ATTACHMENT 1

Building Better Roadways:
An Asset Management Plan for Roadways

City of Saskatoon

OCTOBER 2016

Roadways

INTRODUCTION

Preservation of the City of Saskatoon (City) roadways are funded through the Paved Roadways Infrastructure Reserve. Prior to 2013, this reserve was underfunded and, over time, roadways were deteriorating resulting in a backlog of preservation and maintenance projects.

In 2013, City Council adopted a funding strategy intended to improve the condition of City roadways and, slowly overtime, decrease the backlog of preservation work. A three-year dedicated tax levy starting in 2014 was adopted to increase base funding levels to the required amounts by 2016. This plan was adjusted to a four-year phase-in during 2015 business plan and budget deliberations, which resulted in 2017 being the final year of the roadway dedicated levy phase in.

CURRENT INVENTORY

The City's roadway assets are estimated to have a replacement value of $2.82 Billion. This value includes the cost of replacing the road by physical excavation and with new approved materials.

Table 1: Current Inventory (in billions of dollars)

Asset	Inventory Ln-Km	Replacement Cost	% of Roadway
Local Roads	2,045	$1.36	51%
Collector Roads	788	$0.55	20%
Arterial Roads	734	$0.54	18%
Expressways	447	$0.37	11%
Total	4,014	$2.82	

Roadway Network:
The two types of networks are neighbourhood networks and primary networks.

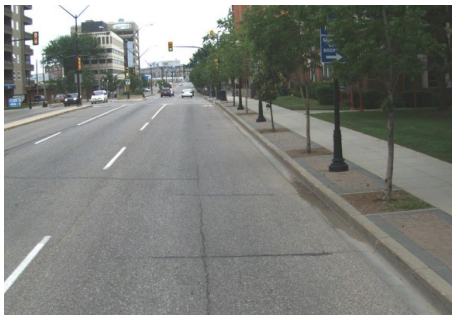
Neighbourhood Network:
Roadways that are classified as Local roads belong to the Neighbourhood Network.

- *Local Roads:* These roadways provide land access and are not intended to carry large volumes of traffic.

Primary Network:
Roadways that are classified as Collector, Arterial, and Expressway Roads belong to the Primary Network.

- *Collector Roads:* These roadways provide both traffic movement and land access. They are typically a connection between Local Roads and Arterials.

- *Arterial Roads:* These roadways provide high traffic movement between major traffic generators such as residential, commercial, and industrial neighbourhoods.

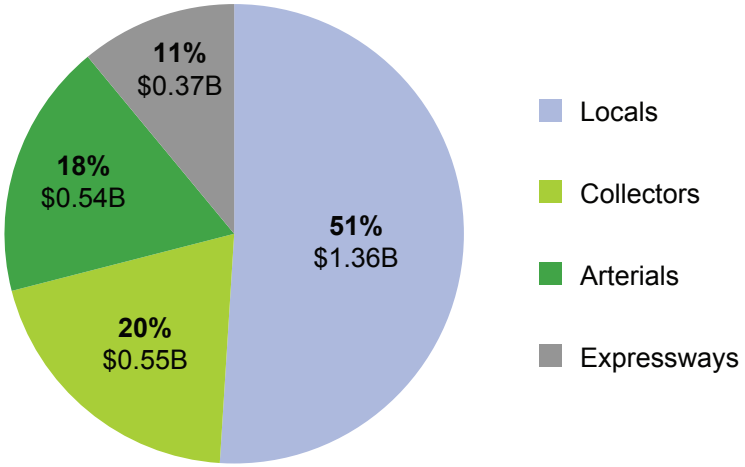


- *Expressway Roads:* These roadways accommodate high-traffic volume at high speeds and move traffic from one sector of the city to another.

Roadways

In order to provide a high-level overview of the state of the roadways, the following graph depicts the percentage of roadways in each classification and its associated values.

Figure 1: 2015 Roadway Inventory by Percent with Replacement Value (Billions)
Total Lane-Kms = 4,014



PHYSICAL CONDITION OF ROADWAYS

In 2014, the City commissioned a full condition assessment of the paved roadway network based on industry standard methodologies. This assessment was used to establish a baseline condition of the network for reporting purposes and to aid in setting future roadway preservation programs. The process of assessing the paved roadways took into account surface pavement condition, ride and roughness, and structural adequacy.

The pavement surface condition was assessed and given a Pavement Condition Index (PCI). The PCI only rates the surface condition of the pavement. Distresses in the surface condition, however, may be symptoms of underlying structural issues and/or cause of poor ride and roughness. The PCI is used as the primary condition categorization of the Roadway Network.

Ride and roughness, which is expressed as the International Roughness Index (IRI), was assessed for all segments, excluding Residential Local Roads. The IRI is an internationally recognized assessment of the quality of ride that will be reported on. The results of the IRI are beneficial for prioritization and treatment selection.

Table 2, 4, and 6 outline the two decisions to be made in order to proceed with an asset management plan.

1. What is the desired condition level?
2. How fast would City Council like to reach the desired condition level (expenditure level)?

Pavement Condition Index (PCI): The pavement surface condition state is represented by a pavement condition index which is based on the American Society for Testing and Materials (ASTM) D 6433 international standard used for roadway condition assessment.

As illustrated in Table 2, a numerical rating is assigned based on the 100 point scale from failed to good.

Table 2: PCI Numerical Rating PCI Pavement Index Range

Condition Description	PCI Pavement Index Range	Example
Good	85 < PCI ≤ 100	Little to no light defects.
Satisfactory	70 < PCI ≤ 85	Up to a few light defects.
Fair	55 < PCI ≤ 70	Multiple light defects, or a few medium defects.
Poor	40 < PCI ≤ 55	Multiple defects, light and medium.
Very Poor	25 < PCI ≤ 10	Many light defects, or a few medium defects, or a combination of a few light and medium defects, or one high defect.
Serious	10 < PCI ≤ 25	Multiple light defects, or multiple medium defects, or a couple high severity defects, or a combination of any defects.
Failed	0 < PCI ≤ 10	Lots of light defects, or multiple medium defects, high defects, or a combination of any defects.

A failed roadway typically exhibits multiple surface condition defects and structural deficiencies as per the photo below. The PCI condition state is calculated based on distinct deduct values for each defect present.

Table 3 indicates that in 2014 the City's roadway network as a whole was considered in satisfactory condition with an average PCI of 74.3 where 83% of the roadway network is in a fair to satisfactory category. The assessment does show the City's investment to roadways is improving slowly as per the approved expenditure level B. The City's Building Better Roads strategy has allowed for the preservation of a good mix of all classifications of roadways. However, due to past levels of underfunding, it is difficult to address the largest portion of the network, local roadways, backlog of work in a quick manner. It is projected that the local road network will begin to improve in PCI over the next few years.

The City's lowest PCI portion of the network in 2016 is the Collector Network. Projecting into 2018, the City's trend shows a continued improvement to PCI since some locations were pulled forward due to favorable contract pricing.

The current target is an average PCI of 80 to 85; which will indicate the City's roads will be

in a satisfactory/good condition. It is not common to have a municipality's inventory in the 90 to 100 PCI range as best practice is to allow roadways to go through a certain life cycle before treatment is applied.

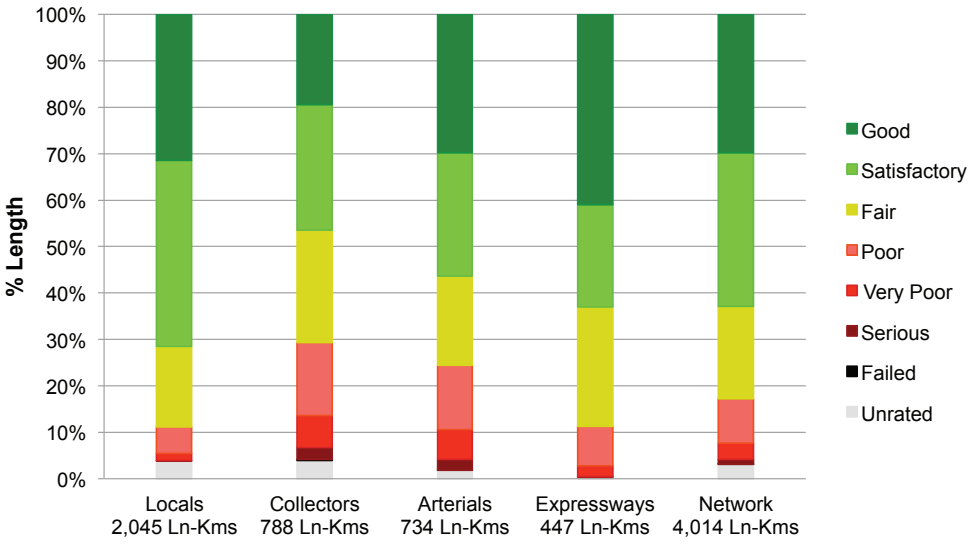
In 2016, the assessment shows the PCI is improving slowly as per the City's approved expenditure level. Future projections show a continued improvement to PCI with the goal of reaching an average PCI of 80 to 85 over time dependent on road classification.

Table 3: Rated Roadway Network Average PCI

Road	Average PCI 2014	Estimated Average PCI 2016*	Condition Description
Locals	77.4	76.2	Satisfactory
Collectors	67.4	69.8	Fair
Arterials	71.1	72.6	Satisfactory
Expressways	77.7	79.0	Satisfactory
Rated Network Avg	74.3	74.6	Satisfactory

**2016 PCI values are projected based on the 2014 condition assessment and completed surface treatments and estimated network deterioration rates. Actual PCI ranges and network improvements will be confirmed during the next City wide roadway condition assessment in 2018. Figure 2 illustrates the PCI as a percentage of length for each road class. This chart also includes the percentage of un-rated roadways.*

Figure 2: PCI by Percent Length per Road Class



International Roughness Index (IRI):

The pavement ride and roughness is represented by an international roughness index, which is a measure of irregularities of the surface that affect the ride quality. The process of IRI was developed in 1986 and is the most commonly used methodology worldwide for evaluating quality of ride.

Index ranges for condition descriptions are shown in Table 4. A higher IRI results in a higher roughness in the ride.

Table 4: IRI Pavement Index Range

Condition Description	IRI Pavement Index Range	Example
Very Low	0 ≤ IRI ≤ 1.8	Brand new road or newly resurfaced road with great ride quality.
Low	1.8 ≤ IRI ≤ 2.5	Pavement with very few undulations and generally a smooth ride.
Moderate	2.5 ≤ IRI ≤ 3.5	Roadway that may have few distresses, but has a significant portion of utility settlements causing an unsmooth ride.
High	3.5 ≤ IRI ≤ 6.5	Roadway with many distresses, patching, and utility settlements creating a bumpy ride.
Very High	IRI > 6.5	Roadways usually pothole ridden with many undulations causing a rough ride.

A roadway with a very high IRI score typically exhibits surface defects that provide a rough or bumpy ride. The photo below is an example of a road with IRI > 9.4.

The City's roadway network is considered in a moderate roughness state as indicated in Table 5 with a weighted average IRI of 3.2mm/m where 64% of the Network rated is in a Moderate to Very Low category.

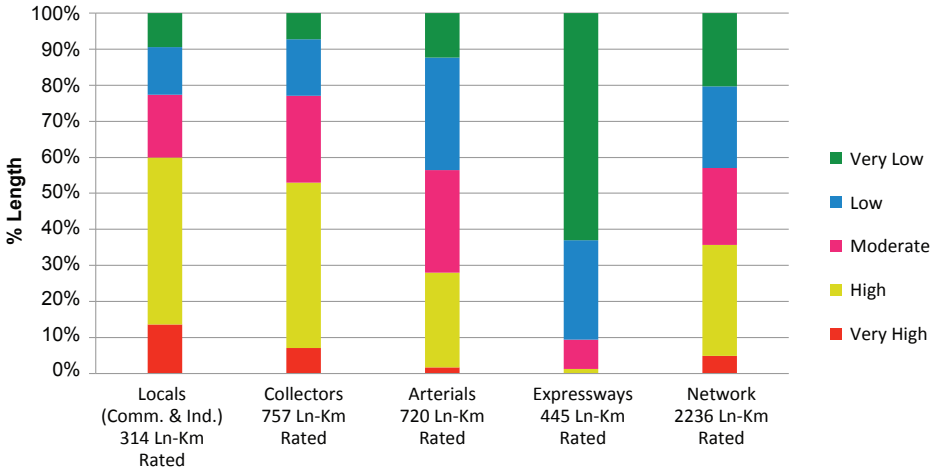
Table 5: Roadway Network Weighted Average IRI (based on In-km rated for each road class)

Road	Average IRI (mm/m)	Condition Description
Locals	4.2	High
Collectors	3.9	High
Arterials	3.1	Moderate
Expressways	1.8	Very Low
Rated Network Avg	**3.3**	**Moderate**

Roadways

Figure 3 illustrates the IRI as a percent of length for each road class. This chart does not include the percentage of un-rated roadways.

Figure 3: IRI as a Percent of Length of Rated Roads



The photo below is an example of Very Low IRI.

EXPENDITURE LEVELS

The Administration evaluates the condition of the City's assets in order to develop annual programs to maintain the assets at a minimum cost. Condition assessments or evaluations are conducted and used to establish condition levels as well as develop annual capital improvement plans.

The level of service for each type of asset is defined; however, as the level of service increases for the asset, so does the cost of maintaining the asset. In order to be able to compare the level of investment for all assets corporate-wide, five levels of expenditures are identified below. It should be noted that expenditure levels are not condition assessments, but lead to a change in the asset condition over time. "A" represents the highest level of expenditure and "F" represents no expenditure.

Table 6: Expenditure Levels

Expenditure Level	Asset Condition	Description
A	Getting Better Quickly	Sufficient expenditures to keep asset in the desired condition and to increase asset condition/value quickly over time.
B	Getting Better	Sufficient expenditures to keep asset in the desired condition and to increase asset condition/value slowly over time.
C	Maintain Assets in Current Condition	Sufficient expenditures to keep asset in constant condition over time.
D	Getting Worse	Insufficient expenditures to maintain asset condition. Over time asset condition will deteriorate.
F	Getting Worse Quickly	No expenditures. Asset condition/value decreased rapidly.

Table 7 aligns the desired condition and expenditure level. The current PCI is at 74.3 and the physical condition desired is an average PCI of 80 to 85. This desired level is at the top range of the satisfactory PCI range. The table also shows the required funding to meet a level "B" expenditure level and associated funding gap.

Table 7: Funding Gap (in Millions of $)

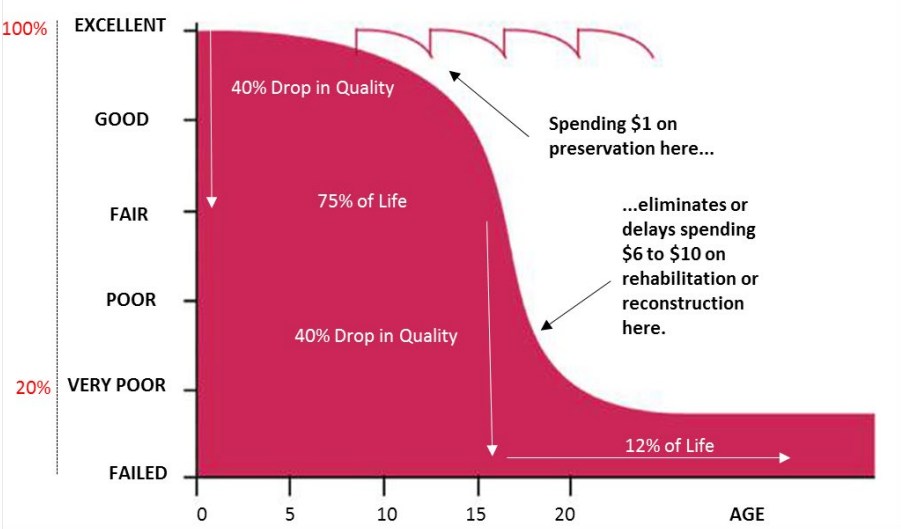
Asset	Physical Condition Actual	Physical Condition Desired	Desired Expenditure Level	Required Annual Funding (to meet Expenditure Level)	2016 Budgeted Annual Funding*	Annual Funding Gap (to meet Expenditure Level)
Roadways	PCI rating - 74.3	PCI target rating - 80.0 to 85.0	Level B	$26.20	$25.10	$1.10

**2016 budgeted funding of $25.1 million includes approximately $2.0 million of one time funding. The final phase in of the Building Better Roads Program to achieve the desired level of service is $3.1 million in 2017.*

As shown in Table 7, the amount of annual budgeted funding is not sufficient to achieve the desired "B" expenditure level. The final year of the building better roads initiative will address the outstanding funding gap of $1.1 million in 2017. If approved by City Council, the desired expenditure level will be reached.

Information from the Canadian Infrastructure Report Card 2016 demonstrates that increasing reinvestment rates will save money in the long-term. Without an increase in current reinvestment rates, the condition of City roadways will gradually decline, costing more money and risking service disruption. For example, Figure 4 demonstrates that when roads are allowed to deteriorate below a Fair condition rating, the rate of deterioration and reinvestment costs both increase substantially. Investing in preventive maintenance and regular repair will prolong the asset service life, avoiding premature and costly reconstruction and long-term service disruptions that are associated with the larger scope of work.

Figure 4: Example of Asset Deterioration Curve for Roadways



PRESERVATION PROGRAMS

The most effective way to achieve an improved roadway network condition is to use a mix of preservation, restoration, and rehabilitation treatments. Preservation treatments are less expensive than the restoration and rehabilitation treatments. Utilizing the preservation treatments are important to preserve the City's fair to good roads so they do not drop into a lower category based on the PCI.

Major Projects develops three year roadway preservation plans that cover full roadway treatments within the Preservation, Restoration, and Rehabilitation Treatment Strategies. Specific details of these treatments may vary year-to-year, depending on requirements or possible cost saving innovations. The specifics of each treatment are provided in yearly terms of reference documentation.

The photos below are examples of Microsurface and Resurfacing before and after photo.

Before microsurface

After microsurface

Before resurface

After resurface

A POTENTIAL PLAN TO ADDRESS THE FUNDING GAP

In 2013, City Council adopted the funding requirements to attain a Level of Service "B" based on "The Neighbourhood and Primary Roadway and Sidewalk Preservation" and "2013 Investing in the Roads to Continued Prosperity" reports. This level of service is intended to improve the condition of our roadways and slowly over time decrease the backlog of preservation work. Prior to 2013, funding received amounted in a resulting Service Level "E" where City's roads were deteriorating and resulting in a backlog as outlined in the October 25, 2013 report presented to the Administration and Finance Committee.

Capital funding spent on preserving roadways has increased significantly from $4.38 million in 2011 to a projected $25.1 million for 2016.

Table 8 illustrates a potential funding plan that could be implemented to meet the desired condition for roadway preservation.

Table 8: Potential Funding Plan Required for Good Condition Level (In Millions of $)

Paved Roadway and Sidewalk Preservation	2017	2018	2019	2020	2021
Arterial Roads	5.90	5.60	5.60	5.60	5.60
Collector Roads	5.90	5.80	5.80	5.80	5.80
Local Roads	3.90	3.90	3.90	3.90	3.90
Expressways	10.50	10.90	10.90	10.90	10.90
Mill Rate Impact	1.54%	0.00	0.00	0.00	0.00

**Increase has been included in the 2017 preliminary budget as part of the Building Better Roads funding strategy.*

The current strategy for preserving City roadways is to take into account where the road is in its lifecycle in relation to the typical design life of that road type. The typical design life of a road is 15 to 20 years before requiring a major restoration such as a resurfacing or structural improvement. Having a treatment cycle between 15 to 20 years is the goal for maintaining the current roadway network, although a treatment cycle closer to 15 years would help to maintain and improve the roadway network by reducing the backlog of roadways in the poor to failed condition. The treatment cycle does not mean that every road will necessarily

be treated in that 20 year period, but that the overall roadway network will have an average 20 year cycle. The condition, road type, the treatment required, and prioritization are all factors for selection of roads to be preserved, restored, or reconstructed.

As illustrated in Table 9 and based on the 2011 funding levels, the average roadway treatment cycle would be once every 83 years. In 2015 and estimated out to 2017, the funding levels and treatment selection strategy improved the average roadway treatment cycle to approximately once every 18 to 20 years, which is still a significant improvement from 5 years ago. This increase shows that the current funding strategy is in line with the typical surface treatments.

Table 9: Capital Funding and Treated Network

Treatment Year	Capital funding Dedicated to Roads ($M)	Ln-km Treated	Network Ln-km	Percent of Network Treated	Average Treatment Cycle
2011	4.38	45.1	3,690	1.2%	83 years
2012	6.96	51.4	3,758	1.4%	71 years
2013	13.33	76.6	3,906	2.0%	50 years
2014	23.40	200	3,958	5.1%	20 years
2015	21.16	220	4,014	5.5%	18 years
2016	25.10	230*	4,075	5.6%	18 years
2017	26.20	202*	4,135	5.0%	20 years

**Projected Lane kilometers*

CLIMATE ADAPTION STRATEGY

The Administration understands that road work is weather dependent. During periods of extreme weather, such as a major rain event or early winter, some projects are unable to be completed or started until favourable conditions return. If current year funding for roads are planned but cannot be completed or started due to unfavourable weather conditions or seasonal changes, work on those roads will be carried over to the next construction season.

In addition, recent changes to the roadway design standards have been implemented to require mandatory edge drainage systems to new roadway structures. This implementation will ensure that the road structure can be drained and protected during extreme weather events and high water tables caused by adverse weather conditions.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City of Saskatoon