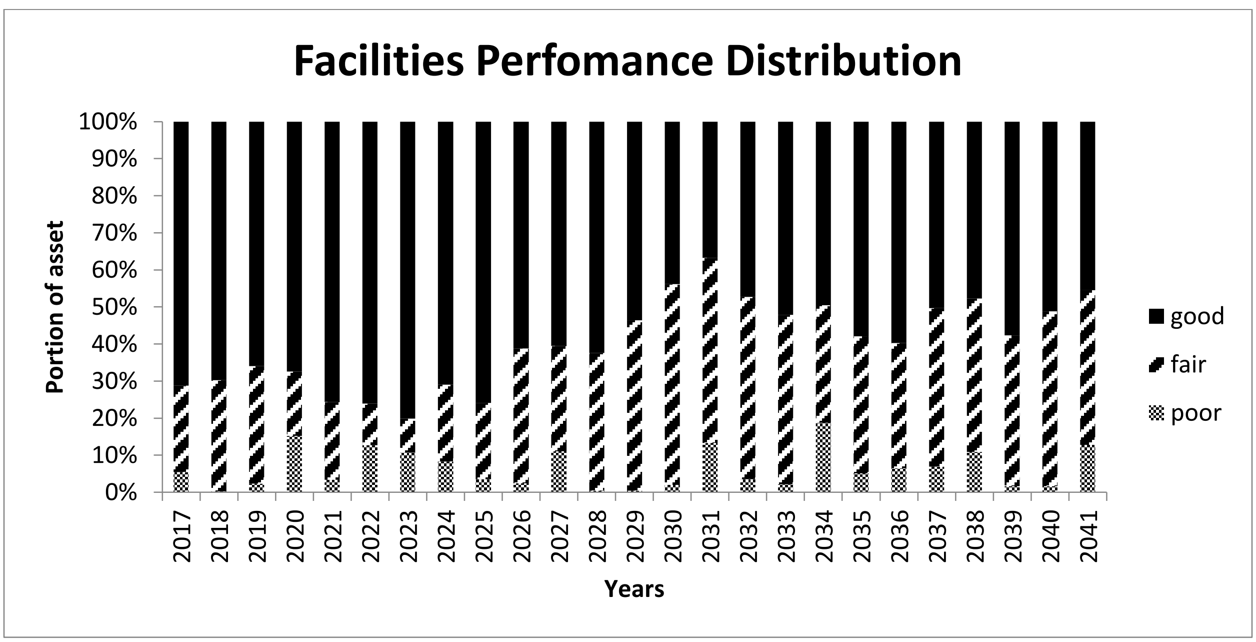

Figure 24: Facilities Performance

The graph is based upon the condition of individual systems, which make up all of the facilities servicing the municipality (e.g. administrative building, fire halls, community centre, etc.). It is weighted according to the replacement value of each system. Although the graphic shows the overall performance of all facilities combined, the individual facility or system graphics are available for the asset management process to support future decision making.

The average poor asset performance for the first five (5) years is 5 %, increasing in the six (6) to 10 year span to 8 %, and averaging out at 6 % in the 11-25 year span. The average fair asset performance for the first five (5) years is 25 %, increasing in the six (6) to ten year span to 20 %, and averaging 42 % in the 11-25 year span. The average good asset performance for the first five (5) years is 70 %, increasing in the six (6) to ten year span to 72 %, and averaging 52 % in the 11-25 year span. As can also be seen from Figure 24, the fair asset performance approximately doubles over the long term, as on average 20 % of the good asset proportion becomes categorized as fair in the 11-25 year span. The ten year period is sufficient for the administration to prepare and adequately address the 11-25 year needs. Other scenarios were modeled; this is the recommended one for implementation according to professional input and corporate-data-driven performance measures.

Furthermore, the use of CFAM is recommended in addition to, or in the absence of an FCI, as a comprehensive performance measure for facility asset management. One which accounts for all of the asset performance categories: public expectations, political commitments, fiscal constraints, and the physical and functional aspects of the assets. Future tracking of the degree of influence each category has on decision making is also recommended, as this will provide a foundation for expanding the portfolio of available performance measures according to each category.

3.11 Land Improvements

3.11.1 State of local infrastructure – Land Improvements

The Land Improvements asset class numbers 25 items, and captures the various land improvements done to municipal properties. This includes the grounds of the community centre, fire departments, parks and recreation, and the cemetery. The improvements range from fencing to playground expansions. Currently 36%, 8%, and 56%, of the land improvement items are in good, fair, and poor condition, respectively. The replacement value is $ 701,481.

3.11.2 Asset management strategy – Land Improvements

Life cycle analysis according to the age of each individual asset is most appropriate for developing the asset management strategy. This is due to the relatively low quantity and high variety of items under the land improvements asset class. At this time, there is a lack of industry-wide accepted key performance indicators for this asset class, such as those for the roads asset. Also, the lack of large quantities of costing and improvement activities data, does not at this time allow for an asset management strategy developed according to corporate-data driven performance measures, such as those for the Facilities asset class.

The assets service life ranges from 10 (e.g. playground soft surface) to 30 (e.g. baseball dugouts), with the median and average being 20 years (e.g. fencing). Unless inspection data indicates otherwise, once an item enters into its last 1/6th of the life span it becomes eligible for an improvement activity. In addition to replacements, the model is professionally managed at an individual item level to ensure the most appropriate asset management strategy is applied over the 25 years. For example, although a skate board park includes a service life of 10 years, analysis indicates that the scenario of replacing it at the end of it is a sub-optimal strategy for the individual item, as well as for the entire asset class. Subsequently, a scenario which includes a maintenance/rehabilitation and/or expansion is part of the preferred asset management strategy, for which the required financing is shown in the next section.

3.11.3 Financing strategy – Land Improvements

Figure 25 shows the 25 year capital expenditure profile necessary for achieving acceptable performance (level of service) over the planning horizon.

The average annual capital expenditure for the 25 years is $ 16,940. It is recommended that the budgeting process for the Land Improvement assets adhere to the existing individual processes of each respective organizational section, rather than attempting a new "pooled" approach. The reason a separate asset class has been created for the plan is due to the assets sharing a common purposes, in that they enhance municipal owned land. However, because they are used for different services and managed under separate asset management processes, the cost / benefit of creating new "engineering/subject matter expert – to – finance – to – administration" information flows is unsustainably high; when taking into consideration that the existing flows already provide the necessary information (asset condition, improvement treatments, costs, etc.) to create pooled performance graphs and expenditure profiles.

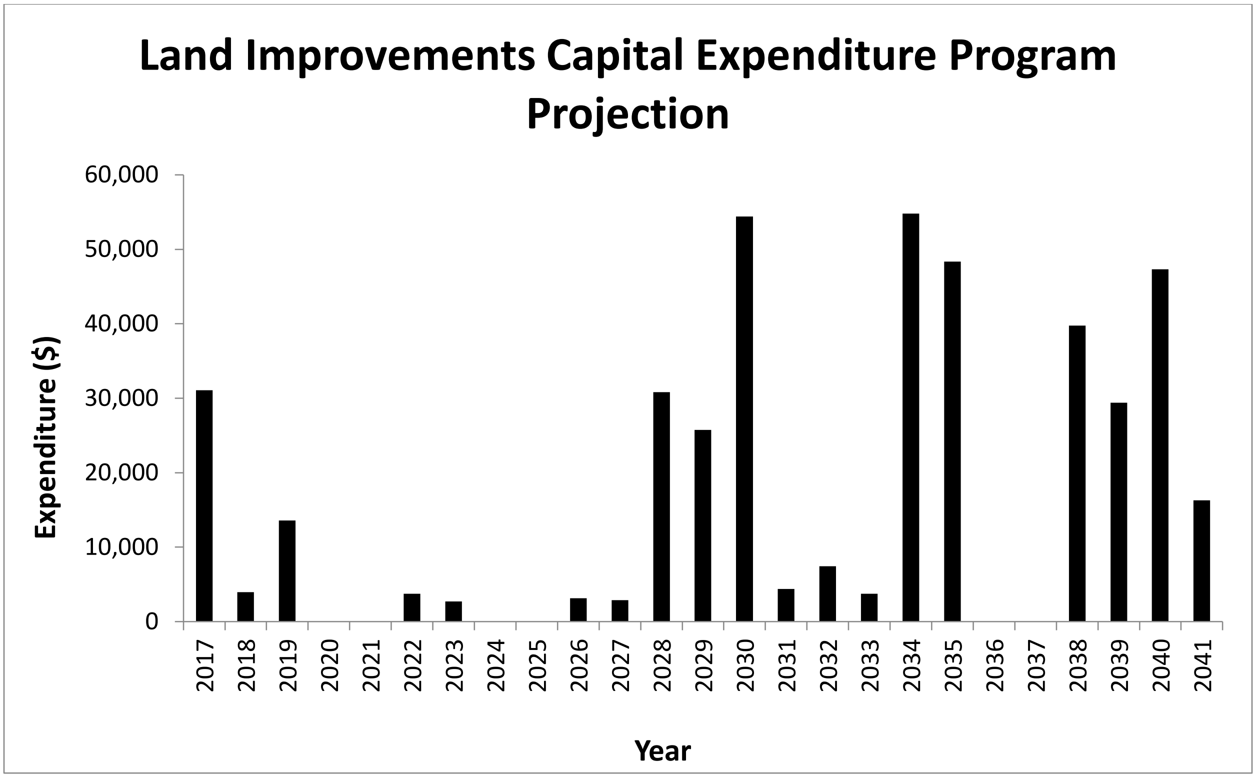

Figure 25: Land Improvements Capital Expenditure Program Projection

Maintaining existing levels of investment is recommended.

3.11.4 Asset performance (Expected levels of service) – Land Improvements

Table 11 contains a cross reference between the quantitative and qualitative performance indicators.

Table 11: Land Improvements Performance Measures

Perfomance	Remaining Life Cycle %
Good	100 - 33.33
Fair	33.33 - 16.66
Poor	less than 16.66

The direct use of asset age for performance projection is optimal. The performance threshold ranges provide appropriate windows of time for the corporation to address the needs with existing organizational processes.

Figure 26 illustrates the 25 year Land Improvements asset class performance (level of service).

The 25 year average Land Improvements asset class performance is 70 % good, 14 % fair, and 16 % poor. Varying performance vs. investment scenarios were analyzed, the shown scenario is recommended for implementation. As more improvement activity data is generated over time, use of engineering risk and reliability methods to fine tune the scenario in future improvements of asset management processing is suggested.

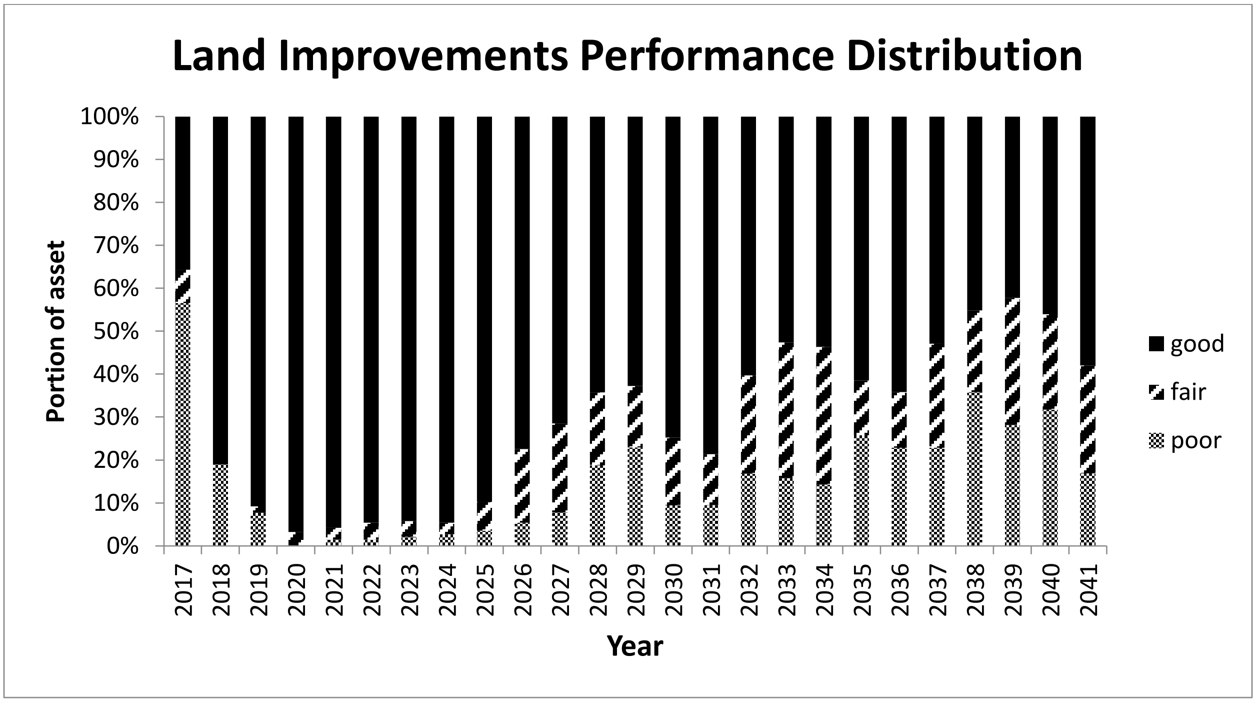

Figure 26: Land Improvements Performance