THE CORPORATION OF THE CITY OF BRANTFORD

2021 Asset Management Plan Transportation

Public Works Core Assets
City of Brantford, Ontario

Prepared by: Infrastructure Planning Asset Management, Public Works
Corporation of the City of Brantford, August 2021

RECORD SHEET

Asset Management Document Set	Asset Group	First Issuance
Strategic Asset Management Policy	All	May 2019
Asset Management Plan Overview	Core Assets	September 2021
Asset Management Plan, Core Assets	Transportation	(this document)
Asset Management Plan, Core Assets	Environmental Services	September 2021
Asset Management Plan Overview	Non-Core Assets	July 1, 2024
Asset Management Plan, Non-Core Assets	Facilities Fleet & Transit Parks & Recreation Housing Fire Services Local Boards Economic Development and Tourism IT Services	July 1, 2024

ASSET MANAGEMENT PLAN TRANSPORTATION

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TRANSPORTATION INTRODUCTION

For the purposes of the Asset Management Plan, Transportation is divided into two (2) Asset Classes: Road, and Bridges & Culverts which are considered core assets as defined in O.Reg 588/17.

Table 1 below outlines which Asset Types are included under each Asset Class, and will be reported on in this AMP. It is important to note that the AMP only includes assets owned by the City, and does not include assets that are owned privately or by other organizations.

Table 1: Asset Type Breakdown

	Asset Class	
	Bridges & Culverts	**Road**
Asset Type:	Bridges	Roads
	Bridge Stairways	Streetlights
	Retaining Walls	Streetlight Poles
	Long Span Culverts (>3m span)	Signs
	Short Span Culverts (<3m span)	Signaled Intersections
		Guide Rails
		Sidewalks

1. BRIDGES & CULVERTS ASSETS

1.1. INTRODUCTION

The City of Brantford owns and maintains several assets under the bridges & culverts asset class. The purpose of this section is to present specific information about the bridges & culverts asset class so that we can answer the questions posed in **Section 2** of the **Asset Management Overview Document**, and includes the following:

- Bridge & Culvert Assets' Data Inventory and Condition Approach;
- Summary of Bridge & Culvert Assets;
- Lifecycle Activities and Cost of Bridge & Culvert Assets;
- Current Bridge & Culvert Assets' Levels of Service;
- Current Bridge &Culvert Asset Performance; and
- Discussion and Conclusions.

1.2. BRIDGE & CULVERT ASSETS' DATA INVENTORY AND CONDITION APPROACH

The City of Brantford has different approaches to establishing the condition for each bridge & culvert asset due to regulatory requirements, available resources, technologies, and budget restrictions.

There are two (2) different approaches to determining the condition of bridge & culvert assets:

- Outsourced condition assessments to consultants; and
- Estimated condition based on asset specific information.

A list of all condition assessments for all core assets can be found in **Table 6** in the **Asset Management Plan Overview Document**.

The origin of the bridge & culvert asset data for inventory, replacement cost, condition as well as data confidence are provided in **Table 2** below. Many bridge and culvert assets are incorporated in the Ministry of Transportation Ontario Structure Inspection Manual (OSIM), 2008 Program.

Table 2: Bridge & Culvert Assets' Inventory, Replacement Cost, and Condition Origin and Confidence Levels

	Inventory			Replacement Cost			Condition		
Asset	Inventory From	Data Confidence Level	Data Confidence Description	Replacement Cost From	Data Confidence Level	Data Confidence Description	Condition From	Data Confidence Level	Data Confidence Description
Bridges	2019 OSIM Report completed by McIntosh Perry Consulting Engineers	High	Formal inventory with few unknowns.	2019 OSIM Report completed by McIntosh Perry Consulting Engineers	High	Formal estimate completed as part of condition assessment.	2019 OSIM Report completed by McIntosh Perry Consulting Engineers	High	Formal condition assessment with few unknowns
Long Span Culverts (span >= 3m)	2019 OSIM Report completed by McIntosh Perry Consulting Engineers	High	Formal inventory with few unknowns.	2019 OSIM Report completed by McIntosh Perry Consulting Engineers	High	Formal estimate completed as part of condition assessment.	2019 OSIM Report completed by McIntosh Perry Consulting Engineers	High	Formal condition assessment with few unknowns
Bridge Stairs	2020 OSIM Report completed by McIntosh Perry Consulting Engineers	High	Formal inventory with few unknowns.	2020 OSIM Report completed by McIntosh Perry Consulting Engineers	High	Formal estimate completed as part of condition assessment.	2020 OSIM Report completed by McIntosh Perry Consulting Engineers	High	Formal condition assessment with few unknowns
Retaining Walls	2019 OSIM Report completed by McIntosh Perry Consulting Engineers and GIS Layer: SiteAmenityLine	Medium	Formal inventory of retaining walls over 0.7m, remaining inventory less than 0.7m contains unknowns.	2019 OSIM Report completed by McIntosh Perry Consulting Engineers	Medium	Formal replacement cost for retaining walls over 0.7m, remaining replacement cost was estimated based on average.	2019 OSIM Report completed by McIntosh Perry Consulting Engineers	Medium	Formal condition assessment for retaining walls over 0.7m height. Retaining walls under 0.7m unknown.
Short Span Culverts (span < 3m)	GIS layer, swCulvert	Low	Inventory is not fully complete and unknowns exist.	Estimated based on Operations pricing.	Low	High level estimate.	Service Life	Low	Service life can be a predictor of condition, but does not always indicate the true condition.

Per **Table 2** above, bridge and culvert assets' inventory and condition data (excluding short-span culverts and retaining walls less than 0.7m) is typically at a High level due to ongoing consultant inventory and condition assessments through the OSIM inspections. The only assets above that are not included in the OSIM inspections are retaining walls < 0.7m in height and short span culverts with spans < 3m. Retaining walls <0.7m in height have not been included for condition due to unknown ages, and the inventory is at a Medium confidence level, but may be incomplete. Short span culverts are typically at a Low confidence level due to unknowns in the inventory, age, and condition. It is a future City initiative to conduct inventory and condition assessments on these assets.

Improvements to the inventories and inspection programs will be ongoing as a result of the AIM project explained in **Section 7** of the **Asset Management Plan Overview document**.

1.2.1. BRIDGE CONDITION INDEX

Through the OSIM program, a condition rating for each bridge & culvert asset (excluding short span culverts) is calculated using a Bridge Condition Index (BCI) score as developed by the Ministry of Transportation of Ontario, and described in

Table 3**.** It is important to note that the BCI does not indicate the safety of the structure, but calculates the economic worth of the structure under the assumption that as structural elements deteriorate to a lower condition, the element's value decreases. This can occasionally result in a bridge or culvert with a BCI > 80 that has one key element which has deteriorated to the extent that the structure is no longer safe and requires immediate repair. The current value of the structure is calculated based on the inspector's review and rating of each element of the structure. At this time, the OSIM inspections are completed as mandated, but the City is currently investigating completing enhanced OSIMs on critical bridge assets.

The BCI is calculated by the following formula:

$$BCI = \frac{Current\ Value}{Replacement\ Value}$$

Table 3: Bridge Condition Index (BCI) Description

BCI	Condition Rating	Description
>80	Excellent	For a structure with a BCI greater than 80, rehabilitation is usually not required within the next 10 years.
70 - 80	Good	For a structure with a BCI between 70 and 80, rehabilitation work is usually not required within the next five years.
60 - 70	Fair	For a structure with a BCI between 60 and 70, rehabilitation work is usually scheduled within the next 5 years. This is the ideal time to schedule major repairs from an economic perspective.
<60	Poor	For a structure with a BCI rating of less than 60, rehabilitation work is usually scheduled within approximately one year.

1.2.2. SERVICE LIFE

For the short span culverts (span <3m), OSIM inspections are not required per the Ministry of Transportation Ontario Structure Inspection Manual (OSIM), 2008. Therefore the condition has been estimated based on the estimated service life of the asset's material indicated below in **Table 4**. It is a future plan for the City to conduct condition assessments internally on our short span culverts but this program has not yet been initiated.

Table 4: Bridge & Culvert Asset's Estimated Service Life

Asset	Estimated Service Life
Short Span Culverts	Corrugated Metal Pipe – 50 years Concrete (including Reinforced) Pipe – 70 years Polyvinyl Chloride (PVC) Pipe – 50 years Unknown – 50 years

1.2.3. CONDITION SCORING

For the purpose of this report and standardizing condition scores across all assets in the Asset Management Plan, the Condition Rating is defined by three (3) Condition Scores as defined in the table below. Where a BCI score is available, it has been modified to fit into this scoring system as indicated below.

Table 5: Condition Score Description

Condition Score	BCI	Condition Rating	Description
1 – 1.4	>= 70	Good	Assets in the system or network are in working order, have few, if any, deficiencies, and will not require repairs or replacement for 5+ years.
1.5 – 2.4	60 – 69.99	Fair	Asset in the system or network show general signs of deterioration, some elements may have significant deficiencies, and asset will likely require repairs in the next 1-5 years.
2.5 - 3	< 60	Poor	Asset is below standard showing signs of significant deterioration, are in danger of imminent failure, and will require repair or replacement within the next year.

1.3. SUMMARY OF BRIDGES & CULVERTS ASSETS

The summary of assets for the Bridge & culvert Asset Class can be found below. The summary of assets includes: Quantity, Replacement Cost, Average Age, and Average Condition Score for each asset type in accordance with O.Reg 588/17.

1.3.1. TOTAL SUMMARY OF ASSETS

A table summarizing all bridge & culvert assets is included in **Table 6** below. Detailed information about each asset is included in individual sections. It is evident that the total replacement cost for bridge & culvert assets is approximately $157.7M, with an average age of 34 years, which is 50% of the average estimated life of all bridge & culvert assets. The overall bridge and culvert assets are in Fair condition. The average condition scores are shown to one decimal place to illustrate how close the scores are to being on a cusp of another rating and were used to calculate the weighted overall average condition score for the asset group, but are shown rounded to the nearest whole number in subsequent sections.

Table 6: Overall Summary of Bridge & Culvert Assets

Asset	Quantity	Unit	Replacement Cost	Average Age (years)	Average Estimated Service Life (years)	% of Estimated Service Life	Average Condition Score	Average Condition Description
Bridge & Culvert Asset Total			**$157.7M**	**34**	**68**	**50%**	**1.7***	**FAIR**
Bridges	40	count	$122.6M	54	56	96%	1.6	FAIR
Bridge Stairways	6	count	$635.0K	39	75	52%	2.0	FAIR
Retaining Walls	36	count	$5.08M	8	75	11%	1.6	FAIR
Long span Culverts	45	count	$24.9M	37	84	44%	2.0	FAIR
Short span Culverts	186	count	$4.47M	32	52	62%	2.0	FAIR

*Denotes Weighted Average

1.3.2. BRIDGES

Bridges are structures which allow passage over an obstacle such as a river. It is evident in **Figure 1** below that the City owns forty (40) bridges which are typically in Fair condition with an average BCI of 68 and average condition score of 2. The replacement cost for all 40 bridges totals $122.6M with an average age of 54 years which is 96% of the average estimated service life of 56 years. It can also be seen that 40% of bridges in the City are I-Beam bridges followed by 28% considered Half-Through truss bridges. Finally, the majority of bridges in the City (68%) are pedestrian bridges while the remaining (32%) are multi-vehicular bridges. The City is currenty investigating completing enhanced OSIM assessment program for critical bridge structures.

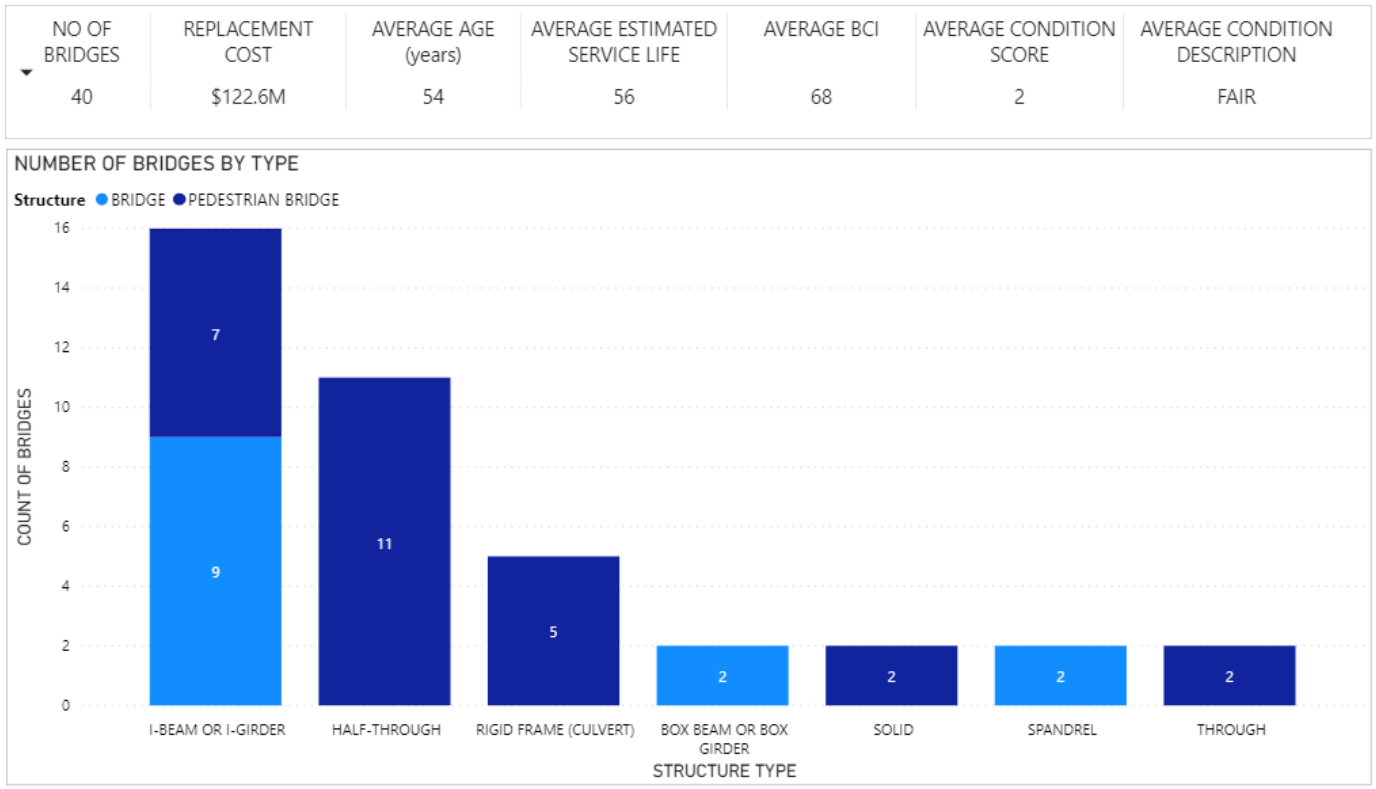

Figure 1: Bridges Asset Summary

1.3.3. BRIDGE STAIRWAYS

Bridge stairways are defined as stairways that are part of a City bridge structure. **Figure 2** below shows that there are six (6) stairways associated with bridges in the City that are in an average Fair condition with an average BCI of 65 and an average condition score of 2. The replacement cost for all six (6) stairways is $0.64M with an average age of 39 years which is 52% of the average estimated service life of 75 years. The breakdown for each replacement cost can be seen above with the most expensive stairway being the Fordview Park Stairway at Lorne Bridge.

NO OF BRIDGE STAIRWAYS	REPLACEMENT COST	AVERAGE AGE (years)	AVERAGE ESTIMATED SERVICE LIFE	AVERAGE BCI	AVERAGE CONDITION SCORE	AVERAGE CONDITION DESCRIPTION
6	$0.64M	39	75	65	2	FAIR

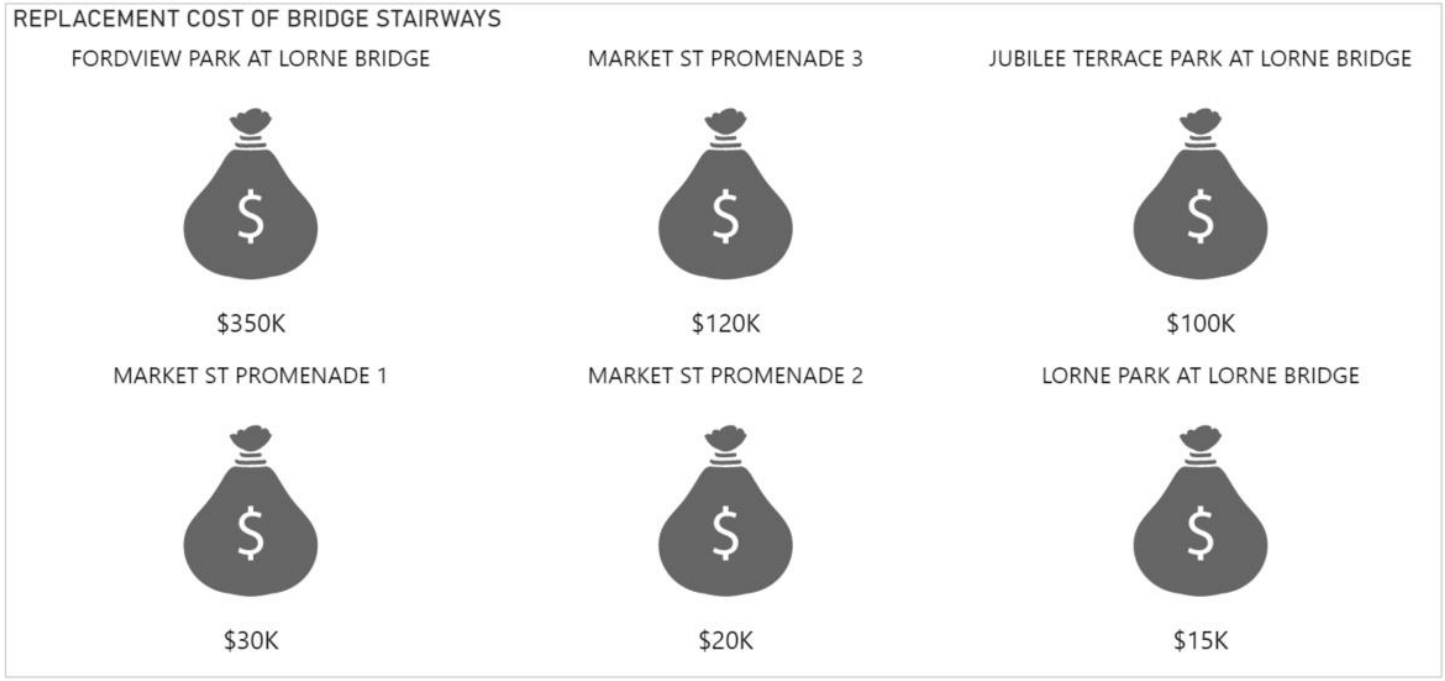

Figure 2: Bridge Stairways Asset Summary

1.3.4. RETAINING WALLS

Retaining walls are wall structures which are designed to resist soil pressure in the event of a large elevation difference from one side of the wall to the other. Retaining wall inspections for structures greater than 0.7m in height occur as part of the OSIM inspection. Retaining walls less than 0.7m do not have an inspection or condition assessment program at this time, and since the ages are unknown, the estimated condition is unknown, however, a formal condition assessment of these walls is expected to be completed in 2021. Per **Figure 3** below, there are 36 known retaining walls in the City, and 23 of these walls were completed as part of the OSIM inspection. The total replacement cost for the 36 retaining walls is $5.1M and the average age (where known) is 8 years which is 11% of the average estimated service life. Based on the OSIM inspection, the 23 walls are an average of Fair conditon with an average BCI of 64 and condition score of 2. It can also be seen below that the most common material used for the City's retaining walls is masonry closely followed by reinforced concrete.

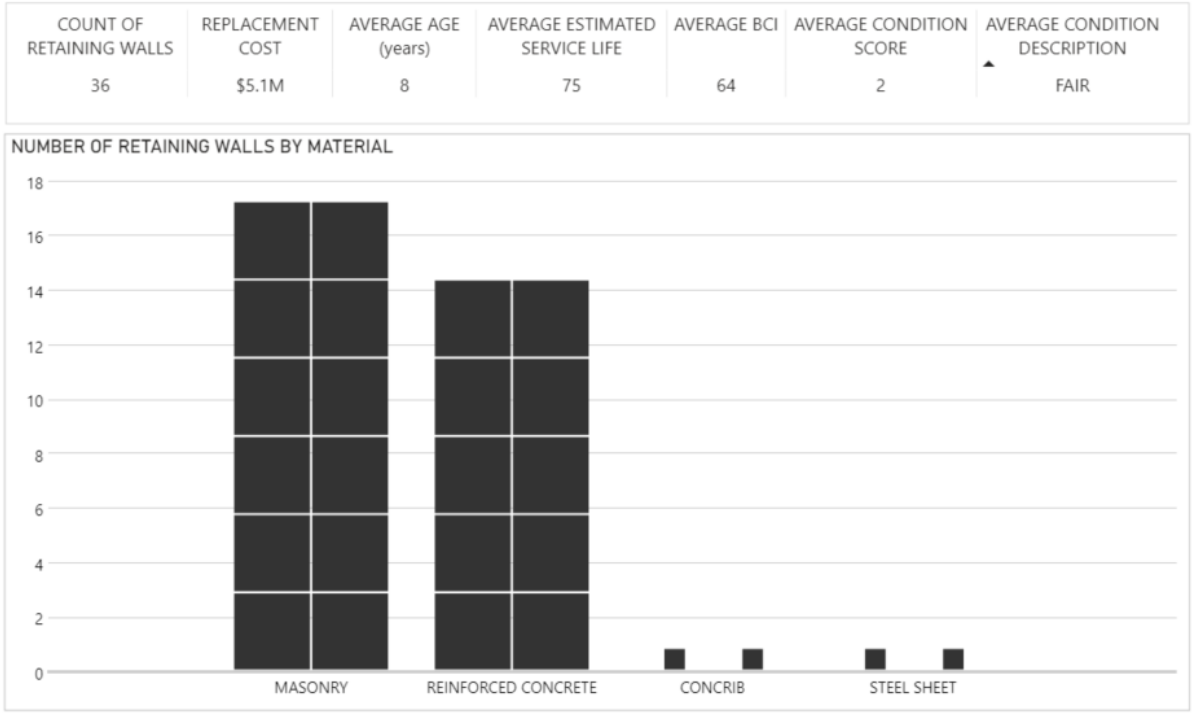

Figure 3: Retaining Walls Asset Summary

1.3.5. LONG SPAN CULVERTS

Culverts are structures which allow for the passage of water or people under a pathway such as a road, trail or driveway. Long span culverts are defined as culverts with a span of greater than 3 metres. It can be seen in **Figure 4** below that there are 45 structrual culverts which are in an average Fair condition with an average BCI of 68 and average condition score of 2. The replacement cost of all long span culverts is $24.9M with an average age of 37 years which is 44% of the average estimated service life of 84 years. It can also be seen that the most common long span culverts in the City are cast-in-place culverts and precast box culverts both being made of concrete.

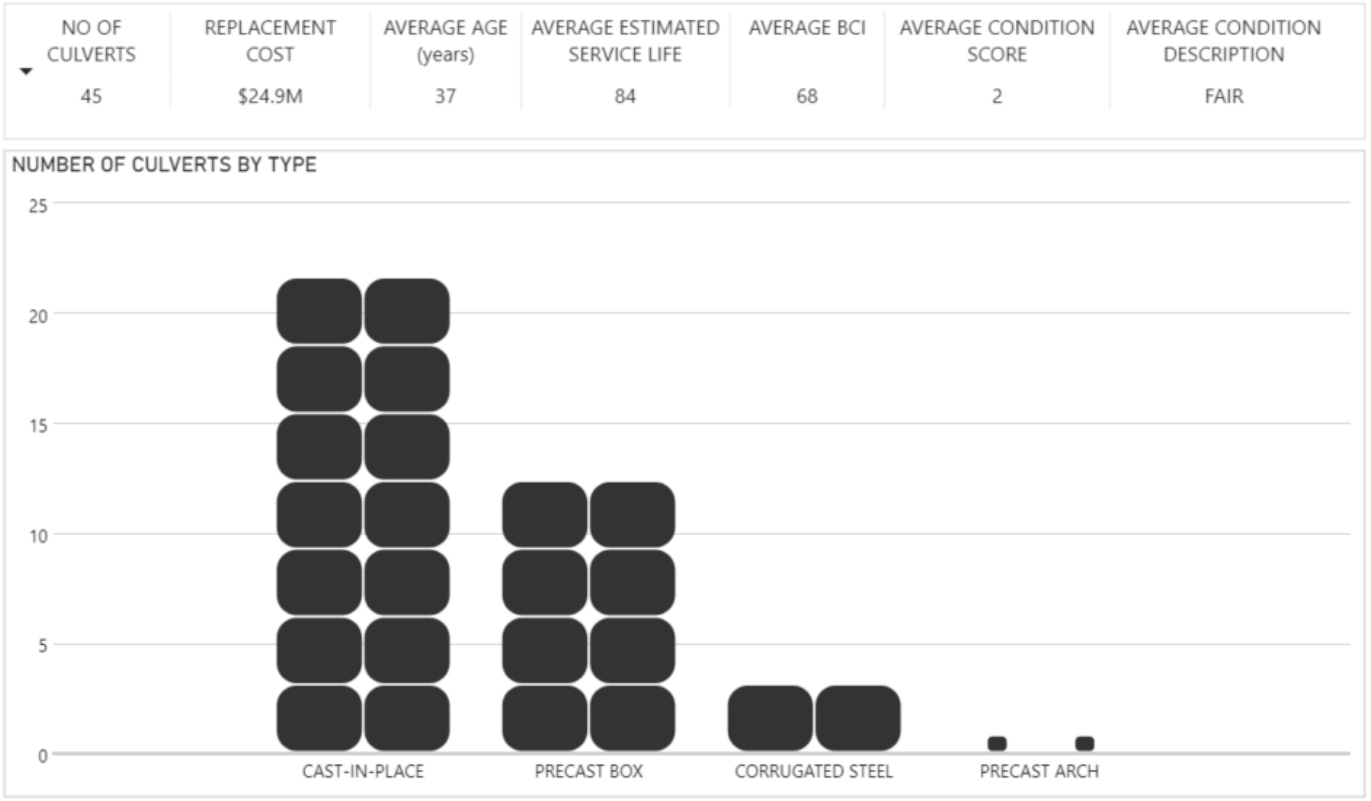

Figure 4: Long Span Culverts Asset Summary

1.3.6. SHORT SPAN CULVERTS

As stated above, culverts are structures which allow for the passage of water under a pathway such as a road, trail or driveway. Short span culverts are defined as culverts with a span of less than 3 metres. It can be seen in **Figure 5** that there are 186 short span culverts which are typically in Fair condition based on the estimated service life with an average condition score of 2. The total replacement cost of short span culverts is $10.7M with an average age of 32 years which is 62% of the average estimated service life of 52 years. However, this data set has unknown information as there are many culverts that are of unknown material. While there is currently not a formal condition assessment completed for this asset, it is anticipated that a condition assessment will occur in 2022.

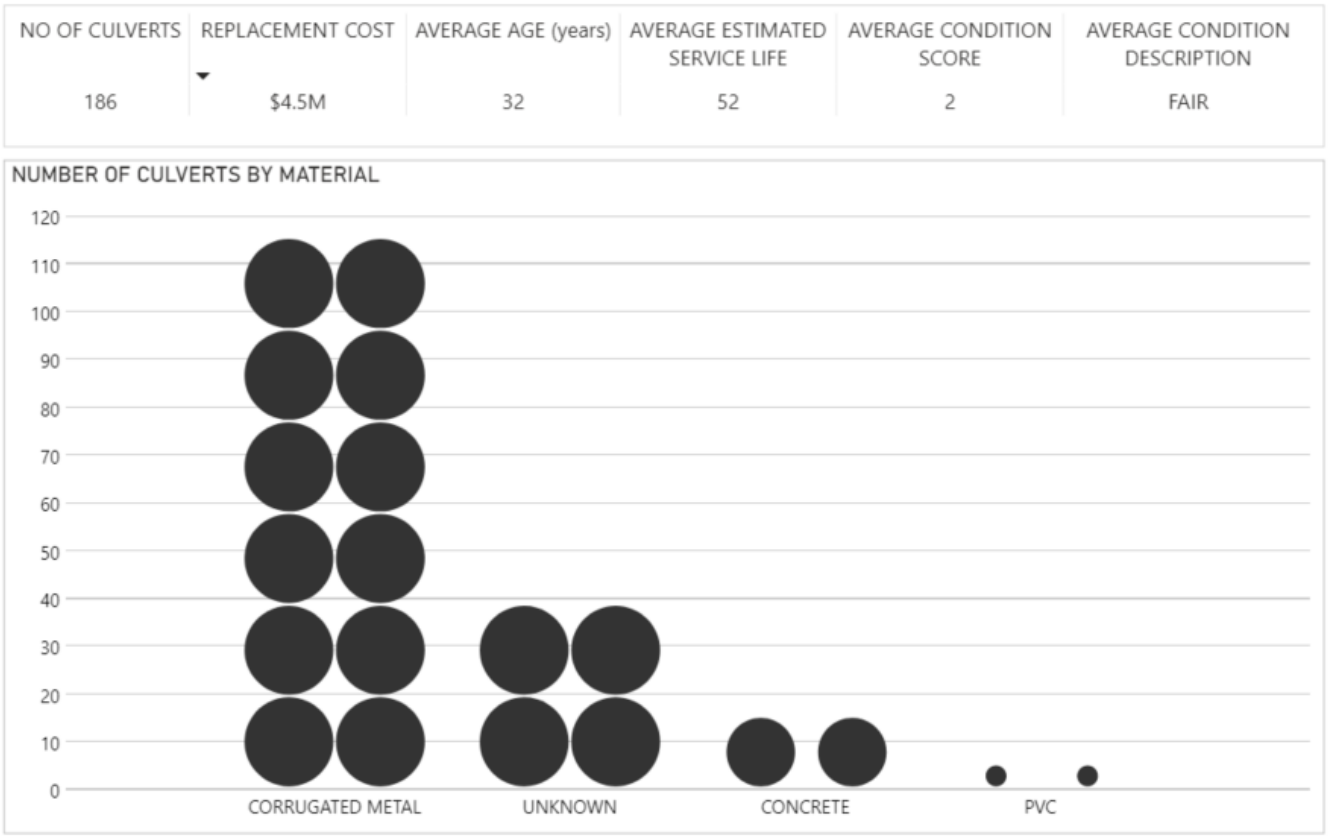

Figure 5: Short span Culverts Asset Summary

1.4. LIFECYCLE OF BRIDGES & CULVERTS ASSETS

The lifecycle of Bridges & Culverts assets has four (4) categories which are described in this section:

- Key Lifecycle Stages of Bridge & culvert Assets;
- Lifecycle Activities;
- Risks of Lifecycle Activities; and
- 10 Year Lifecycle Costs of Bridge & culvert Assets.

1.4.1. KEY LIFECYCLE STAGES OF BRIDGE & CULVERT ASSETS

The lifecycle of an asset refers to the following stages: Planning, Creation/Acquisition, Operations and Maintenance, Renewal/Disposal which are defined in the Main Body of the report. For bridge & culvert assets specifically our general process is as follows:

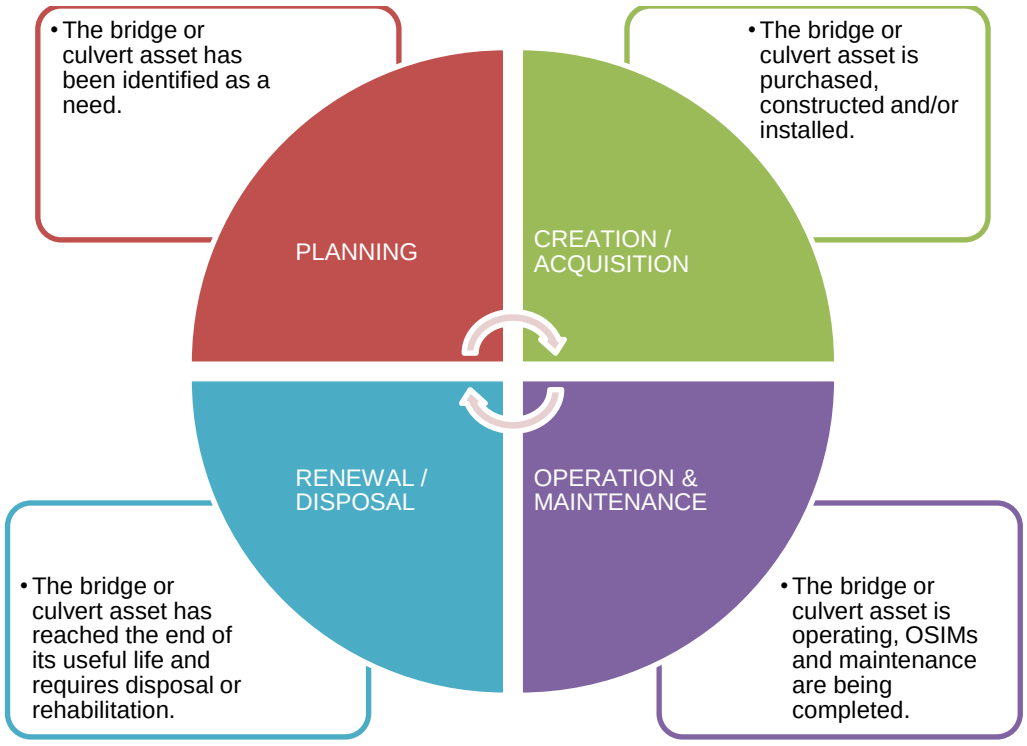

Figure 6: Lifecycle Stages of Bridge & Culvert Assets

1. **Planning** – The bridge & culvert asset has been identified as a need through the Official Plan or Transportation Master Plan, or due to the identified poor condition of an existing asset. In order to evaluate how to get the most value of the asset, this process considers: existing assets, resources, operating efficiencies, funding availability, future growth management, and the maintenance of asset. The asset is designed using all applicable codes and standards.

2. **Creation / Acquisition** – The cost and requirements for the bridge & culvert asset are defined. The asset is purchased, constructed and/or installed. Extra care is taken at this stage to ensure the asset is constructed properly using all appropriate design standards and guidelines to avoid any premature repairs or replacements due to installation errors.
3. **Operation and Maintenance** – Maintenance (Lifecycle) Activities are completed on the asset at specific time intervals as indicated in **Section 1.4.2** below to prevent premature failures of our assets. OSIM inspections are being completed on applicable assets. Additional monitoring and potential improvements are evaluated during this process.
4. **Renewal / Disposal** – The bridge & culvert asset has reached the end of its useful life and/or is underperforming, and requires disposal or major rehabilitation. The disposal considers the effect on customers such as required detouring which are taken into account in the Planning stage thereby restarting the cycle.

1.4.2. LIFECYCLE ACTIVITIES

A list of the planned Lifecycle Activities, annual cost, and frequency for each bridge & culvert Asset Class can be found in **Table 7** below. These activities are currently being undertaken to maintain our Bridge & culvert assets and therefore maintain the current levels of service.

Table 7: Lifecycle Activities for Bridge & Culvert Assets

Asset Type	Lifecycle Activity	2020 Annual Cost	Frequency	Completed by
Bridges	Inspection	$30,890 (2019 Cost)	Biannual	Contracted Service -Asset Management
	Graffiti Removal	$2,900/per 8 hour day	Ad Hoc	Operational Services
	Cleaning	$35,000	2x per year	Operational Services
	Vegetation Removal	$15,000	Program	Operational Services
	Painting	N/A	Ad Hoc	Operational Services
	Deck Repair	Per OSIM Recommendations	Ad Hoc	Contracted Service -Asset Management
	Joint Repair		Ad Hoc	Contracted Service -Asset Management
	Railing Repair (separate from guide rails included in Road section)		Ad Hoc	Operational Services
	Concrete Repair		Ad Hoc	Contracted Service -Asset Management
Bridge Stairway	Inspection	$1,470 (2019 Cost)	Biannual	Contracted Service -Asset Management
	Winter Control	N/A	Seasonal	Operational Services
	Repair	Per OSIM Recommendations	Ad Hoc	Operational Services
	Fence Inspection and Repairs	N/A	Ad Hoc	Operational Services
Long span culverts	Inspection	$17,736 (2019 Cost)	Biannual	Contracted Service -Asset Management
	Vegetation Removal	$15,000	Program	Operational Services
	Repair	Per OSIM Recommendations	Ad Hoc	Contracted Service -Asset Management
	Replacement		Ad Hoc	Contracted Service -Asset Management
	Utility Cut Restorations		Ad Hoc	Operational Services
	Crack Sealing		Ad Hoc	Operational Services
Short span Culverts	Inspection (Priority Culverts, known issues)	$2,000 per 8 hour day	Monthly	Operational Services
	Repair	N/A	Ad Hoc	Operational Services
	Replacement	N/A	Ad Hoc	Operational Services
Retaining Walls	Inspection (>0.7m height)	$5,830 (2019 Cost)	Biannual	Contracted Service -Asset Management
	Graffiti Removal	$2,900/per 8 hour day	Ad Hoc	Operational Services
	Repair	Per OSIM Recommendations	Ad Hoc	Contracted Service -Asset Management
	Replacement		Ad Hoc	Contracted Service -Asset Management
	Removal		Ad Hoc	Contracted Service -Asset Management

Lifecycle activities occur on each of our bridge & culvert assets per recommendations outlined in the OSIM reports. These activities are tracked using Avantis, but they will be improved and included in the implementation of the AIM project described in **Section 7** of the **Asset Management Plan Overview Document**. When these activities are integrated into AIM, the City will have a better idea of the frequency and cost associated with these activities.

1.4.3. RISKS OF LIFECYCLE ACTIVITIES

The identified lifecycle activities in **Table 7** above are typical activities taken on by Operational Services. Some risks with these activities include:

- **Traffic Accidents** - when performing maintenance in the vicinity of traffic vehicles, there is a risk of a traffic accident. This is mitigated by implementing a traffic control plan and wearing high visibility clothing during maintenance activities in the right of way;
- **Falling** – Some activities require working from heights and there is a risk of falling. This risk is mitigated by having maintenance personnel trained on all equipment and having fall arrest training where required.
- **Operator Error** – When operators are operating equipment, there is a risk of an operator related accident. This risk is mitigated by ensuring all operators have the required licenses and are trained on equipment.

In addition, if these activities were not completed, the risks would include:

- **Health and Safety Issues** due to unexpected failure of structural bridge or culvert element (e.g. concrete breaking off and hitting someone under bridge).
- **Unscheduled Service Disruptions** due to sudden closure of bridge (e.g. need for sudden repair of bridge which wasn’t planned).
- **Flooding of nearby Infrastructure** due to blocked culvert which was not inspected.
- **Increased Cost** due to reactive repairs which could have been prevented with preventative maintenance (e.g. reactive repairs are often 3x more expensive than planned repairs).

1.4.4. 10 YEAR LIFECYCLE COSTS OF BRIDGE & CULVERT ASSETS

Figure 22 below outlines the 10 year lifecycle costs of bridge & culvert assets. This lifecycle costing is mostly based on the 10-year strategic plan completed as part of the 2019 OSIM, and so spikes associated with any backlogs are mostly avoided because the plan has been created based on the actual physical condition of the asset. However, since the 2019 and 2020 OSIM reports only provided a 10-year strategic plan, it can be seen that there are gaps in the capital forecast in 2031 and 2032.

The only backlog associated with this lifecycle costing is associated with the short span culverts many of which have already passed their service lives and are therefore estimated to be due for replacement. Therefore there is a large cost associated with short span culverts as a result in 2022.

Based on the information presented in the figure below, to maintain the state of good repair, the City would need to invest an average of $2.74M annually in bridge and culvert assets. When removing non-OSIM costs from the graph below (i.e. short-span culverts, and retaining walls under 0.7m), the 10-year average is $2.62M. Since the costing provided from the OSIM 10-year strategic was created based on a budgetary amount, it is recommended the City follow the OSIM recommendations closely.

The O&M costs shown below are based on the 2021 preliminary City budget inflated to 2032 and indicates that the City will be spending an annual average of approximately $197.1K. When the AIM project, explained in **Section 7** of the **Asset Management Overview document,** is implemented, it will assist the City with adjusting this O&M cost with actual costs.

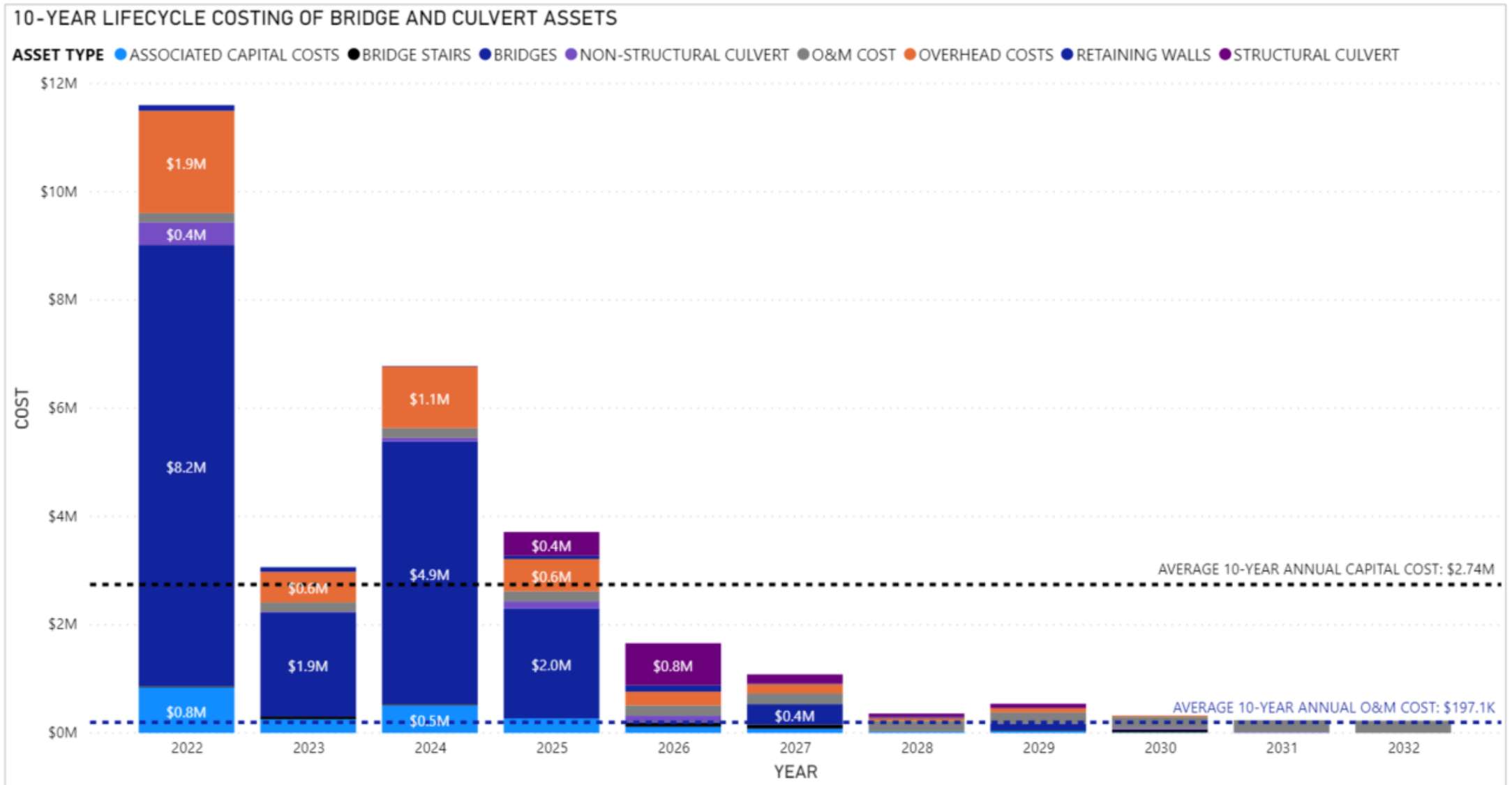

Figure 7: 10-Year Lifecycle Cost Per Bridge & Culvert Asset Type

Notes:

1. Capital costs excluding Short span Culverts are estimated based on the Strategic Plan including in the 2019 OSIM completed by McIntosh Perry Consulting Engineers.
2. O&M Costs are estimated based on the 2021 Preliminary Operating Budget inflated by 3% each year. Some O&M Costs are partially broken down in **Table 7.**
3. Short span Culvert replacement years are based on estimated service life and estimated replacement costs.

Per **Figure 8** below, the existing 10-year forecast from 2021 – 2030, further explained in **Section 8.2.2** of the **Asset Management Plan Overview Document**, indicates that the City is currently planning to spend an average of $2.5M on bridge & culvert assets capital annually, and as noted above, the required 10-year average amount is $2.74M for all bridge & culvert assets and $2.62M for OSIM structures, therefore there is currently an average annual 10-year funding gap of $240K for all bridge & culvert assets and $120K for OSIM structures. As noted on the graph, the impacts resulting from these funding gaps will be monitored and reported as appropriate. It is evident that the City is intending to expend over the required 10-year average amount from 2022 - 2025 in the existing 10-year forecast, however, as the forecast continues moving forward to 2030, gradually less budget is expected to be expended on SOGR for bridge & culvert assets. However, this is a similar distribution to **Figure 7** above which is largely based on the OSIM financial plan indicating that the City is following the OSIM financial plan. Since the budget is revised annually, OSIMs are completed biannually, and the Prioritization Matrix explained in **Section 9** of the **Asset Management Plan Overview Document** is currently in its implementation phase, it is anticipated that this forecast will continue to change as City priorities shift. It is important to note that currently the City does not have access to detailed data on O&M for bridge & culvert assets, but with the implementation of the AIM project explained in **Section 7** of the **Asset Management Plan Overview Document,** it is anticipated this information will be provided in the next iteration of the AMP.

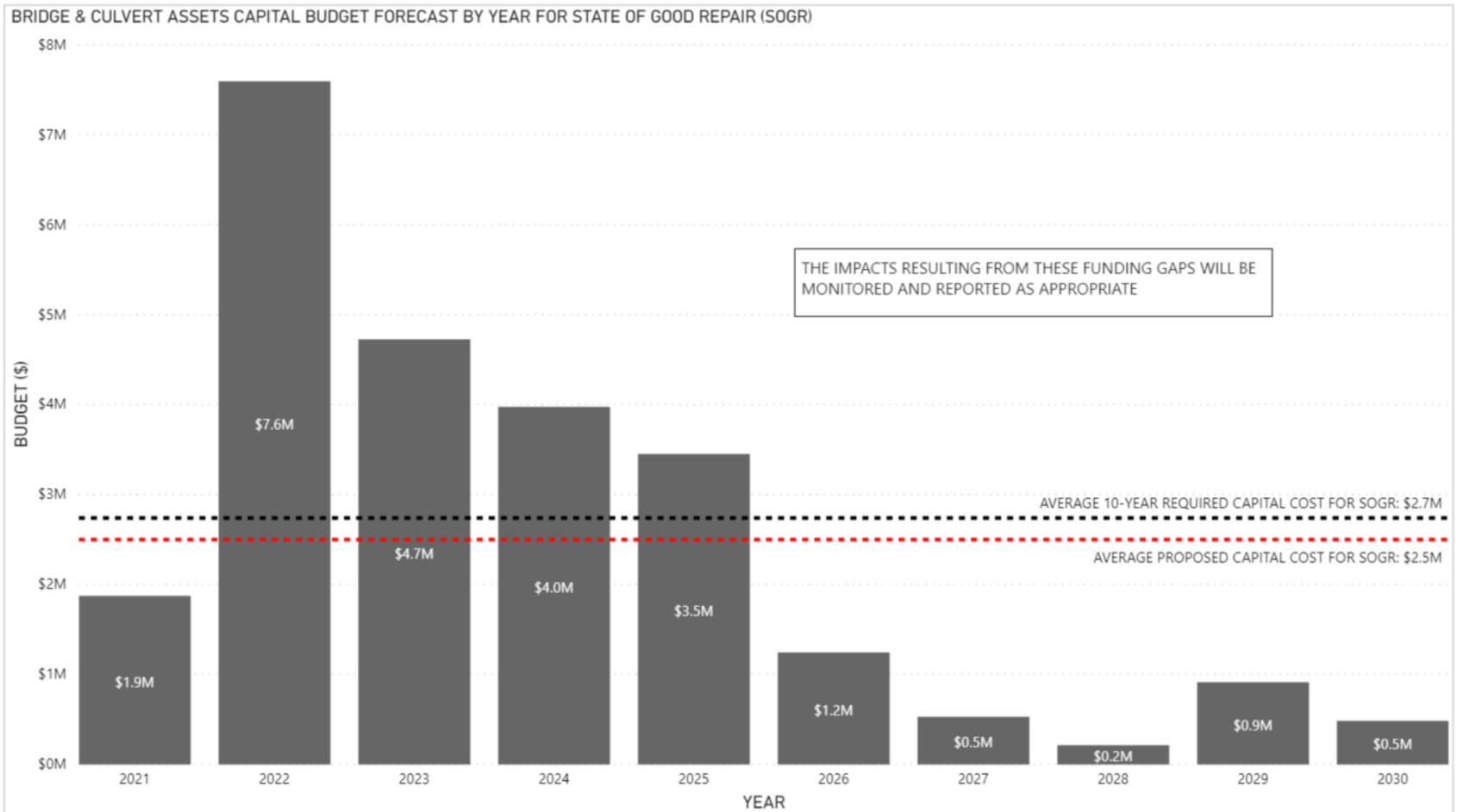

Figure 8: Existing Capital Budget Forecast from 2021 – 2030 for Bridge & Culvert Assets

1.5. CURRENT LEVELS OF SERVICE

1.5.1. O.REG 588/17 CUSTOMER LEVELS OF SERVICE

The customer levels of service as dictated by O.Reg 588/17 are described below.

1. *Description of Traffic Supported by Municipal Bridges*

   Figure 9 below illustrates the bridges by traffic type. As shown in **Figure 1** in **Section 1.3.2**, the majority of bridges in the City are pedestrian bridges. The City's pedestrian bridges support the following traffic: pedestrians, cyclists, assistive devices, maintenance equipment, and other non-motor vehicles.

   Municipal bridges that are not pedestrian bridges support all types of traffic including: heavy transport vehicles, motor vehicles, emergency vehicles, pedestrians, cyclists, transit etc.

2. *Description of the condition of bridges or culverts and how this would affect use of the bridges or culverts*

   Figure 10 below illustrates bridges by BCI condition. The condition of bridges and culverts per the BCI describes when bridge or culverts defects are recommended for rehabilitation (major or minor). Some examples of major rehabilitation are: deck repair/replacement, semi-integral conversion, and barrier replacement, and some examples of minor rehabilitation are: concrete patching, waterproofing, and paving operations.

   Per the OSIM, bridges and culverts in Excellent or Good condition are not expected to require rehabilitation for 10+ and 5+ years respectively. These assets are in working order and would be used accordingly.

   The typical bridge and long span culvert in the City is in Fair condition which means the asset is expected to require rehabilitation in 1 to 5 years. In terms of how this would affect the use of the bridge or culvert, if the recommended works were completed on the asset in the timeline dictated by the OSIM, the bridge or culvert would continue to operate until the required rehabilitation. When the required rehabilitation occurs, the bridge or road under the bridge or above or through the culvert may be temporarily closed or usage may be modified. Once the rehabilitation is completed, the bridge or culvert would be in working order.

   Bridges or culverts in Poor condition are recommended for rehabilitation in the next year. In some cases these bridges or roads above culverts would need to be closed until the required rehabilitations or replacement occurs. There are

currently five (5) pedestrian bridges that are closed. Bridges by open status are illustrated in **Figure 11**. More information on closed bridges can be found in **Section 1.6.1**.

OSIMs occur on each bridge or long span culvert every two (2) years where condition assessments will be completed and the timeline would be modified. Detailed photos and descriptions of each bridge can be found in the 2019 OSIM Report.

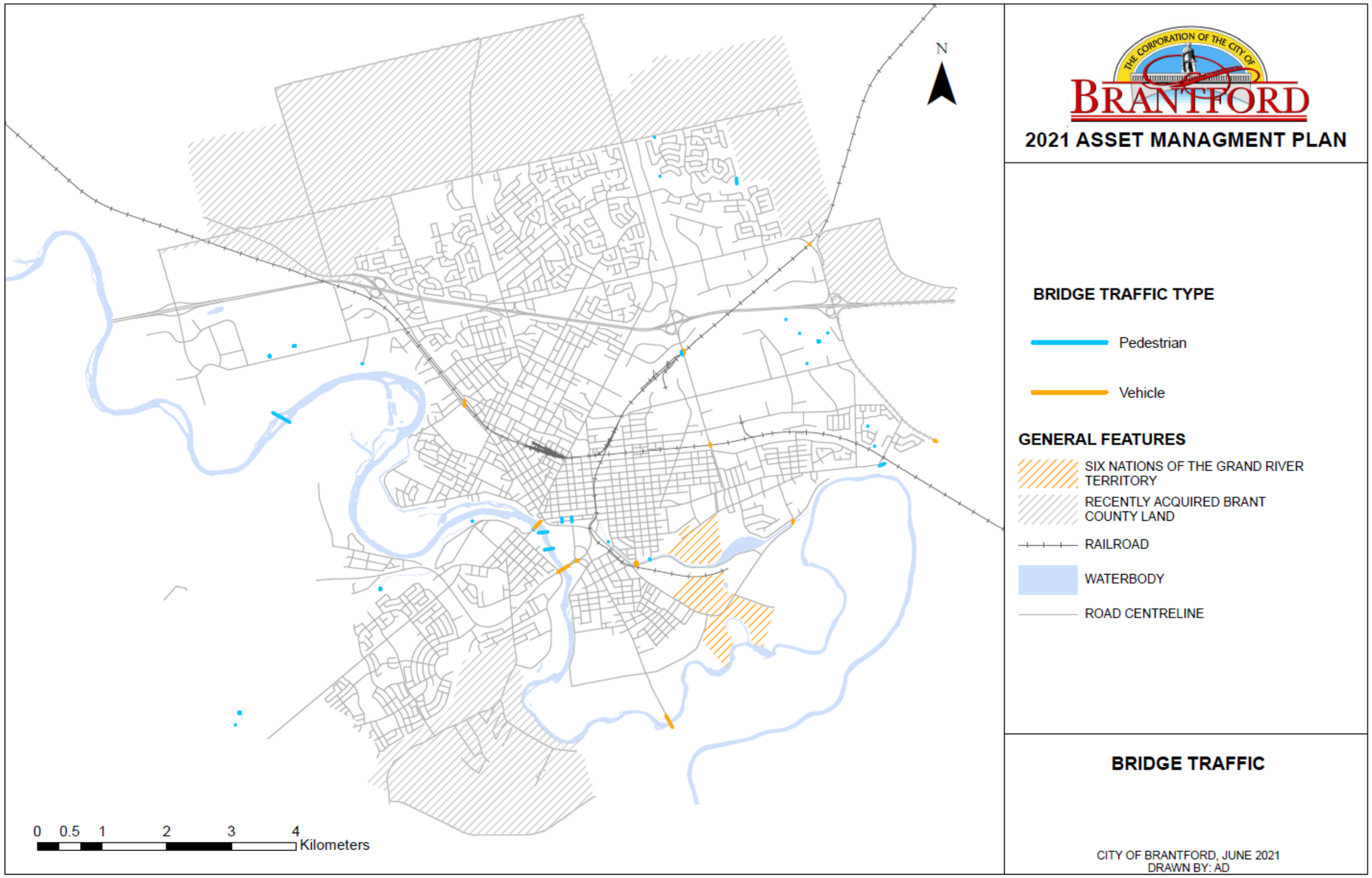

Figure 9: Bridges by Traffic Type

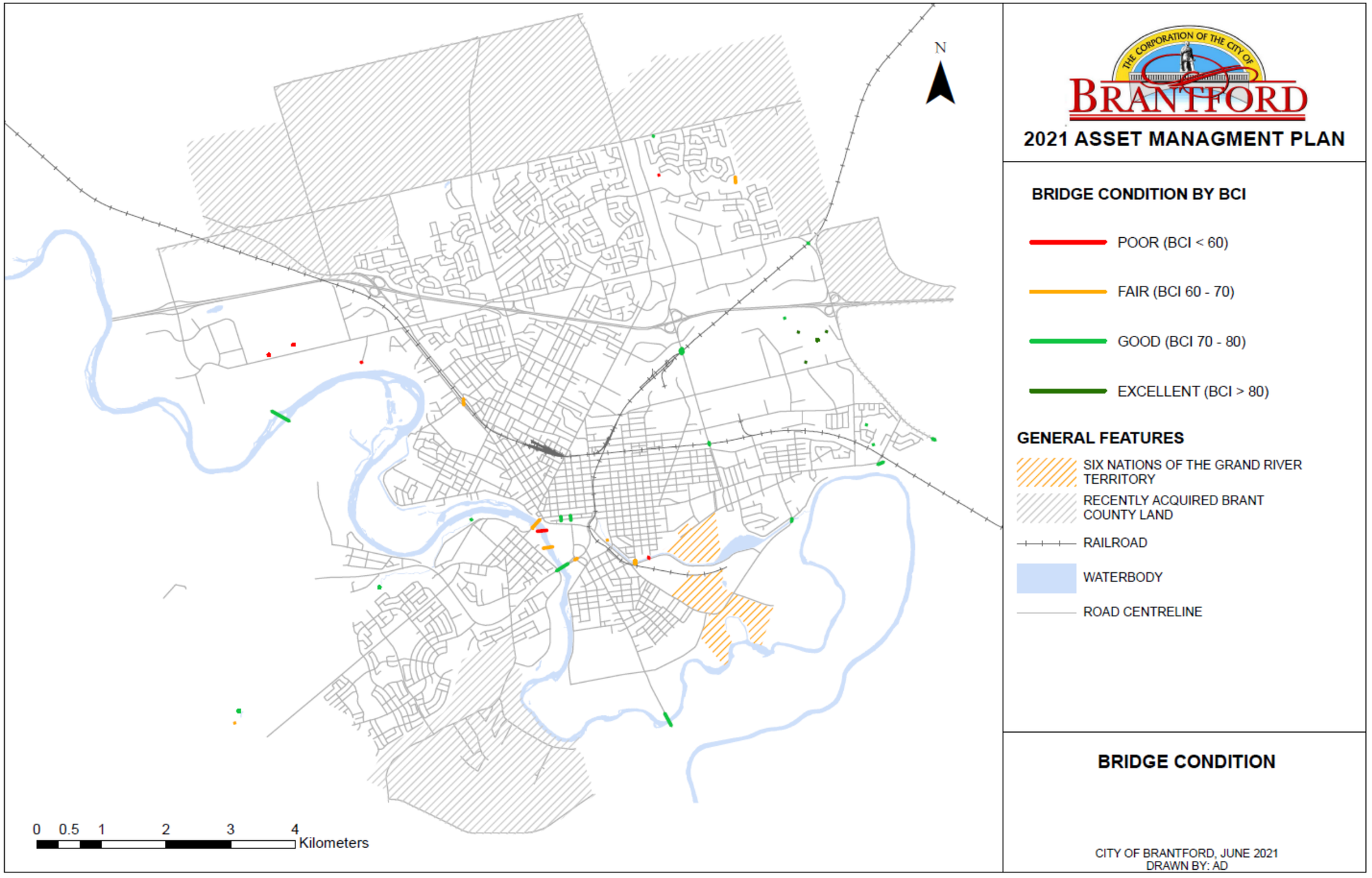

Figure 10: Bridge Condition by BCI score

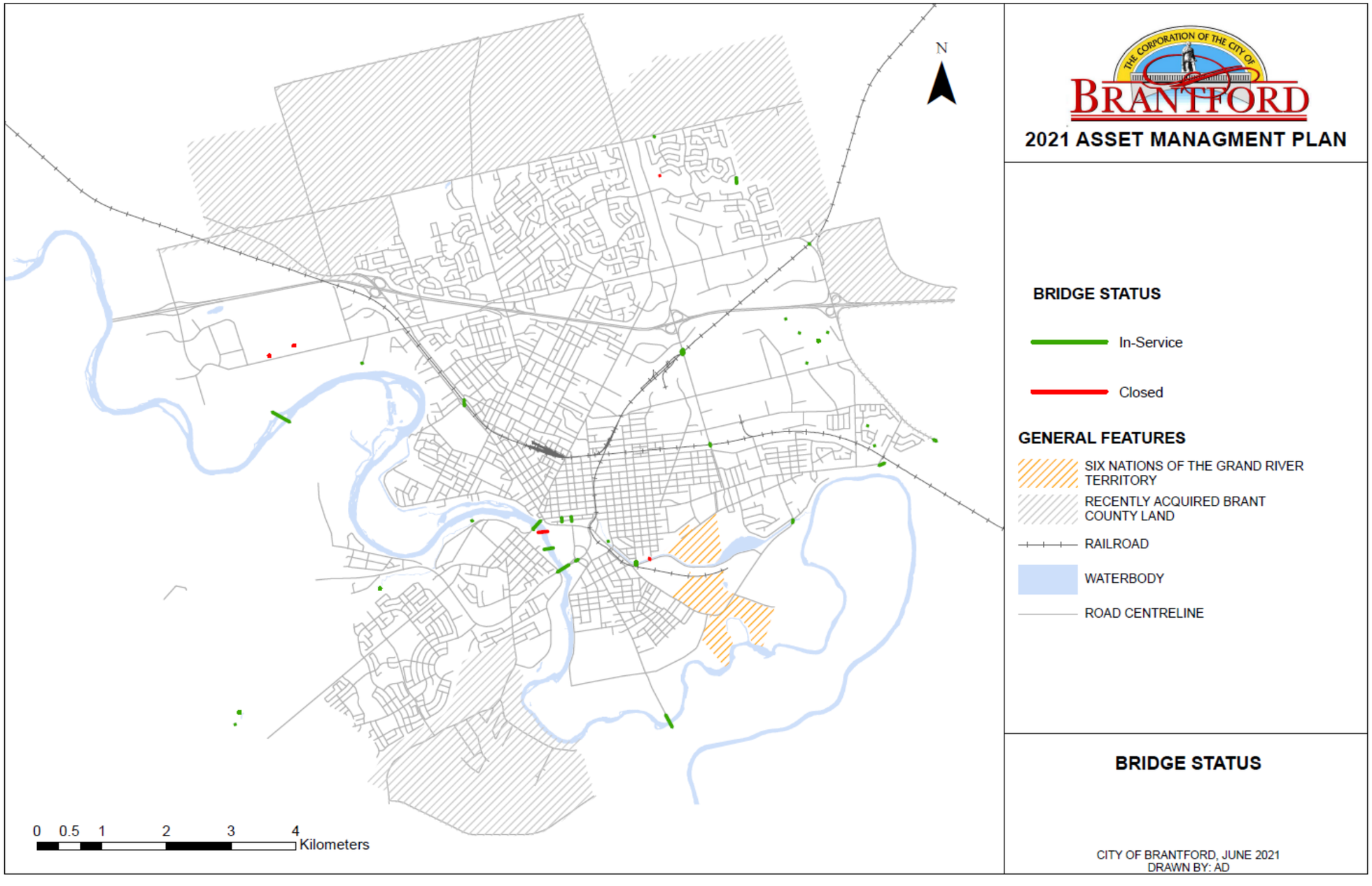

Figure 11: Bridges by Open Status

1.5.2. O.REG 588/17 TECHNICAL LEVELS OF SERVICE

The technical levels of service as dictated by O.Reg 588/17 can be found in **Table 8** below.

Table 8: O.Reg 588/17 Bridge & Culvert Technical Levels of Service

Service	Service attribute	Technical levels of service (technical metrics)	2017/2018	2019/2020
Bridges and Culverts	**Scope**	Percentage of bridges in the municipality with loading or dimensional restrictions.	2.5% (1) of 40 bridges	2.5% (1) of 40 bridges
	Quality	1. For bridges in the municipality, the average bridge condition index value.	64.7	67.8
		2. For structural (long span) culverts in the municipality, the average bridge condition index value.	63.7	68.1

1.5.3. MUNICIPALLY DEFINED CUSTOMER LEVELS OF SERVICE

The customer levels of service are defined in **Section 6.2** of the **Asset Management Plan Overview**. For bridge & culvert assets, the asset specific interpretation of these levels of service is defined below in **Table 9**.

Table 9: Municipally Defined Customer Levels of Service

Customer Level of Service	Definition
Accessibility	Bridge & culvert assets should be accessible to various transportation types including, but not limited to, personal and transit vehicles, pedestrians, mobility assistive devices, and cyclists.
Quality	Bridge & culvert assets should fulfill their intended purpose, be the appropriate capacity, and be in a state of good repair.
Cost Efficiency	Bridge & culvert assets should be operated efficiently with extra care to minimize costs.
Safety	Bridge & culvert assets should be both safe to use and promote community safety, and customers should feel safe using these services.
Environmental Sustainability	Bridge & culvert assets should be operating as environmentally as possible and also be promoting sustainable lifestyles.
Reliability	Bridge & culvert assets should be available when customers need them.
Responsiveness	Bridge & culverts assets should be fixed quickly when service disruptions occur.

1.5.4. MUNICIPALLY DEFINED TECHNICAL LEVELS OF SERVICE

The technical levels of service for bridge & culvert assets have been adopted based on the above defined customer levels of service in **Table 9**. The customer levels of service with the corresponding technical levels of service and KPI metrics are defined below in **Table 10.**

The AIM project will also assist the City with identifying and adding additional KPIs in future iterations because a system will be available to formally track this data.

Table 10: Newly Defined Level of Service KPIs

Customer Level of Service	Technical LoS	2020 KPI	Units
Accessibility	Number of winter control complaints on bridges	0	Count
	Percentage of municipally owned vehicular bridges with sidewalks	64.3	%
Quality	Number of vehicular bridges with one (1) lane	0	# of bridges
	Number of vehicular bridges that require a lane reduction	0	# of bridges
	Average AADT on bridge	9807	Average
	Culverts Inspected < 3m	1.61	%
	Bridge with equipment under height restrictions	3	Count
	Number of complaints regarding detouring due to bridge work	0	Count
	Number of complaints regarding detouring due to culvert work	0	Count
Cost Efficiency	Average cost of bridge maintenance per m	N/A	$/m
	Average cost of culvert maintenance per m	N/A	$/m
Safety	Number of bridges requiring emergency repairs	1	Count
	Number of bridges requiring design modifications to accommodate ice jam	2	Count
	Number of bridge complaints due to condition	3	Count
	Number of retaining wall complaints due to condition	5	Count
	Lost hours due to field accidents associated with bridges	N/A	hours
	Lost hours due to field accidents associated with culverts	N/A	hours
Environmental Sustainability	Number of bridges with cycling lanes	0	# of bridges
Reliability	Number of closed pedestrian bridges	3	Count
	Number of closed vehicular bridges	0	Count
	Number of closed bridges due to flood closures	0	Count
	Number of flooded road events due to culvert debris	1	location
	Number of blocked culvert complaints	1	Count
Responsiveness	Average amount of time to respond to emergency bridge issue	N/A	Days
	Average amount of time bridge is out of service for unplanned bridge closure	N/A	Days

1.6. CURRENT ASSET PERFORMANCE

The current asset performance for bridge & culvert assets is based on metrics related to operating performance.

1.6.1. BRIDGE CURRENT OPERATING PERFORMANCE

To assess the current operating performance for bridges, the City looks at five (5) components: Loading Restrictions, Width Restrictions, Under Height Restrictions, Open Status and Flood Level. The KPIs associated with these are reported in **Section 1.5**.

In terms of load restrictions, there is a seasonal load restriction of 30 tonnes on one (1) vehicular bridge in the City, Lorne Bridge. Due to reduced loading capacity as a result of lower temperatures, this is in place seasonally from November 1st to March 31st. Lorne Bridge is currently being assessed for improvements.

At the time of writing, there are currently no width restrictions on any bridges in the City, and so bridges are operating effectively with respect to width.

In addition, there are three (3) areas in the City with under height restrictions at CN Rail Bridges including: Elgin St, Niagara St, and McMurray St. These areas will be assessed in future for improvements which may need to be discussed with CN Rail prior to implementation.

With respect to the open status of bridges, as shown in **Figure 11**, at the time of writing this report, there are five (5) pedestrian bridges which are closed which include: Drummond St Canal Bridge (since 2015), LEN Corridor Crossing 1 and 2 (since 2016), Jaycee Park Bridge (since 2017), and Brant's Crossing Bridge (since 2018). These bridges are considered to be below operating performance since they are closed and require rehabilitation work to open. Rehabilitation work at the Brant's Crossing Bridge is expected to begin in 2021/2022.

Finally, flood levels due to open water and ice jams for bridges are currently being investigated for bridges that cross the Grand River (i.e. Lorne Bridge, Brant's Crossing Bridge, and TH&B Crossing Bridge). At the time of writing this report, the draft 2020 Hydraulic Modelling Methodology and Results technical memo completed by Ecosystem Recovery Inc indicates that Lorne Bridge is within the 100-year open water and ice jam flood level limits, and does not require any soffit adjustments. However, while Brant's Crossing and TH&B Crossing Bridges are well within the open water levels, for 10-year ice jam events the soffits of both bridges are within the forecasted flood levels.

1.6.2. CULVERT CURRENT OPERATING PERFORMANCE

To assess our culvert operating performance, the City assesses the number of road flooding events that may be due to undersized or blocked culverts. At this time

Operations staff is aware of “hot spot” locations where road flooding can occur and City staff visit and maintain these sites monthly or before a storm event is projected to occur. The “hot spot” sites associated with culverts include: Golf Road at Hardy Road, Glenwood at Kwanis Way, and Mohawk at Morrison. These “hot spot” locations should be assessed in future to improve the capacity and reduce the maintenance load. The KPIs associated with these are reported in **Section 1.5**.

1.7. DISCUSSION & CONCLUSIONS

In conclusion, the City of Brantford operates and maintains several bridge & culvert assets. These assets are typically in Fair condition with a total estimated replacement cost of approximately $158M.

The inventory and condition data confidence for bridge and culvert assets (excluding short-span culverts and retaining walls less than 0.7m) are at a High level due to formal condition assessments (OSIMs) having been completed. Short span culverts are at a Low confidence level because the inventory is not complete, and there is not yet an inspection program available. Retaining walls are at a medium level because walls under 0.7m in height haven’t been inspected and the inventory may not be complete. Inventory and inspection programs for these assets are currently being investigated and developed. As stated, some of these inspection improvements are ongoing and also will improve as a result of the AIM project explained in **Section 7** of the **Asset Management Plan (AMP) Overview document**.

Furthermore, the lifecycle stages for bridge & culvert assets includes: Planning, Creation, O&M, and Disposal. During the Planning stage, the City identifies the need for the asset; during the Creation stage the asset is purchased and installed or constructed; during the O&M stage, the asset is operating and lifecycle activities (i.e. maintenance) occur on each of our bridge & culvert assets to maintain the state of good repair; and the Disposal stage is when the asset has reached the end of its useful life or is underperforming and requires disposal.

Lifecycle activities are currently typically tracked through Avantis for these assets. For more information on key database applications and work order management, please refer to **Section 4.2** and **Section 7**, respectively, in the **AMP Overview document**. At this time, the costs associated with these activities are partially broken down in **Table 7** and are estimated based on calculated staff time and resources, contract costs, and OSIM estimates. When these activities are integrated into AIM, the frequency and costs associated with specific activities will be better represented. Therefore, future updates of the AMP will include specific costs for these activities as well as the time associated with these activities in order to properly allocate budget and identify operational inefficiencies.

It is estimated based on the average annual cost in the 10 Year Life Cycle Costing that the City should be spending an average $2.74M annually for capital bridge & culvert assets and will be spending an average of $197.1K annually on O&M for bridge & culvert assets based on total estimates in the 2021 Preliminary Operating Budget, however, the City is currently proposing to spend an average of $2.5M annually on capital for bridge & culvert assets' state of good repair.

Additionally, Current Levels of Service have been created and identified for bridge & culvert assets. These technical levels of service were created based on the customer levels of service defined in **Table 9**. Brantford is also working to develop and include additional metrics in AIM which will assist us with tracking these KPIs for future iterations.

Finally, asset performance for bridge & culvert assets is defined as operating performance. For operating performance the City has identified the key services these assets are providing and has identified any deficiencies. For bridges these components are: Loading Restrictions, Width Restrictions, Under Height Restrictions, Open Status and Flood Level, and for culverts these are the number of road flooding events caused by undersized or blocked culverts.

2. ROAD ASSETS

2.1. INTRODUCTION

The City of Brantford owns and maintains several assets under the road asset class. The purpose of this section is to present specific information about the road asset class to answer the questions posed in **Section 2** of the **Asset Management Plan Overview Document**, and includes the following:

- Road Assets' Data Inventory and Condition Approach;
- Summary of Road Assets;
- Lifecycle Activities and Cost of Road Assets;
- Current Road Assets' Levels of Service;
- Current Road Asset Performance; and
- Conclusion.

2.2. ROAD ASSETS' DATA INVENTORY AND CONDITION APPROACH

Information related to the City's data collection methodologies as well as data confidence level definitions are defined in the **Asset Management Plan Overview Document**.

The City of Brantford has three (3) different approaches to establishing the condition for each road asset due to regulatory requirements, available resources, technologies, and budget restrictions:

- Outsourced condition assessments to consultants;
- Periodic inspection programs conducted by City employees;
- Estimated condition based on asset specific information.

A list of all condition assessments for all core assets can be found in **Table 6** in the **Asset Management Plan Overview Document**.

The origin of the road asset data for inventory, replacement cost, condition as well as data confidence are provided in **Table 11** below.

Table 11: Road Assets' Inventory, Replacement Cost and Condition Origin and Confidence Level

	Inventory			Replacement Cost			Condition		
Asset Type	**Inventory (incl. Quantity and Age) From**	**Data Confidence Level**	**Data Confidence Description**	**Replacement Cost From**	**Data Confidence Level**	**Data Confidence Description**	**Condition From**	**Data Confidence Level**	**Data Confidence Description**
Road	GIS Layer - Road Centrelines	High	GIS inventory complete.	Asset Management 2020 Unit Costs	Medium	Estimated based on internal Class D pricing.	2020 Roadway Condition Assessments completed by Stantac	High	Formal condition assessment with few unknowns
Guide Rails	2019 Guide Rail Inventory and Condition Assessment completed by Safe Roads Engineering	High	Formal inventory with few unknowns.	2019 Guide Rail Inventory and Condition Assessment completed by Safe Roads Engineering	High	Formal estimate by Consultant.	2019 Guide Rail Inventory and Condition Assessment completed by Safe Roads Engineering	High	Formal condition assessment with few unknowns
Streetlights	Streetlight Inventory and Condition Assessment program, GIS Layer - Street Lights	Medium	GIS inventory mostly complete, with some assumptions.	Asset Management 2020 Unit Costs	Medium	Estimated based on internal Class D pricing.	Streetlight Inventory and Condition Assessment program and Service Life	Medium	Formal condition assessment, but annual program not yet encompassing all assets.
Streetlight Poles	Streetlight Inventory and Condition Assessment program, GIS Layer - Poles	Medium	GIS inventory mostly complete, with some assumptions.	2019 Streetlights and Pole Inventory Condition Assessment completed by NBM Engineering	High	Formal estimate by Consultant.	Streetlight Inventory and Condition Assessment program and Service Life	Medium	Formal condition assessment, but annual program not yet encompassing all assets.
Traffic Signs	2019 Traffic Signs Inventory and Condition Assessment completed by Advantage Data Solutions	Medium	GIS inventory mostly complete, with some assumptions.	Estimated based on Consultant bid	High	Formal estimate by Consultant.	2019 Traffic Signs Inventory and Condition Assessment completed by Advantage Data Solutions	High	Formal condition assessment with few unknowns.
Sidewalks	GIS Layer - Sidewalk	High	GIS inventory complete.	Asset Management 2020 Unit Costs	Medium	Estimated based on internal Class D pricing.	2020 Condition Assessment completed by Precision Concrete Cutting.	High	Formal condition assessment with few unknowns.
Intersections	GIS Layer - Street Intersection	Medium	GIS inventory mostly complete, with some assumptions.	Asset Management 2020 Unit Costs	Medium	Estimated based on internal Class D pricing.	2019 Inspection Report	Medium	Informal, visual inspection to identify deficiencies.

Per **Table 11** above, road assets' inventory and condition data is typically at a High level due to ongoing consultant inventory and condition assessments as well as annual programs. While there is a periodic internal inspection program for intersections, it is a future plan for the City to conduct formal inventory and condition assessments on intersection assets.

In addition to the inspections above, the City has a daily Road Patrol to ensure these assets are in compliance with the Minimum Maintenance Standard (MMS). While the Road Patrol does not replace a formal condition assessment, it does ensure assets are functioning on a day to day basis at a functional level.

Improvements to the inventories and inspection programs will be ongoing as a result of the AIM project explained in **Section 7** of the **Asset Management Overview document**.

2.2.1. PAVEMENT CONDITION INDEX

The Pavement Condition Index (PCI) was developed using the models established in the ASTM D6433-18 specification. The index uses individual distress deduct values (DV), and aggregates these scores into a weighted PCI score.

Stantec completed the City's 2020 Road Condition Assessment and used their internal pavement management software to develop this score. The PCI scores with the associated condition rating and description is outlined below in **Table 12**.

Table 12: Pavement Condition Index (PCI) Description

PCI	Condition Rating	Remediation Description
100 - 90	Very Good	Requires routine maintenance (e.g. crack sealing, spot repairs)
89.9 - 75	Good	Requires preventative maintenance (e.g. surface treatment)
74.9 - 45	Fair	Requires resurfacing (e.g. mill and overlay)
20 - 44.9	Poor	Requires rehabilitation (e.g. full depth asphalt removal and replace base)

19.9 - 0	Very Poor	Requires Reconstruction

2.2.2. SERVICE LIFE

Where condition assessments have not been completed, the condition has been estimated based on the estimated service life of the asset. In addition, where replacement/repair forecasts are not available, the Life Cycle Analysis in **Section 2.4.5** plans replacements based on the service life below in **Table 13**. While streetlights and poles have a geographically rotating annual inspection program, the program has not yet encompassed all streetlights, and so service life was used when condition data was not available.

Table 13: Road Assets' Estimated Service Life

Asset	Estimated Service Life
Streetlight Support Arm	30 years
Streetlight Pole	30 years
Traffic Signal Head	20 years
Traffic Signal Pole and Arm	30 years

2.2.3. CONDITION SCORING

For the purpose of this report and standardizing condition scores across all assets in the Asset Management Plan, the Condition Rating is defined by three (3) Condition Scores as defined in the table below. Where a PCI score is available, it has been modified to fit into this scoring system as indicated below. For other assets, if a condition assessment score was available, the conditions were modified to fit into this model.

Table 14: Condition Score Description

Condition Score	PCI	Condition Rating	Description
1 – 1.4	>= 75	Good	Assets in the system or network are in working order, have few, if any, deficiencies, and will not require repairs or replacement for 5+ years. Where condition data is not available, this category applies to assets which are within the first 40% of their estimated service life.
1.5 – 2.4	74.9 – 45	Fair	Assets in the system or network show general signs of deterioration, some elements may have significant deficiencies, and assets will likely require repairs in the next 1-5 years. Where condition data is not available, this category applies to assets which are within 41% - 80% of their estimated service life.
2.5 - 3	< 44.9	Poor	Assets are below standard showing signs of significant deterioration, are in danger of imminent failure, and will require repair or replacement within the next year. Where condition data is not available, this category applies to assets which have exceeded 80% of their estimated service life.

2.3. SUMMARY OF ROAD ASSETS

The summary of assets for the road asset class can be found below. The summary of assets includes: Quantity, Replacement Cost, Average Age, and Average Condition Score for each asset type in accordance with O.Reg 588/17.

Assets missing from this section which could be considered road assets and will be included in future iterations of the AMP include: parking lots, traffic medians, sound barriers, and street trees.

2.3.2. TOTAL SUMMARY OF ASSETS

A table summarizing all road assets is included in **Table 15** below. Detailed information about each asset is included in individual sections. It can be seen that the total replacement cost for road assets is approximately $592.6M and the average age of road assets is 28 years. The average condition scores are shown to one decimal place to illustrate how close the scores are to being on a cusp of another rating and were used to calculate the weighted overall average condition score for the asset group, but are shown rounded to the nearest whole number in subsequent sections. It is evident that overall road assets are typically in Fair condition with an overall weighted score of 1.7.

Table 15: Overall Summary of Road Assets

Asset	Quantity	Unit	Replacement Cost	Average Age (years)	Average Estimated Service Life (years)	% of Estimated Service Life	Average Condition Score	Average Condition Description
Road Asset Total			**$592.6M**	**28**	**32**	**86%**	**1.7***	**FAIR**
Roads	1,067	lane km	$457.6M	31	50	62%	1.9	FAIR
Guide Rails	29	km	$5.2M	33	30	110%	2.6	POOR
Streetlights	10,378	count	$12.5M	30	30	100%	2.1	FAIR
Streetlight Pole	4,096	count	$27.9M	28	30	93%	1.9	FAIR
Traffic Signs	19,875	count	$379K	N/A	N/A	N/A	1.1	GOOD
Signaled Intersections	140	count	$20.0M	14	25	56%	1.5	FAIR
Sidewalks	587	km	$69.2M	32	30	107%	1.2	GOOD

*Denotes Weighted Average

2.3.3. ROADS

City roads are used by various modes of transportation (i.e. motor vehicles, transit, bicycles, etc.) to traverse the City. Roads are broken down into major and minor arterial, major and minor collector and local road classes. Local roads provide access to properties and are low traffic volume corridors, arterial roads are major corridors for higher traffic volume, and collector roads collect and distribute traffic between local and arterial roads.

Per **Figure 12** below, the average annual daily traffic (AADT) is separated by road class. Per O. Reg. 366/18, s. 1 (5), roads (or highways) in Brantford are typically classified between 1 (higher AADT, higher speed limit) and 5 (lower AADT, lower speed limit) which classifies a highway based on AADT and the speed limit.

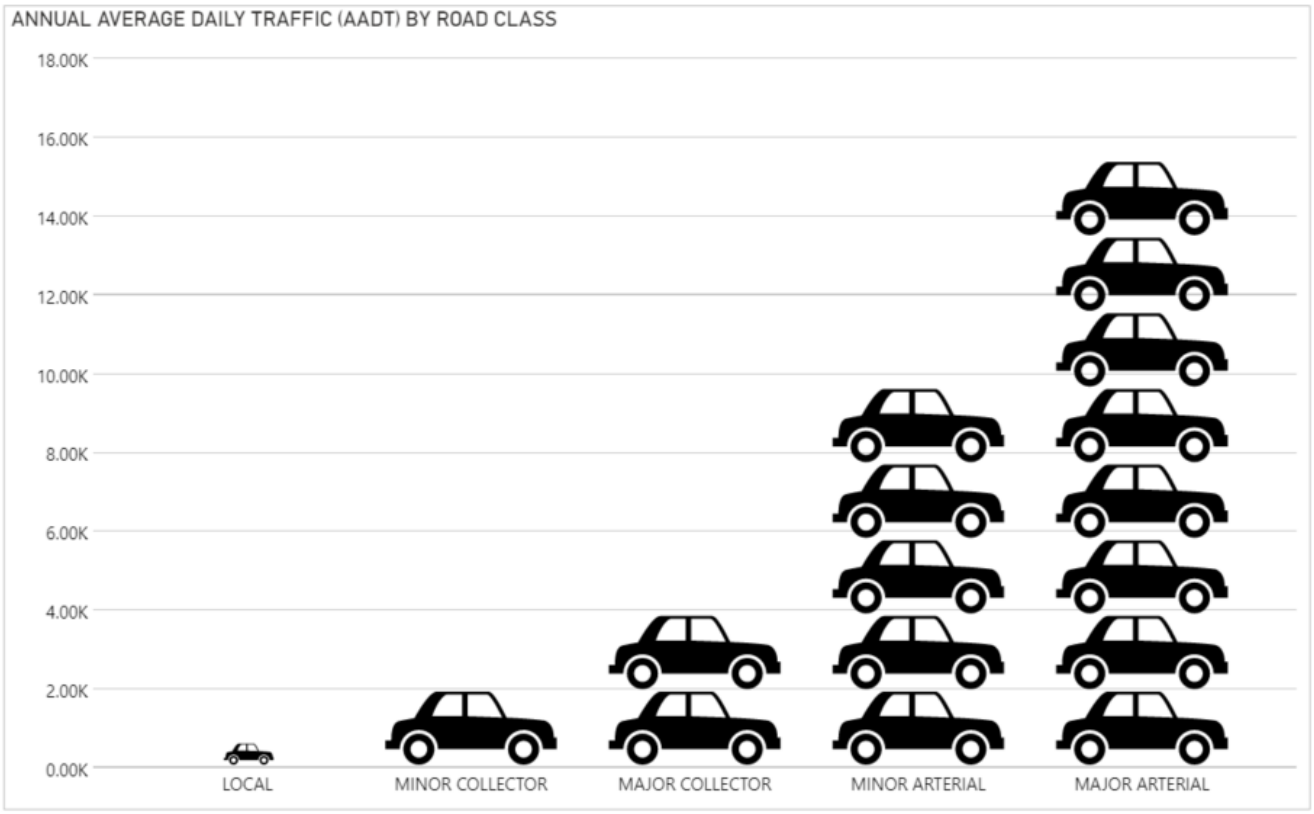

Figure 12: Road Average Annual Daily Traffic (AADT) by Road Class

Per **Figure 13** below, the total lane kilometers of road in the City is approximately 1,070 km with a total replacement cost of $339.7M. A “lane kilometer” measures the total number of kilometers for each individual lane instead of the length of a road (e.g. a 1 km, 4 lane road would be 4 lane kms).

The roadways are typically an age of 31 years which means they were installed or reconstructed an average of 31 years ago, which is 62% of the estimated service life of

50 years. Roads are in Fair condition with an average PCI of 64 and an average condition score of 2. Local roads make up approximately 58% of the City's road network, and it can be seen that local roads have the most Fair and Poor condition roads.

Figure 13: Road Asset Summary
Note: It was assumed that all roads would be replaced with machine cut curbing in the replacement cost.

2.3.4. GUIDE RAILS

Guide rails are structures which are installed along the edge of the road to protect motorists from off road hazards. Per **Figure 14** below, the total lane kilometers of guide rails in the City is approximately 28.7km with a total replacement cost of $5.2M. The guide rails were typically installed 33 years ago, which is past the estimated service life of 30 years. Based on the most recent condition assessment, guide rails are in overall Poor condition with an average condition score of 3. The most common type of guide rail in the City is a three cable guide rail followed by steel W beam guide rails. The condition assessment also recommended that when the cable guide rails reach the end of their service life that they be replaced with new high tension cable guide rails as the MTO has moved away from the three cable system, and that steel box beam guide rails be replaced with steel W beam guide rails. The Consultant recommended a forecast to repair high priority guide rails based on condition and road safety concerns which has been incorporated into the Life Cycle Costing in **Section 2.4.5**.

Figure 14: Guide Rail Asset Summary

2.3.5. STREETLIGHTS

Streetlights are installed along the road to illumuinate roadways at night. It can be seen in **Figure 15** below that there are approximately 10,380 City owned streetlights with a total replacement cost of $12.5M. The average age of a streetlight is 30 years which is at the support arm's estimated service life of 30 years. The support arm is typically in Fair condition and luminaires are typically in Good condition with an average condition score of 2 and 1 respectively. It is important to note that the age of luminaires could not be provided as this data is not able to be accurately obtained from the database, and therefore the indicated condition of luminaires exclusively includes known condition data from the condition assessment program and does not contain estimated conditions using service life. The majority of streelights in the City have High Pressure Sodium (HPS) bulbs. However, the City is moving toward upgrading HPS bulbs to Light Emitting Diode (LED) bulbs as seen below.

Figure 15: Streetlights Asset Summary

2.3.6. STREETLIGHT POLES

Streetlight poles support the aforementioned streetlights. Based on **Figure 16** below, there are approximately 4,100 City owned streetlight poles with a total replacement cost of $27.9M. The average age of a streetlight pole is 28 years, which is 93% of the estimated service life of 30 years. Streetlight poles are an average of Fair condition with a condition score of 2. It can also be seen that the data below is based on a combination of condition assessment and age based condition data, with mostly age based data. It is important to note that many streetlight poles in the City are owned by other entities (e.g. Brantford Hydro) and this report includes City-owned assets exclusively, which is why there is a large difference in quantity between streetlight arms/luminaires and poles.

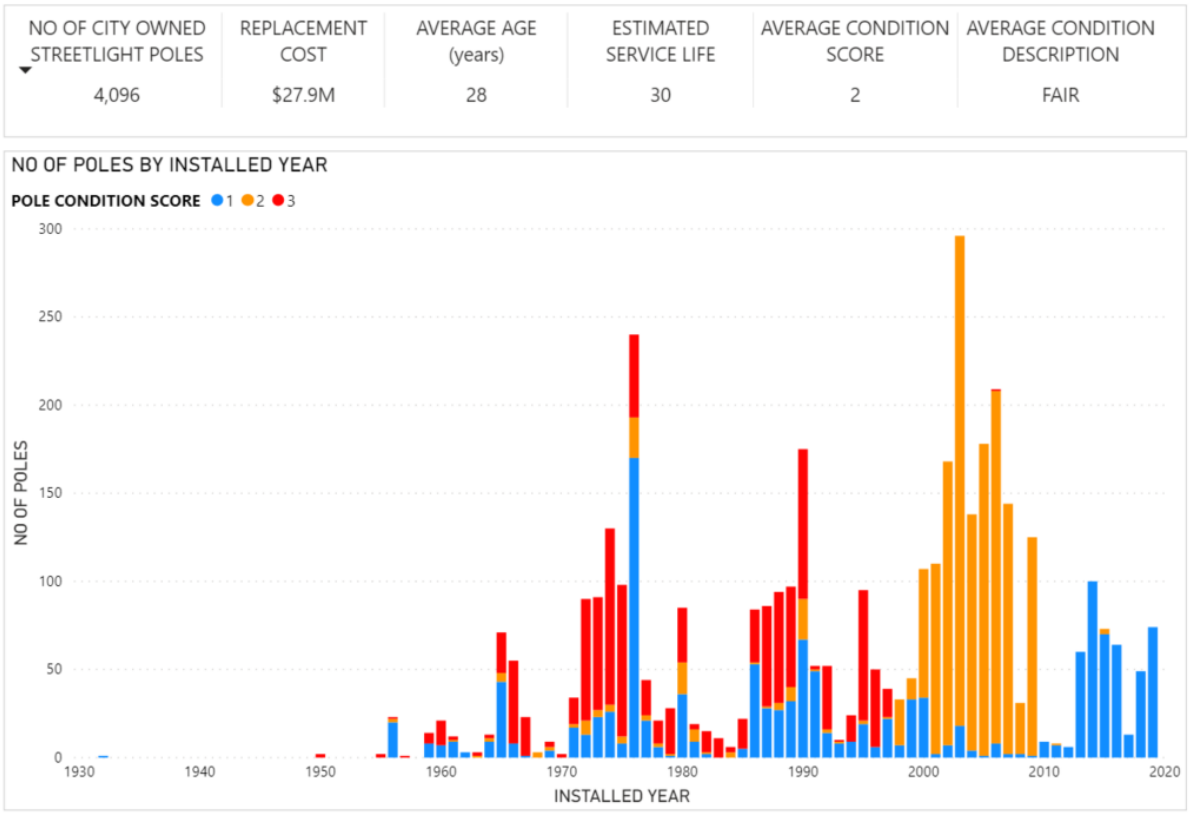

Figure 16: Pole Asset Summary

2.3.7. SIDEWALKS

Sidewalks are typically installed alongside roadways to accommodate pedestrians and mobility aids. It can be seen in **Figure 17** below that the City owns and maintains approximately 590 km of sidewalk with a total replacement cost of $69.2M. Sidewalks are an average age of 32 years old which is beyond the estimated service life of 30 years. Sidewalks have been installed over the last 70 years with peak installations occurring in the mid-1970s. Per the City's annual Condition Assessment program, sidewalks are typically in Good condition with a condition score of 1.

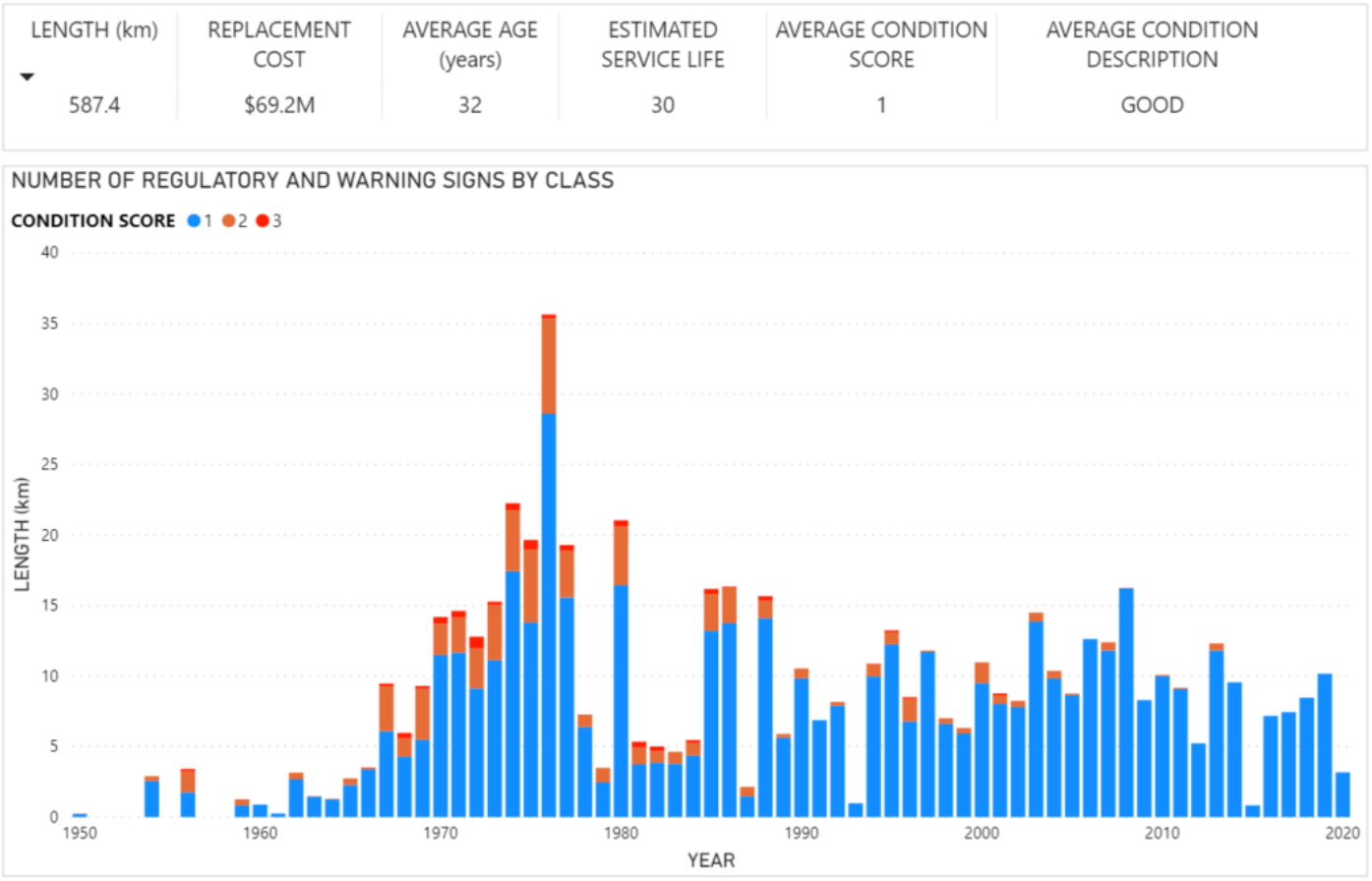

Figure 17: Sidewalks Asset Summary

2.3.8. REGULATORY & WARNING TRAFFIC SIGNS

Traffic signs are installed along the roadway to alert motorists and cyclists of any road information or hazards. Based on **Figure 18** below, the City owns and maintains approximately 19,900 regulatory and warning traffic signs, with 78 of these signs having flashers. The City only maintains the inventory of signs that are identified in the Minimum Maintenance Standard O.Reg 239/02 which are indicated as regulatory and warning signs, however, it is a possible future initiative to incorporate other signs such as Information or Guidance signs into this inventory. The total replacement cost for these traffic signs is $379K and the signs are typically in Good condition with an average condition score of 1. The average age for signs has not been identified because signs are typically replaced on a regular basis and recorded on paper. With the implementation of AIM identified in **Section 7** of the **AMP Overview Document**, the City will have updated installation dates as signs are replaced.

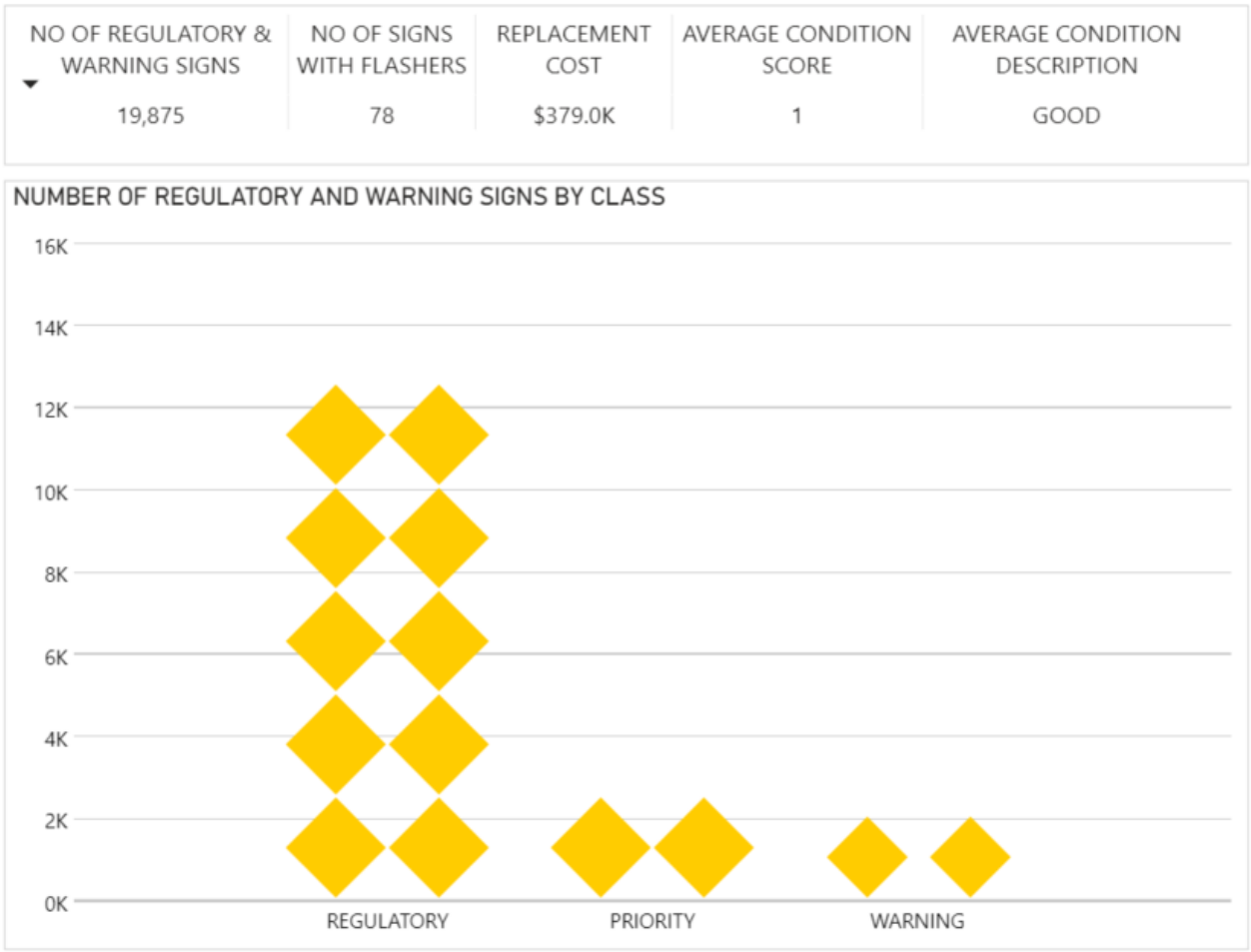

Figure 18: Traffic Signs Asset Summary

2.3.9. SIGNALED INTERSECTIONS

Per **Figure 19** below, there are 140 signaled traffic intersections in the City with a total replacement cost of all assets at an intersection being $20M. The average age for a traffic signal head is 14 years, and for traffic poles and support arms the average age is 19 years. Traffic signals are 70% of the estimated service life of 20 years, where traffic pole and support arms are 63% of their estimated service life of 30 years. There is currently a periodic inspection program completed by Traffic Services for signaled intersection assets and so the condition was based on the results of the last inspection in 2019 indicating intersections are typically in Fair condition with an average condition score of 2.

NO OF SIGNALED INTERSECTIONS	REPLACEMENT COST	AVERAGE SIGNAL AGE (years)	AVERAGE POLE AND SUPPORT AGE (years)	ESTIMATED SERVICE LIFE	AVERAGE CONDITION SCORE	AVERAGE CONDITION DESCRIPTION
140	$20.0M	14	19	25	2	FAIR

NO OF TRAFFIC SIGNALS	1.12K	NO OF FIRE PRE-EMPTORS	181	NO OF PEDESTRIAN SIGNALS	840
NO OF TRAFFIC POLES & ARMS	891	NO OF VATCS	12	NO OF PUSH BUTTONS	451

Figure 19: Signaled Intersections Asset Summary

Note: VATCS denotes Vehicle Activated Traffic Calming Signs

2.4. LIFECYCLE OF ROAD ASSETS

The lifecycle of road assets has four (4) categories which are described in this section:

- Key Lifecycle Stages of Road Assets;
- Lifecycle Activities;
- Risks of Lifecycle Activities; and
- 10 Year Lifecycle Costs of Road Assets.

2.4.2. KEY LIFECYCLE STAGES OF ROAD ASSETS

The lifecycle of an asset refers to the following stages: Planning, Creation/Acquisition, Operations and Maintenance, Renewal/Disposal which are defined in the Main Body of the report. For road assets specifically our general process is as follows:

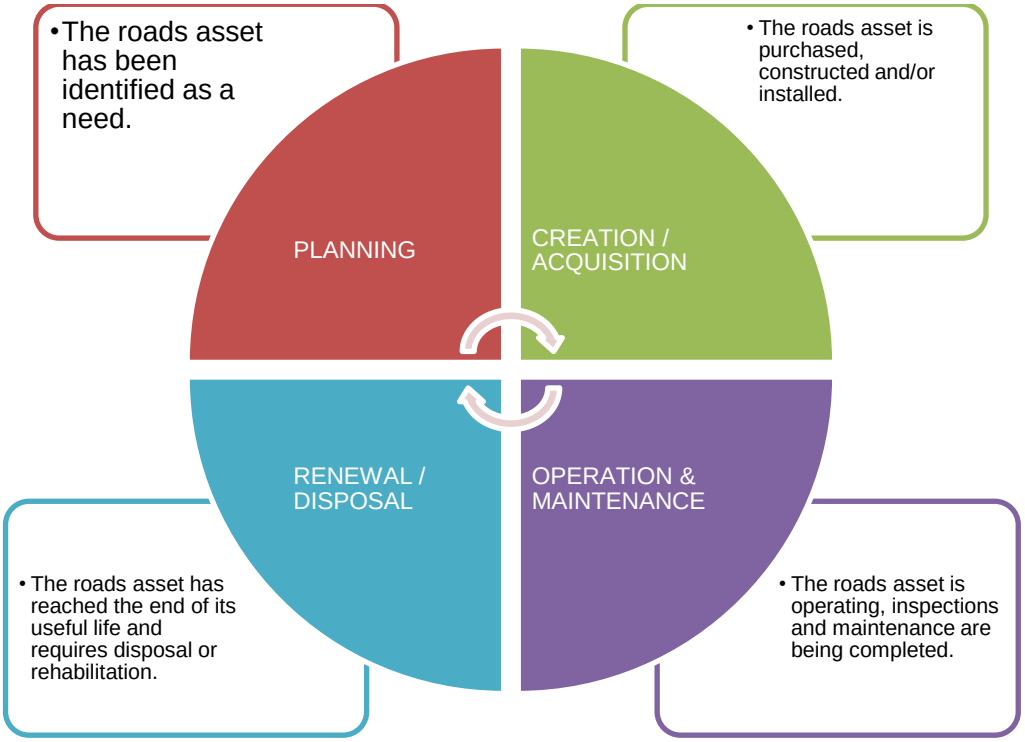

Figure 20: Lifecycle Stages of Road Assets

1. **Planning** – The road asset has been identified as a need through the Official Plan or Transportation Master Plan, or due to the identified poor condition of an existing asset. In order to evaluate how to get the most value of the asset, this process considers: existing assets, resources, operating efficiencies, funding availability, future growth management, and the maintenance of asset. The asset is designed using all applicable codes and standards. Typically this phase also involves planning on how to optimize the value of the assets which may include: replacing neighbouring corridor assets at the same time, improving operating and

maintenance efficiencies, adding road safety features (e.g. Traffic Calming), or adding additional lanes for growth. The road asset business process is included below in **Figure 21**.

2. **Creation / Acquisition / Replacement** – The cost and requirements for the new or replacement road asset are defined. The asset is purchased, constructed and/or installed. Extra care is taken at this stage to ensure the asset is constructed properly using all appropriate design standards and guidelines to avoid any premature repairs or replacements due to installation errors.
3. **Operation and Maintenance** – The road asset is currently performing and delivering the necessary service. Maintenance (Lifecycle) Activities are completed on the asset at specific time intervals as indicated in **Section 2.4.3** below to prevent premature failures of our assets. Minimum Maintenance inspections are also being completed on applicable assets. Additional monitoring and potential improvements are evaluated during this process.
4. **Renewal / Disposal** – The road asset has reached the end of its useful life and/or is underperforming, and requires disposal or major rehabilitation. The disposal considers the effect on customers such as required detouring which are taken into account in the Planning stage thereby restarting the cycle.

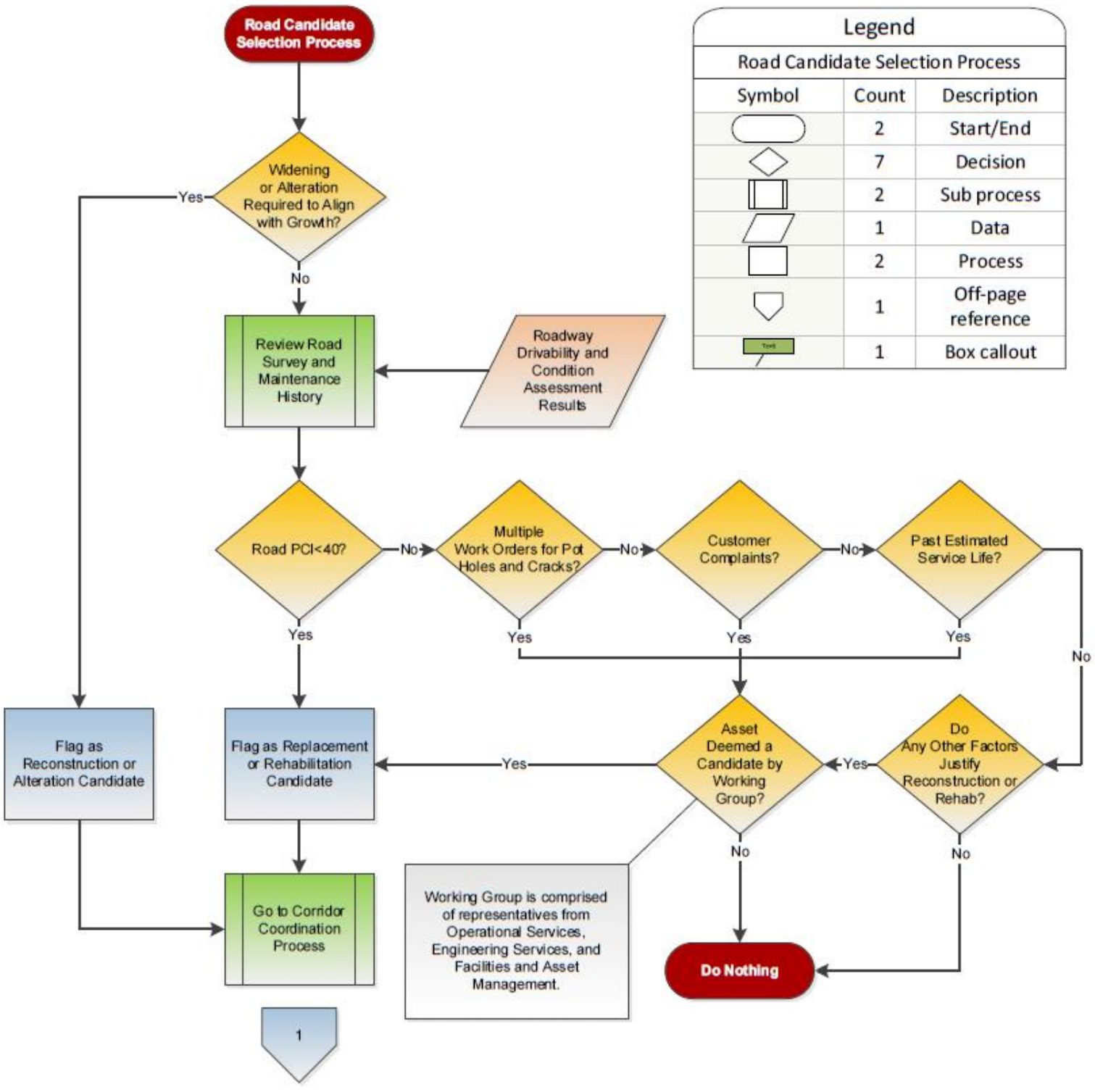

Figure 21: Road Asset Business Process

2.4.3. LIFECYCLE ACTIVITIES

A list of the planned Lifecycle Activities, annual cost, and frequency for each road asset class can be found in **Table 16** below. These activities are currently being undertaken to maintain our road assets and therefore maintain the current levels of service.

Table 16: Lifecycle Activities for Road Assets

Asset Type	Lifecycle Activity	2020 Annual Cost (unless noted otherwise)	Frequency	Completed by
Road	MMS Patrol (winter/summer)	$273,821.44 – 2 operators and two trucks per day	Daily	Operational Services
	Sweeping	$467,210.88 – 2 operators/2 machines 8 months	4x per year entire network	Operational Services
	Condition Assessment (2020)	$69,985	Biannually	Asset Management
	Snow Removal	$6,171.80 – per 8 hour shift	Ad Hoc	Operational Services
	Line Painting	N/A	Annually	Traffic Services
	Crack Sealing	Contract program $2.1500 per linear metre year 1 $2.3000 per linear metre year 2	Program	Operational Services
Intersections	MMS Inspection	Covered in road patrol above	Annually	Traffic Services
	Routine Inspection	N/A	Biannually	Traffic Services
Sidewalks	Condition Assessment (2020)	$29,300	Annually	Asset Management
	Sweeping (Downtown)	$84,922.24– 1 operator, 1	Weekly	Operational Services

		machine – 1 time a week		
	Snow Removal (Certain Areas)	$6,171.80 – per 8 hour shift	Ad Hoc	Operational Services
Traffic Signs	Retroreflectivity (2019)	$151,360	Every 16 months	Traffic Services / Asset Management
	Condition Assessment (2019)		Semi-annually	Asset Management
	MMS Road Patrol (winter/summer)	Covered in road patrol above	Daily	Operational Services
Guide Rails	MMS Road Patrol (winter/summer)	Covered in road patrol above	Daily	Operational Services
	Condition Assessment (2019)	$40,000	Periodic	Asset Management
Streetlights and Poles	Condition Assessment (2020)	$35,800	Program	Asset Management
	MMS Road Patrol (winter/summer)	Covered in road patrol above	Annually	Traffic Services

Lifecycle activities occur on each of our road assets to maintain the state of good repair. Typically lifecycle activities and timelines for road assets are dictated per the Minimum Maintenance Standard (MMS) regulations. MMS inspections are recorded through Avantis, and non-MMS activities are documented on paper records. Improvements will be made to the work order tracking system with the implementation of the AIM project described in **Section 7** of the **Asset Management Plan Overview Document**. When these activities are integrated into AIM, the City will have a more accurate report of the frequency and cost associated with these activities.

2.4.4. RISKS OF LIFECYCLE ACTIVITIES

The identified lifecycle activities in **Table 16** above are historical activities taken on by Traffic and Operational Services. However, some risks with these activities include:

- **Traffic Accidents** - when performing maintenance in the vicinity of traffic vehicles, there is a risk of a traffic accident. This is mitigated by implementing a traffic control plan and wearing high visibility clothing during maintenance activities in the right of way;
- **Falling** – Some activities require working from heights and there is a risk of falling. This risk is mitigated by having maintenance personnel trained on all equipment and having fall arrest training where required.
- **Operator Error** – When operators are operating equipment, there is a risk of an operator related accident. This risk is mitigated by ensuring all operators have the required licenses and are trained on equipment.

However, if these activities were not completed, other risks would include:

- **Health and Safety Issues** due to unexpected failure of asset (e.g. potholes forming on roadway, priority signs with failed retroreflectivity not visible at night, guide rail not functioning properly).
- **Unscheduled Service Disruptions** due to sudden closure of road (e.g. need for sudden repair of traffic signal which wasn't planned).
- **Increased Cost** due to reactive repairs which could have been prevented with preventative maintenance (e.g. reactive repairs are often 3x more expensive than planned repairs).

2.4.5. 10 YEAR LIFECYCLE COSTS OF ROAD ASSETS

Figure 22 below outlines the 10 year lifecycle costs of road assets. As noted on the graph, typically when the condition of an asset is estimated based on service life there are spikes in the first two (2) years to account for the backlog.

It can be seen that the asset which requires the most funding over the next 10 years is roads. As noted below the graph, the replacement year for the road was based on the PCI value, and roads with PCIs <75 are including in the life cycle costing with pricing based on the recommended rehabilitation for that PCI. Since roads are indicated to be in Fair condition, there is a peak in 2027 indicating that many roads require resurfacing.

Based on the information presented in the figure below, the total annual average capital cost for the next 10 years to alleviate the backlog and maintain the state of good repair spent on road assets is $20.9M, and the average annual O&M cost to maintain the state of good repair is $19.6M. Therefore, this is the amount recommended that the City invest in road assets annually to maintain the state of good repair.

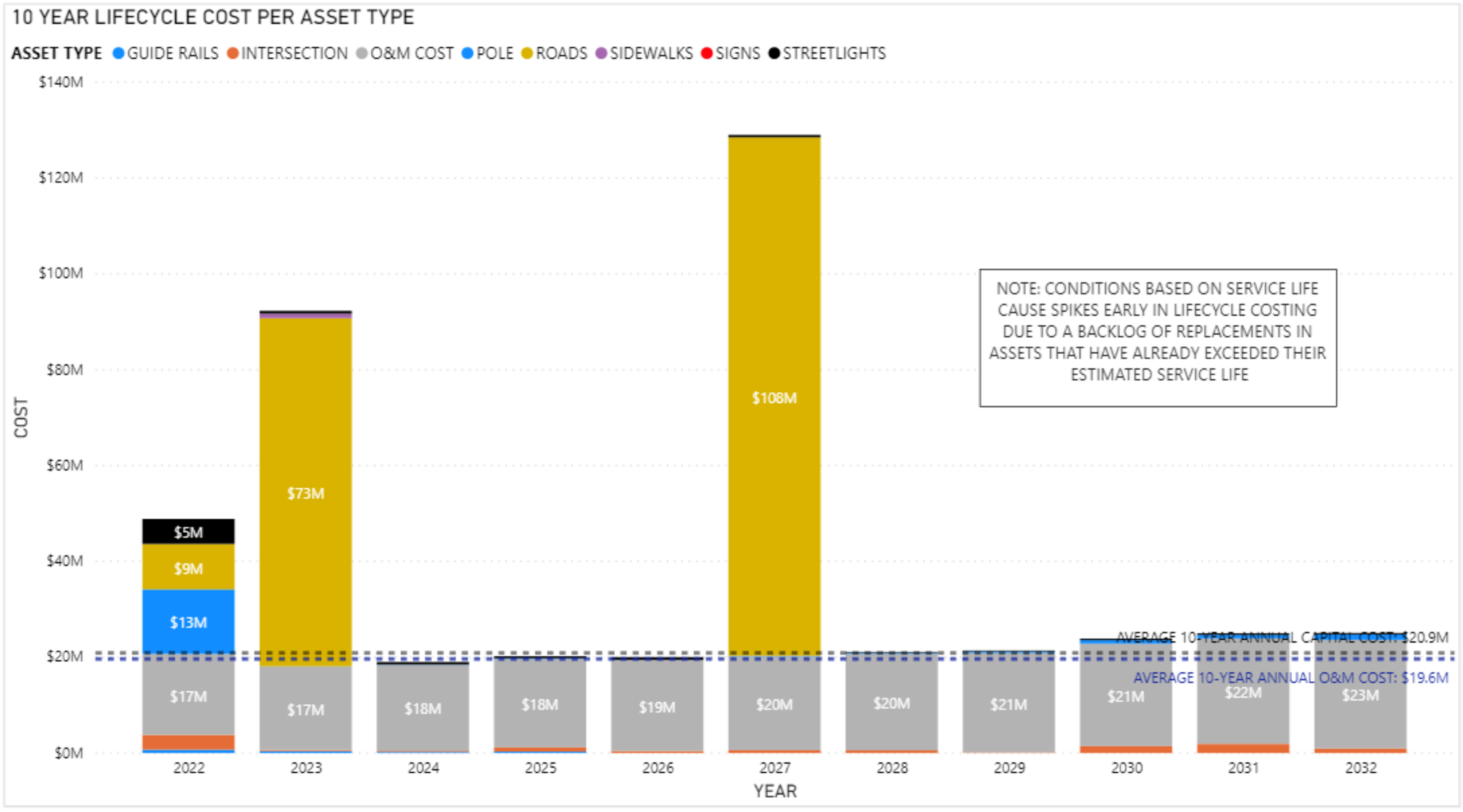

Figure 22: 10-Year Lifecycle Cost Per Road Asset Type

Notes:

1. O&M Costs are estimated based on the 2021 Preliminary Operating Budget inflated by 3% each year. Some O&M Costs are partially broken down in **Table 16.**
2. Guide Rail replacement costs and years were taken from the respective condition assessment referred to in **Table 11**.
3. Road replacement year was based on PCI. PCI 0-20 (Very Poor) then 2022, PCI 20.01-45 (Poor) then 2023, PCI 45.01-74.99 (Fair) then 2027. Replacement cost was based on estimated required work (e.g. rehabilitation, resurface etc.).
4. For all other assets where no formal forecast was available, if the asset was considered to be in Poor condition during a condition assessment it was assumed to be replaced in 2022 to clear the backlog, otherwise the replacement year is based on the estimated remaining service life of each asset.

Per **Figure 23** below, the existing 10-year forecast from 2021 – 2030, further explained in **Section 8.2.2** of the **Asset Management Plan Overview Document**, indicates that the City is currently planning to spend an average of $11.2M on road assets capital annually, and as noted above, the required 10-year average amount is $20.9M for road assets, therefore there is currently an average annual 10-year funding gap of $9.7M for road assets. As noted on the graph, the impacts resulting from these funding gaps will be monitored and reported as appropriate. It is evident that the City never expends over the required 10-year average in the existing 10-year forecast. Since the budget is revised annually, and the Prioritization Matrix explained in **Section 9** of the **Asset Management Plan Overview Document** is currently in its implementation phase, it is anticipated that this forecast will continue to change as City priorities shift. It is important to note that currently the City does not have access to detailed data on O&M for road assets, but with the implementation of the AIM project explained in **Section 7** of the **Asset Management Plan Overview Document,** it is anticipated this information will be provided in the next iteration of the AMP.

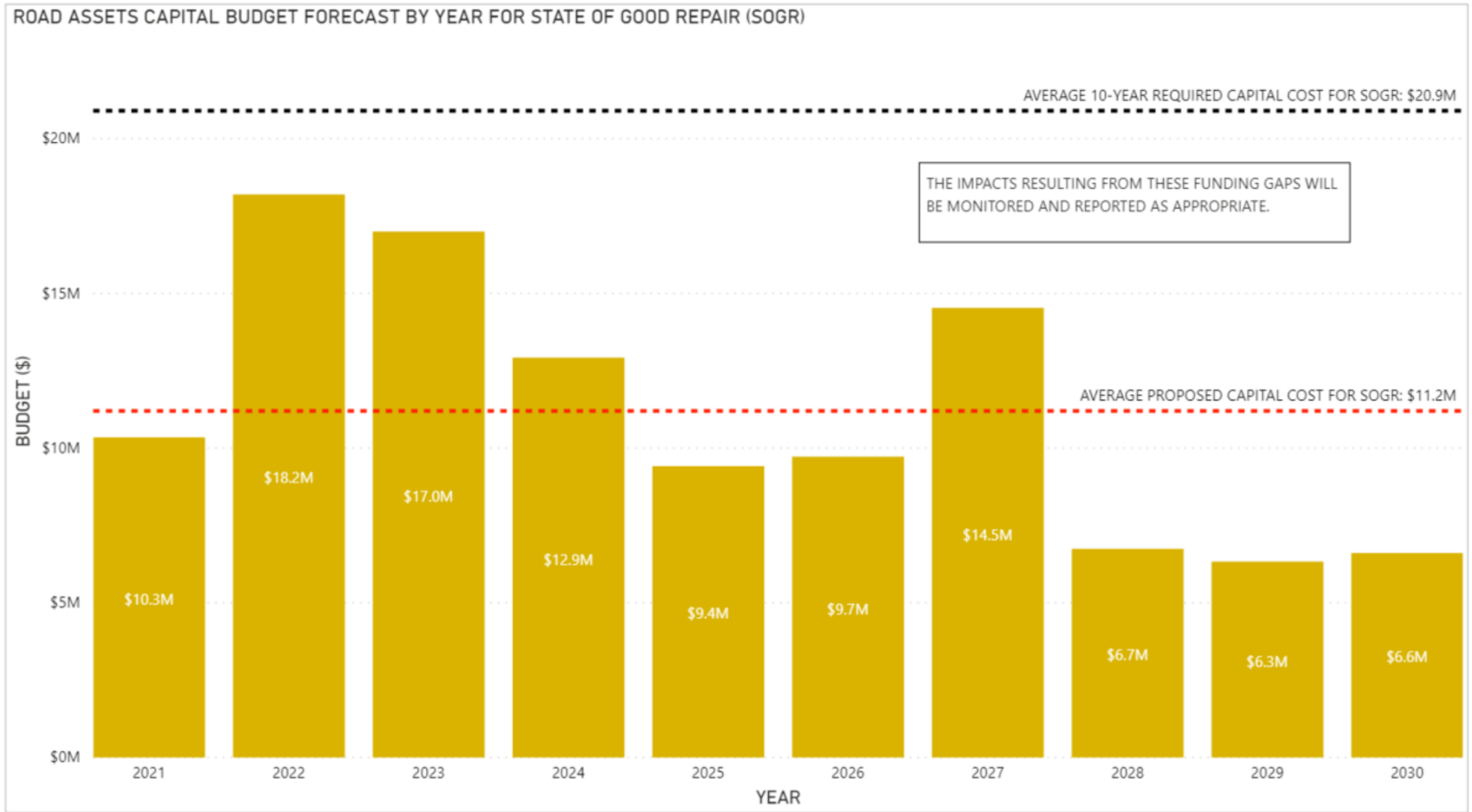

Figure 23: Existing Capital Budget Forecast from 2021 – 2030 for Road Assets

2.5. CURRENT LEVELS OF SERVICE

2.5.2. O.REG 588/17 CUSTOMER LEVELS OF SERVICE

The customer levels of service as dictated by O.Reg 588/17 are described below.

1. *Description, which may include maps, of the road network in the municipality and its level of connectivity:*

   The City of Brantford has a mature, connected road network as shown in **Figure 24**. The 403 runs West-East through the City with five (5) on/off ramps (Oak Park Rd, Paris Rd, King George Rd, Wayne Gretzky Pkwy, and Garden St).

   The two (2) major arterial roads that run North-South are Wayne Gretzky Parkway which runs from Powerline Rd to Colborne St, and King George Rd which runs from Governor's Rd E and becomes a minor arterial road at St Paul Avenue. The three (3) major arterial roads that run West-East are Colborne St which runs from Garden Ave to the City Limits, splits into Dalhousie St in the downtown core and briefly becomes Icomm Dr before becoming Colborne St W; the Veterans Memorial Parkway which splits from Colborne St and rejoins Colborne St W at Canning St; and Governors Rd E which was recently acquired from Brant County in the recent boundary expansion and runs from Park Rd N to Golf Rd.

   The City is bisected by the Grand River which creates traffic bottlenecks at river connection points and limits efficient North-South connectivity to the 403 especially in the west side of the City. At the time of writing, to improve the south's connectivity to the 403, a project is currently being investigated to create another river crossing point at Oak Park Rd as shown in purple in **Figure 24.**

2. *Description or images that illustrate the different levels of road class pavement condition:*

   The road network map coloured by PCI rating is show in **Figure 25.** PCI scores were developed based on the level of rehabilitation required as described in **Table 12**. The road class separated by condition can be found in **Section 2.3.3** . Examples of photos showing roads with different PCI scores are shown in **Figure 26.**

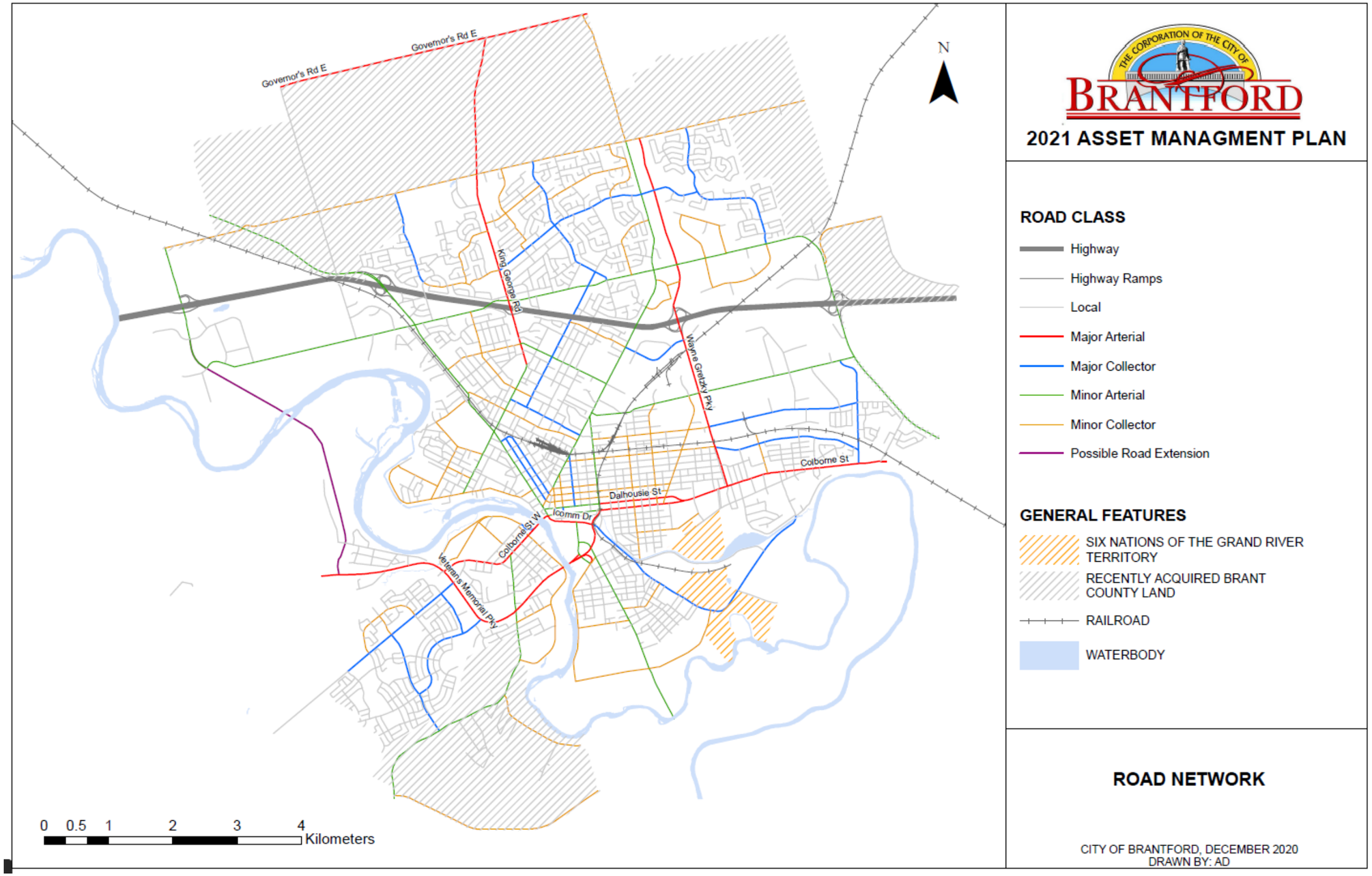

Figure 24: City of Brantford Road Network

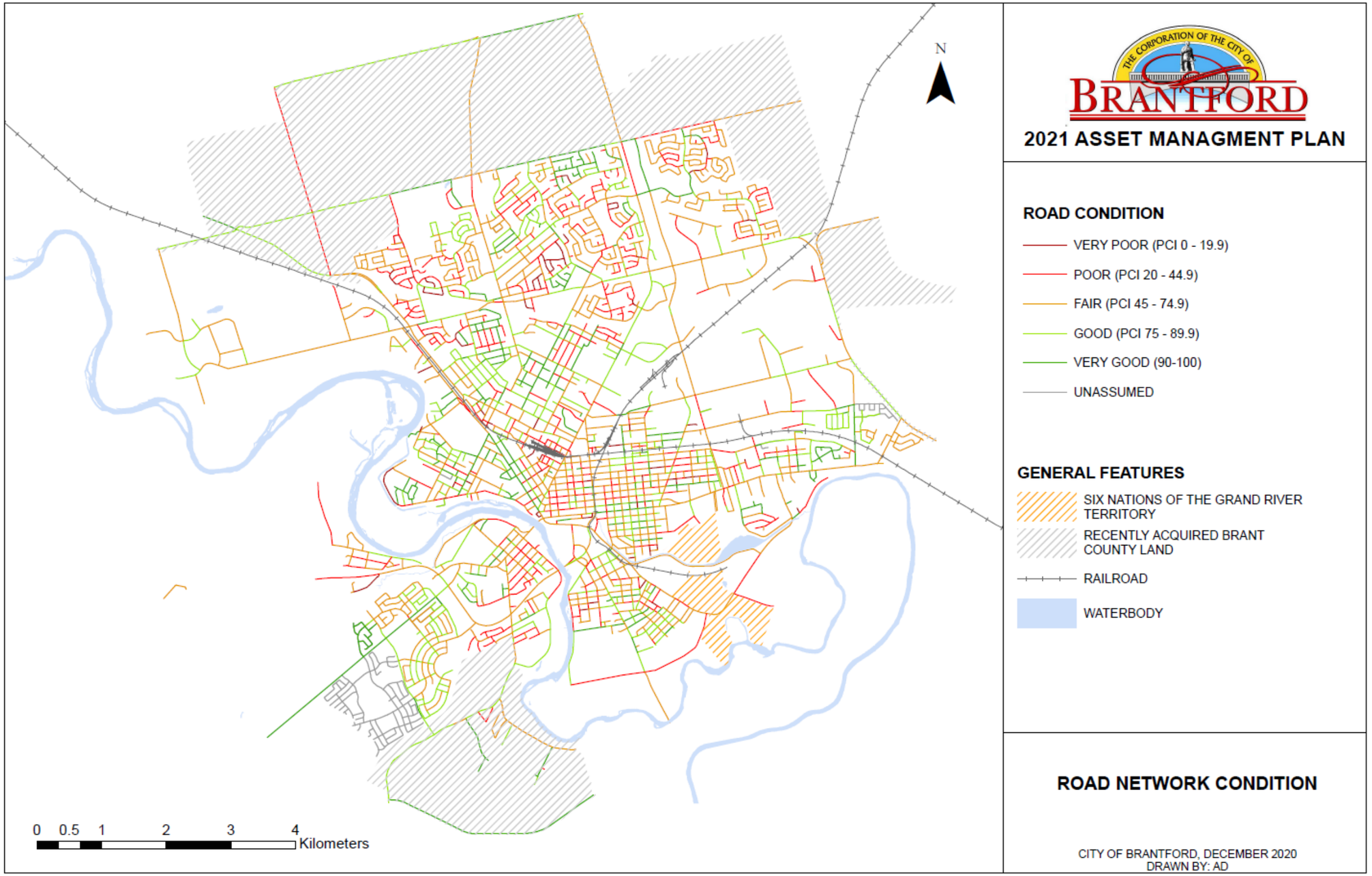

Figure 25: City of Brantford Road Network Condition

Figure 26: PCI Rating Photo Examples

2.5.3. O.REG 588/17 TECHNICAL LEVELS OF SERVICE

The technical levels of service that the City is required to report in this iteration of the AMP as dictated by O.Reg 588/17 can be found in **Table 17** below:

Table 17: O.Reg 588/17 Road Technical Levels of Service

Service	Service attribute	Technical levels of service (technical metrics)	2019	2020
Roads	**Scope**	Number of lane-kilometres of each of arterial roads, collector roads and local roads as a proportion of square kilometres of land area of the municipality.	253.3 km arterial of 102.46 km^2 land area 246.0 km collector of 102.46 km^2 land area 651.1 km local of 102.46 km^2 land area	253.3 km arterial of 102.46 km^2 land area 247.7 km collector of 102.46 km^2 land area 650.2 km local of 102.46 km^2 land area
	Quality	1. For paved roads in the municipality, the average pavement condition index value.	66 (2017 assessment)	64
		2. For unpaved roads in the municipality, the average surface condition (reported as PCI value).	N/A	63

Note: Values for collector and local roads changed from 2019 to 2020 possibly due to corrections in mapping or reclassification of roads

2.5.4. MUNICIPALLY DEFINED CUSTOMER LEVELS OF SERVICE

The customer levels of service are defined in **Section 6.2** of the **Asset Management Plan Overview**. For road assets, the asset specific interpretation of these levels of service is defined below in **Table 18**.

Table 18: Municipally Defined Customer Levels of Service

Customer Level of Service	Definition
Accessibility	Road assets should be accessible to various transportation types including, but not limited to, personal and transit vehicles, pedestrians, mobility aids, and cyclists.
Quality	Road assets should fulfill their intended purpose, be the appropriate capacity, and be in a state of good repair.
Cost Efficiency	Road assets should be operated efficiently with extra care to minimize costs.
Safety	Road assets should be both safe to use and promote community safety, and customers should feel safe using these services.
Environmental Sustainability	Road assets should be operating as environmentally as possible and also be promoting sustainable lifestyles.
Reliability	Road assets should be available when customers need them.
Responsiveness	Road assets should be fixed quickly when service disruptions occur.

2.5.5. MUNICIPALLY DEFINED TECHNICAL LEVELS OF SERVICE

The technical levels of service for road assets have been adopted based on the above defined customer levels of service in **Table 18**. The customer levels of service with the corresponding technical levels of service and KPI metrics are defined below in **Table 19**.

The AIM project will also assist the City with identifying and adding additional KPIs in future iterations because a system will be available to formally track this data.

Table 19: Newly Defined Level of Service KPIs

Customer Level of Service	Technical Level of Service Description	2020 KPI	Units
Accessibility	Number of road sweeping complaints	0	Count
	Number of identified sidewalk vertical faults (trip steps)	7500	Count
	Number of winter maintenance road complaints	95	Count
	Number of winter maintenance sidewalk complaints	133	Count
	Number of winter maintenance windrow complaints	32	Count
Quality	AADT on major arterial roads	16,630	Average
	Length of on-road line painting	478.5	km
	Number of single lane roads	2	Count
	Length of closed laneways	1.82	km
	Length of open laneways	12.5	km
	Total lane kms of gravel road	4.32	km
	% of road network assessed for PCI by road segment	92.5%	%
	Length of identified substandard road capacity corridors	61.28	Lane km
	Length of identified substandard road capacity corridors	22.79	Centreline km
	Length of full road reconstruction	2.8	km / year
	Length of resurfacing (asphalt base and top)	4.2	km / year
	Length of resurfacing (partial depth or overlay)	9.2	km/year
	Length of road top lift	3.1	km / year
	Length of newly installed sidewalk	0.778	km / year
	Length of replaced sidewalk	5.9	km/year
	New traffic signal or timing request	32	Count
	New traffic sign request	68	Count
	Number of right of way graffiti complaints	18	Count
Cost Efficiency	Number of streetlights on during the day	28	Count
	Number of overtime hours to resolve right of way issues	N/A	Hours
Safety	Number of traffic collisions	1,769	Count
	Number of traffic collisions involving cyclists	21	Count
	Number of traffic collisions involving pedestrians	35	Count
	Number of traffic collisions resulting in injuries	182	Count
	Number of traffic collisions resulting in fatalities	5	Count
	Number of road safety complaints	107	Count
	Road condition or damage complaints	275	Count

	Sidewalk condition complaints	194	Count
	Number of traffic sign retroreflectivity failures at time of inspection	381	Count
	Length of guide rails requiring immediate attention	9.62	km
	Number of guide rail complaints	8	Count
	MMS Compliance for road patrol inspections – Class 2 Roads	85%	%
	MMS Compliance for road patrol inspections – Class 3 Roads	70%	%
	MMS Compliance for road patrol inspections – Class 4 Roads	70%	%
	MMS Compliance for road patrol inspections – Class 5 Roads	70%	%
	MMS Compliance for road patrol inspections – Class 6 Roads	70%	%
	Field accidents with lost time	N/A	Count
	New streetlight requests	8	Count
	Number of streetlight condition complaint	1328	Count
	Lost hours due to field accidents	N/A	hrs
Environmental Sustainability	Length of On-Road Painted Bike Lane	37.7	km
	Bike lane complaints	1	Count
	% of LED streetlights	7.13%	%
	% of LED traffic signals	100	%
	Traffic Flashers	95	%
	Number of roadway spill complaint	9	Count
Reliability	Number of traffic signal complaints	123	Count
	Number of traffic sign complaints	87	Count
	Number of unexpected road closures	2	Count
Responsiveness	No of weather deployment events	31	Count
	Average length of time to finish sweeping on roads	N/A	Hrs
	Average time to fix identified pothole after reported complaint	N/A	Hrs
	Average time to fix sidewalk vertical fault (trip step) after reported complaint	N/A	Hrs
	Average time to replace substandard sign after reported complaint	N/A	Hrs
	Average time to clean up road debris after reported complaint	N/A	Hrs

2.6. CURRENT ASSET PERFOMANCE

The current asset performance for road assets is based on metrics related to operating performance.

2.6.2. ROAD ASSET CURRENT OPERATING PERFORMANCE

For roads, the current operating performance is largely determined by the current PCI, asphalt road material, and road capacity.

As shown in the above technical metrics in **Table 19**, the current average PCI shows that road conditions are typically Fair condition with a PCI of 64. Although the above technical levels of service shown in **Table 17** show the PCI has declined since the last roads assessment in 2017, it is important to note that the previous assessment did not include the expansion lands acquired from County of Brant in 2017. In addition, a score of Fair indicates that many roads require resurfacing, which is a less costly strategy to improve the overall PCI, since these roads have not yet reached a Poor condition.

In terms of road material, the majority of City roads are paved with asphalt in accordance with the City's design guidelines, however, there are a small portion of roads acquired from County of Brant which are gravel. These roads will be assessed for paving in the coming years as they do not meet the City's current road performance standard.

Finally, the 2020 Transportation Master Plan (TMP) has identified fourteen (14) road corridors with capacity restrictions to accommodate future growth which total 61.28 lane kms. The recommendations for how these projects will be addressed, including costing, are included in the TMP, and included in **Section 8.3** of the **AMP Overview Document**. The fourteen (14) road corridors identified with deficiencies include:

1. Brant Avenue – St Paul Avenue to Colborne Street
2. Wayne Gretzky Parkway – Henry Street to Highway 403
3. Wayne Gretzky Parkway – North of Highway 403
4. King George Road – Crossing Highway 403
5. Paris Road – Highway 403 to Powerline Road
6. Lorne Bridge – Grand River Crossing
7. West Street – Charing Cross Street to Henry Street
8. Veterans Memorial Parkway – Mt Pleasant Street to Market Street
9. Paris Road – South of Highway 403 to Hardy Road
10. Powerline Road – Paris Road to Wayne Gretzky Parkway
11. Hardy Road – Ferrero Boulevard to Paris Road
12. Erie Avenue – Veterans Memorial Parkway to Birkett Lane

13. Clarence Street – Dalhousie Street to Icomm Drive
14. Colborne Street West – County Road 7 to D'Aubigny Road

The total costs associated with these projects are included in **Section 8.3.3** of the **AMP Overview Document**.

2.7. DISCUSSION & CONCLUSIONS

In conclusion, the City of Brantford operates and maintains several road assets. These assets are typically in Fair condition with a total estimated replacement cost of approximately $593M.

The inventory and condition data confidence for road assets are at a medium or high level due to formal condition assessments having been completed. Assets that are at a medium level will increase to a high level as annual inspection programs encompass all assets. In addition, the City is currently investigating a more frequent and formal inspection for signalized intersections. As stated, some of these inspection improvements are ongoing and also will improve as a result of the AIM project explained in **Section 7** of the **Asset Management Plan (AMP) Overview document**.

Furthermore, the lifecycle stages for road assets includes: Planning, Creation, O&M, and Disposal. During the Planning stage, the City identifies the need for the asset; during the Creation stage the asset is purchased and installed or constructed; during the O&M stage, the asset is operating and lifecycle activities (i.e. maintenance) occur on each of our road assets to maintain the state of good repair; and the Disposal stage is when the asset has reached the end of its useful life or is underperforming and requires disposal.

Lifecycle activities are currently typically tracked through Avantis for Minimum Maintenance Standard (MMS) activities and paper records for non-MMS activities. For more information on key database applications and work order management, please refer to **Section 4.2 and Section 7**, respectively, in the **AMP Overview Document**. At this time, the costs associated with these activities are partially broken down in **Table 16** and are estimated based on calculated staff time and resources and contract amounts. When these activities are integrated into AIM, the frequency and accurate costs associated with specific activities will be better represented. Therefore, future updates of the AMP will include specific costs for these activities as well as the time associated with these activities in order to properly allocate budget and identify operational inefficiencies.

It is estimated based on the average annual cost in the 10 Year Life Cycle Costing that the City should be spending an average $20.9M annually for capital road assets and will be spending an average of $19.6M annually on O&M for road assets based on total

estimates in the 2021 Preliminary Operating Budget, however, the City is currently proposing to spend an average of $11.2M annually on capital for road assets' state of good repair.

Additionally, Current Levels of Service have been created and identified for road assets. These technical levels of service were created based on the customer levels of service defined in **Table 18**. Brantford is also working to develop and include additional metrics in AIM which will assist us with tracking these KPIs for future iterations.

Finally, asset performance for road assets is defined as operating performance. For operating performance the City has identified the key services these assets are providing and has identified any deficiencies. For roads these components are current PCI, asphalt road material, and road capacity.