Road Needs Study Report - 2019

The Township of Zorra

D.M. Wills Project No.19-4698

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Peterborough

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Prepared for The Township of Zorra

Executive Summary

The Township of Zorra (Township) retained the services of D.M. Wills Associates (Wills) to undertake a review of the Township's existing road network, and assess its physical condition as well as confirm various road attributes. Data collected during the field review was used to develop a prioritized listing of the road network needs, the results of which are documented in this report.

The Township's road infrastructure system spans a total of 474 km primarily within a rural setting, with small areas of urban and semi-urban development. The road network includes surfaces ranging from gravel to hot mix pavement (asphalt). The Township has approximately 344 km of gravel roads, 8 km of surface treated roads (low class bituminous (LCB) and intermediate class bituminous (ICB)), and 123 km of hot mix asphalt paved roads (high class bituminous (HCB)).

Two (2) primary indicators of the relative health of a road are the structural adequacy and surface condition ratings. The current average structural adequacy rating for the Township's road network is 14.8/20. The current average surface condition rating for the Township's road network is 7.7/10.

4% (~18 km) of the road network has a Structural "NOW" need, 4% (~20 km) has a Structural "1-5" year need, and 6% (~26 km) of the road network has a Structural "6-10" year need.

It should be noted that a structural "NOW" need does not explicitly mean that work must be undertaken on the road immediately (although this may be so in some cases). A structural "NOW" need means that a significant portion of the road is showing distress and requires significant intervention i.e. reconstruction or major rehabilitation to renew its service life. A structural "1-5" year need is expected to become a "NOW" need in the next five years, and a "6-10" year need is expected to become a "NOW" need in the next 10 years should no intervention treatments take place.

Preservation Management

In addition to addressing currently deficient roads (i.e. capital reconstruction), a dedicated preservation management approach is required, **and perhaps even more important**, to "keep the good roads good"; the fundamental principle being that it costs much less to maintain a good road than it does to let it fail and then reconstruct it, from a life cycle cost perspective. Ultimately, the goal of preservation management is to extend the useful life of a road and road network, maximizing the Township's investment over the road life-cycle.

Roads with a structural adequacy of 12/20 or greater are included as candidates for potential resurfacing. Preliminary recommendations and prioritization for road resurfacing are based on condition rating and traffic demands on each road section, as per the Inventory Manual. A road with higher traffic volumes and fair structural

adequacy is given priority over a road with moderate traffic and good structural adequacy score, in an attempt to intervene and extend the life of the road before it deteriorates to a level that can no longer be resurfaced (i.e. more expensive reconstruction is required). Specific resurfacing treatment recommendations must be assessed through further field investigation and detail design effort, prior to selecting and implementing the resurfacing strategy.

Based on typical degradation rates for gravel roads, surface treatment, and hot mix, a resurfacing program and related budget is recommended as follows:

Hot Mix Paved Roads:

- 122.7 km of paved roads (HCB).
- Degradation rate 0.25 / year (rating drops from 10 to 5, over a 20-year period).
- Annual resurfacing 6.1 km / year.
- **Annual budget $1,732,400**: (6.1 km / year x $142,000 / ln **RMP1** x 2 lanes).

Surface Treated Roads:

- 7.8 km of surface treated roads (LCB & ICB).
- Degradation rate 0.625 / year (rating drops from 10 to 5, over a 7-year period).
- Annual resurfacing 1.1 km / year.
- **Annual budget $26,950** (1.1 km / year x $25,000 / km **ST1**).

Gravel roads require regular maintenance. Maintenance includes regular grading and reapplication of new gravel. Typically, gravel roads should be resurfaced on a 3 year cycle.

Gravel Roads:

- 343.7 km of earth / gravel roads.
- 50 mm gravel every 3 years.
- Annual gravelling of 114.6 km.
- Granular A ($12,000 / km).
- **Annual budget $1,375,200** (114.6 km / year x $12,000 **G**) **.

*** Cost based on supply and application of gravel by external forces.*

The total resurfacing program, (hot mix, surface treatment and gravel) is estimated at $3,134,550 per year.

Preservation techniques seal the surface as to prevent water infiltration into the granular base. Route and Seal is used on HCB pavements to seal individual cracks. Slurry Seal /

Microsurfacing is used on LCB and HCB pavements to seal large areas, although wide / active cracks will reflect through the treatment. An annual preservation management budget has been estimated as follows:

Cracksealing

- 6.1 km of paved roads (HCB).
- Assume that cracksealing will be applied, on average, once per resurfacing cycle.
- Annual cracksealing of 6.1 km / year
- **Annual budget $24,400** (6.1 km x $4,000 / km **Cracksealing**).

Slurry Seal / Microsurfacing

- 122.3 km of paved roads (HCB).
- 7.8 km of surface treated roads (LCB & ICB).
- Assume that slurry seal / microsurfacing will be applied, on average, once per resurfacing cycle.
- 7.2 km of road to preserve per year (6.1 km HCB and 1.1 km of LCB).
- **Annual budget $146,160** (7.2 km x $20,000 / km **Slurry Sealing / Microsurfacing**).

Further to the recommendations above with respect to resurfacing, it is also recommended that regular maintenance in the form of roadside ditch cleanout and clearing be undertaken as a critical component to preservation management in order to extend the useful service life of the existing roads.

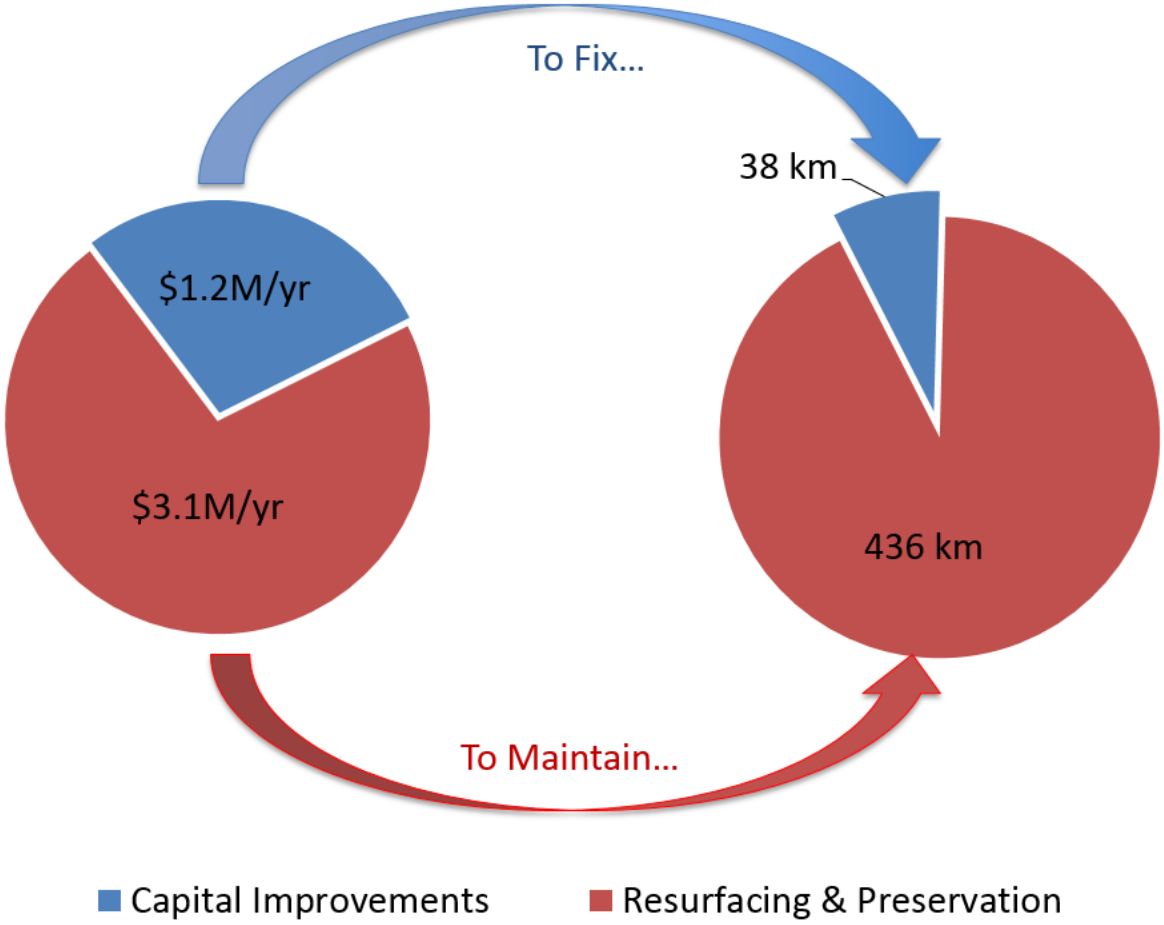
Capital Improvements

Preliminary recommendations and prioritization for planned capital improvements i.e. reconstruction, have been developed based on the condition rating and traffic demands on each road section, as per the Inventory Manual. Those roads identified as having a "NOW" or 1 - 5 year need have been included in the capital improvement plan for reconstruction.

A total length of 37.9 km of roads were identified as having structural needs in the "NOW," or 1 – 5 year periods. The estimated cost to improve these roads is approximately $ 11.6 M.

It is important to highlight the network's average structural adequacy score of 14.8/20, as noted previously. A significant portion of the Townships roads are approaching a condition that will require reconstruction, as opposed to less costly resurfacing.

A fully funded 10 year plan following the recommendations in this report includes $3.1M/year for resurfacing needs and $11.6M ($1.2M/year) for the capital needs over ten years. Funding recommendations can be visualized in the graphic below.



Given that 86% of Zorra's Road network has no structural need identified, Wills recommends that priority should be given to resurfacing and preservation over capital needs should funding fall short of ideal levels.

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1.0 Purpose, Background and Study Method

1.1 Purpose

The purpose of the 2019 Road Needs Study Report is to update the current road inventory and road condition assessments within the Township of Zorra (Township). Using this information, a prioritized listing of the road network needs is developed. The information derived from the study and documented in this report will provide assistance to the Township for developing and executing a planned road maintenance and improvement program.

The Township retained the services of D.M. Wills Associates (Wills) to undertake a review of the existing road network, and assess its physical condition as well as confirm various attributes. Data collected as a result of the field review is used to develop a prioritized listing of the road network needs, the results of which are documented in this report.

1.2 Background

The Township of Zorra is located in the County of Oxford, east of London and west of Woodstock. The Township is largely rural with some scattered urban / semi-urban developments. Several gravel pits are located within the Township, contributing to high heavy truck volumes.

This Road Needs Study was completed to inventory and document the Township's existing road assets. This current study (2019) utilizes and builds from the road asset information maintained by the Public Works Department in addition to Oxford County GIS information.

1.3 Study Objectives

Based on discussion with Township staff, the following study objectives were identified:

- Provide a current inventory and value of the Township's roads, assess road conditions and needs, and develop a priority listing for construction needs and improvements.
- Provide a prioritized list of capital projects for the Township to invest in.

To ensure compliance with the latest Ministry of Transportation (MTO) guidelines, the inventories were completed in accordance with the most current edition of the Inventory Manual for Municipal Roads.

1.4 Study Methodology

The procedure utilized to complete the study was in accordance with the Ministry of Transportation's Inventory Manual for Municipal Roads (February 1991).

Additionally, field reviews for the purpose of Pavement Condition Index (PCI) were undertaken in accordance with:

- MTO Manual for Condition Rating of Flexible Pavements, SP-024.
- MTO Manual for Condition Rating of Surface-Treated Roads, SP-021.

There are two (2) key observations when using PCI methods: the Ride Condition Rating (RCR), and the Distress Manifestation Index (DMI). RCR is a subjective measurement of how smooth a travelled surface is, rated from 0 to 10, with 10 representing excellent, new surfaces, and 0 representing an extremely rough, impassible road. DMI aggregates various forms of visible pavement distress into a rating from 0 to 10, with 10 representing a new surface and 0 representing a destroyed surface.

RCR and DMI are rated strictly independently. A rough road may have relatively few visible distresses while a fairly smooth road may display many distresses. In general, rough roads display associated visible distresses.

The combined approach facilitates comparing all the Township's roads, as the Inventory Manual prescribes the same rating system regardless of surface type, while also providing detailed descriptions of the types of distress encountered on surfaces as per the PCI ratings. This approach is compliant with O. Reg. 588/17. Wills undertook the field study in July of 2019.

During the field study, a visual assessment of the following road characteristics was documented to assess the current adequacy of the road:

- Platform Width (overall width of road).
- Surface Width (width of pavement surface).
- Shoulder Width.
- Surface Type (gravel, low class bituminous, or high class bituminous).
- Drainage Type (open ditches vs. storm sewers etc.).
- Surface Condition (assigned based on Ride Condition Rating for this Study).
- Maintenance Demand.
- Roadside Environment.
- Capacity.
- Alignment.

1.4.1 Critical Deficiencies

Critical deficiencies represent road characteristics that result in increased maintenance costs or lead to an inadequate level of service. Road sections may be assessed as critically deficient if any one (1) of the following characteristics fall below the minimum tolerable standards defined in the MTO Inventory Manual:

- Surface type - Insufficient surface type for traffic volumes.
- Surface width - Insufficient width of the road surface excluding the shoulders.
- Capacity - Inability of the road to accommodate traffic volumes at peak periods.
- Structural Adequacy - Inability of the road base to support vehicular traffic.
- Drainage - Increased frequency of flooding or excessive maintenance effort required to prevent flooding.

Critically deficient roads have generally reached the end of their service life and /or require major work to improve e.g. widening or new surface type. As such, reconstruction is generally required.

Surface Type

The following parameters were used to assess the adequacy of the road surface type. Road sections with traffic volumes (AADT) in excess of the Minimum Tolerable values for Earth and Gravel in **Table 1**, were noted as critically deficient triggering a "NOW" surface type need as per the Inventory Manual Method.

Table 1 – Surface Type by Annual Average Daily Traffic (AADT)

Surface Type	AADT		
	Inventory Manual		MTO Pavement Design and Rehabilitation Manual[1]
	Minimum Tolerable	Design Standard	
Earth (E)	<50	-	-
Gravel (G)	<400	0-199	0 - 199
Low Class Bituminous (LCB) / Surface Treatment	-	200-399	200 - 1500
High Class Bituminous (HCB) / Hot Mix	-	400+	>1500

Table 1 provides further guidance with respect to surface type from both the Inventory Manual as well as the MTO Pavement Design and Rehabilitation Manual.

[1] Ministry of Transportation. Pavement Design and Rehabilitation Manual, Second Edition, 2013, Table 3.3.3 Structural Design Guidelines for Flexible Pavement – Secondary Highways

As detailed in **Table 1**, Gravel surfaces are generally considered acceptable for AADT of less than 200 vehicles but may be tolerable up to 400 AADT. Transition to Surface Treatment should be considered above 200 AADT. Gravel road maintenance costs (resurfacing, grading, dust suppression, etc.) versus surface treatment costs are key considerations.

Low Class Bituminous (LCB) i.e. Surface Treatment may be acceptable for traffic volumes between 200 and 1500 AADT. A transition to a Hot Mix or High Class Bituminous surface from Surface Treatment must be considered on a case by case basis. The following factors require consideration:

- Surface Treatment Maintenance Costs.
- Commercial Vehicle Loading.
- Roadside Environment (Urban, Semi-urban, vs. Rural).
- On-street Parking.
- Adjacent Drainage Infrastructure i.e. curb and gutter, catch basins etc.
- Asphalt Availability/Cost.
- Surface/Platform Width.
- Traffic Volume Growth.
- Sub-base Quality.
- Roadbed Frost Susceptibility.
- Future Resurfacing/Rehabilitation Costs.

Vehicle loading is one of the key considerations for pavement design and ultimately the decision between Hot Mix and Surface Treatment. Roads with high levels of commercial traffic require a more substantial pavement structure. The values noted in **Table 1**, for the "MTO Method" are generally reflective of a highway with 10% commercial vehicles. Roads with AADT in excess of 400 vehicles with a good sub-base and commercial vehicles up to 10% may still perform very well with a Surface Treatment. Existing/past performance of a Surface Treatment can be an excellent indicator when considering the upgrade to Hot Mix.

Surface Width

Surface widths that fall below minimum tolerable standards, as detailed in the MTO Inventory Manual are noted as critically deficient triggering a "NOW" need. The Minimum Tolerable Surface Widths for Rural roads are included in **Table 2**:

Table 2 – Rural Road Surface Width by Annual Average Daily Traffic (AADT)

	AADT							
	1-49	**40-199**	**200-399**	**400-999**	**1000-1999**	**2000-2999**	**3000-3999**	**4000+**
Road Width (m)	5.0	5.5	5.5	6.0	6.0	6.0	6.5	6.5

Capacity

An in-depth traffic capacity analysis was not completed as part of the scope of this Road Needs Study. Decisions with respect to expansion of roads should be made within the context of a Transportation Master Plan or Official Plan for the Township.

However, from a general perspective, a two-lane road can typically provide adequate service up to an AADT of approximately 12,000 vehicles. The functionality of a road from a capacity standpoint is of course dependent upon other factors in combination with volume. Adjacent land uses, number of access points i.e. entrances and side roads etc. also have a significant impact on how the road functions.

A rural road with limited entrances and side roads will have a much greater capacity to flow traffic versus an urban street with many entrances and side road intersections. The AADT of 12,000 can be used as a 'rule of thumb' to trigger further analysis on the road capacity and operation. For the purposes of this study, a detailed capacity analysis was not undertaken as part of the scope of work. All roads were assigned to be adequate from a capacity perspective noting that no road section had an AADT greater than 5000 vehicles.

Structural Adequacy

In cases where road base or structure is showing distress over more than 20% of the length of the road section, a score between 1 and 7 (out of 20) is assessed and the road section is assigned a "NOW" need and considered Critically Deficient per the Inventory Manual. The structural adequacy rating is often the best indicator of the overall road section's health.

It should be noted that a structural "NOW" need does not explicitly mean that work must be undertaken on the road immediately (although this may be so in some cases). A structural "NOW" need means that a significant portion of the road is showing distress of the road bed and requires significant intervention i.e. reconstruction or major rehabilitation to renew it service life. A structural "1-5" year need is expected to become a "NOW" need in the next five years, and a "6-10" year need is expected to become a "NOW" need in the next 10 years.

Drainage

A road section is assessed as a "NOW" need for drainage generally when a road becomes impassible due to water one or more times a year. This information is not readily accessible from inspection. Characteristics such as ditching, water ponding on or around the road, and evidence of past washouts were used to assess road drainage. As such, a road was given a "NOW" need for drainage if there were evident drainage problems that would likely lead to an impassable road during a heavy rain or a rapid snow melt.

2.0 The Road System

2.1 Inventory and Classification

All roads in the Township road system were inventoried according to the methods outlined in the Inventory Manual for Municipal Roads.

The inventory procedure requires that each road in the system be studied as a separate unit. Initially, the road system was divided into sections so that each conformed, as close as possible, to the following requirements:

- Uniform traffic volume.
- Uniform terrain.
- Uniform physical conditions.
- Uniform adjacent land.

Depending on location with respect to the built up areas, roads were classified in a manner generally descriptive of the type of construction as follows:

- Urban - Roads with curb and gutter and storm sewer drainage.
- Semi-Urban - Roads in built up areas (development exceeds 50% of the frontage) without curb and gutter or curb and gutter on one (1) side only.
- Rural - Roads with development on less than 50% of the frontage.

Rural roads were further evaluated based on estimated traffic volumes; such as 0 to 50 vehicles per day, 51 to 200, and 201 to 400 etc. For the purpose of this study, traffic volumes were adopted or estimated from traffic counts completed by the Township.

Table 3 summarizes the total road length in kilometres by surface type and road environment as of July, 2019.

The existing road system contains a total of 474 km of roadway, including 344 km of gravel roads, 8 km of surface treated roads (LCB & ICB) and 123 km of HCB (asphalt paved) roads; with all calculations being approximate and rounded to the nearest kilometre.

Table 3 – Road System Inventory

Township of Zorra		
Road System in Kilometres		
(As of July 2019)		
A.	**Surface Type**	**Totals***
	Gravel (loose Top Gravel)	343
	Surface Treatment (LCB & ICB)	8
	Hot Mix Asphalt (HCB)	123
	Total A	**474 km**
B.	**Roadside Environment**	
(i)	**Rural**	
	Gravel (loose Top Gravel)	342
	Surface Treatment (LCB & ICB)	7
	Hot Mix Asphalt (HCB)	96
	Total Rural	**445 km**
(ii)	**Semi-Urban**	
	Gravel (loose Top Gravel)	2
	Surface Treatment (LCB)	<1
	Hot Mix Asphalt (HCB)	9
	Total Semi-Urban	**12 km**
(iii)	**Urban**	
	Gravel (loose Top Gravel)	0
	Surface Treatment (LCB)	0
	Hot Mix Asphalt (HCB)	17
	Total Urban	**17 km**
	Total B	**474 km**
**Estimated to the nearest centreline kilometre.*		

3.0 Road Needs

The primary purpose of the study is to develop a list of all roads within the Township ranked according to priority with respect to road needs.

The method of evaluating road needs in terms of type, cost and timing of improvements is identified in the Inventory Manual for Municipal Roads.

It is important to note that budgetary restrictions will often influence the level of upgrades to the road system and therefore it is imperative to maximize the improvements based on availability of funds and needs priority.

3.1 Critical Deficiencies

The inventory of the road system revealed that certain road sections are now deficient or will become deficient during the study period.

As noted previously, critical deficiencies include road characteristics which result in increased maintenance costs and which inevitably lead to an inadequate level of service. A road section is critically deficient if any one of the following characteristics fall below the minimum tolerable standards defined in the Inventory Manual.

- Surface type - Incorrect surface type to suit traffic volumes on the roadway.
- Surface width - Insufficient width of the road surface excluding the shoulders.
- Capacity - Inability of the road to accommodate traffic volumes at peak periods.
- Structural Adequacy - Inability of the road base to support vehicular traffic.
- Drainage - Increased frequency of flooding or excessive maintenance effort required to prevent flooding.

Of the 474 km of roads inventoried, a total of 99 km were found to be critically deficient in one (1) or more areas. Of the 99 km, approximately 2.8 km represents roads with AADT of less than 50 vehicles. Regardless of condition, roads with AADT of fifty (50) or less are typically assigned as "Adequate" (as per the Ministry protocol) for the purpose of the system adequacy calculation.

The overall system adequacy for the Township's road network, which is based upon the total road kilometres less the identified critically deficient ("NOW" needs) roads, is as follows:

$$\textbf{2019 System Adequacy} = \frac{\textbf{474 - (99 - 2.8)}}{\textbf{474}} \textbf{ x 100\% = 80\%}$$

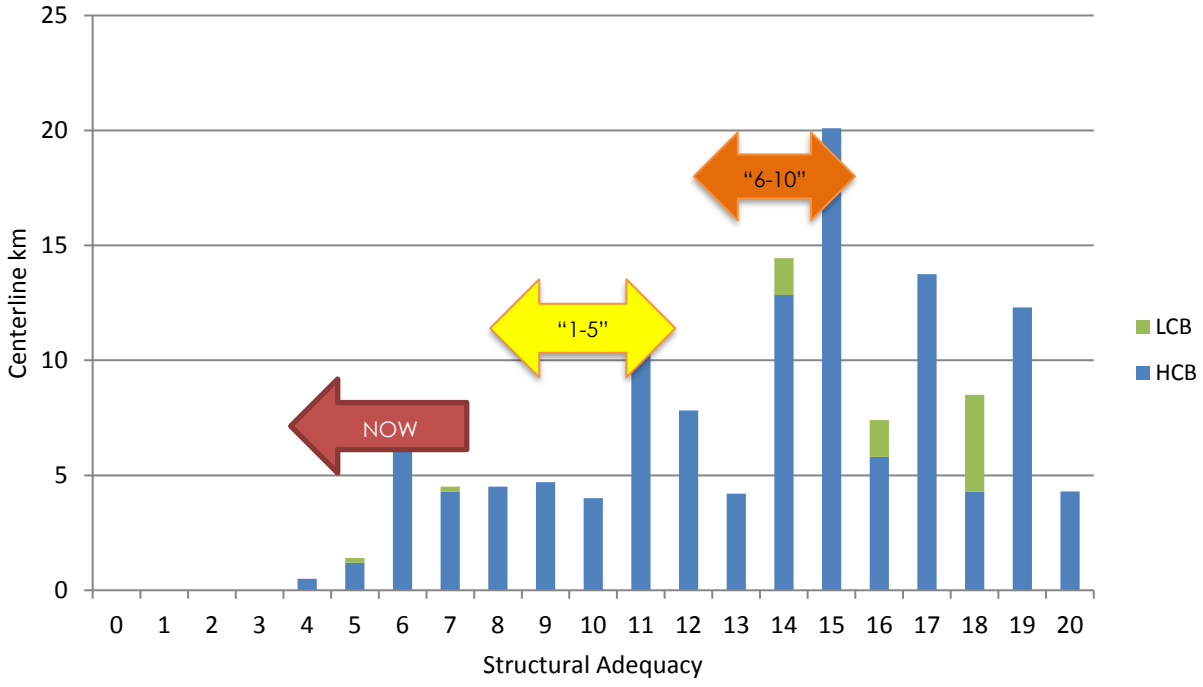
The average surface condition rating of all roads is 7.7/10 while the average structural adequacy rating is 14.8/20. This suggests that the typical road has a fair to good riding quality, but just at the point where significant rehabilitation or reconstruction is required.

As required by O. Reg. 588/17, the average unpaved road was in good condition and the average PCI for hard top surfaces in the Township is 78.9.

A review of the structural adequacy distribution of the Township's hard top roads identifies a group of roads, 66 km, that are in very good condition (structural adequacy of 15 and over), and with regular resurfacing and preservative maintenance, should not require reconstruction in the next 10 years. Another cohort of roads, approximately 27 km, are in average condition (Structural Adequacy from 12 to 14). Some of these roads may continue to perform well, but without timely resurfacing and preventative maintenance, many of them are expected to become NOW or 1 – 5 year needs. The remaining 38 km of hard top road network is well distributed over the very poor to poor range (structural adequacy from 4 to 11). Most of these roads will require reconstruction over the next 5 years to fully repair them.

It is therefore recommended that, while the Township endeavors to repair these poor roads as part of its 10-year capital plan, every reasonable effort is made, through preservation management, to prevent the current cohort of fair to very good roads (66 km) from becoming capital reconstruction needs themselves.

Figure 1 – Structural Adequacy Distribution



3.2 Priority Ratings of Roads

A mathematical empirical formula was used to calculate the priority rating for each road section. The priority rating is a weighted calculation which takes into account the existing traffic volume and overall condition rating of the road.

This priority analysis is an impartial procedure to place the deficiencies in order of relative need. **A higher Priority Rating number indicates a relatively greater need for improvement.**

The formula takes into account the current traffic volume (AADT), whether it is from actual road counts or estimated road counts and the Condition Rating (CR) of the road at the time of this Road Needs Study Report. The formula is as follows:

$$\textbf{Priority Rating} = 0.2 \times (100 - CR) \times (AADT + 40)^{0.25}$$

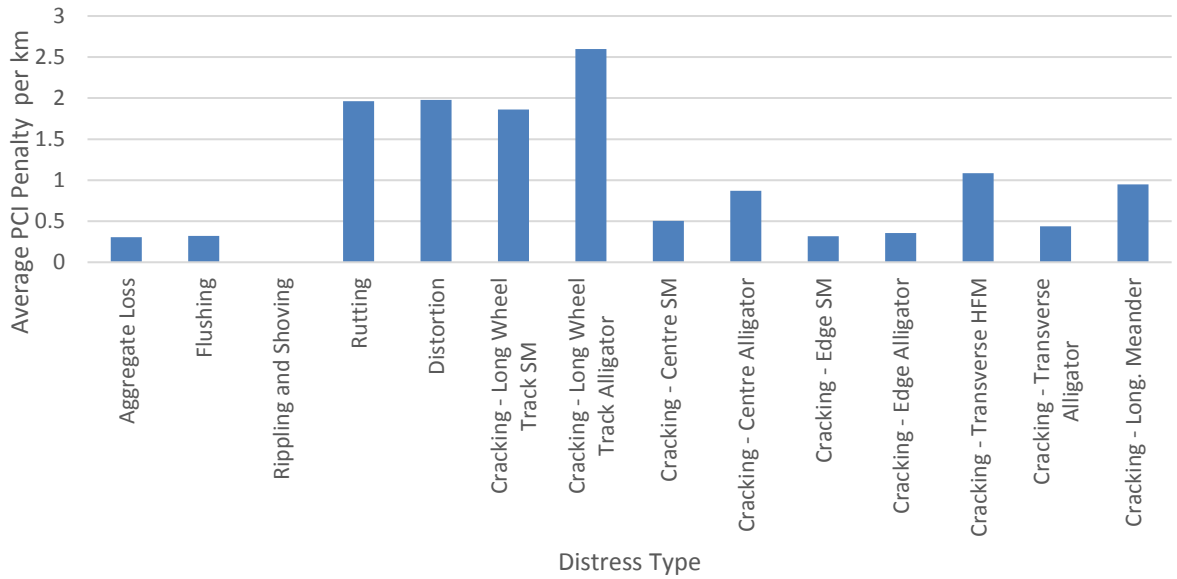
In utilizing the above equation Wills identified a priority listing for review with Township staff. It is important to emphasize that the priority rating calculation considers only CR and traffic volumes.

When developing the recommended capital expenditure plan consideration may be given to the remaining useful service life of a road / roadbed with a view to coordinating major reconstruction efforts at / near the end of the road's life. Furthermore, while a priority rating will give a general idea of which roads should be improved before others, it does not prescribe an exact order for road improvements nor does it determine the timing of preservation and rehabilitation work. For example, it may be wise to defer the full reconstruction of a high priority road ("let the bad roads fail") in favour of resurfacing work on a medium priority road ("keep the good roads good").

3.3 Dominant Distress Types

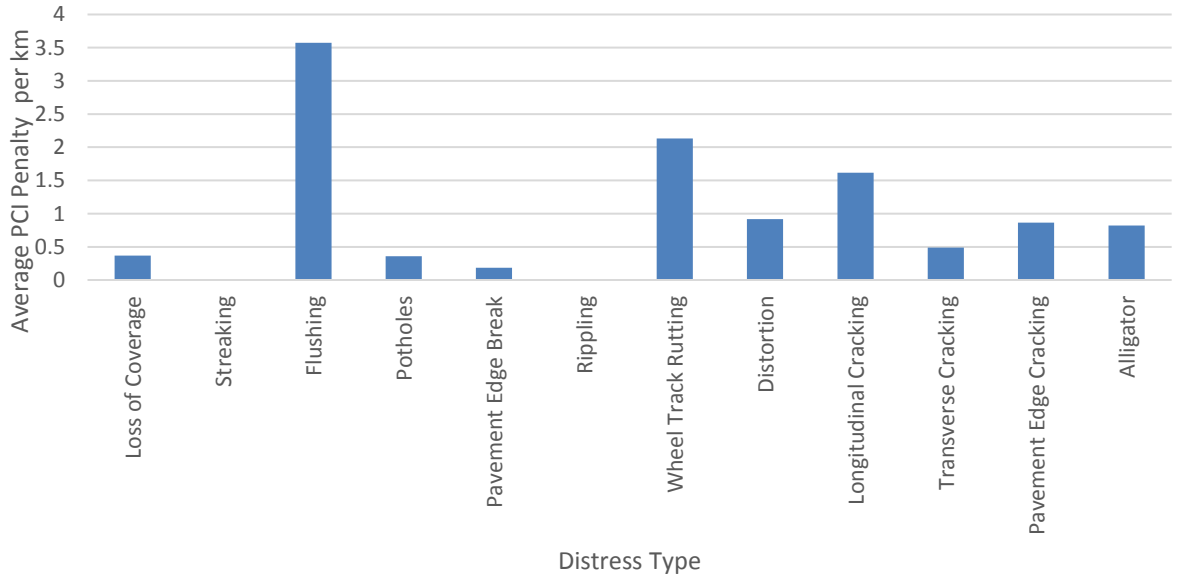
As detailed in **Figure 2,** distortion had the highest effect on PCI rating on the Township's HCB network. Transverse and wheel track cracking were also substantial, with rutting and aggregate loss also responsible for significant penalties to the Township's PCI ratings. Flushing, and rippling and shoving were not observed during inspections.

Figure 2 – HCB Distress Type Prevalence



As detailed in **Figure 3** the principal distress type in the Township's LCB roads was also distortion. Other distress types were moderately significant except for flushing, rippling and transverse cracking which had a minor average impact on average PCI ratings for LCB Roads.

Figure 3 – Surface Treated Distress Type Prevalence



Distress descriptions can be found in **Appendix B**.

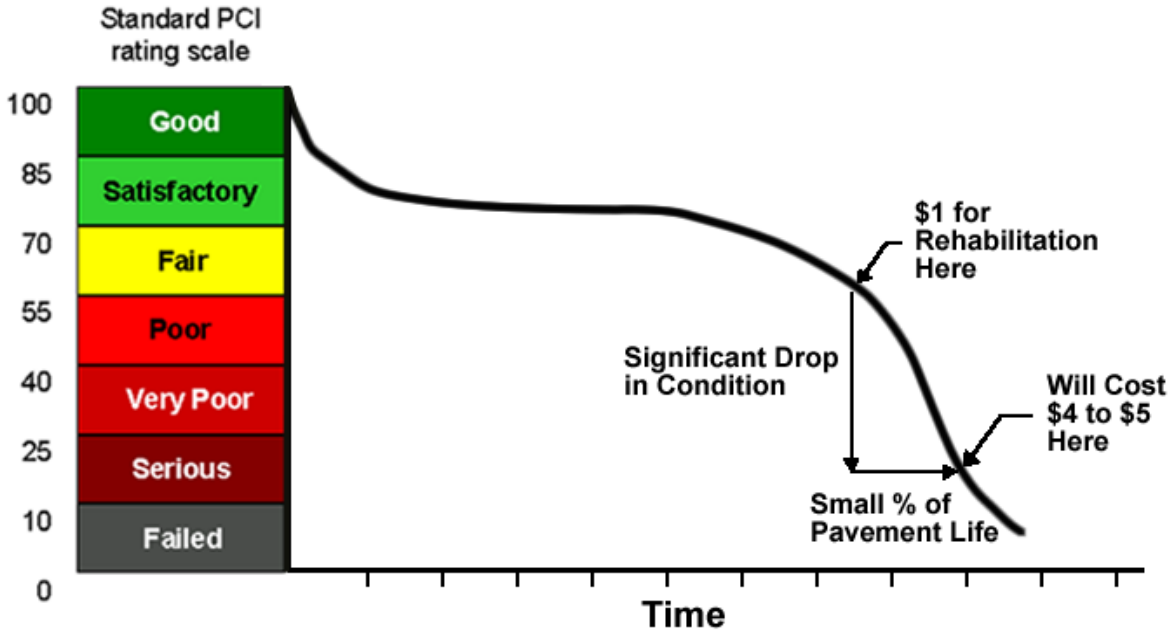
4.0 Roads Best Management Practices

The key to managing a pavement / road network is the timing of maintenance and rehabilitation activities. This idea evolves from the fact that a pavement's structural integrity does not fall constantly with time. A pavement generally provides a constant, acceptable condition for the first part of its service life and then begins to deteriorate very rapidly. In many cases, maintenance and rehabilitation measures are not taken until structural failure or noticeable changes in ride quality become apparent. This is the "fix it once it is already broken" approach.

The unfortunate consequence of this decision is that maintenance and rehabilitation becomes exponentially more expensive over the life of the pavement and is often overlooked until the pavement condition reaches a severe state of distress. There is opportunity for substantial cost savings when intervention is made *before* the pavement becomes severely compromised; i.e. "fix it before it breaks". **Figure 3** illustrates the underlying principle in support of a preservation management approach to pavement infrastructure. The principle also has application to each of the classes of roads maintained by the Township. Significant cost savings will result from proactive intervention rather than simply waiting as long as possible before performing maintenance.

Examples of approach to roads management with their associated cost implications over the lifecycle of a road are set out below in **Figure 4** and are provided as an illustration of the benefit of a "preservation management approach".

Figure 4 – Typical Service Life of an Asphalt Pavement



4.1 Example Life Cycle Cost Analysis

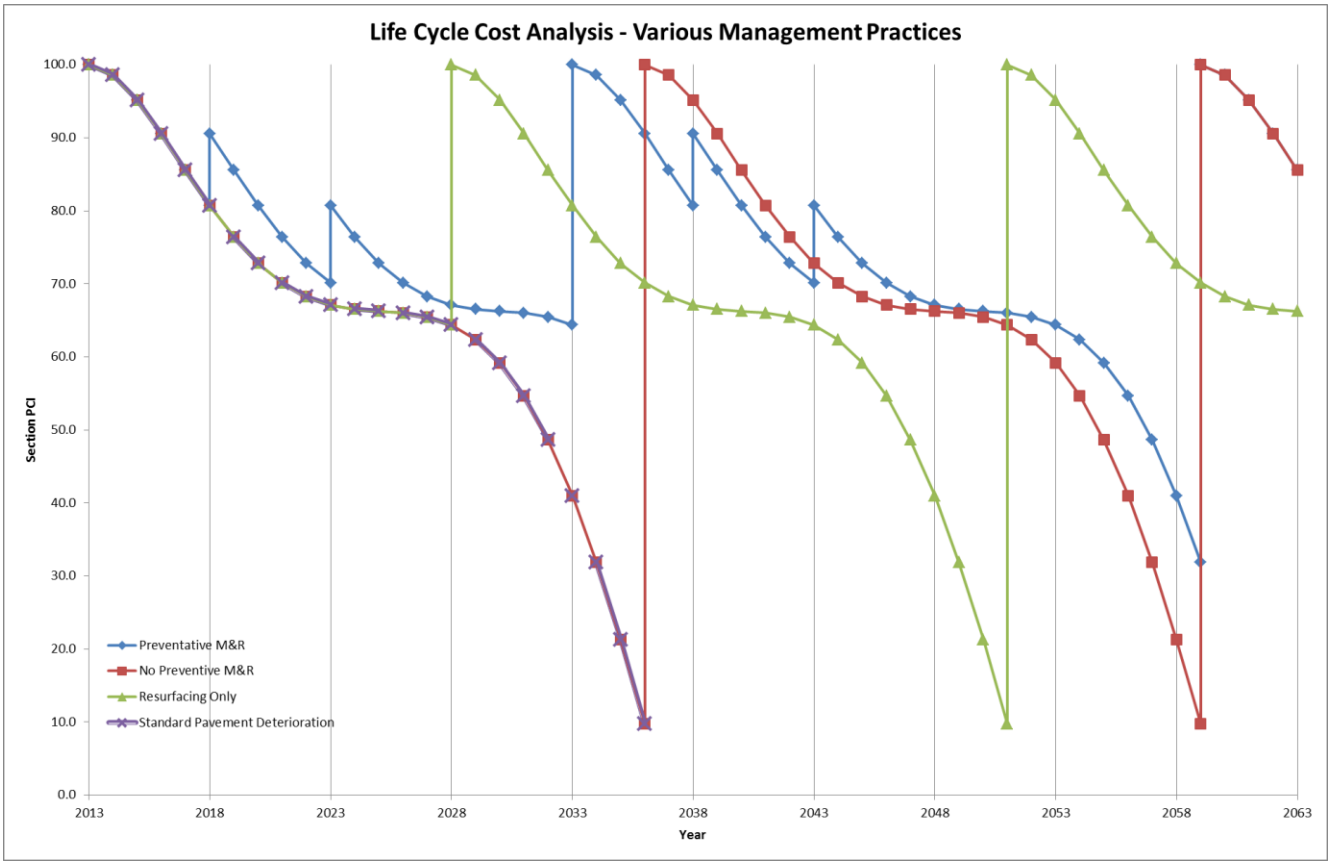
The following life cycle costs analysis compares three (3) different municipalities Municipality 1, Municipality 2 and Municipality 3; each with three (3) distinct approaches to pavement management. For this analysis we will assume each of the three (3) municipalities has 7000 m^2 of pavement, i.e. 1 km of asphalt paved road that is 7 m wide. In each scenario, the road is assumed to have been constructed in 2013 and will operate under normal traffic loading.

The Life Cycle Cost Analysis (LCCA) assumes no user costs. The LCCA uses a discount rate of 2.5% / year.

The LCCA shows the three (3) different municipalities and tracks their pavement management decisions and related condition over the specified time period. Municipality 1 represents decisions made based on strategic preventive maintenance and rehabilitation (M&R), Municipality 2 represents decisions based on no preventive M&R and Municipality 3 represents decisions based on resurfacing only.

Figure 5 below illustrates a time- pavement condition plot for each municipality.

Figure 5 – Time-Condition Plot for 3 Municipalities



The costs associated with the corresponding maintenance and rehabilitation decisions are outlined in the following three (3) charts:

Preventive M&R									
Year	**Age**	**Treatment**	**Δ PCI**	**PCI_q**	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**	**Present Worth**
		-- Annual Ditching/Clearing --							
2018	**5**	**Localized Preventive - Rout and Seal**	81-90	Satisfactory-Good	1000	m	$1.50	$1,500.00	**$1,325.78**
2023	**10**	**Global Preventive - Slurry Seal**	70-81	Satisfactory-Good	7000	m^2	$6.50	$45,500.00	**$35,544.53**
2033	**20**	**Surface Course**	64-100	Poor-Good					
		Mill and Dispose of Surface Course			7000	m^2	$12.00	$84,000.00	
		50mm Surface Course			892.5	t	$135.00	$120,487.50	
								$204,487.50	**$124,792.78**
2038	**25**	**Localized Preventive - Rout and Seal**	81-88	Satisfactory-Good	4500	m	$1.50	$6,750.00	**$3,640.89**
2043	**30**	**Global Preventive - Slurry Seal**	68-78	Satisfactory-Good	7000	m^2	$6.50	$45,500.00	**$21,691.79**
2048	**35**	**Safety/Stopgap Maintenance - AC Patching/Leveling**	N/A	N/A	5%	m^2	$30.00	$10,500.00	**$4,424.40**
2053	**40**	**Safety/Stopgap Maintenance - AC Patching/Leveling**	N/A	N/A	10%	m^2	$30.00	$21,000.00	**$7,821.04**
2058	**45**	**Full Reconstruction**	32-100	Serious-Good					
		Remove Asphalt Full Depth			7000	m^2	$15.00	$105,000.00	
		Add and Compact Corrective Aggregate/Correct Crossfall (25mm avg.)			420	t	$35.00	$14,700.00	
		40mm Base Course			686	t	$125.00	$85,750.00	
		50mm Surface Course			892.5	t	$135.00	$120,487.50	
								$325,937.50	**$107,290.28**
2063	**5**	**Localized Preventive - Rout and Seal**	81-90	Satisfactory-Good	1000	m	$1.50	$1,500.00	**$436.41**
		Final PCI in 2063:	**90**	**Good**				**Net:**	**$306,967.90**
								Residual Value:	**$85,346.08**
								Total Cost:	**$221,621.82**

The policy of Municipality 1 is to strategically intervene with preventative maintenance measures over the course of the pavement's service life. Two (2) significant maintenance measures are performed on the pavement at various times and ultimately extend the service life of the pavement, prorating the total cost of the pavement over a longer period of time. Eventually, a full reconstruction is required and this cycle repeats. The total life cycle costs are substantially less when compared to Municipality 2 and 3, at a total of $221,622 over 50 years.

No Preventive M&R									
Year	**Age**	**Treatment**	**Δ PCI**	**PCI_q**	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**	**Present Worth**
2023	**10**	**Safety/Stopgap Maintenance - AC Patching/Leveling**	N/A	N/A	5%	m^2	$30.00	$10,500.00	**$8,202.58**
2028	**15**	**Safety/Stopgap Maintenance - AC Patching/Leveling**	N/A	N/A	10%	m^2	$30.00	$21,000.00	**$14,499.78**
2030	**17**	**Safety/Stopgap Maintenance - AC Patching/Leveling**	N/A	N/A	20%	m^2	$30.00	$42,000.00	**$27,602.19**
2036	**23**	**Full Reconstruction**	10-100	Poor-Good					
		Remove Asphalt Full Depth			7000	m^2	$15.00	$105,000.00	
		Add and Compact Corrective Aggregate/Correct Crossfall (25mm avg.)			420	t	$35.00	$14,700.00	
		40mm Base Course			686	t	$125.00	$85,750.00	
		50mm Surface Course			892.5	t	$135.00	$120,487.50	
								$325,937.50	**$184,707.88**
2043	**7**	**Safety/Stopgap Maintenance - AC Patching/Leveling**	N/A	N/A	5%	m^2	$30.00	$10,500.00	**$5,005.80**
2048	**12**	**Safety/Stopgap Maintenance - AC Patching/Leveling**	N/A	N/A	10%	m^2	$30.00	$21,000.00	**$8,848.79**
2053	**17**	**Safety/Stopgap Maintenance - AC Patching/Leveling**	N/A	N/A	20%	m^2	$30.00	$42,000.00	**$15,642.09**
2059	**23**	**Full Reconstruction**	10-100	Poor-Good					
		Remove Asphalt Full Depth			7000	m^2	$15.00	$105,000.00	
		Add and Compact Corrective Aggregate/Correct Crossfall (25mm avg.)			420	t	$35.00	$14,700.00	
		40mm Base Course			686	t	$125.00	$85,750.00	
		50mm Surface Course			892.5	t	$135.00	$120,487.50	
								$325,937.50	**$104,673.45**
		Final PCI in 2063:	**86**	**Good**				**Net:**	**$369,182.56**
								Residiual Value:	**$81,552.92**
								Total Cost:	**$287,629.64**

The policy of Municipality 2 is to simply construct the pavement and wait until serious deficiencies begin to appear before acting. This approach unfortunately remains common still today. Over the last period of the pavement's life, maintenance is required to ensure safety and operation until the pavement becomes completely destroyed. Once the pavement has failed, a complete reconstruction is carried out restoring the pavement to new condition. This cycle repeats again until a second reconstruction is required. The total costs are substantial and total $287,630 over 50 years.

The policy of Municipality 3 is periodic resurfacing. The pavement is constructed and time passes until early signs of serious distress are observed. This occurs after the time when preventive maintenance is neither appropriate nor possible, but before the pavement becomes completely destroyed. Resurfacing is performed and restores the pavement to almost new condition. The pavement then deteriorates for the remainder of its life, requiring significant maintenance in the last years before it becomes completely destroyed. A full reconstruction is then carried out and the cycle continues. The total costs are in between that of Municipality 1 and 2 at $260,038 over 50 years.

Resurfacing Only									
Year	**Age**	**Treatment**	**Δ PCI**	**PCI_q**	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**	**Present Worth**
2028	**15**	**Surface Course**	64-100	Poor-Good					
		Mill and Dispose of Surface Course			7000	m^2	$12.00	$84,000.00	
		50mm Surface Course			892.5	t	$135.00	$120,487.50	
								$204,487.50	**$141,191.58**
2051	**23**	**Full Reconstruction**	10-100	Serious-Good					
		Remove Asphalt Full Depth			7000	m^2	$15.00	$105,000.00	
		Add and Compact Corrective Aggregate/Correct Crossfall (25mm avg.)			420	t	$35.00	$14,700.00	
		40mm Base Course			686	t	$125.00	$85,750.00	
		50mm Surface Course			892.5	t	$135.00	$120,487.50	
								$325,937.50	**$127,534.43**
2067	**15**	**Surface Course**	64-100	Poor-Good					
		Mill and Dispose of Surface Course			7000	m^2	$12.00	$84,000.00	
		50mm Surface Course			892.5	t	$135.00	$120,487.50	
								$204,487.50	**$53,898.67**
		Final PCI in 2063:	**66**	**Good**				**Net:**	**$322,624.67**
								Residiual Value:	**$62,587.12**
								Total Cost:	**$260,037.55**

It may be easy to see upfront cost savings by understanding that as long as any costs associated with maintaining the pavement are deferred as long as possible, money will be saved. The reality is that extending a pavements service life prorates the total cost of the pavement over a longer period of time and ultimately becomes more economical in the long run. If preventive maintenance measures are strategically planned and carried out then the service life of the pavement can be maximized and substantial reconstruction costs can be deferred for longer periods of time. In a time when economy and efficiency are becoming more and more important, this type of proactive management is essential in the management of infrastructure.

4.1.1 Gravel Roads

The Township currently maintains approximately 344 km of gravel road. The proposed preservation management approach for this class of road is outlined in the following **Table 4** and **Table 5.**

Table 4 – Preservation Management Approach- Gravel Surface

Action	Frequency
Regrade surfaces to maintain smooth / safe driving surface and proper crossfall.	As needed, generally 2-3 times per year for higher volume gravel, or more frequently as necessary; 1-2 for lower volume.
Add calcium to tighten surface, retain aggregate and reduce dust.	Each spring on all roads of higher volume and as needed during summer months.
Ditching and brushing of right-of-ways to improve roadbed drainage and safety.	Complete road network every 10 years.

Table 5 – Capital Activities – Gravel Roads

Action	Frequency
Add layer (50 mm) of granular material to road surface.	Every 3 years for gravel roads.
Base and sub-base improvements.	As needed or as dictated by traffic volumes.
Reconstruct / convert to hard top.	As dictated by traffic volumes.

4.1.2 Surface Treated Roads

Surface treated roads have a hard wearing surface that must be preserved in order to be effective. The Township currently maintains 8 km of surface treated roads. Unlike gravel roads, a significant investment has been made in the surface and consequently these roads must be managed properly to obtain the longest possible service life from the surface.

Table 6 – Preservation Management Approach – Surface Treated Roads

Activity	Age (Years)	Ride Condition Rating	Estimated Service Life Extension (Years)
Slurry Seal	3	8	4
Single Surface Treatment	6	7	3
Double Surface Treatment	10	6	5
Pulverize and DST	14	<4	8

In addition to the noted preservation approach in **Table 6**, the following best management practices may be employed to preserve the surface, extend the service life and reduce life cycle costs of surface treated roads:

1. Surface treatment shall be applied to the entire road platform, from "grass to grass", including any shoulders. This will eliminate grading on surface treated roads, which has a tendency to damage the edge of the surface treatment and cause premature failure of the surface.
2. Suitable new technologies will be utilized where they can be demonstrated to reduce life cycle costs, such as fibre-reinforced surface treatment. This technology can be used to mitigate reflective cracking (if cracks are narrow and inactive) when a single or double surface treatment is applied over an aging surface. It can eliminate the need for pulverizing the underlying surface in certain situations and can reduce overall costs.
3. Assess drainage and culvert needs prior to any significant renewal or rehabilitation strategy and complete any improvements concurrently. This will eliminate the need to cut / excavate a relatively new surface to replace a culvert.
4. Ditching and clearing (brushing) of the right-of-ways (ROW) to improve roadbed drainage and safety.

4.1.3 Asphalt Roads

Asphalt surfaces are the smoothest and most durable hard top surface used by the Township however; they are also the most expensive. The Township currently maintains 123 km of asphalt surface roads. Asphalt provides a constant, acceptable condition for the initial portion of its service life but then begins to deteriorate rapidly as it ages. Surface defects such as cracking and raveling are the first signs of the deterioration. If left untreated, the pavement will rapidly deteriorate to the point where reconstruction is the only option. A preservation management strategy can mitigate this by applying renewal treatments earlier in the pavements life before the conditions begin to deteriorate too far. **Table 7** below summarizes preservation management activities to be considered for asphalt roads:

Table 7 – Preservation Management Approach – Rural Asphalt Roads

Activity	Age (Years)	Ride Condition Rating	Estimated Service Life Extension (years)
Crack seal	2-6	9	2
Slurry Seal / Microsurface	4-8	8	4-6
Overlay	12-15	6-7	10
Pulverize and Pave	20-25	< 5	20
Reconstruct	30	< 4	30

Note: Slurry seal can be used on lower volume paved roads (less than 1000 vehicles per day). For roads with volumes in excess of 1000 AADT, microsurfacing should be considered.

In addition to the above noted preservation approach, the following best management practices may be employed to extend the service life and reduce life cycle costs of asphalt roads:

1. Review the condition of other infrastructure, particularly underground infrastructure prior to implementing any major renewal or rehabilitation of the pavement. Any repairs or capital upgrades to other infrastructure should be coordinated. This should reduce utility cuts in newer asphalt.
2. Repair potholes in the surface in a timely fashion to prevent saturation and weakening of road base.
3. Undertake regular shouldering program of rural paved roads to promote proper drainage. Poorly maintained shoulders allow surface water to pond and saturate the road base, which weakens the base and leads to cracking at the edge of pavements.
4. Undertake a ditching program to ensure there is adequate drainage for road base on rural roads. This will reduce the likelihood of structural distresses caused by softening of the road base due to poor drainage.
5. Specify the appropriate type of performance graded asphalt cement for the location.
6. Undertake a clearing program to reduce shading of the roadbed and remove roots / vegetation from the road base.

4.2 Application of Preservation Management Approach

The preservation management activities detailed in each of the tables above are not necessarily intended or required to be completed on each and every road. Road deterioration rates and the type of deterioration will dictate when action should be taken and what kind of treatment is most appropriate. The intention of the above is to outline the series of techniques to be considered in an effort to realize and extend the useful service life of the road asset for the lowest overall lifecycle cost while maintaining the highest overall condition. As detailed in the life cycle costs analysis presented above, the preservation management approach to roads is proven to yield the lowest overall life-cycle costs.

Each of the preservation management activities for gravel, surface treatment and asphalt roads identified above (including route and seal, slurry seal, resurfacing etc.), shall be considered as part of the regular Road Needs Study Report every five (5) years. Recommendations on the specific treatments required shall be documented and prioritized in this Report.

4.3 HCB/LCB to Gravel Considerations

When deciding to change the surface of a road from HCB/LCB to gravel, there are many factors to consider. These factors are:

- Financial.
- Condition, Structure, and Drainage.
- Platform Width.
- Horizontal and Vertical alignment.
- Traffic Volumes.
- Less tangible benefits.
- Risk Management.

The MTO Inventory Manual provides guidance as to what the appropriate surface types should be for various AADT ranges (See **Table 1**). It is not recommended to 'lower' the surface type from HCB/LCB to gravel if the AADT volumes are greater than the design standard of 0-199.

5.0 Road Needs Study Summary Table

5.1 Types of Improvements

All roads were examined to appraise the extent and type of improvement necessary.

"Order of Magnitude" construction costs were developed for each of the below options on a per kilometre basis. An estimated cost for isolated frost heave repairs was also considered.

The below alternative rehabilitation strategies are considered preliminary in nature and are intended to assist in providing an order of magnitude cost estimate to rehabilitate the road. Further field investigations and engineering design is required to confirm and develop the rehabilitation strategies for each road.

5.1.1 Asphalt

High Class Bituminous roads (HCB) or hot mix asphalt roads have rehabilitation alternatives ranging from a simple overlay to complete reconstruction. The following is a listing of standard road rehabilitation techniques that were considered for HCB or hot mix asphalt roads.

RO1 Resurfacing, Single-Lift Overlay.

RO2 Resurfacing, Double-Lift Overlay.

RMP1 Resurfacing, Mill and Pave 1-Lift.

RMP2 Resurfacing, Mill and Pave 2-Lifts.

PP1 Pulverize and Pave 1-Lift.

PP2 Pulverize and Pave 2-Lifts.

Recon 1R Excavate and Reconstruct Road and Pave 1-Lift – Rural.

Recon 1S Excavate and Reconstruct Road and Pave 1-Lift – Semi-Urban.

Recon 2S Excavate and Reconstruct Road and Pave 2-Lifts – Semi-Urban.

Recon 2U Excavate and Reconstruct Urban Road and Pave 2-Lifts – Urban.

SS Slurry Seal (Preventative Maintenance).

MS Microsurfacing (Preventative Maintenance).

RS Route and Seal (Preventative Maintenance).

5.1.2 Surface Treatment

Surface treated roads are generally able to be rehabilitated with either a single or double Low Class Bituminous (LCB) overlay treatment. They may also be upgraded to HCB pavement or downgraded to gravel. In some cases, previous resurfacing of LCB roads has occurred or the LCB surface or road structure has deteriorated to a state where a simple overlay surface treatment is not feasible. In these cases consideration can be given to removal or pulverizing of the existing surface treatment and placement of a new application. In some cases, where it is necessary to improve the overall roadbed structure, the addition of Granular A to build up the road and the reapplication of a surface treatment is recommended. The following is a listing of standard road rehabilitation techniques that were considered for LCB (surface treated) roads:

ST1 Single Surface Treatment.

ST2 Double Surface Treatment.

ST2R Double Surface Treatment, with Removal of Existing.

ST2A Double Surface Treatment, over New Granular A.

ST2PA Double Surface Treatment, over Pulverized Existing and New Granular A.

ST2PAW Double Surface Treatment, over Pulverized Existing and New Granular A with 1 m Widening.

SS Slurry Seal (Preventative Maintenance).

5.1.3 Gravel

Gravel roads can likewise be upgraded with the reapplication of Gravel (G) or surface treatments (ST2).

5.2 Benchmark Construction Costs

The Unit Price Form found in **Appendix A** is based on average prices for the local area. The unit prices were used to prepare an array of benchmark construction costs.

The design standards in **Table 8** were utilized for development of the benchmark cost estimates for reconstruction. It should be noted that these are suggested standards and therefore should not necessarily be used as standards for detail design of roadway improvements.

Table 8 – Design Standards for Construction Cost Estimates

Functional Classification	Surface Width (m)	Shoulder Width (m)	Granular A Depth (mm)	Granular B Depth (mm)	Hot Mix Depth (mm)*
Rural R200 (50 to 199 vpd)	6.0	1.5	150	450	-
Rural R300 (200 to 399 vpd)	6.0	1.5	150	450	16*
Rural R400 (400 to 999 vpd)	6.5	1.5	150	450	50
Semi - Urban Local Residential	6	1.5	150	450	50
Semi - Urban Local Industrial	6.5	1.5	150	450	50
Urban Local Residential	8.5	-	150	600	100
Urban Local Industrial	9.0	-	150	600	100

Note - Prime and Double Surface Treatment is based on 16 mm of Hot Mix.

6.0 Improvement Plan

In the following tables you will find three (3) columns being used to describe the condition of the road; Surface Condition, Structural Adequacy, and Condition Rating. To better understand the prioritization of the lists, descriptions of these ratings can be found below.

Surface Condition: Surface conditions relate to driving ease, comfort and safety. Inadequacies for paved surface include excessive or uneven crowns, washboarding, raveling and bumpiness because of cracking, sealing, and rough patching. Inadequacies on loose top surfaces do not include situations that can be readily corrected by maintenance blading. They do include unconsolidated surfaces due to poorly graded or clean aggregate and permanent roughness due to insufficient depth of aggregate or weak subgrade. The effects of surface inadequacies in ascending order of seriousness are noise, vibration, sway, excessive steering effort and reduced speed. *Rated on a scale of 1 to 10*.

Structural Adequacy: The Structural Adequacy point rating relates to the capability of the surface and base courses to support a load and to resist deformation or rupture. Soft spots and frost boils are structural adequacy distress signs for loose top roads. For

paved surfaces, distress signs may be cracking, rutting, heaving, pot-holing, roughness, alligatoring, dishing, breakup, distortion, frost boils, etc. *Rated on a scale of 1 to 10*.
Condition Rating: A holistic rating that sums point ratings from alignment, surface condition, surface width, level of service, structural adequacy, drainage and maintenance demands. The condition rating is one of the major factors used to calculate the Priority Rating. *Rated on a scale of 1 to 100*.

6.1 Road Needs

The Road Needs Summary Table is included on the next page, **Table 9.** This table notes the recommended Capital Construction Plan based on priorities throughout the Township. AADT is based on traffic counts completed by the Township. **All costs are based on 2019 dollars and should be adjusted for inflation based on program year, for budgeting purposes.** The capital improvements are listed in descending priority based on traffic volumes and Condition Rating, as described previously.

Table 9 – Township of Zorra Road Needs – Capital Construction Plan

Sect. No.	Road Name	From - To	Length (km)	AADT	Preliminary Improvement Type Recommendation	Cost (x1000)	Surface Condition	Structural Adequacy	Condition Rating
NOW Needs									
112	Embro St. Beachville	From Queen St. To 43rd Line	0.5	250	*Recon 1S - Full Reconstruction + 1 Lift*	*$197*	3	4	42
46	Road 92	From 25th Line To 27th Line	1.4	800	*Recon 1R - Full Reconstruction + 1 Lift*	*$551*	5	6	63
69	Delatre St. E	From Mills Street To 21st Line	0.3	250	*Recon 1S - Full Reconstruction + 1 Lift*	*$118*	5	7	52
53	Road 96	From 13th Line To 15th Line	1.4	825	*Recon 1R - Full Reconstruction + 1 Lift*	*$551*	6	7	64
116	Hampden St.	From Cemetery Gates To North Town Line	0.2	75	*ST2A - Double Surface Treatment with Granular A*	*$14*	4	5	43
64	Sullivan	From Washington St. E. To Road 68	0.2	75	*Recon 1S - Full Reconstruction + 1 Lift*	*$79*	4	5	44
98	25th Line	From Road 92 To CPR Crossing	0.2	250	*Recon 1S - Full Reconstruction + 1 Lift*	*$79*	6	7	55
8	15th Line	From Road 68 To Road 74	2.5	600	*Recon 1R - Full Reconstruction + 1 Lift*	*$983*	5	6	64
113	Piovesan St.	From Embro St. To Embro St.	1	75	*Recon 1S - Full Reconstruction + 1 Lift*	*$393*	4	5	45
117	Davey St.	From Dead End North to North Town Line	0.2	125	*ST2A - Double Surface Treatment with Granular A*	*$14*	6	7	49
110	Mcnab St.	From Road 60 To Road 60 (U SHAPE)	0.7	125	*Recon 1S - Full Reconstruction + 1 Lift*	*$275*	6	7	50
97	Colborne St. Lakeside	From CPR Crossing To Queen St.	0.2	100	*Recon G - Full Reconstruction 6m Gravel Road*	*$22*	6	6	48
99	Queen St. Lakeside	From King St. To Dead End At South	0.3	75	*Recon 1S - Full Reconstruction + 1 Lift*	*$118*	5	6	47
723	Road 78	From 35th Line the 37th Line	1.4	650	*Recon 1R - Full Reconstruction + 1 Lift*	*$551*	6	6	67
107	Newton St.	From 31st Line To North Town Line	0.3	75	*Recon 1S - Full Reconstruction + 1 Lift*	*$118*	5	6	51
837	Bates Lane	From 19th Hwy. To End Of Road	0.3	50	*Recon 1S - Full Reconstruction + 1 Lift*	*$118*	5	6	48

Sect. No.	Road Name	From - To	Length (km)	AADT	Preliminary Improvement Type Recommendation	Cost (x1000)	Surface Condition	Structural Adequacy	Condition Rating
839	Young Crescent	From 19th Hwy. To End Of Road	0.3	50	*Recon 1S - Full Reconstruction + 1 Lift*	*$118*	6	7	50
297	Road 80	From End Of Commissioner (East) to 0.4km East	0.4	200	*Recon 1R - Full Reconstruction + 1 Lift*	*$157*	5	5	62
58	Perth-Oxford Road	From 35th Line To 37th Line	0.7	350	*Recon 1R - Full Reconstruction + 1 Lift*	*$275*	6	7	68
161	25th Line	From Thames River To Road 60	0.7	100	*Recon 1R - Full Reconstruction + 1 Lift*	*$275*	6	7	69
1-5 Year Needs									
100	Sunova Cres.	From Road 92 To 25th Line	1.6	500	*PP1 - Pulverize and Pave 1 Lift*	*$253*	6	9	53
11	31st Line	From Road 78 To Road 84	3.1	1250	*Recon 1R - Full Reconstruction + 1 Lift*	*$1,219*	6	8	69
17	35th Line	From Road 68 To Road 74	3.1	900	*Recon 1R - Full Reconstruction + 1 Lift*	*$1,219*	6	10	71
722	Road 78	From 31st Line to 33rd Line	1.4	700	*Recon 1R - Full Reconstruction + 1 Lift*	*$551*	6	8	70
12	31st Line	From Road 84 To Road 88	3.1	550	*Recon 1R - Full Reconstruction + 1 Lift*	*$1,219*	6	9	70
62	Milton St.	From Washington St. E. To Road 68	0.2	75	*PP1 - Pulverize and Pave 1 Lift*	*$32*	6	10	55
724	Road 92	From 19th Line To 23rd Line	1.42	950	*PP1 - Pulverize and Pave 1 Lift*	*$225*	7	11	74
45	Road 84	From 45th Line To 47th Line	1.4	900	*PP1 - Pulverize and Pave 1 Lift*	*$221*	7	11	74
54	Road 96	From 15th Line To 19th Line	1.4	825	*PP1 - Pulverize and Pave 1 Lift*	*$221*	7	11	74
52	Road 96	From Cobble Hills Road To 13th Line	1.4	800	*PP1 - Pulverize and Pave 1 Lift*	*$221*	7	11	74
41	Road 78	From 33rd Line To 35th Line	1.4	700	*PP1 - Pulverize and Pave 1 Lift*	*$221*	7	11	74
57	Perth-Oxford Road	From 33rd Line To 35th Line	0.7	350	*Recon 1R - Full Reconstruction + 1 Lift*	*$275*	6	10	72
55	Perth-Oxford Road	From 29th Line To 31st Line	0.7	350	*PP1 - Pulverize and Pave 1 Lift*	*$111*	7	11	74
56	Perth-Oxford Road	From 31st Line To 33rd Line	0.7	350	*PP1 - Pulverize and Pave 1 Lift*	*$111*	7	11	74
19	35th Line	From Road 78 To Road 84	3.1	50	*PP1 - Pulverize and Pave 1 Lift*	*$490*	7	11	74

Sect. No.	Road Name	From - To	Length (km)	AADT	Preliminary Improvement Type Recommendation	Cost (x1000)	Surface Condition	Structural Adequacy	Condition Rating
6-10 Year Needs									
27	Road 64	From Hunt Road To 15th Line	1.1	1300	*PP1 - Pulverize and Pave 1 Lift*	*$174*	7	12	73
32	Road 74	From 15th Line To 19th Line	1.4	1200	*PP1 - Pulverize and Pave 1 Lift*	*$221*	7	12	74
725	Road 92	FROM 23rd Line TO 25th Line	1.42	1000	*PP1 - Pulverize and Pave 1 Lift*	*$225*	7	12	75
48	Road 92	From 29th Line To 31st Line	1.4	1000	*PP1 - Pulverize and Pave 1 Lift*	*$221*	7	12	76
25	Road 60	From 25th Line To 27th Line	1.9	300	*PP1 - Pulverize and Pave 1 Lift*	*$300*	6	12	73
23	Road 60	From 17th Line To 21st Line	0.6	200	*PP1 - Pulverize and Pave 1 Lift*	*$95*	7	12	75

Notes:

1. *Rehabilitation strategy to be confirmed by geotechnical investigations at detail design.*

2. *Timing of storm sewer/culvert work should be considered in conjunction with road reconstruction and vice versa, where applicable.*

3. *Costing is zero for roads within the network but maintained by others (i.e. boundary roads).*

6.2 Annual Resurfacing Program

Based on typical degradation rates for gravel roads, surface treatment, and hot mix, a resurfacing program / budget is recommended, in addition to the noted capital construction works, as follows:

Hot Mix Paved Roads:

- 122.7 km of paved roads (HCB).
- Degradation rate 0.25 / year (rating drops from 10 to 5, over a 20-year period).
- Annual resurfacing 6.1 km / year.
- **Annual budget $1,732,400**: (6.1 km / year x $142,000 / ln **RMP1** x 2 lanes).

Surface Treated Roads:

- 7.8 km of surface treated roads (LCB).
- Degradation rate 0.625 / year (rating drops from 10 to 5, over a 7-year period).
- Annual resurfacing 1.1 km / year.
- **Annual budget $26,950** (1.1 km / year x $25,000 / km **ST1**).

Gravel roads require regular maintenance. Maintenance includes regular grading and reapplication of new gravel. Typically, gravel roads should be resurfaced on a 3 year cycle.

Gravel Roads:

- 343.7 km of earth / gravel roads.
- 50 mm gravel every 3 years.
- Annual gravelling of 114.6 km.
- Granular A ($12,000 / km).
- **Annual budget $1,375,200** (114.6 km / year x $12,000 **G**) **.

*** Cost based on supply and application of gravel by external forces.*

The total resurfacing program, (hot mix, surface treatment and gravel) is estimated at $3,134,550 per year.

Relative road preservation / resurfacing priorities for all roads not included in the previous Capital Reconstruction priorities table are listed below in **Table 10,** Township of Zorra's Resurfacing Priorities. Roads are listed in order of descending preservation priorities.

Table 10 – Township of Zorra, Resurfacing Priorities

Sect. No.	Road Name	From - To	Length (km)	AADT	Preliminary Improvement Type Recommendation	Cost (x1000)	Surface Condition	Structural Adequacy	Condition Rating
266	Road 66	From Hunt Road To 15th Line	1.25	800	*G - Gravel (50mm)*	*$14*	7	14	61
33	Road 74	From 19th Line To 23rd Line	1.4	1350	*RMP1 - Mill & Pave, 1 Lift*	*$398*	7	13	69
726	Sunova Cres	From Road 92 To 25th Line	0.3	500	*G - Gravel (50mm)*	*$3*	7	14	61
139	15th Line	From Road 62 To Road 64	1.4	800	*G - Gravel (50mm)*	*$16*	7	14	67
300	Road 82	From 37th Line To 41st Line	1.9	150	*G - Gravel (50mm)*	*$22*	7	14	53
834	Hunt Road	From Road 60 TO CN RAIL	0.7	150	*G - Gravel (50mm)*	*$8*	6	10	53
138	15th Line	From Road 60 To Road 62	1.5	800	*G - Gravel (50mm)*	*$17*	8	16	70
818	North Town Line	19th Line To Ingersoll Boundary	0.4	800	*Preventative Maintenance*	-	9	17	70
63	St Patrick St	From Brock St to Road 68	0.2	600	*Preventative Maintenance*	-	8	16	68
101	Cornelia St.	From Road 96 To Dead End	0.2	75	*G - Gravel (50mm)*	*$2*	6	10	53
744	Elizabeth St. Harrington	From Count Rd. 28 To 152m South Dead End	0.2	75	*G - Gravel (50mm)*	*$2*	6	10	53
171	25th Line	From Road 96 To Wildwood Road	1.4	100	*G - Gravel (50mm)*	*$16*	6	12	56
10	31st Line	From Road 74 To Road 78	3.1	2200	*RO1 - Hot Mix Overlay, 1 Lift*	*$436*	8	15	79
115	Cobble Hills Road	From Road 78 To Road 84	1.6	1800	*ST1 - Single Surface Treatment*	*$39*	7	14	78
28	Road 64	From 15th Line To 17th Line	2	1300	*RMP1 - Mill & Pave, 1 Lift*	*$569*	8	14	77

Sect. No.	Road Name	From - To	Length (km)	AADT	Preliminary Improvement Type Recommendation	Cost (x1000)	Surface Condition	Structural Adequacy	Condition Rating
746	Albert St. Harrington	From Road 96 To Victoria St.	0.2	200	*G - Gravel (50mm)*	*$2*	8	16	65
182	27th Line	From Road 96 To Perth County Road 21	1.9	75	*G - Gravel (50mm)*	*$22*	7	14	58
1	Cobble Hills Road	From Road 68 To Road 74	1.6	1800	*Preventative Maintenance*	-	9	17	79
111	Haines St.	From Ingersoll W. Boundary To West to Dead End +- 8.3M	0.2	75	*RMP1 - Mill & Pave, 1 Lift*	*$57*	7	14	59
108	Pemberton St.	From North Town Line To CNR Tracks	0.5	600	*Preventative Maintenance*	-	10	20	74
833	Road 62	From 33rd To 35th Line	0.9	150	*G - Gravel (50mm)*	*$10*	7	14	65
745	Victoria St. Harrington	From Road 96 To East ST	1.1	200	*G - Gravel (50mm)*	*$13*	8	16	67
119	Ralph St	From 37th Line To End Of Road	0.4	50	*G - Gravel (50mm)*	*$5*	7	13	58
106	North Town Line	From 33rd Line To 31st Line	0.6	800	*Preventative Maintenance*	-	10	20	76
819	North Town Line	Ingersoll Boundary To 31st Line	1.2	800	*Preventative Maintenance*	-	10	20	76
330	Perth-Oxford Road	From 25th Line To 27th Line	1.4	350	*G - Gravel (50mm)*	*$16*	6	13	71
2	Cobble Hills Road	From Road 84 To Skee-Hi Resort Entrance	1.55	1025	*RMP1 - Mill & Pave, 1 Lift*	*$441*	7	14	78
336	Perth-Oxford Road	From 37th Line To 41st Line	0.7	300	*G - Gravel (50mm)*	*$8*	6	13	71
337	Perth-Oxford Road	From 41st Line To 43rd Line	0.7	350	*G - Gravel (50mm)*	*$8*	6	13	72
118	Charles St	From 37th Line To End Of Road	0.1	50	*G - Gravel (50mm)*	*$1*	7	14	60
5	Cobble Hills Road	From Road 96 To Elginfield	1.7	1675	*RO1 - Hot Mix Overlay, 1 Lift*	*$239*	8	15	81

Sect. No.	Road Name	From - To	Length (km)	AADT	Preliminary Improvement Type Recommendation	Cost (x1000)	Surface Condition	Structural Adequacy	Condition Rating
176	27th Line	From Road 68 To Road 74	0.5	100	*G - Gravel (50mm)*	*$6*	7	14	65
181	27th Line	From Road 92 To Road 96	3.1	125	*G - Gravel (50mm)*	*$36*	8	15	66
272	Road 66	From 33rd Line To 37th Line	2.5	175	*G - Gravel (50mm)*	*$29*	7	14	69
36	Road 74	From 27th Line To 29th Line	0.8	1400	*RO1 - Hot Mix Overlay, 1 Lift*	*$113*	8	15	81
37	Road 74	From 29th Line To 31st Line	1.3	1400	*RO1 - Hot Mix Overlay, 1 Lift*	*$183*	8	15	81
109	Cemetery Lane	From Pemberton St. to Cemetery Gates	0.3	50	*RO1 - Hot Mix Overlay, 1 Lift*	*$42*	8	15	62
114	Cobble Hills Road	From Road 74 To Road 78	1.6	1725	*ST1 - Single Surface Treatment*	*$39*	8	16	82
180	27th Line	From Road 88 To Road 92	3.1	75	*G - Gravel (50mm)*	*$36*	8	15	64
43	Road 84	From 41st Line To 43rd Line	1.4	900	*RMP1 - Mill & Pave, 1 Lift*	*$398*	8	13	79
44	Road 84	From 43rd Line To 45th Line	1.4	900	*RMP1 - Mill & Pave, 1 Lift*	*$398*	8	13	79
4	Cobble Hills Road	From Road 92 To Road 96	1.6	1350	*RO1 - Hot Mix Overlay, 1 Lift*	*$225*	8	15	81
225	43rd Line	From Road 68 To Road 74	3.1	75	*G - Gravel (50mm)*	*$36*	7	13	65
322	Road 92	From 37th Line To 41st Line	1.4	400	*G - Gravel (50mm)*	*$16*	8	15	75
323	Road 92	From 41st Line To 43rd Line	1.4	400	*G - Gravel (50mm)*	*$16*	8	15	75
16	33rd Line	From Road 66 To Road 68	1.3	650	*RMP1 - Mill & Pave, 1 Lift*	*$370*	7	14	78
31	Road 74	From 13th Line To 15th Line	1.4	1200	*RO1 - Hot Mix Overlay, 1 Lift*	*$197*	8	15	81
331	Perth-Oxford Road	From 27th Line To 29th Line	0.25	350	*G - Gravel (50mm)*	*$3*	7	14	75

Sect. No.	Road Name	From - To	Length (km)	AADT	Preliminary Improvement Type Recommendation	Cost (x1000)	Surface Condition	Structural Adequacy	Condition Rating
30	Road 74	From Cobble Hills Road To 13th Line	1.4	1100	*RO1 - Hot Mix Overlay, 1 Lift*	*$197*	8	15	81
160	23rd Line	From Road 96 To WILDWOOD Road	3.4	150	*G - Gravel (50mm)*	*$39*	7	13	71
325	Road 92	From 45th Line To Zorra/East Zorra-Tavistock Line	1.4	150	*G - Gravel (50mm)*	*$16*	6	13	71
338	Perth-Oxford Road	From 43rd Line To 45th Line	0.7	350	*G - Gravel (50mm)*	*$8*	7	14	76
339	Perth-Oxford Road	From 45th Line To Zorra/East Zorra-Tavistock Line	0.7	350	*G - Gravel (50mm)*	*$8*	7	14	76
170	25th Line	From Road 92 To Road 96	3.1	200	*G - Gravel (50mm)*	*$36*	7	14	73
39	Road 74	From 33rd Line To 35th Line	1.4	1450	*Preventative Maintenance*	-	9	16	83
42	Road 84	From 37th Line To 41st Line	1.4	900	*RO1 - Hot Mix Overlay, 1 Lift*	*$197*	8	15	81
271	Road 66	From 31st Line To 33rd Line	1.2	175	*G - Gravel (50mm)*	*$14*	8	16	73
287	Road 78	From 13th Line To 15th Line	1.4	325	*G - Gravel (50mm)*	*$16*	7	14	76
288	Road 78	From 15th Line To 19th Line	1.4	325	*G - Gravel (50mm)*	*$16*	7	14	76
38	Road 74	From 31st Line To 33rd Line	1.4	1400	*Preventative Maintenance*	-	9	16	83
273	Road 66	From 37th Line To Lot 19/20	1.2	100	*G - Gravel (50mm)*	*$14*	7	15	70
13	31st Line	From Road 88 To Road 92	3.1	700	*RMP1 - Mill & Pave, 1 Lift*	*$881*	8	14	80
244	Zorra/East Zorra-Tavistock Line	From Road 88 To Road 92	1.6	150	*G - Gravel (50mm)*	*$18*	6	13	72

Sect. No.	Road Name	From - To	Length (km)	AADT	Preliminary Improvement Type Recommendation	Cost (x1000)	Surface Condition	Structural Adequacy	Condition Rating
232	45th Line	From Road 66 To Road 68	2.7	125	*G - Gravel (50mm)*	*$31*	8	14	71
195	31st Line	From Road 92 To Road 96	3.1	200	*G - Gravel (50mm)*	*$36*	6	13	74
324	Road 92	From 43rd Line To 45th Line	1.4	200	*G - Gravel (50mm)*	*$16*	7	15	74
14	33rd Line	From Road 62 To Road 64	1.5	800	*RO1 - Hot Mix Overlay, 1 Lift*	*$211*	8	15	81
207	35th Line	From Road 62 To Road 64	1.4	50	*G - Gravel (50mm)*	*$16*	8	16	67
157	23rd Line	From Road 84 To Road 88	3.1	225	*G - Gravel (50mm)*	*$36*	8	15	75
24	Road 60	From 21st Line To 25th Line	1.8	300	*RMP1 - Mill & Pave, 1 Lift*	*$512*	7	14	77
15	33rd Line	From Road 64 To Road 66	1.4	675	*RO1 - Hot Mix Overlay, 1 Lift*	*$197*	8	15	81
269	Road 66	From 25th Line To 27th Line	1.9	100	*G - Gravel (50mm)*	*$22*	8	16	72
166	25th Line	From Road 68 To Road 74	3.1	425	*G - Gravel (50mm)*	*$36*	8	15	79
218	41st Line	From Road 68 To Road 74	3.1	275	*G - Gravel (50mm)*	*$36*	8	16	77
308	Road 88	From 19th Line To 23rd Line	1.4	150	*G - Gravel (50mm)*	*$16*	7	14	74
268	Road 66	From 21st Line To 25th Line	1.8	100	*G - Gravel (50mm)*	*$21*	8	15	72
293	Road 78	From 29th Line To 31st Line	1.4	725	*G - Gravel (50mm)*	*$16*	8	16	82
40	Road 74	From 35th Line To 37th Line	1.4	1475	*Preventative Maintenance*	-	9	17	85
267	Road 66	From 15th Line To 21st Line	1.4	100	*G - Gravel (50mm)*	*$16*	8	16	73
310	Road 88	From 25th Line To 27th Line	1.4	100	*G - Gravel (50mm)*	*$16*	6	12	73

Sect. No.	Road Name	From - To	Length (km)	AADT	Preliminary Improvement Type Recommendation	Cost (x1000)	Surface Condition	Structural Adequacy	Condition Rating
286	Road 78	From Cobble Hills Road To 13th Line	1.4	100	*G - Gravel (50mm)*	*$16*	7	14	73
188	29th Line	From Road 92 To Road 96	3.1	325	*G - Gravel (50mm)*	*$36*	8	15	79
253	Road 62	From Hunt Road To 15th Line	1.25	200	*G - Gravel (50mm)*	*$14*	7	14	77
299	Road 80	From 41st Line To 43rd Line	1.4	200	*G - Gravel (50mm)*	*$16*	8	15	77
3	Cobble Hills Road	From Road 88 To Road 92	1.55	1250	*Preventative Maintenance*	-	9	17	85
270	Road 66	From 27th Line To 31st Line	2.4	75	*G - Gravel (50mm)*	*$28*	8	15	73
311	Road 88	From 27th Line To 29th Line	0.8	100	*G - Gravel (50mm)*	*$9*	8	16	74
274	Road 66	From 41st Line To 43rd Line	0.7	100	*G - Gravel (50mm)*	*$8*	8	16	74
22	Road 60	From 15th Line To 17th Line	1.8	200	*RMP1 - Mill & Pave, 1 Lift*	*$512*	7	14	78
152	21st Line	From Road 66 To Road 68	1.3	75	*G - Gravel (50mm)*	*$15*	8	17	74
155	23rd Line	From Road 74 To Road 78	3.1	100	*G - Gravel (50mm)*	*$36*	7	15	75
168	25th Line	From Road 84 To Road 88	3.1	100	*G - Gravel (50mm)*	*$36*	7	13	75
309	Road 88	From 23rd Line To 25th Line	1.4	100	*G - Gravel (50mm)*	*$16*	8	15	75
21	Road 60	From Hunt Road To 15th Line	1.1	300	*RMP1 - Mill & Pave, 1 Lift*	*$313*	8	14	80
130	Hunt Road	From Road 66 To Road 68	0.6	150	*G - Gravel (50mm)*	*$7*	8	15	77
165	25th Line	From Road 66 To Road 68	1.3	150	*G - Gravel (50mm)*	*$15*	7	14	77
167	25th Line	From Road 74 To Road 78	3.1	150	*G - Gravel (50mm)*	*$36*	8	15	77

Sect. No.	Road Name	From - To	Length (km)	AADT	Preliminary Improvement Type Recommendation	Cost (x1000)	Surface Condition	Structural Adequacy	Condition Rating
215	39th Line	From 37th Line To 41st Line	2.7	75	*G - Gravel (50mm)*	*$31*	7	14	74
217	41st Line	From Road 66 To Road 68	1.4	75	*G - Gravel (50mm)*	*$16*	8	16	74
189	29th Line	From Road 96 To Perth County Road 21	3.3	225	*G - Gravel (50mm)*	*$38*	8	15	79
7	15th Line	From Road 66 To Road 68	1.3	1300	*Preventative Maintenance*	-	9	18	86
298	Road 80	From 0.4km East of Commissioner (East) To 41st Line	0.4	200	*G - Gravel (50mm)*	*$5*	8	16	79
172	27th Line	From Road 60 To Road 62	1.4	100	*G - Gravel (50mm)*	*$16*	7	13	76
220	41st Line	From Road 78 To Road 84	3.1	100	*G - Gravel (50mm)*	*$36*	7	14	76
314	Road 88	From 33rd Line To 35th Line	1.4	100	*G - Gravel (50mm)*	*$16*	8	15	76
758	Road 88	From 31st Line To 33rd Line	1.4	100	*G - Gravel (50mm)*	*$16*	8	16	76
158	23rd Line	From Road 88 To Road 92	3.1	250	*G - Gravel (50mm)*	*$36*	8	17	80
823	Road 78	From 25th Line To 27th Line	1.4	400	*G - Gravel (50mm)*	*$16*	8	16	82
824	Road 78	From 27th Line To 29th Line	0.8	400	*G - Gravel (50mm)*	*$9*	8	16	82
239	45th Line	From Road 96 To Perth County Road 21	3.4	125	*G - Gravel (50mm)*	*$39*	7	14	77
233	45th Line	From Road 68 To Road 74	3.1	125	*G - Gravel (50mm)*	*$36*	8	16	77
219	41st Line	From Road 74 To Road 78	3.1	150	*G - Gravel (50mm)*	*$36*	8	15	78
243	Zorra/East Zorra-Tavistock Line	From Road 84 To Road 88	1.6	150	*G - Gravel (50mm)*	*$18*	8	16	78

Sect. No.	Road Name	From - To	Length (km)	AADT	Preliminary Improvement Type Recommendation	Cost (x1000)	Surface Condition	Structural Adequacy	Condition Rating
245	Zorra/East Zorra-Tavistock Line	From Road 92 To Road 96	1.6	150	*G - Gravel (50mm)*	*$18*	7	14	78
835	Zorra/East Zorra-Tavistock Line	From Road 96 To Perth-Oxford Road	1.6	150	*G - Gravel (50mm)*	*$18*	7	14	78
153	21st Line	From Road 68 To Road 74	1.2	75	*G - Gravel (50mm)*	*$14*	8	16	75
206	33rd Line	From Road 96 To Perth County Road 21	3.4	50	*G - Gravel (50mm)*	*$39*	7	13	74
6	15th Line	From Road 64 To Road 66	1.5	750	*Preventative Maintenance*	-	9	17	85
826	Road 60	From 27th Line To Ingersoll Boundary	1.3	1875	*Preventative Maintenance*	-	10	20	88
154	23rd Line	From Road 68 To Road 74	3.1	100	*G - Gravel (50mm)*	*$36*	7	15	77
164	25th Line	From Road 64 To Road 66	1.4	100	*G - Gravel (50mm)*	*$16*	7	14	77
235	45th Line	From Road 78 To Road 84	3.1	125	*G - Gravel (50mm)*	*$36*	8	15	78
796	Road 78	From 19th Line To 23rd Line	1.4	325	*G - Gravel (50mm)*	*$16*	8	16	82
805	Road 78	From 23rd Line To 25th Line	1.4	325	*G - Gravel (50mm)*	*$16*	8	16	82
131	13th Line	From Road 68 To Road 74	3	75	*G - Gravel (50mm)*	*$35*	7	14	76
137	13th Line	From Road 96 To Road 98	3.4	75	*G - Gravel (50mm)*	*$39*	7	14	76
179	27th Line	From Road 84 To Road 88	3.1	75	*G - Gravel (50mm)*	*$36*	7	15	76
263	Road 64	From 27th Line To 31st Line	2.4	75	*G - Gravel (50mm)*	*$28*	8	15	76
128	Hunt Road	From Road 62 To Road 64	0.7	150	*G - Gravel (50mm)*	*$8*	8	15	79

Sect. No.	Road Name	From - To	Length (km)	AADT	Preliminary Improvement Type Recommendation	Cost (x1000)	Surface Condition	Structural Adequacy	Condition Rating
129	Hunt Road	From Road 64 To Road 66	0.7	150	*G - Gravel (50mm)*	*$8*	8	15	79
144	15th Line	From Road 78 To Road 84	3.1	150	*G - Gravel (50mm)*	*$36*	8	15	79
143	15th Line	From Road 74 To Road 78	3.1	225	*G - Gravel (50mm)*	*$36*	8	16	81
196	31ST Line	From Road 96 To Perth County Road 21	3.2	75	*G - Gravel (50mm)*	*$37*	7	14	77
228	43rd Line	From Road 84 To Road 88	3.1	75	*G - Gravel (50mm)*	*$36*	8	15	77
224	41st Line	From Road 96 To Road 98	3.2	125	*G - Gravel (50mm)*	*$37*	8	15	79
20	Road 58	From 17th Line To End Of Road	1.1	150	*RO1 - Hot Mix Overlay, 1 Lift*	*$155*	8	15	80
127	Hunt Road	From Road 60 To Road 62	0.7	150	*G - Gravel (50mm)*	*$8*	8	15	80
231	43rd Line	From Road 96 To Perth County Road 21	3.2	150	*G - Gravel (50mm)*	*$37*	7	16	80
242	Zorra/East Zorra-Tavistock Line	From Road 78 To Road 84	1.6	150	*G - Gravel (50mm)*	*$18*	8	16	80
18	35th Line	From Road 74 To Road 78	3.1	175	*RO1 - Hot Mix Overlay, 1 Lift*	*$436*	8	15	81
315	Road 88	From 35th Line To 37th Line	1.4	225	*G - Gravel (50mm)*	*$16*	8	16	82
757	Road 92	35th Line To 37th Line	1.4	925	*Preventative Maintenance*	-	9	18	87
148	15th Line	From Road 96 To Elginfield	3.4	100	*G - Gravel (50mm)*	*$39*	7	15	79
201	33rd Line	From Road 74 To Road 78	3.1	100	*G - Gravel (50mm)*	*$36*	8	15	79
234	45th Line	From Road 74 To Road 78	3.1	125	*G - Gravel (50mm)*	*$36*	8	16	80

Sect. No.	Road Name	From - To	Length (km)	AADT	Preliminary Improvement Type Recommendation	Cost (x1000)	Surface Condition	Structural Adequacy	Condition Rating
200	33rd Line	From Road 68 To Road 74	3.1	200	*G - Gravel (50mm)*	*$36*	8	16	82
205	33rd Line	From Road 92 To Road 96	3.1	50	*G - Gravel (50mm)*	*$36*	7	15	77
329	Wildwood Road	From 19th Line To 23rd Line	1.4	50	*G - Gravel (50mm)*	*$16*	7	14	77
169	25th Line	From Road 88 To Road 92	1.5	150	*G - Gravel (50mm)*	*$17*	8	16	81
236	45th Line	From Road 84 To Road 88	3.1	150	*G - Gravel (50mm)*	*$36*	8	16	81
241	Zorra/East Zorra-Tavistock Line	From Road 74 To Road 78	1.6	150	*G - Gravel (50mm)*	*$18*	8	17	81
177	27th Line	From Road 74 To Road 78	3.1	25	*G - Gravel (50mm)*	*$36*	7	14	75
216	41st Line	From Domtar Line To Road 66	1.1	75	*G - Gravel (50mm)*	*$13*	8	16	79
756	Road 92	33rd Line TO 35th Line	1.4	800	*Preventative Maintenance*	-	9	18	87
755	Road 92	31st Line TO 33rd Line	1.4	775	*Preventative Maintenance*	-	9	18	87
162	25th Line	From Road 60 To Road 62	1.4	100	*G - Gravel (50mm)*	*$16*	8	15	80
262	Road 64	From 25th Line To 27th Line	1.9	100	*G - Gravel (50mm)*	*$22*	8	16	80
185	29th Line	From Road 78 To Road 84	3.1	75	*G - Gravel (50mm)*	*$36*	8	15	79
186	29th Line	From Road 84 To Road 88	3.1	75	*G - Gravel (50mm)*	*$36*	8	16	79
223	41st Line	From Road 92 To Road 96	3.1	75	*G - Gravel (50mm)*	*$36*	8	15	79
227	43rd Line	From Road 78 To Road 84	3.1	75	*G - Gravel (50mm)*	*$36*	8	16	79

Sect. No.	Road Name	From - To	Length (km)	AADT	Preliminary Improvement Type Recommendation	Cost (x1000)	Surface Condition	Structural Adequacy	Condition Rating
221	41st Line	From Road 84 To Road 88	3.1	125	*G - Gravel (50mm)*	*$36*	8	16	81
791	Road 74	From 23rd Line To 25th Line	1.3	1400	*Preventative Maintenance*	-	10	19	89
792	Road 74	From 25th Line To 27th Line	1.4	1400	*Preventative Maintenance*	-	10	19	89
265	Road 64	From 33rd Line To 35th Line	0.9	50	*G - Gravel (50mm)*	*$10*	7	14	78
156	23rd Line	From Road 78 To Road 84	3.1	150	*G - Gravel (50mm)*	*$36*	8	16	82
255	Road 62	From 21st Line To 25th Line	1.8	150	*G - Gravel (50mm)*	*$21*	8	16	82
256	Road 62	From 25th Line To 27th Line	1.9	150	*G - Gravel (50mm)*	*$22*	8	16	82
260	Road 64	From 19th Line To 27th Line	0.1	150	*G - Gravel (50mm)*	*$1*	8	16	82
307	Road 88	From 15th Line To 19th Line	1.4	150	*G - Gravel (50mm)*	*$16*	8	16	82
822	Road 64	From 17th Line To 21st Line	0.6	1300	*Preventative Maintenance*	-	10	19	89
226	43rd Line	From Road 74 To Road 78	3.1	75	*G - Gravel (50mm)*	*$36*	8	16	80
135	13th Line	From Road 88 To Road 92	3.1	100	*G - Gravel (50mm)*	*$36*	8	16	81
136	13th Line	From Road 92 To Road 96	3.1	100	*G - Gravel (50mm)*	*$36*	8	16	81
163	25th Line	From Road 62 To Road 64	1.4	100	*G - Gravel (50mm)*	*$16*	8	16	81
173	27th Line	From Road 62 To Road 64	3	100	*G - Gravel (50mm)*	*$35*	8	16	81
174	27th Line	From Road 64 To Road 66	1.4	100	*G - Gravel (50mm)*	*$16*	8	16	81
175	27th Line	From Road 66 To Road 68	1.3	100	*G - Gravel (50mm)*	*$15*	8	16	81

Sect. No.	Road Name	From - To	Length (km)	AADT	Preliminary Improvement Type Recommendation	Cost (x1000)	Surface Condition	Structural Adequacy	Condition Rating
183	29th Line	From Road 68 To Road 74	3.1	100	*G - Gravel (50mm)*	*$36*	8	15	81
222	41st Line	From Road 88 To Road 92	3.1	100	*G - Gravel (50mm)*	*$36*	8	16	81
238	45th Line	From Road 92 To Road 96	3.1	100	*G - Gravel (50mm)*	*$36*	8	16	81
804	33rd Line	From Road 78 To Road 84	3.1	100	*G - Gravel (50mm)*	*$36*	8	16	81
9	31st Line	From Road 68 To Road 74	3.1	1200	*Preventative Maintenance*	-	10	19	89
740	Road 64	From 21st Line To 19th Line	1.7	1200	*Preventative Maintenance*	-	10	19	89
214	35th Line	From Road 96 To Perth County Road 21	3.3	50	*G - Gravel (50mm)*	*$38*	8	15	79
257	Road 62	From 27th Line To 19th Line	0.8	125	*G - Gravel (50mm)*	*$9*	8	16	82
132	13th Line	From Road 74 To Road 78	3.1	75	*G - Gravel (50mm)*	*$36*	8	16	81
133	13th Line	From Road 78 To Road 84	3.1	75	*G - Gravel (50mm)*	*$36*	8	16	81
134	13th Line	From Road 84 To Road 88	3.1	75	*G - Gravel (50mm)*	*$36*	8	16	81
145	15th Line	From Road 84 To Road 88	3.1	75	*G - Gravel (50mm)*	*$36*	8	16	81
203	33rd Line	From Road 84 To Road 88	3.1	75	*G - Gravel (50mm)*	*$36*	8	16	81
212	35th Line	From Road 88 To Road 92	3.1	75	*G - Gravel (50mm)*	*$36*	8	16	81
237	45th Line	From Road 88 To Road 92	3.1	75	*G - Gravel (50mm)*	*$36*	8	16	81
146	15th Line	From Road 88 To Road 92	3.1	100	*G - Gravel (50mm)*	*$36*	8	16	82
147	15th Line	From Road 92 To Road 96	3.1	100	*G - Gravel (50mm)*	*$36*	8	16	82

Sect. No.	Road Name	From - To	Length (km)	AADT	Preliminary Improvement Type Recommendation	Cost (x1000)	Surface Condition	Structural Adequacy	Condition Rating
825	Road 88	From 29th Line To 31st Line	1.4	100	*G - Gravel (50mm)*	*$16*	8	16	82
159	23rd Line	From Road 92 To Road 96	3.1	50	*G - Gravel (50mm)*	*$36*	8	16	80
204	33rd Line	From Road 88 To Road 92	3.1	50	*G - Gravel (50mm)*	*$36*	8	16	80
240	Zorra/East Zorra-Tavistock Line	From Road 68 To Road 74	1.6	150	*G - Gravel (50mm)*	*$18*	8	17	84
47	Road 92	From 27th Line To 29th Line	0.8	800	*Preventative Maintenance*	-	10	19	89
230	43RD Line	From Road 92 To Road 96	3.1	75	*G - Gravel (50mm)*	*$36*	8	17	82
149	21ST Line	From Road 60 To Road 62	1.4	75	*G - Gravel (50mm)*	*$16*	8	17	82
150	21ST Line	From Road 62 To Road 64	1.4	75	*G - Gravel (50mm)*	*$16*	8	17	82
151	21st Line	From Road 64 To Road 66	1.4	75	*G - Gravel (50mm)*	*$16*	8	17	82
178	27th Line	From Road 78 To Road 84	3.1	75	*G - Gravel (50mm)*	*$36*	8	16	82
211	35th Line	From Road 84 To Road 88	3.1	75	*G - Gravel (50mm)*	*$36*	8	16	82
305	Road 88	From Cobble Hills Road To 13th Line	1.4	75	*G - Gravel (50mm)*	*$16*	8	16	82
306	Road 88	From 13th Line To 15th Line	1.4	75	*G - Gravel (50mm)*	*$16*	8	16	82
184	29th Line	From Road 74 To Road 78	3.1	100	*G - Gravel (50mm)*	*$36*	9	16	83
213	35th Line	From Road 92 To Road 96	3.1	50	*G - Gravel (50mm)*	*$36*	8	16	82
254	Road 62	From 15th Line To 21st Line	2.4	50	*G - Gravel (50mm)*	*$28*	8	16	82

Sect. No.	Road Name	From - To	Length (km)	AADT	Preliminary Improvement Type Recommendation	Cost (x1000)	Surface Condition	Structural Adequacy	Condition Rating
264	Road 64	From 31st Line To 33rd Line	1.2	50	*G - Gravel (50mm)*	*$14*	8	16	82
187	29th Line	From Road 88 To Road 92	3.1	75	*G - Gravel (50mm)*	*$36*	9	17	84
229	43rd Line	From Road 88 To Road 92	3.1	50	*G - Gravel (50mm)*	*$36*	8	17	83
59	Stanley St. N.	From Lot 1/2 To Road 68	0.6	800	*Preventative Maintenance*	-	8	16	92
78	Brock St	From Stanley St. To St. Patrick St.	0.8	400	*Preventative Maintenance*	-	6	16	91
61	George St.	From CPR ROW To Road 68	0.6	500	*Preventative Maintenance*	-	8	16	92
67	Washington	From Stanley St. To Allen Street	0.8	250	*Preventative Maintenance*	-	8	16	92
73	Stanley St. S.	From Banner Road To Road 68	0.8	800	*Preventative Maintenance*	-	9	17	95
76	Middleton	From Sloan Dr. To Road 68	1.1	450	*Preventative Maintenance*	-	9	17	95
95	Commissioners St.	From 35th Line To Town Limit	1.9	1000	*Preventative Maintenance*	-	9	18	96
65	Mc Carty St.	From Stanley St. To Allen Street	0.8	300	*Preventative Maintenance*	-	9	17	95
81	Alison Rd.	From Stanley St. To Seldon	0.4	300	*Preventative Maintenance*	-	9	17	95
60	Church St.	From Mc Carty To Road 68	0.5	250	*Preventative Maintenance*	-	9	17	95
66	Byron St.	From Stanley St. To Allen Street	0.8	250	*Preventative Maintenance*	-	9	17	95
82	Seldon	From Stanley St. To Middleton	0.5	250	*Preventative Maintenance*	-	9	17	95
70	Finlayson Dr.	From Stanley St. To Stanley	0.5	200	*Preventative Maintenance*	-	9	17	95
79	Elizabeth St.	From Stanley St. To Middleton	0.4	200	*Preventative Maintenance*	-	9	17	95

Sect. No.	Road Name	From - To	Length (km)	AADT	Preliminary Improvement Type Recommendation	Cost (x1000)	Surface Condition	Structural Adequacy	Condition Rating
68	Delatre St. W	From Stanley St. To Allen Street	0.8	150	*Preventative Maintenance*	-	9	17	95
77	Andrew St.	From Brock St. To Dundas St. W	0.1	150	*Preventative Maintenance*	-	9	17	95
90	John St.	From Ross To Sutherland	0.7	250	*Preventative Maintenance*	-	9	18	96
71	Conway Ct.	From Turning Circle To Stanley	0.2	75	*Preventative Maintenance*	-	9	17	95
72	Minler Rd.	From Turning Circle To Finlayson	0.2	75	*Preventative Maintenance*	-	9	17	95
74	Pamela Ct.	From Alison To Turning Circle	0.2	75	*Preventative Maintenance*	-	9	17	95
88	St. Andrews St	From 37th Line To Thames	0.4	200	*Preventative Maintenance*	-	9	18	96
75	Boyd Blvd.	From Sloan Dr. To Sloan Dr.	0.4	400	*Preventative Maintenance*	-	10	19	99
92	Elgin St.	From CPR ROW To John	0.5	300	*Preventative Maintenance*	-	10	19	99
93	Argyle St.	From Hallady To John	0.6	200	*Preventative Maintenance*	-	10	19	99
80	Linda Lane	From Stanley 15th Line To Boyd Bvld.	0.4	175	*Preventative Maintenance*	-	10	19	99
87	Union St.	From Dead End At West To 37th Line	0.3	150	*Preventative Maintenance*	-	10	19	99
94	Thames St.	From St. Andrews To Commissions	0.1	150	*Preventative Maintenance*	-	10	19	99
96	Sutherland St.	From Commissions To John	0.1	150	*Preventative Maintenance*	-	10	19	99
85	James St.	From Dead End At West To 37th Line	0.2	125	*Preventative Maintenance*	-	10	19	99
86	Kincardine St.	From 37th Line To Argyle St.	0.2	125	*Preventative Maintenance*	-	10	19	99

Sect. No.	Road Name	From - To	Length (km)	AADT	Preliminary Improvement Type Recommendation	Cost (x1000)	Surface Condition	Structural Adequacy	Condition Rating
84	Hallady St.	From 37th Line To Argyle St.	0.2	100	*Preventative Maintenance*	-	10	19	99
89	Wallace Crescent	From Commissions To Commissions	0.2	100	*Preventative Maintenance*	-	10	19	99
91	Ross St.	From Road 80 To John	0.2	100	*Preventative Maintenance*	-	10	19	99
83	Sloan	From 15th Line To Middleton	0.7	400	*Preventative Maintenance*	-	10	20	100

Notes:

1. *Priorities in descending order. The higher the priority rating the greater the need.*
2. *Rehabilitation strategy to be confirmed by geotechnical investigations at detail design.*
3. *Costing is zero for roads within the network but maintained by others (i.e. boundary roads).*

6.3 Preservation Management

Preservation techniques seal the surface as to prevent water infiltration into the granular base. Route and Seal is used on HCB pavements to seal individual cracks. Slurry Seal / Microsurfacing is used on LCB and HCB pavements to seal large areas, although wide / active cracks will reflect through the treatment. An annual preservation management budget has been estimated as follows:

Cracksealing

- 122.7 km of paved roads (HCB).
- Assume that cracksealing will be applied, on average, once per resurfacing cycle.
- Annual cracksealing of 6.1km / year
- **Annual budget $24,400** (6.1 km x $4,000 / km **Cracksealing**).

Slurry Seal / Microsurfacing

- 122.7 km of paved roads (HCB).
- 7.8 km of surface treated roads (LCB & ICB).
- Assume that slurry seal / microsurfacing will be applied, on average, once per resurfacing cycle.
- 7.2 km of road to preserve per year (6.1 km HCB and 1.1 km of LCB).
- **Annual budget $146,160** (7.2 km x $20,000 / km **Slurry Sealing / Microsurfacing**).

6.4 Road Maintenance

Preventative road and roadside maintenance is critical to prolonging the useful service life of a road and maximizing the capital investment. A continuous road and roadside maintenance program is recommended to reduce the road degradation rates. Ditch cleanout and clearing of vegetation from the right-of-way should be carried out on a regular basis. This can either be accomplished through dedicated internal Township forces or sub-contracting to private contractors. Consideration may be given to a dedicated capital program of ditch cleanout and clearing, to ensure resources are

6.5 Replacement Cost

In conjunction with this Road Needs Study Report, a replacement cost for the road asset was calculated based strictly on roadbed materials i.e. sub-base, base and surface. Road design standards noted in **Table 8** were used to estimate the existing depth of road bed materials for the purpose of the replacement cost calculation.

The total replacement cost for the Township's road infrastructure is approximately $68.0 M.

Note this cost represents the theoretical road bed materials costs only and does not include items such as removal of the existing road bed, installation of signs, pavement markings, lighting, drainage infrastructure, property etc.

7.0 Summary

D.M. Wills Associates (Wills) undertook a review of the Township of Zorra's (Township) existing road network to assess its physical condition and confirm various road attributes. Data collected as a result of the field review was used to develop a prioritized listing of the road network needs based primarily on condition and traffic volumes.

Wills undertook the field study in July of 2019. A visual assessment of each road within the Township was undertaken to assess the current condition of the road.

Two primary indicators of the relative health of a road are the structural adequacy and surface condition ratings. The current average structural adequacy rating for the Township's road network is 14.8/20. The current average surface condition rating for the Township's road network is 7.7/10.

4% (~18 km) of the road network has a Structural "NOW" need, 4% (~20 km) has a Structural "1-5" year need, and 6% (~26 km) of the road network has a Structural "6-10" year need.

Preservation Management

In addition to addressing currently deficient roads (i.e. capital reconstruction), a dedicated preservation management approach is required, **and perhaps even more importantly**, to "keep the good roads good"; the fundamental principle being that it costs much less to maintain a good road than it does to let it fail and then reconstruct it, from a life cycle cost perspective. Ultimately, the goal of preservation management is to extend the useful life of a road and road network, maximizing the municipality's investment over the road life-cycle.

Road resurfacing is an effective way of extending the overall life of the pavement structure and therefore a road resurfacing program is highly recommended. Roads with a structural adequacy of 12/20 or greater are included as candidates for potential resurfacing. Preliminary recommendations and prioritization for road resurfacing are based on condition rating and traffic demands on each road section, as per the Inventory Manual. A road with higher traffic volumes and fair structural adequacy is given priority over a road with moderate traffic and good structural adequacy score, in an attempt to intervene and extend the life of the road before it deteriorates to a level that can no longer be resurfaced (i.e. more expensive reconstruction is required). Specific resurfacing treatment recommendations must be assessed through further field investigation and detail design effort, prior to selecting and implementing the resurfacing strategy.

Based on typical degradation rates for gravel roads, surface treatment, and hot mix, a total resurfacing program, (hot mix, surface treatment and gravel) is estimated at $3,134,550 per year.

Further to the recommendations above with respect to resurfacing, it is also recommended that regular maintenance in the form of roadside ditch cleanout and clearing be undertaken as a critical component to preservation management in order to extend the useful service life of the existing roads.

Capital Improvements

Preliminary recommendations and prioritization for planned capital improvements i.e. reconstruction, have been developed based on the condition rating and traffic demands on each road section, as per the Inventory Manual. Those roads identified as having a "NOW" or 1 - 5 year need have been included in the capital improvement plan for reconstruction.

A total length of 37.9 km of roads were identified as having structural needs in the "NOW," or 1 – 5 year periods. The estimated cost to improve these roads is approximately $ 11.6 M.

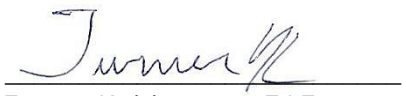
An additional length of approximately 29.3 km of road is identified as having inadequate surface widths. Generally, provided no operational or safety concerns are identified, roads with surface width deficiencies are typically addressed / considered at the next full reconstruction cycle. All roads currently meet the minimum tolerable standard for surface type, based on the Inventory Manual methodology.

The time of inspection plays a significant role in assessing a road's condition. Certain deficiencies, particularly for gravel roads, are only obvious during the "spring break-up" period. By midsummer, any evidence to suggest these deficiencies may have disappeared due to regular grading and grooming activities and general drying of the roadbed. The field work for this study was carried out in July 2019, by which time of "spring break-up" was not evident.

We trust the above and attached information will be of benefit to the Township and appreciate the opportunity to assist the Township in developing its road improvement plan.

Respectfully submitted,

Eric St. Pierre, P.Eng
Transportation Engineer



Turner Kuhlmeyer, E.I.T
Transportation E.I.T.

ESP/TK/ms

Statement of Limitations

This report has been prepared by D.M. Wills Associates on behalf of the Township of Zorra. The conclusions and recommendations in this report are based on available background documentation and discussions with applicable Township staff at the time of preparation.

The report is intended to document the 2019 Roads Needs Study Report findings and assist the Township in developing budgetary plans for investment into their road network.

Any use which a third party makes of this report, other than as a Road Needs Study Report is the responsibility of such third parties. D.M. Wills Associates Limited accepts no responsibility for damages, if any, suffered by a third party as a result of decisions made or action taken based on using this report for purposes other than as a summary of the 2019 Road Needs Study Report findings.

Appendix A

Unit Price Form

ROAD IMPROVEMENT COSTS
Township of Zorra

Unit Costs	Units	Unit Cost
Granular A	t	$10.00
Granular B	t	$7.00
Hot Mix	t	$135.00
Earth Excavation	m3	$15.00
Asphalt Removal	m2	$6.00
Asphalt Removal - Partial Depth	m2	$3.00
Removal of Concrete Curb & Gutter	m	$20.00
Concrete Curb & Gutter	m	$133.50
In-Place Full Depth Reclamation	m2	$4.00
Surface Treatment - Single	m2	$3.50
Surface Treatment - Double	m2	$7.00
Granular A Conversion	2.2	t/m3
Granular B Conversion	2	t/m3
Hot Mix Conversion	2.45	t/m3

Gravel (50mm)

Item	*Width - m*	*Depth - mm*	*Conversion Factor*	*Unit*		*Quantity*	*Unit Cost*	*Cost/km (x 1000)*	
Granular A	7.0	75	2.2	t		1155	$10.00	$ 12	
							G	**12**	**(per Kilometre)**

Frost Heave Treatment

Item	*Width - m*	*Depth - mm*	*Conversion Factor*	*Unit*		*Quantity*	*Unit Cost*	*Cost/50m Digout (x 1000)*	
Earth Excavation	8.0	800		m3		320	$15.00	$ 5	
Granular A	7.0	150	2.2	t		115.5	$10.00	$ 1	
Granular B	8.0	650	2	t		520	$7.00	$ 4	
							FT	**10**	**(per Kilometre)**

Surface Treatment - Rural/Semi Urban - Single [ST1]

Item	*Width - m*	*Depth - mm*	*Conversion Factor*	*Unit*		*Quantity*	*Unit Cost*	*Cost/km (x 1000)*	
Surface Treatment - Single (Overlay)	7.0			m2		7000	$3.50	$ 25	
							ST1	**25**	**(per Kilometre)**

Surface Treatment - Rural/Semi Urban - Double [ST2]

Item	*Width - m*	*Depth - mm*	*Conversion Factor*	*Unit*		*Quantity*	*Unit Cost*	*Cost/km (x 1000)*	
Surface Treatment - Double (Overlay)	7.0			m2		7000	$7.00	$ 49	
							ST2	**49**	**(per Kilometre)**

Surface Treatment - Rural/Semi Urban - Double with Removal of Existing [ST2R]

Item	*Width - m*	*Depth - mm*	*Conversion Factor*	*Unit*	*Crossfall Correction*	*Quantity*	*Unit Cost*	*Cost/km (x 1000)*	
Surface Treatment - Double	7.0			m2		7000	$7.00	$ 49	
Removal Asphalt Pavement	7.0	16		m2		7000	$6.00	$ 42	
							ST2R	**91**	**(per Kilometre)**

Surface Treatment - Rural/Semi Urban - Double with Granular Base [ST2A]

Item	*Width - m*	*Depth - mm*	*Conversion Factor*	*Unit*	*Crossfall Correction*	*Quantity*	*Unit Cost*	*Cost/km (x 1000)*	
Surface Treatment - Double	7.0			m2		7000	$7.00	$ 49	
Granular A	7.0	150	2.2	t		2310	$10.00	$ 23	
							ST2A	**72**	**(per Kilometre)**

Surface Treatment - Rural/Semi Urban - Double with Pulverization and Granular Base [ST2PA]

Item	*Width - m*	*Depth - mm*	*Conversion Factor*	*Unit*	*Crossfall Correction*	*Quantity*	*Unit Cost*	*Cost/km (x 1000)*	
Surface Treatment - Double	7.0			m2		7000	$7.00	$ 49	
Granular A	7.0	150	2.2	t		2310	$10.00	$ 23	
Pulverizing	7.0			m2		7000.0	$4.00	$ 28	
Minor Items @ 25%								$ 7	
							ST2PA	**107**	**(per Kilometre)**

Surface Treatment - Rural/Semi Urban - Widening and Double with Pulverization and Granular Base [ST2PAW]									
Item	*Width - m*	*Depth - mm*	*Conversion Factor*	*Unit*	*Crossfall Correction*	*Quantity*	*Unit Cost*	*Cost/km (x 1000)*	
Surface Treatment - Double	7.0			m2		7000	$7.00	$ 49	
Granular A	7.0	150	2.2	t		2310	$10.00	$ 23	
Pulverizing	7.0			m2		7000.0	$4.00	$ 28	
Earth Excavation	2	450		m3		900	$15.00	$ 14	
Granular B	1	450	2	t		900	$7.00	$ 6	
Minor Items @ 25%								$ 12	
							ST2PAW	**132**	**(per Kilometre)**

Resurfacing - Rural/Semi Urban Single Lift Overlay [RO1]									
Item	*Width - m*	*Depth - mm*	*Conversion Factor*	*Unit*	*Crossfall Correction ** *	*Quantity*	*Unit Cost*	*Cost/km (x 1000)*	
Hot Mix	3	50	2.45	t	74	441	$135.00	$ 60	
Granular A	1.5	50	2.2	t		165	$10.00	$ 2	
Minor Items @ 15%								$ 9	
							RO1	**70**	**(per Lane Kilometre)**

Resurfacing - Rural/Semi Urban - Double Lift Overlay [RO2]									
Item	*Width - m*	*Depth - mm*	*Conversion Factor*	*Unit*	*Crossfall Correction ** *	*Quantity*	*Unit Cost*	*Cost/km (x 1000)*	
Hot Mix	3	90	2.45	t	66	728	$135.00	$ 98	
Granular A	1.5	90	2.2	t		297	$10.00	$ 3	
Minor Items @ 15%								$ 15	
							RO2	**116**	**(per Lane Kilometre)**

Resurfacing - Urban - Single Lift Mill and Pave [RMP1]									
Item	*Width - m*	*Depth - mm*	*Conversion Factor*	*Unit*	*Crossfall Correction*	*Quantity*	*Unit Cost*	*Cost/km (x 1000)*	
Hot Mix	4.25	50	2.45	t		521	$135.00	$ 70	
Remove Curb and Gutter				m		200	$20.00	$ 4.00	
Curb and Gutter - 20%				m		200	$133.50	$ 26.70	
Milling	4.25			m2		4250	$3.00	$ 12.75	
Minor Items @ 25%								$ 28	
							RMP1	**142**	**(per Lane Kilometre)**

Resurfacing - Urban - Double Lift Mill and Pave [RMP2]									
Item	*Width - m*	*Depth - mm*	*Conversion Factor*	*Unit*	*Crossfall Correction*	*Quantity*	*Unit Cost*	*Cost/km (x 1000)*	
Hot Mix	4.25	90	2.45	t		937	$135.00	$ 127	
Remove Curb and Gutter				m		200	$20.00	$ 4.00	
Curb and Gutter - 20%				m		200	$133.50	$ 26.70	
Milling	4.25			m2		4250	$3.00	$ 12.75	
Minor Items @ 25%								$ 42	
							RMP2	**212**	**(per Lane Kilometre)**

Pulverize and Pave One Lift [PP1] Rural/Semi-Urban									
Item	*Width - m*	*Depth - mm*	*Conversion Factor*	*Unit*	*Crossfall Correction*	*Quantity*	*Unit Cost*	*Cost/km (x 1000)*	
Hot Mix	3	50	2.45	t		367.5	$135.00	$ 50	
Granular A	1.5	50	2.2	t		165	$10.00	$ 2	
Pulverize	3			m2		3000	$4.00	$ 12.00	
Minor Items @ 25%								$ 16	
							PP1	**79**	**(per Lane Kilometre)**

Pulverize and Pave Two Lifts [PP2] Rural/Semi-Urban									
Item	*Width - m*	*Depth - mm*	*Conversion Factor*	*Unit*	*Crossfall Correction*	*Quantity*	*Unit Cost*	*Cost/km (x 1000)*	
Hot Mix	3	90	2.45	t		661.5	$135.00	$ 89	
Granular A	1.5	90	2.2	t		297	$10.00	$ 3	
Pulverize	3			m2		3000	$4.00	$ 12	
Minor Items @ 25%								$ 26	
							PP2	**130**	**(per Lane Kilometre)**

Semi-Urban: Resurfacing and Widening - Residential (Single Lift Widening)

Item	*Width - m*	*Depth - mm*	*Conversion Factor*	*Unit*	*Crossfall Correction* **	*Quantity*	*Unit Cost*	*Cost/km (x 1000)*	
Earth Excavation	2	600		m3		1200	$15.00	$ 18	
Granular A	5	150	2.2	t		1650	$10.00	$ 17	
Granular B	5	450	2	t		4500	$7.00	$ 32	
Hot Mix	8	50	2.45	t	196	1176	$135.00	$ 159	
Milling	4			m2		4000	$3.00	$ 12	
Minor Items @ 25%								$ 59	
							RW1	**296**	**(widening one side)**

Commercial and Industrial (Double Lift Widening)

Item	*Width - m*	*Depth - mm*	*Conversion Factor*	*Unit*	*Crossfall Correction*	*Quantity*	*Unit Cost*	*Cost/km (x 1000)*	
Earth Excavation	2	600		m3		1200	$15.00	$ 18	
Granular A	5	150	2.2	t		1650	$10.00	$ 17	
Granular B	5	450	2	t		4500	$7.00	$ 32	
Hot Mix	8	90	2.45	t	353	2117	$135.00	$ 286	
Milling	4			m2		4000	$3.00	$ 12	
Minor Items @ 25%								$ 91	
							RW2	**455**	**(widening one side)**

Gravel Road Widening

Item	*Width - m*	*Depth - mm*	*Conversion Factor*	*Unit*	*Crossfall Correction*	*Quantity*	*Unit Cost*	*Cost/km (x 1000)*	
Earth Excavation	2	600		m3		1200	$15.00	$ 18	
Granular A	1	150	2.2	t		330	$10.00	$ 3	
Granular B	1	450	2	t		900	$7.00	$ 6	
Minor Items @ 25%								$ 7	
							GW	**35**	**(widening one side)**

Rural: Full Excavation and Reconstruction - Gravel (6 m surface width)

Item	*Width - m*	*Depth - mm*	*Conversion Factor*	*Unit*	*Crossfall Correction*	*Quantity*	*Unit Cost*	*Cost/km (x 1000)*	
Earth Excavation	5	600		m3		3000	$15.00	$ 45	
Granular A	3	150	2.2	t		990	$10.00	$ 10	
Granular B	5	450	2	t		4500	$7.00	$ 32	
Minor Items @ 25%								$ 22	
							Recon G	**108**	**(per Lane Kilometre)**

Rural: Full Excavation and Reconstruction - 1 Lift

Item	*Width - m*	*Depth - mm*	*Conversion Factor*	*Unit*	*Crossfall Correction*	*Quantity*	*Unit Cost*	*Cost/km (x 1000)*	
Asphalt Removal - Full Depth	3			m2		3000	$6.00	$ 18	
Earth Excavation	5	600		m3		3000	$15.00	$ 45	
Granular A	4	150	2.2	t		1320	$10.00	$ 13	
Granular B	5	450	2	t		4500	$7.00	$ 32	
Hot Mix	3	50	2.45	t		368	$135.00	$ 50	
Minor Items @ 25%								$ 39	
							Recon 1R	**197**	**(per Lane Kilometre)**

Semi-Urban: Full Excavation and Reconstruction - 1 Lift

Item	*Width - m*	*Depth - mm*	*Conversion Factor*	*Unit*	*Crossfall Correction*	*Quantity*	*Unit Cost*	*Cost/km (x 1000)*	
Asphalt Removal - Full Depth	3			m2		3000	$6.00	$ 18	
Earth Excavation	5	600		m3		3000	$15.00	$ 45	
Granular A	4	150	2.2	t		1320	$10.00	$ 13	
Granular B	5	450	2	t		4500	$7.00	$ 32	
Hot Mix	3	50	2.45	t		368	$135.00	$ 50	
Minor Items @ 25%								$ 39	
							Recon 1S	**197**	**(per Lane Kilometre)**

Semi-Urban: Full Excavation and Reconstruction - 2 Lift

Item	Width - m	Depth - mm	Conversion Factor	Unit	Crossfall Correction	Quantity	Unit Cost	Cost/km (x 1000)	
Asphalt Removal - Full Depth	3			m2		3000	$6.00	$ 18	
Earth Excavation	5	600		m3		3000	$15.00	$ 45	
Granular A	4	150	2.2	t		1320	$10.00	$ 13	
Granular B	5	450	2	t		4500	$7.00	$ 32	
Hot Mix	3	90	2.45	t		662	$135.00	$ 89	
Minor Items @ 25%								$ 49	
							Recon 2S	**246**	**(per Lane Kilometre)**

Urban: Full Excavation and Reconstruction - 2 Lift

Item	Width - m	Depth - mm	Conversion Factor	Unit	Crossfall Correction	Quantity	Unit Cost	Cost/km (x 1000)	
Asphalt Removal - Full Depth	4.25			m2		4250	$6.00	$ 26	
Earth Excavation	5.5	750		m3		4125	$15.00	$ 62	
Granular A	4.5	150	2.2	t		1485	$10.00	$ 15	
Granular B	5.5	600	2	t		6600	$7.00	$ 46	
Hot Mix	4.25	90	2.45	t		937	$135.00	$ 127	
Remove Curb and Gutter				m		1000	$20.00	$ 20.00	
Curb and Gutter				m		1000	$133.50	$ 133.50	
Minor Items @ 25%								$ 69	
							Recon 2U	**497**	**(per Lane Kilometre)**

Rout and Seal

Item				Unit		Quantity	Unit Cost	Cost/km (x 1000)	
Rout and Seal				m		1000	$4.00	$ 4	
							RS	**4**	**(per Lane Kilometre)**

Slurry Seal

Item	Width - m			Unit		Quantity	Unit Cost	Cost/km (x 1000)	
Slurry Seal	7			m2		7000	$2.90	$ 20	
							SS	**20**	**(per Lane Kilometre)**

Microsurfacing

Item	Width - m			Unit		Quantity	Unit Cost	Cost/km (x 1000)	
Microsurfacing	7			m2		7000	$2.90	$ 20	
							MS	**20**	**(per Lane Kilometre)**

Semi-Urban: Upgrade to Urban - 2 Lift

Item	Width - m	Depth - mm	Conversion Factor	Unit	Crossfall Correction	Quantity	Unit Cost	Cost/km (x 1000)	
Asphalt Removal - Full Depth	4.25			m2		4250	$6.00	$ 26	
Earth Excavation	5.5	600		m3		3300	$15.00	$ 50	
Granular A	4.5	150	2.2	t		1485	$10.00	$ 15	
Granular B	5.5	450	2	t		4950	$7.00	$ 35	
Hot Mix	4.25	90	2.45	t		937	$135.00	$ 127	
Curb and Gutter				m		1000	$133.50	$ 133.50	
Minor Items @ 25%								$ 63	
							Recon 2U	**447**	**(per Lane Kilometre)**

Rural: Full Excavation and Reconstruction with 700mm grade raise - Gravel (6 m surface width)

Item	Width - m	Depth - mm	Conversion Factor	Unit	Crossfall Correction	Quantity	Unit Cost	Cost/km (x 1000)	
Earth Excavation	5	450		m3		2250	$15.00	$ 34	
Granular A	4	150	2.2	t		1320	$10.00	$ 13	
Granular B	6	1000	2	t		12000	$7.00	$ 84	
Minor Items @ 25%								$ 33	
							Recon G	**164**	**(per Lane Kilometre)**

Appendix B

PCI Distress Definitions

Flexible Pavements – Distress Descriptions

Loss of Coarse Aggregates: Pavement surface is breaking up into small pock-marks as coarse aggregate particles are lost from the surface.

Ravelling: progressive loss of pavement materials (coarse or fine aggregates, or both) from surface downward results in a pock-marked appearance.

Segregation: A construction-related deficiency resulting in areas of the pavement surface having comparatively coarser or finer texture than that of the surrounding surface; a non-uniform distribution of aggregate sizes through the mat.

Flushing: The presence of free asphalt cement on the pavement surface. Most likely to occur in the wheel tracks during hot weather.

Rippling: Regular transverse undulations in the surface of the pavement, consisting of closely spaced, alternate valleys and crests (Washboard Effect).

Shoving: Singular and multiple waves or humps located transversely or longitudinally on the pavement surface.

Wheel Track Rutting: Longitudinal depressions taking the form of a single or double rut in the wheel tracks after repeated load application. Wheel track rutting results from densification and permanent deformation under the load, combined with displacement of pavement materials. Deep ruts are often accompanied by longitudinal cracking in the wheel tracks.

Distortion: Any deviation (other than described for rippling, shoving, and rutting) of the pavement surface from its original shape. Generally, distortions result from settlement, slope failure, volume changes due to moisture changes or frost heaving, and from residual effects of frost heaving accumulating after each winter.

Distortion may take the form of dishing, bumps, dips (do not include the bumps associated with cupped or tented cracks), all of which give rise to pitch, roll, and jarring drop in a moving vehicle.

Longitudinal Wheel-Track Cracking: Cracks that follow a course approximately parallel to the centre line of the pavement and are situated at or near the centre of the wheel tracks.

Centreline Cracking: Crack(s) that run(s) along or near the road centre line.

Pavement Edge Cracking: Crack parallel to extending out from the pavement lane edge, and is either a fairly continuous "straight" crack or consists of crescent-shaped cracks in a wave forma-tion. On some thin asphalt surfaces, pavement edge cracking

progressively encroaches onto the outer wheel tracks through the middle of the lane, and may even progress to the centre line.

Transverse Cracking: Crack follows a course approximately at right angles to the pavement centre line. Full transverse cracks tend to be regularly spaced along the length of the road, while half transverse and partial transverse occur at shorter, intermediate distances.

Longitudinal Meander and Mid-lane Cracking: Crack, usually quite long, that wanders from edge to edge of the pavement, or crack that is usually straight and parallel to the centre line, at or near the middle of the lane. These types of cracks are usually single cracks, but occasionally secondary cracks do develop parallel to them.

Random / Map Cracking: Interconnected cracks forming a series of large polygons that resemble a map. The cracking appears to combine transverse and longitudinal cracks.

Alligator Crack: Cracks that form a network of polygon blocks resembling the skin of an alligator.

2.0 Surface-Treated Pavements – Distress Descriptions

Loss of Cover Aggregate: The whipping off of cover aggregate under traffic from a surface-treated pavement, leaving only the asphalt.

Streaking: Alternating lean and heavy lines of asphalt running parallel to the centerline of the road. Sometimes streaking also occurs at right angles to the centerline.

Flushing: Free Asphalt migrating upward to the pavement surface. Most likely to occur in the wheels tracks, especially during hot weather.

Potholes: Round of irregular shaped holes in pavement; can be unrelated to other surface defects or a direct result of other defects such as alligator cracking, frost boil, etc.

Pavement Edge Breaks: Edge breaking occurs with or without cracks.

Rippling: Regular transverse undulations in the pavement surface consisting of closely spaced alternate valleys and crests (washboard effect); unevenness of pavement surface caused by traffic action moving surface mat forward, backward or sideways; often accompanied by "flushing".

Wheel Track Rutting: Longitudinal depression left in the wheel tracks after repeated load application resulting from compaction and permanent deformation under load, and pavement materials shoving sideways. Deep ruts are often accompanied by longitudinal cracking in the wheel tracks.

Distortion: Any deviation of pavement surface from its original shape (other than described for rippling or rutting). Generally, these distortion result from settlement, slope

failure, and volume changes due to moisture and frost heaving accumulating after each winter. The resulting deformation may take the form of dishing, bumps, dips, tenting or stepping at cracks, all of which give rise to pitch, roll and jarring drop in a moving vehicle.

Longitudinal Cracking: Cracks follow a course approximately parallel to the direction of travel and are situated at or near the centre of the wheel tracks, centerline, mid-lane, etc.

Transverse Cracking: Crack follows a course approximately at right angles to the pavement centerline. Full width transverse cracks tend to be regularly spaced along the length of the road while half width transverse and part transverse cracks occur at shorter intermediate distances.

Pavement Edge Cracking: Crack is parallel to and within 300 mm of the pavement edge and is either a straight continuous crack or consists of crescent shaped cracks in a wave formation. Pavement edge cracking will progressively encroach into the outer wheel tracks through the middle of the pavement lane and may even progress right across the centerline.

Alligator Cracking: Cracks forming from a network of multi-sided (polygon) blacks resemble the skin of an alligator.