Road Needs Study Report - 2020

The Township of Cavan Monaghan

D.M. Wills Project No. 20-4726

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Peterborough

July 2020
Prepared for The Township of Cavan Monaghan

Executive Summary

The Township of Cavan Monaghan (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 245 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 paved (asphalt). The Township has approximately 36 km of gravel roads, 182 km of surface treated roads (low class bituminous (LCB)), and 27 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 14.1/20. The current average surface condition rating for the Township's road network is 7.5/10.

5% (~12 km) of the road network has a Structural "NOW" need, 11% (~26 km) has a Structural "1-5" year need, and 30% (~70 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 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.

Note that many "6-10" year reconstruction needs may be deferred by timely resurfacing, extending their service lives. As highlighted above, the Township has a portion of their roads (30%) with a" 6–10" Year Structural Need.

Resurfacing and 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 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 resurfacing program and related budget is recommended as follows:

Hot Mix Paved Roads:

- 26.9 km of paved roads (HCB).
- Degradation rate 0.25 / year (rating drops from 10 to 5, over a 20-year period).
- Annual resurfacing 1.3 km / year.
- **Annual budget $361,400**: (1.3 km / year x $139,000 / ln **RMP1** x 2 lanes).

Surface Treated Roads:

- 181.6 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 25.9 km / year.
- **Annual budget $634,550** (25.9 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 - 5 year cycle.

Gravel Roads:

- 36.2 km of earth / gravel roads.
- 75 mm gravel every 5 years.
- Annual gravelling of 7.2 km.
- Granular A ($12,000 / km).
- **Annual budget $86,400** (7.2 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 $1,082,350 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

- 26.9 km of paved roads (HCB).
- Assume that cracksealing will be applied, on average, once per resurfacing cycle.
- Annual cracksealing of 1.3 km / year.
- **Annual budget $5,200** (1.3 km x $4,000 / km **Cracksealing**).

Slurry Seal / Microsurfacing

- 26.9 km of paved roads (HCB).
- 181.6 km of surface treated roads (LCB).
- Assume that slurry seal / microsurfacing will be applied, on average, once per resurfacing cycle.
- 27.2 km of road to preserve per year (1.3 km HCB and 25.9 km of LCB).
- **Annual budget $599,760** (27.2 km x $22,050 / 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.

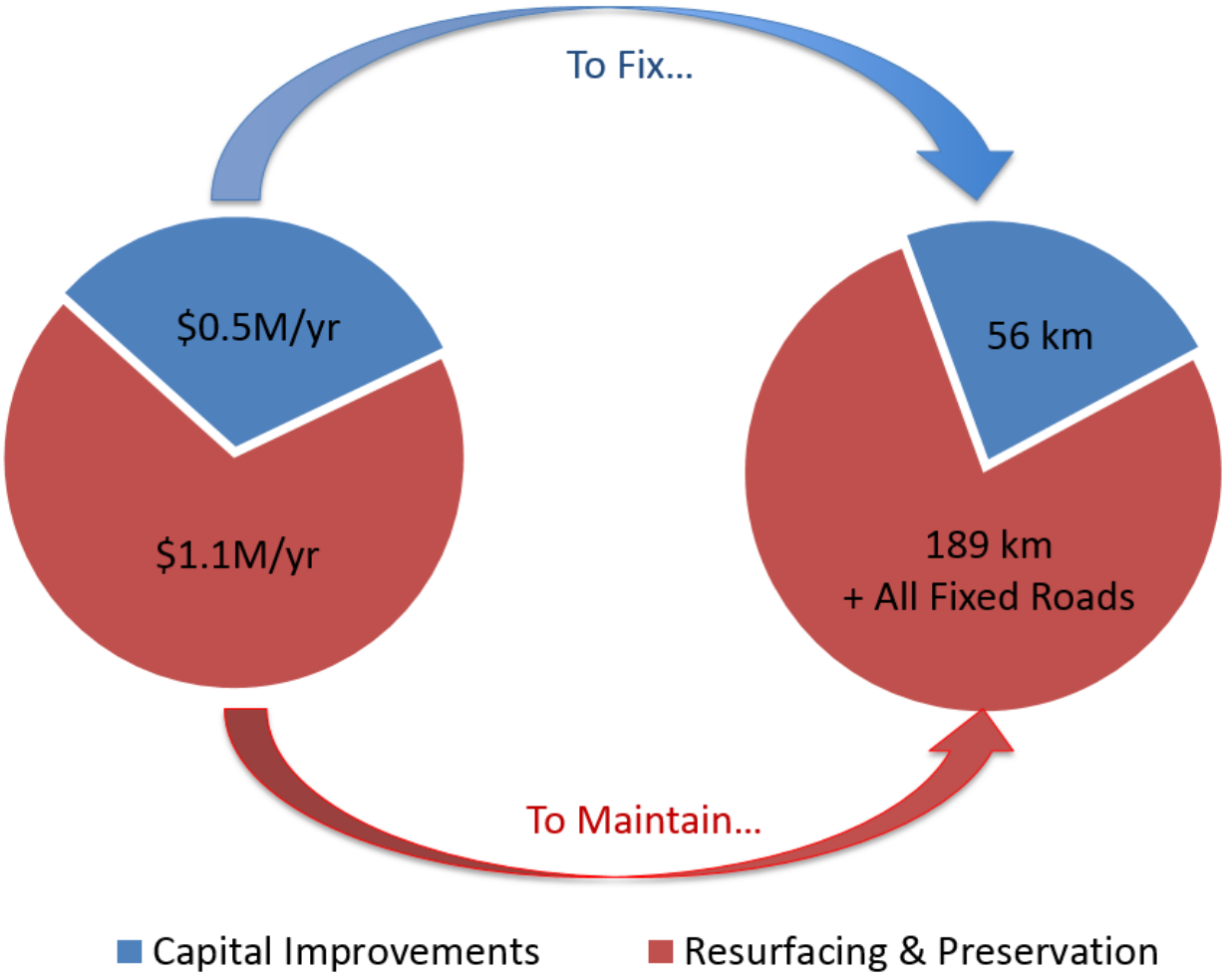
Capital Improvements

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", 1 – 5, or 6 - 10 year need have been included in the capital improvement plan for reconstruction.

A total length of 55.6 km of roads were identified as having structural needs in the "NOW", 1 – 5 or 6-10 year periods. The estimated cost to improve these roads is approximately $ 4.6 M.

It is important to highlight the network's average structural adequacy score of 14.1/20, as noted previously. A significant portion of the Township's 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 $1.1M/year for resurfacing needs and $4.6M ($0.5M/year) for the capital needs over ten years. Funding recommendations can be visualized in the graphic below.



Given that 55% of the Township'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 2020 Road Needs Study Report is to update the current road inventory and road condition assessments within the Township of Cavan Monaghan (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 Cavan Monaghan is located in Peterborough County and is bisected by Highway 115. The Village of Millbrook is the Township's largest and main population centre. Outside of Millbrook, the Township is largely rural with some scattered semi-urban developments.

In 2016, a Road Needs Study Report was undertaken to inventory and document the Township's existing road assets. This current study (2020) utilizes and builds from the road asset information documented in the 2016 Road Needs Study. Additionally, the road inventory was also built using a GIS shapefile of the road network that was provided by the County of Peterborough.

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.
- MTO Manual for Condition Rating of Gravel Roads, SP-025.

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 May of 2020.

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]
	Tolerable Range	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 City.

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 municipal 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 in the 2014 Study.

Table 3 summarizes the total road length in kilometres by surface type and road environment as of May 2020.

The existing road system consists of 245 km of roadway, 36 km of gravel roads, 182 km of surface treated roads (LCB) and 27 km of HCB (asphalt paved) roads; with all calculations being approximate and rounded to the nearest kilometre.

Table 3 - Road System Inventory

Township of Cavan Monaghan		
Road System in Kilometres		
(As of May 2020)		
A.	**Surface Type**	**Totals***
	Earth	0
	Gravel (loose Top Gravel)	36
	Surface Treatment (LCB & ICB)	182
	Hot Mix Asphalt (HCB)	27
	Total A	**245 km**
B.	**Roadside Environment**	
(i)	**Rural**	
	Earth	0
	Gravel (loose Top Gravel)	36
	Surface Treatment (LCB & ICB)	179
	Hot Mix Asphalt (HCB)	19
	Total Rural	**234 km**
(ii)	**Semi-Urban**	
	Gravel (loose Top Gravel)	0
	Surface Treatment (LCB)	3
	Hot Mix Asphalt (HCB)	4
	Total Semi-Urban	**7 km**
(iii)	**Urban**	
	Gravel (loose Top Gravel)	0
	Surface Treatment (LCB)	0
	Hot Mix Asphalt (HCB)	4
	Total Urban	**4 km**
	Total B	**245 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 245 km of roads inventoried, a total of 58 km were found to be critically deficient in one (1) or more areas. Of the 58 km, approximately 6 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:

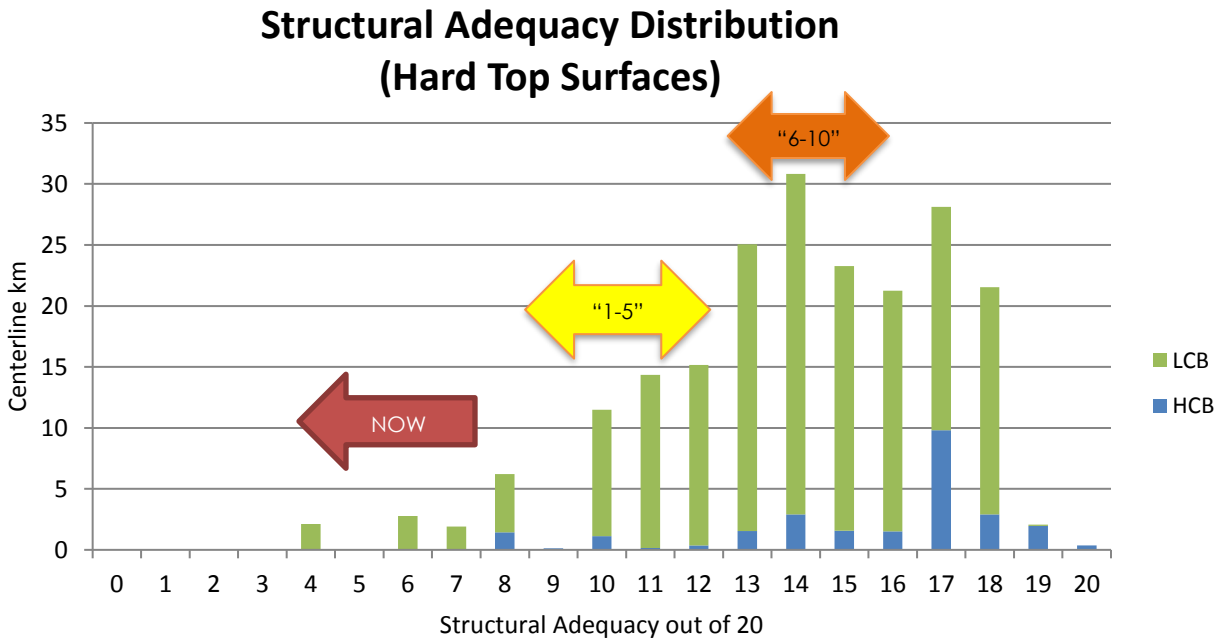
$$\textbf{2020 System Adequacy} = \frac{\textbf{242 - (58 - 6)}}{\textbf{242}} \textbf{ x 100\% = 79\%}$$

The average surface condition rating of all roads is 7.5/10 while the average structural adequacy rating is 14.1/20. 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 per O. Reg. 588/17, the average unpaved road was in good condition and the average PCI for hard top surfaces in the Township is 74.0.

A review of the structural adequacy distribution of the Township's hard top roads identifies a group of roads, 97 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 72 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 40 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 (97 km) from becoming capital reconstruction needs themselves.



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:

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

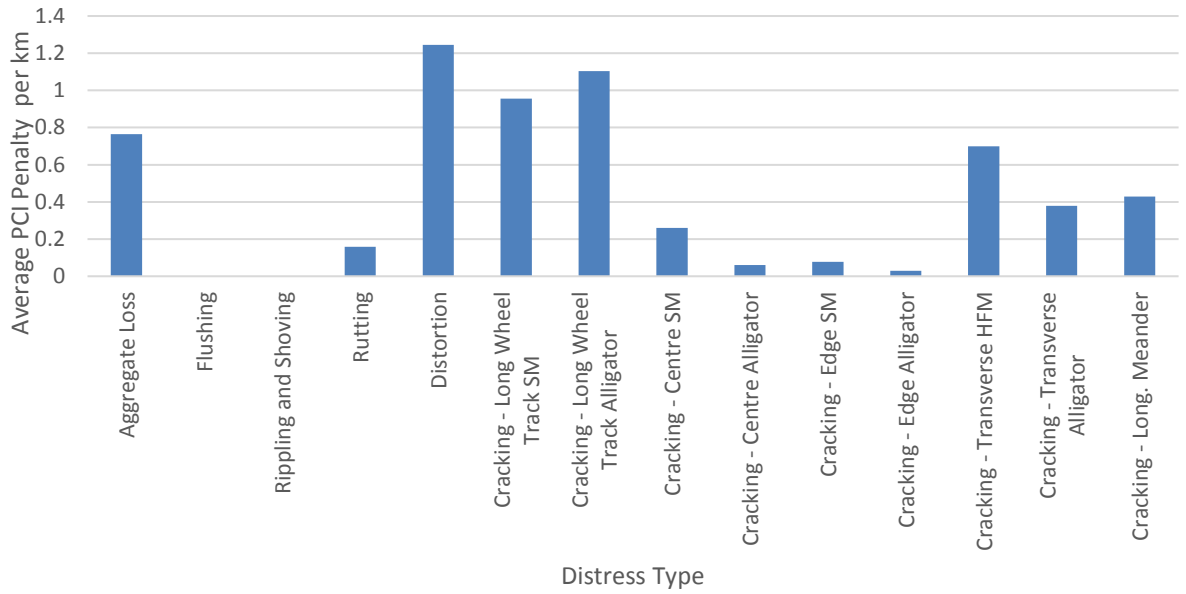
In utilizing the above equation Wills identified a priority listing for review with Township staff. It is important to emphasize that the priority rating calculation considers only CR and traffic volumes.

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

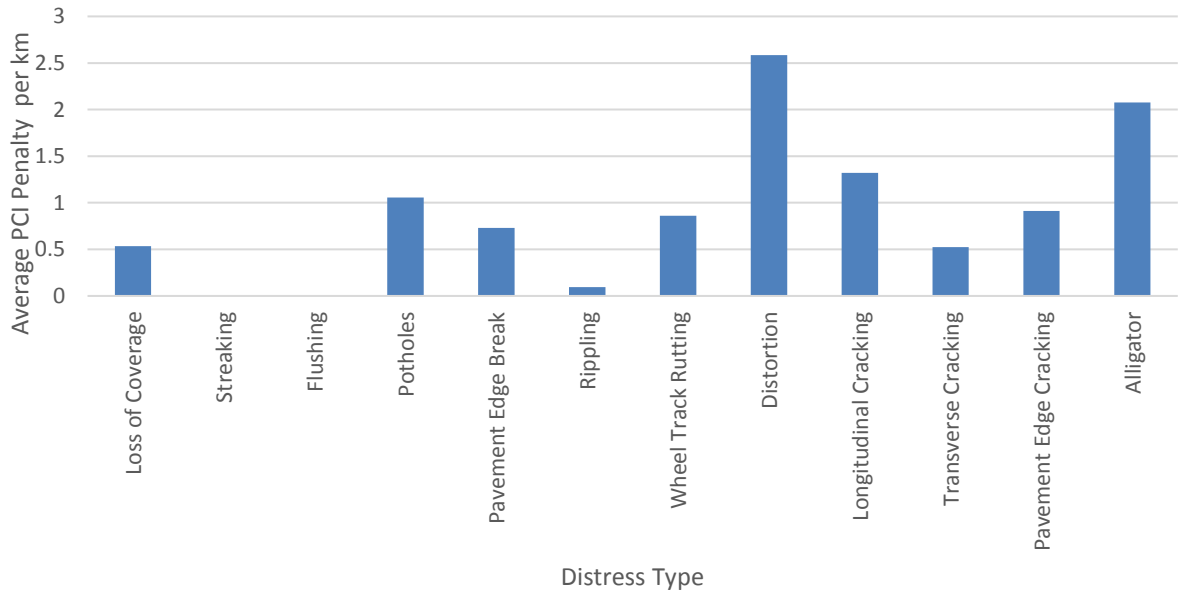
As detailed in **Figure 1,** distortion had the highest effect on PCI rating on the Township's HCB network. Transverse and wheel track cracking were also substantial, with rutting and aggregate loss also responsible for significant penalties to the Township's PCI ratings. Flushing, and rippling and shoving were not observed during inspections.

Figure 1 – HCB Distress Type Prevalence



As detailed in **Figure 2** 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 2 – Surface Treated Distress Type Prevalence



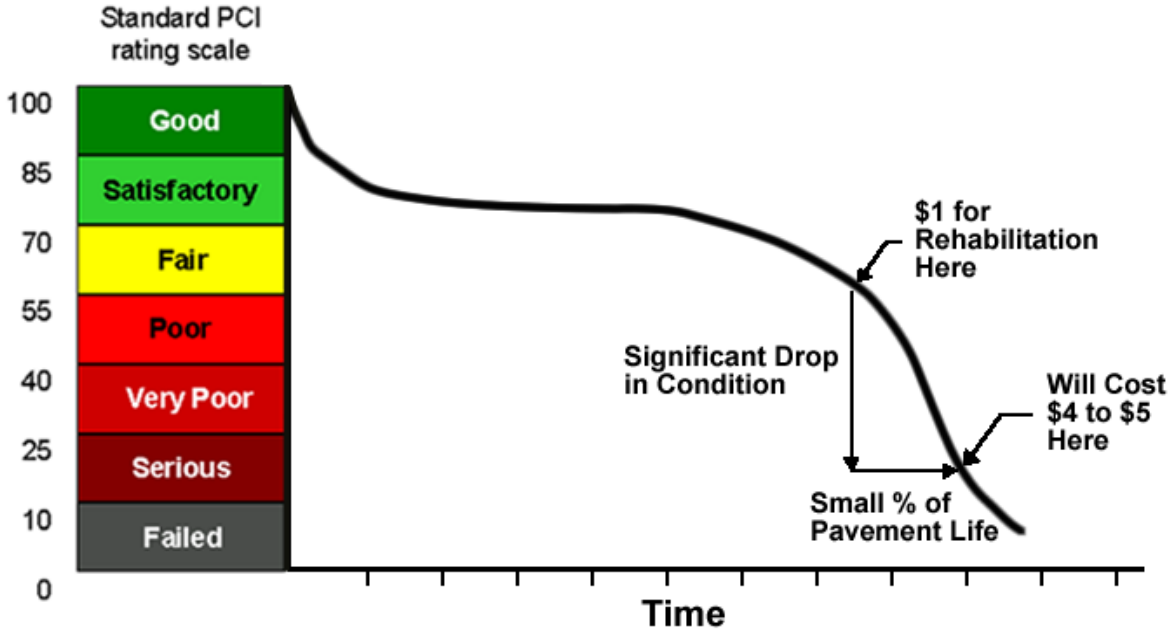
4.0 Roads Best Management Practices

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 1** 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 **Section 4.1** and are provided as an illustration of the benefit of a "preservation management approach".

Figure 3 - Typical Service Life of an Asphalt Pavement



4.1 Example Life Cycle Cost Analysis

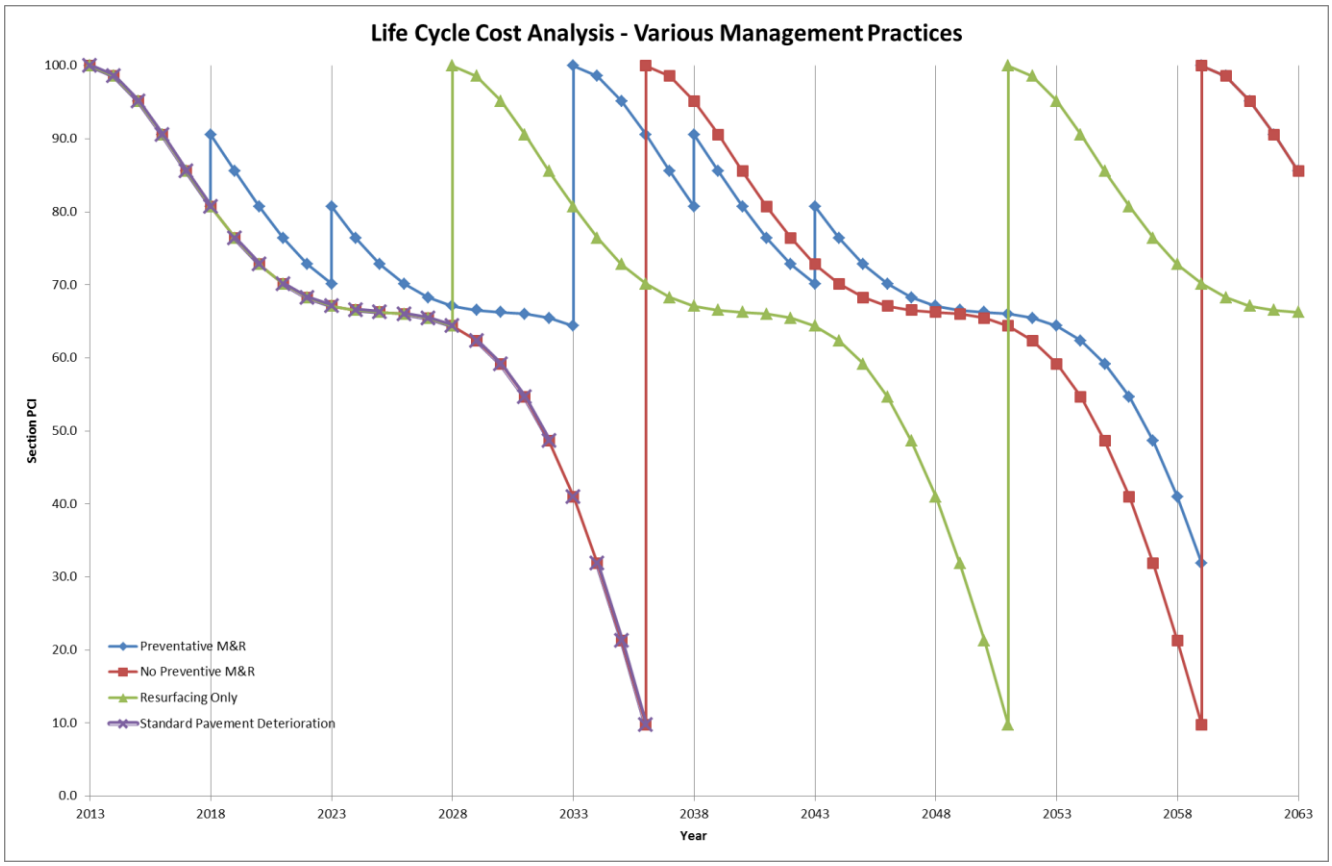
The following life cycle costs analysis compares three (3) different municipalities Municipality 1, Municipality 2 and Municipality 3; each with three (3) distinct approaches to pavement management. For this analysis we will assume each of the three (3) municipalities has 7000 m^2 of pavement, i.e. 1 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 2 below illustrates a time- pavement condition plot for each municipality.

Figure 4 - 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.
Preservation Management Approach

4.1.1 Gravel Roads

The Township currently maintains approximately 36 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 (75 mm) of granular material to road surface.	Every 5 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 182 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 27 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.

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 (ST1).

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)	6.4	1.0	150	450	-
Rural R300 (200 to 399 vpd)	6.4	1.0	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

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 2020 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 Cavan Monaghan 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										
1605	Manor Dr	Cnty Rd 10	Union Street	0.175	800	*ST2A - Double Surface Treatment with Granular A*	*$11*	6	8	52
1920	Tapley 1/4 Li	Highway 115 Ramp	Cnty Rd 21	1.3	900	*ST2A - Double Surface Treatment with Granular A*	*$83*	6	8	54
1060	Beardsmore Dr	Cnty Rd 11	Johnston Dr	1.55	425	*ST2A - Double Surface Treatment with Granular A*	*$99*	6	6	50
1280	Dobbin Rd	Cnty Rd 15	North End	1.12	525	*PP1 - Pulverize and Pave 1 Lift*	*$189*	6	8	54
1600	Main St	King Street West	South end	0.6	375	*ST2A - Double Surface Treatment with Granular A*	*$38*	6	7	51
1315	Dufferin St	Gravel Rd	End	0.15	425	*ST2A - Double Surface Treatment with Granular A*	*$10*	6	8	53
1570	Larmer Li	Highway 115	Cnty Rd 10	1.3	425	*ST2A - Double Surface Treatment with Granular A*	*$83*	6	7	59
1620	Marshall St	West End	East End	0.22	50	*ST2A - Double Surface Treatment with Granular A*	*$14*	4	4	42
1270	Deyell Li	T-Way Dr	Hutchinson Dr	1.33	200	*ST2A - Double Surface Treatment with Granular A*	*$85*	5	4	55
1230	Charles St	West End	East End	0.145	50	*ST2A - Double Surface Treatment with Granular A*	*$9*	4	4	43
1955	Turner St	Hunter Street	King Street West	0.18	100	*ST2A - Double Surface Treatment with Granular A*	*$11*	6	8	51
1835	Sowden Ln	Main St	East End	0.13	25	*ST2A - Double Surface Treatment with Granular A*	*$8*	4	4	43
1415	Hayes Li	Howden 1/4 Unopened	Highway 7	2.8	600	*ST2A - Double Surface Treatment with Granular A*	*$179*	6	8	69
1830	Skiview Dr	Hillview Dr	North End	0.37	50	*ST2A - Double Surface Treatment with Granular A*	*$24*	5	6	52
2010	Whittington Dr	750m East	East End	0.75	225	*Recon 1R - Full Reconstruction + 1 Lift*	*$304*	6	7	66
1740	Poplar Plains Dr	Cnty Rd 10	East End	0.18	75	*ST2A - Double Surface Treatment with Granular A*	*$11*	5	4	62

Sect. No.	Road Name	From	To	Length (km)	AADT	Preliminary Improvement Type Recommendation	Cost (x1000)	Surface Condition	Structural Adequacy	Condition Rating
1990	White Birch Rd	Elgar Dr	End	0.85	75	*ST2A - Double Surface Treatment with Granular A*	*$54*	5	6	63
1360	Fallingbrook Dr	Poplar Plains Dr	Cavan Wood Dr	0.115	50	*ST2A - Double Surface Treatment with Granular A*	*$7*	5	4	64
1095	Blue Jay St.	County Rd 10	Alexander Dr	0.22	50	*Recon 1R - Full Reconstruction + 1 Lift*	*$89*	6	8	70
1190	Cavan Wood Dr	Cnty Rd 10	East End	0.18	50	*ST2A - Double Surface Treatment with Granular A*	*$11*	6	8	70
1010	Alexander St.	Blue Jay St.	North End	0.09	25	*Recon 1R - Full Reconstruction + 1 Lift*	*$36*	6	8	70
1-5 Year Needs										
1845	Stewart Li	Cnty Rd 10	Howden 1/4 Line	3.55	800	*ST2A - Double Surface Treatment with Granular A*	*$227*	6	10	56
1785	Sharpe Li	Howden 1/4 Li	1100m West of Hwy 7	1.68	600	*ST2A - Double Surface Treatment with Granular A*	*$107*	6	10	56
1370	Fallis Li	Valleyview East	Cty Rd 10	2.11	525	*ST2A - Double Surface Treatment with Granular A*	*$135*	6	10	55
1405	Gravel Rd	King St E	End	0.3	425	*ST2A - Double Surface Treatment with Granular A*	*$19*	6	10	56
1540	Johnston Dr	Worboy Ct	Carolyn St	0.42	425	*Recon 1R - Full Reconstruction + 1 Lift*	*$170*	6	10	56
1015	Allen Ln	Needler's Lane	King Street West	0.12	275	*PP1 - Pulverize and Pave 1 Lift*	*$20*	6	9	53
1395	Frederick St	Main St	Anne St	0.41	275	*ST2A - Double Surface Treatment with Granular A*	*$26*	6	11	56
1535	Johnston Dr	Carolyn St	North End	0.91	425	*Recon 1R - Full Reconstruction + 1 Lift*	*$369*	6	10	64
1775	Rothesay Av	South End	Lansdowne St W	0.54	150	*ST2A - Double Surface Treatment with Granular A*	*$34*	5	11	56
1420	Hayes Li	Cnty Rd 10	Howden 1/4 Unopened	3.5	300	*ST2A - Double Surface Treatment with Granular A*	*$223*	7	11	65
1910	Syer Li	Tapley 1/4 Line	Vista Cres	2.53	225	*ST2A - Double Surface Treatment with Granular A*	*$161*	6	10	63

Sect. No.	Road Name	From	To	Length (km)	AADT	Preliminary Improvement Type Recommendation	Cost (x1000)	Surface Condition	Structural Adequacy	Condition Rating
1265	Deyell Li	Cnty Rd 10	T-Way Dr	2.11	250	*ST2A - Double Surface Treatment with Granular A*	*$135*	6	11	64
1425	Hayes Li	Jones 1/4 Line	Cnty Rd 10	3.5	275	*ST2A - Double Surface Treatment with Granular A*	*$223*	7	11	66
1515	Hutchison Dr	Zion Li	Cnty Rd 21	1.5	200	*ST2A - Double Surface Treatment with Granular A*	*$96*	6	11	64
1960	T-Way Dr	Deyell Li	South End	0.6	75	*ST2A - Double Surface Treatment with Granular A*	*$38*	6	11	57
1290	Dranoel Rd	Highway 7A	Morton Li	0.83	275	*ST2A - Double Surface Treatment with Granular A*	*$53*	7	11	67
1345	Elgar Dr	White Birch Rd	South End	0.48	150	*ST2A - Double Surface Treatment with Granular A*	*$31*	6	10	63
1590	Lisa Crt	King Street West	South End	0.22	50	*PP1 - Pulverize and Pave 1 Lift*	*$37*	6	10	56
1860	Stewart Li	1320 West of Cty Rd 10	2220m West of Cty Rd 10	0.9	425	*ST2A - Double Surface Treatment with Granular A*	*$57*	7	11	72
2020	Whittington Dr	600m East	750m East	0.15	300	*PP1 - Pulverize and Pave 1 Lift*	*$25*	7	11	72
1030	Ashley Cres	Cathcart Cres	South End	0.3	50	*ST2A - Double Surface Treatment with Granular A*	*$19*	6	11	65
6-10 Year Needs										
1890	Syer Li	Hutchinson Dr	Cnty Rd 28	2.85	675	*ST2A - Double Surface Treatment with Granular A*	*$182*	6	12	58
1895	Syer Li	Highway 115 Ramp	Hutchinson Dr	3.5	600	*ST2A - Double Surface Treatment with Granular A*	*$223*	6	12	58
1935	Tapley 1/4 Li	Larmer Li	Syer Li	1.33	550	*ST2A - Double Surface Treatment with Granular A*	*$85*	7	12	60
1275	Distillery St	Needler's Lane	South End	0.16	175	*ST2A - Double Surface Treatment with Granular A*	*$10*	6	12	56
1900	Syer Li	Vista Cresc	Cty Rd 10	1.05	375	*ST2A - Double Surface Treatment with Granular A*	*$67*	7	12	66
1930	Tapley 1/4 Li	Fallis Li	Larmer Li	1.11	700	*ST2A - Double Surface Treatment with Granular A*	*$71*	7	12	74
1025	Anne St	Cavan Street	South End	0.24	75	*ST2A - Double Surface Treatment with Granular A*	*$15*	6	12	60

Sect. No.	Road Name	From	To	Length (km)	AADT	Preliminary Improvement Type Recommendation	Cost (x1000)	Surface Condition	Structural Adequacy	Condition Rating
1465	Hooton Dr	2480m East	1500m East	1.52	75	*ST2A - Double Surface Treatment with Granular A*	*$97*	7	12	60
1755	Prince St	Anne St	South End	0.13	50	*PP1 - Pulverize and Pave 1 Lift*	*$22*	7	12	59
1850	Stewart Li	Winslow 1/4 Li	1300m East	1.3	425	*ST2A - Double Surface Treatment with Granular A*	*$83*	7	12	73
1685	Morningside Pl	Valleyview Drive	End	0.27	100	*ST2A - Double Surface Treatment with Granular A*	*$17*	6	12	65
1945	Tapley 1/4 Li	Highway 7A	Morton Li	1.4	100	*ST2A - Double Surface Treatment with Granular A*	*$89*	7	12	67
1965	Union St	King Street West	Manor Dr	0.22	1475	*PP1 - Pulverize and Pave 1 Lift*	*$37*	6	12	83
1195	Cedar Cres	Hutchinson Dr	South End	0.07	25	*ST2A - Double Surface Treatment with Granular A*	*$4*	7	12	65

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:

- 26.9 km of paved roads (HCB).
- Degradation rate 0.25 / year (rating drops from 10 to 5, over a 20-year period).
- Annual resurfacing 1.3 km / year.
- **Annual budget $361,400**: (1.3 km / year x $139,000 / ln **RMP1** x 2 lanes).

Surface Treated Roads:

- 181.6 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 25.9 km / year.
- **Annual budget $634,550** (25.9 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 - 5 year cycle.

Gravel Roads:

- 36.2 km of earth / gravel roads.
- 75 mm gravel every 5 years.
- Annual gravelling of 7.2 km.
- Granular A ($12,000 / km).
- **Annual budget $86,400** (7.2 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 $1,082,350 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 Cavan Monaghan's Resurfacing Priorities. Roads are listed in order of descending preservation priorities

Table 10 – Township of Cavan Monaghan, Resurfacing Priorities

Sect. No.	Road Name	From	To	Length (km)	AADT	Preliminary Improvement Type Recommendation	Cost (x1000)	Surface Condition	Structural Adequacy	Condition Rating
1840	Stewart Li	Howden 1/4 Li	Preston Rd	2.82	800	*ST1 - Single Surface Treatment*	*$69*	7	14	62
1565	Larmer Li	Cnty Rd 10	Hutchinson Dr	3.52	550	*ST1 - Single Surface Treatment*	*$86*	7	13	60
1610	Maple Grove Rd	Preston Rd	Highway 7	0.45	425	*RMP1 - Mill & Pave, 1 Lift*	*$125*	7	13	59
1210	Centre St	Tupper St	Union Street	0.16	1800	*Preventative Maintenance*	*$0*	9	18	71
2055	Zion Li	Cty Rd 10	Carveth Dr	2.15	475	*ST1 - Single Surface Treatment*	*$53*	8	15	61
1940	Tapley 1/4 Li	Syer Li	Highway 7A	1.32	475	*ST1 - Single Surface Treatment*	*$32*	7	14	62
1120	Brown Li	Elmdale Rd	Country Rd 11	1.76	450	*ST1 - Single Surface Treatment*	*$43*	7	13	62
1455	Hooton Dr	Fieldview Dr	Preston Rd	0.3	450	*ST1 - Single Surface Treatment*	*$7*	7	14	62
1790	Sharpe Li	1100m West of Hwy 7	Highway 7	1.1	600	*ST1 - Single Surface Treatment*	*$27*	8	15	65
1365	Fallis Li	Tapley 1/4 Line	Valleyview Drive East	1.37	575	*ST1 - Single Surface Treatment*	*$34*	8	16	65
1495	Huston St	Carveth Dr	King Street West	0.35	425	*RMP1 - Mill & Pave, 1 Lift*	*$97*	8	14	63
1470	Hooton Dr	County Rd 10	2480m East	2.48	75	*G - Gravel (50mm)*	*$30*	6	10	51
1310	Dranoel Rd	Syer Li	South End	1.65	100	*G - Gravel (50mm)*	*$20*	7	14	54
1115	Brown Li	Hwy 7	Elmdale Rd	1.8	475	*ST1 - Single Surface Treatment*	*$44*	8	16	67
1745	Preston Rd	Stewart Li	Hooton Dr	1.46	500	*ST1 - Single Surface Treatment*	*$36*	8	16	68
1215	Centre St	Union St	West End	0.44	275	*RO1 - Hot Mix Overlay, 1 Lift*	*$69*	8	15	64
1645	Mervin Li	County Road 11	240m East	0.24	100	*G - Gravel (50mm)*	*$3*	7	13	56
1355	Elmdale Rd	Brown Li	Cnty Rd 15	1.4	375	*ST1 - Single Surface Treatment*	*$34*	7	13	67
1295	Dranoel Rd	Syer Li	Highway 7A	1.28	225	*G - Gravel (50mm)*	*$16*	8	15	64
1825	Shield's Dr	Bland Line	South End	1.2	50	*G - Gravel (50mm)*	*$15*	8	14	53
1690	Morton Li	Highway 7A	520m West	0.52	275	*ST1 - Single Surface Treatment*	*$13*	8	16	66
1235	Clifford Li	Highway 7A	East End	1.54	225	*ST1 - Single Surface Treatment*	*$38*	8	15	65
2090	Mount Pleasant Rd	County Road 10	High St.	0.13	225	*RO1 - Hot Mix Overlay, 1 Lift*	*$20*	8	15	65
1200	Cedar Valley Rd	Hutchinson Dr	Cntry Rd 28	3.01	325	*ST1 - Single Surface Treatment*	*$74*	7	13	68
1285	Dranoel Dr	Dranoel Rd	Highway 7A	0.52	175	*G - Gravel (50mm)*	*$6*	8	15	64

Sect. No.	Road Name	From	To	Length (km)	AADT	Preliminary Improvement Type Recommendation	Cost (x1000)	Surface Condition	Structural Adequacy	Condition Rating
1240	Collins Ln	Centre St	North end	0.08	25	*G - Gravel (50mm)*	*$1*	6	12	53
1500	Hutchison Dr	Cnty Rd 21	Cedar Valley Rd	1.55	300	*ST1 - Single Surface Treatment*	*$38*	7	14	69
1505	Hutchison Dr	Cedar Valley Rd	Larmer Li	1.09	300	*ST1 - Single Surface Treatment*	*$27*	7	14	69
1925	Tapley 1/4 Li	Highway 115 Ramp	Fallis Li	0.22	900	*RMP1 - Mill & Pave, 1 Lift*	*$61*	7	14	76
1635	Meadow Ln	Workman St	East End	0.21	50	*G - Gravel (50mm)*	*$3*	7	13	57
1085	Bland Li	Jones 1/4 Line	2500m East	2.5	250	*ST1 - Single Surface Treatment*	*$61*	8	16	68
1875	Stewart Li	Winslow 1/4 Li	2850m West	2.85	275	*ST1 - Single Surface Treatment*	*$70*	7	14	69
1560	King George St	Cty Rd 10	Elizabeth Street	0.115	50	*G - Gravel (50mm)*	*$1*	7	14	58
1510	Hutchison Dr	Larmer Li	Syer Li	1.32	225	*ST1 - Single Surface Treatment*	*$32*	7	13	68
1585	Larmer Li	Highway 115	Tapley 1/4 Li	2.08	250	*ST1 - Single Surface Treatment*	*$51*	7	14	69
1545	Jones 1/4 Line	Hayes Li	Bland Li	1.3	125	*G - Gravel (50mm)*	*$16*	8	15	64
1070	Best Rd	Mount Pleasant Rd	Hayes Li	1.42	50	*G - Gravel (50mm)*	*$17*	7	14	59
1695	Morton Li	520m West	Cnty Rd 10	5.66	225	*Preventative Maintenance*	*$0*	9	17	69
2065	Zion Li	Hutchinson Dr	Cnty Rd 10	3.25	225	*ST1 - Single Surface Treatment*	*$80*	7	14	69
1650	Mervin Li	240m East of Cty Rd 11	East End	0.56	25	*G - Gravel (50mm)*	*$7*	7	13	56
1180	Cathcart Cr	Stewart Li	Highway 7	1.15	375	*ST1 - Single Surface Treatment*	*$28*	8	14	72
1905	Syer Li	Highview Cres	Tapley 1/4 Li	1.18	250	*G - Gravel (50mm)*	*$14*	8	16	70
1710	Morton Li	Dranoel Rd	1550m East	1.55	50	*G - Gravel (50mm)*	*$19*	8	15	60
1975	Valleyview Dr	Fallis Li East	Morningside Pl	0.75	175	*ST1 - Single Surface Treatment*	*$18*	7	13	68
1320	Eagleson Li	McCamus 1/4 Line	Cty Rd 28	2.85	150	*ST1 - Single Surface Treatment*	*$70*	7	13	67
1435	Hayes Li	Cty Rd 38	1500m East of Cty Rd 38	1.5	225	*ST1 - Single Surface Treatment*	*$37*	8	15	70
1130	Buckland Dr	Cty Rd 10	East End	0.2	50	*G - Gravel (50mm)*	*$2*	7	14	61
1350	Elizabeth St	King George St	Miller St	0.12	25	*G - Gravel (50mm)*	*$1*	7	14	58
2025	Wilson Li	West End	1000m West of Cnty Rd 10	1.78	175	*ST1 - Single Surface Treatment*	*$44*	7	14	69

Sect. No.	Road Name	From	To	Length (km)	AADT	Preliminary Improvement Type Recommendation	Cost (x1000)	Surface Condition	Structural Adequacy	Condition Rating
2030	Wilson Li	1000m West of Cnty Rd 10	Cnty Rd 10	1	175	*ST1 - Single Surface Treatment*	*$25*	7	14	69
1185	Cavan St	King Street West	Anne St	0.3	125	*Preventative Maintenance*	*$0*	9	18	67
1950	Thorne Dr	Deyell Li	Zion Li	1.53	75	*G - Gravel (50mm)*	*$19*	8	15	64
1020	Anne St	Needler's Lane	Cavan Street	0.47	375	*Preventative Maintenance*	*$0*	10	19	74
1665	Mill St	Cty Rd 10	West End	0.15	25	*ST1 - Single Surface Treatment*	*$4*	7	14	59
1795	Sharpe Li	Cnty Rd 10	Howden 1/4 Li	3.52	425	*ST1 - Single Surface Treatment*	*$86*	6	13	75
1050	Bartlett Rd	Moncrief Li	Whitfield Rd	1.45	300	*ST1 - Single Surface Treatment*	*$36*	8	16	73
1475	Howden 1/4 Li	Sharpe Li	Stewart Li	1.45	150	*ST1 - Single Surface Treatment*	*$36*	7	13	69
1980	Valleyview Dr	Fallis Li West	Morningside Pl	0.85	175	*ST1 - Single Surface Treatment*	*$21*	7	14	70
1625	McCamus 1/4 Li	Eagleson Li	Carmel Li	1.43	75	*G - Gravel (50mm)*	*$17*	8	15	65
1440	High St	Mill St	North End	0.465	25	*G - Gravel (50mm)*	*$6*	7	13	60
1430	Hayes Li	1500 East of Cty Rd 38	Jones 1/4 Li	1.84	225	*ST1 - Single Surface Treatment*	*$45*	8	15	72
1340	Elgar Dr	Zion Li	White Birch rd	0.74	150	*ST1 - Single Surface Treatment*	*$18*	7	14	70
1325	Eagleson Li	McCamus 1/4 Line	Cty Rd 10	3	75	*ST1 - Single Surface Treatment*	*$74*	7	13	66
1700	Morton Li	Tapley 1/4 Line	1300m East	1.3	175	*G - Gravel (50mm)*	*$16*	8	15	71
1670	Miller St	Cty Rd 10	South End	0.32	50	*ST1 - Single Surface Treatment*	*$8*	8	16	64
1870	Stewart Li	2850m West of Winslow 1/4	300m West	0.3	275	*ST1 - Single Surface Treatment*	*$7*	8	16	74
1880	Stewart Li	Dranoel Rd	300m East	0.3	275	*ST1 - Single Surface Treatment*	*$7*	8	16	74
1005	Albert St	Mount Pleasant Rd	Bland Li	0.305	50	*Preventative Maintenance*	*$0*	8	16	65
1450	Hillview Dr	South End	North End	0.925	125	*ST1 - Single Surface Treatment*	*$23*	7	13	70
2075	Zion Li	2500m West of Elgar	Glamorgan Rd	2.5	125	*ST1 - Single Surface Treatment*	*$61*	8	14	70
2100	Maplehill Dr	County Rd 9	South End	0.41	125	*Preventative Maintenance*	*$0*	9	17	70
1970	Valley Rd	Larmer Li	Tapley 1/4 Li	2.2	200	*ST1 - Single Surface Treatment*	*$54*	8	16	73
2060	Zion Li	Hutchison Dr	Cty Rd 28	2.87	350	*ST1 - Single Surface Treatment*	*$70*	8	15	76

Sect. No.	Road Name	From	To	Length (km)	AADT	Preliminary Improvement Type Recommendation	Cost (x1000)	Surface Condition	Structural Adequacy	Condition Rating
1485	Howden 1/4 Li	Sharpe Li	South End	0.14	25	*G - Gravel (50mm)*	*$2*	8	15	63
1660	Mill St	Cnty Rd 10	Workman St.	0.29	50	*Preventative Maintenance*	*$0*	9	17	66
2050	Workman St.	Mount Pleasant Rd	Mill St.	0.19	50	*Preventative Maintenance*	*$0*	9	17	66
1460	Hooton Dr	1500m East	Fieldview Dr	2.52	175	*ST1 - Single Surface Treatment*	*$62*	8	15	73
1915	Syer Li	Dranoel Rd	Highview Cres	2.48	100	*G - Gravel (50mm)*	*$30*	8	15	70
2045	Worboy Crt	Beardsmore Dr	West End	0.19	25	*G - Gravel (50mm)*	*$2*	8	16	64
2110	Cavan Station Rd	Highway 7A	North End	0.44	50	*G - Gravel (50mm)*	*$5*	8	16	67
1035	Ava Cres	Deyell Li	North End	1.41	75	*ST1 - Single Surface Treatment*	*$35*	7	14	70
1855	Stewart Li	Cty Rd 10	1040m West of Cty Rd 10	1.04	425	*ST1 - Single Surface Treatment*	*$25*	8	15	79
1655	Mervin Li	550m West of Cty Rd 11	West end	1.63	25	*G - Gravel (50mm)*	*$20*	8	14	66
1490	Hunter St	Queen St	Turner St	0.26	100	*Preventative Maintenance*	*$0*	10	19	72
1765	Queen St	King Street West	Hunter Street	0.175	100	*Preventative Maintenance*	*$0*	10	19	72
1090	Bland Li	Jones 1/4 Line	1850m West	1.85	175	*G - Gravel (50mm)*	*$22*	8	15	75
1760	Princess St	Anne St	South End	0.13	50	*Preventative Maintenance*	*$0*	9	18	69
1150	Carmel Li	Brackenridge Dr	Cnty Rd 28	3.11	375	*Preventative Maintenance*	*$0*	9	18	79
1575	Larmer Li	Hutchinson Dr	1820m East	1.82	375	*Preventative Maintenance*	*$0*	9	18	79
1580	Larmer Li	Cty Rd 28	925m West	0.925	375	*Preventative Maintenance*	*$0*	9	18	79
1155	Carmel Li	Brackenridge Dr	Cty rd 10	3.19	350	*Preventative Maintenance*	*$0*	9	18	79
1865	Stewart Li	1040m West of Cty Rd 10	1320m West of Cty Rd 10	0.28	425	*ST1 - Single Surface Treatment*	*$7*	8	15	80
1065	Bee Dr	Deyell Li	South End	0.705	50	*Preventative Maintenance*	*$0*	9	18	70
2105	Maplehill Crt	Maplehill Dr	West End	0.05	50	*Preventative Maintenance*	*$0*	9	17	70
1520	Hutchison Dr	Deyell Li	Zion Li	1.51	175	*Preventative Maintenance*	*$0*	9	17	76
2040	Winslow 1/4 Li	Sharpe Li	North End	1.67	75	*G - Gravel (50mm)*	*$20*	8	16	72
1300	Dranoel Rd	Morton Li	Sharpe Li	2.02	200	*Preventative Maintenance*	*$0*	9	17	77
1675	Moore Dr	2440m West of Cty Rd 28	West End	1.7	750	*Preventative Maintenance*	*$0*	9	17	83

Sect. No.	Road Name	From	To	Length (km)	AADT	Preliminary Improvement Type Recommendation	Cost (x1000)	Surface Condition	Structural Adequacy	Condition Rating
1480	Howden 1/4 Li	Stewart Li	Hooton Dr	1.45	100	*ST1 - Single Surface Treatment*	*$36*	8	16	74
1045	Bank St S	Cty Rd 21	North End	0.19	50	*Preventative Maintenance*	*$0*	10	19	71
1715	Morton Li	Tapley1/4	2220m West	2.22	50	*G - Gravel (50mm)*	*$27*	8	15	71
2035	Wing St	Bank Street South	East End	0.1	50	*Preventative Maintenance*	*$0*	10	19	71
1550	Kalman Dr	Carmel Li	South End	0.51	100	*RMP1 - Mill & Pave, 1 Lift*	*$141*	7	13	74
1160	Carmel Li	Cty Rd 10	1400m West	1.4	150	*ST1 - Single Surface Treatment*	*$34*	8	15	76
1225	Challice Li	Cty Rd 10	End	2.05	175	*ST1 - Single Surface Treatment*	*$50*	7	14	77
1705	Morton Li	Cnty Rd 10	2150m West	2.15	175	*Preventative Maintenance*	*$0*	9	18	77
1075	Bland Li	925m East	Albert St	0.925	250	*ST1 - Single Surface Treatment*	*$23*	8	17	79
2080	Zion Li	Carveth Dr	Elgar Dr	0.35	125	*ST1 - Single Surface Treatment*	*$9*	7	14	76
2070	Zion Li	Elgar Dr	2500m West	2.5	125	*ST1 - Single Surface Treatment*	*$61*	8	15	76
1100	Brackenridge Dr	Deyell Li	Carmel Li	1.33	225	*Preventative Maintenance*	*$0*	9	18	79
1680	Moore Dr	Cty Rd 28	2440m West	2.44	575	*Preventative Maintenance*	*$0*	9	17	83
1375	Fallis Li	Tapley 1/4 Line	West End	3.89	275	*ST1 - Single Surface Treatment*	*$95*	8	16	80
1305	Dranoel Rd	Sharpe Li	Stewart Li	1.44	125	*Preventative Maintenance*	*$0*	9	17	77
1735	Plains Cl	Deer Avenue	Deer Avenue Loop	0.84	125	*Preventative Maintenance*	*$0*	9	18	77
1165	Carmel Li	1400m West of Cty Rd 10	West end	1.35	125	*ST1 - Single Surface Treatment*	*$33*	8	16	77
2015	Whittington Dr	Elmdale Rd	West End	1.48	375	*Preventative Maintenance*	*$0*	9	17	82
1175	Carveth Dr	Zion Li	Huston Street	1.39	475	*Preventative Maintenance*	*$0*	9	17	83
1260	Deer Ave.	Larmer Li	Plains Cl	0.76	225	*Preventative Maintenance*	*$0*	9	18	80
1750	Preston Rd	Hooton Dr	Cnty Rd 9	1.52	225	*G - Gravel (50mm)*	*$18*	8	16	80
1995	Whitfield Rd	740m East of Cty Rd 28	End	1.89	225	*ST1 - Single Surface Treatment*	*$46*	8	15	80
1250	Darling Cres	Stewart Li	South End	0.925	50	*G - Gravel (50mm)*	*$11*	8	16	74
1105	Brewda Cres	Kalman Dr	East End	0.11	50	*RMP1 - Mill & Pave, 1 Lift*	*$30*	7	13	74
1615	Maple Tree Crt	Pine Tree Court	West End	0.29	50	*Preventative Maintenance*	*$0*	9	18	74
1385	Ford Cres	Highway 7A	East End	1.37	125	*RMP1 - Mill & Pave, 1 Lift*	*$380*	7	14	78

Sect. No.	Road Name	From	To	Length (km)	AADT	Preliminary Improvement Type Recommendation	Cost (x1000)	Surface Condition	Structural Adequacy	Condition Rating
1390	Ford Dr	Highway 7A	South End	0.74	125	*RMP1 - Mill & Pave, 1 Lift*	*$205*	7	14	78
2005	Whittington Dr	Elmdale Rd	600m East	0.6	300	*Preventative Maintenance*	*$0*	9	17	82
1125	Brown Li	Cty Rd 11	East End	0.53	50	*ST1 - Single Surface Treatment*	*$13*	7	13	75
1335	Edgewood Park Dr	Loop	Loop	0.48	175	*RO1 - Hot Mix Overlay, 1 Lift*	*$75*	8	15	80
1810	Sharpe Li	Jack Lane	700m West of Winslow 1/4	1.32	100	*Preventative Maintenance*	*$0*	9	17	78
1245	Cora Dr	Sharpe Li	South End	0.37	75	*ST1 - Single Surface Treatment*	*$9*	7	14	77
1330	Edgewood Park Dr	Mount Pleasant Rd	North End	0.52	200	*RO1 - Hot Mix Overlay, 1 Lift*	*$81*	8	15	81
1780	Scout Cr	Tapley 1/4 Line	East End	0.22	25	*Preventative Maintenance*	*$0*	9	18	74
1255	Davis Rd	Stewart Li	Maple Grove Rd	1.48	375	*Preventative Maintenance*	*$0*	9	17	84
1410	Hay St	Anne St	King Street West	0.095	625	*Preventative Maintenance*	*$0*	9	18	86
1730	Pine Tree Crt	Valley Rd	West End	0.19	50	*Preventative Maintenance*	*$0*	9	18	77
1080	Bland Li	Albert St	Cty Rd 10	0.08	250	*Preventative Maintenance*	*$0*	9	17	84
1885	Sunset Dr	Highway 7A	South End	0.74	100	*Preventative Maintenance*	*$0*	8	16	81
1000	Acadia Crt	Valley Rd	South end	0.21	50	*ST1 - Single Surface Treatment*	*$5*	8	16	79
1170	Carolyn St	Johnston Dr	South End	0.3	50	*ST1 - Single Surface Treatment*	*$7*	8	14	79
2000	Whitfield Rd	Cty Rd 28	740m East	0.74	400	*Preventative Maintenance*	*$0*	9	18	86
1220	Century Bv	Centennial Ln	Nina Ct	0.185	475	*RMP1 - Mill & Pave, 1 Lift*	*$51*	7	13	87
1445	Highview Cres	Syer Li	North End	0.7	50	*ST1 - Single Surface Treatment*	*$17*	8	15	80
1525	Jack Ln	Sharpe Li	North End	0.6	50	*ST1 - Single Surface Treatment*	*$15*	8	16	80
1985	Vista Cres	Syer Li	North End	0.37	50	*ST1 - Single Surface Treatment*	*$9*	8	15	81
2085	Hogsback Rd	Ski Hill Rd	South End	0.3	50	*G - Gravel (50mm)*	*$4*	8	16	81
2095	Glamorgan Rd	Fallis Road	County Rd 21	1.06	50	*G - Gravel (50mm)*	*$13*	8	16	81
2096	Glamorgan Rd	County Rd 21	North End	0.17	50	*G - Gravel (50mm)*	*$2*	8	16	81
2097	Glamorgan Rd	Zion Li	County Rd 21	1.43	50	*G - Gravel (50mm)*	*$17*	8	16	81

Sect. No.	Road Name	From	To	Length (km)	AADT	Preliminary Improvement Type Recommendation	Cost (x1000)	Surface Condition	Structural Adequacy	Condition Rating
2098	Glamorgan Rd	South End	Zion Li	1.11	50	*G - Gravel (50mm)*	*$13*	8	16	81
1815	Sharpe Li	700m West of Winslow 1/4	Winslow 1/4 Li	0.7	100	*Preventative Maintenance*	*$0*	9	17	83
1595	Longview Dr	Cnty Rd 9	North End	0.48	175	*Preventative Maintenance*	*$0*	9	17	85
1530	Jill Ln	Stewart Li	South End	0.22	25	*G - Gravel (50mm)*	*$3*	8	16	80
1820	Sharpe Li	Dranoel Rd	Jack Lane	1.495	100	*Preventative Maintenance*	*$0*	9	17	84
1380	Filman Cr	Longview Dr	Longview Dr	0.38	100	*Preventative Maintenance*	*$0*	9	17	85
1800	Sharpe Li	Winslow 1/4 Li	1780m East	1.78	100	*Preventative Maintenance*	*$0*	9	18	85
1805	Sharpe Li	1780m East of Winslow	Cty Rd 10	1.75	100	*Preventative Maintenance*	*$0*	9	17	85
1140	Campbell Av	Longview Dr	Longview Dr	1	125	*Preventative Maintenance*	*$0*	9	18	86
1725	Nina Crt	West End	East End	0.23	200	*RMP1 - Mill & Pave, 1 Lift*	*$64*	7	14	88
1640	Mervin Li	County Road 11	300m West	0.3	175	*Preventative Maintenance*	*$0*	10	19	88
1040	Bank St N	Cty Rd 10	End	0.28	75	*RMP1 - Mill & Pave, 1 Lift*	*$78*	7	13	86
1145	Carmel Cres	Cty Rd 10	West end	0.56	50	*Preventative Maintenance*	*$0*	9	18	86
1555	Kennedy Dr	Mount Pleasant Rd	South End	0.44	50	*Preventative Maintenance*	*$0*	10	19	89
1770	Rose Cres	Kennedy Dr	South End	0.13	50	*Preventative Maintenance*	*$0*	10	19	89
1720	Needler's Ln	Anne St	Distillery St	0.22	375	*Preventative Maintenance*	*$0*	9	17	93
1630	McGuire Dr	Manor Dr	West End	0.47	275	*Preventative Maintenance*	*$0*	8	16	93
1205	Centennial Ln	Cty Rd 10	East End	0.32	850	*Preventative Maintenance*	*$0*	9	18	96
1110	Brookside St	Cnty Rd 10	Cnty Rd 10	0.86	300	*Preventative Maintenance*	*$0*	9	18	96
1055	Baxter Creek Crt N	Brook Street	South End	0.1	25	*Preventative Maintenance*	*$0*	9	17	95
1135	Burnham Crt	McGuire Dr	North End	0.055	50	*Preventative Maintenance*	*$0*	9	18	96
1396	Frederick St	Main St	West End	0.12	100	*Preventative Maintenance*	*$0*	10	20	100
1400	George St	Cnty Rd 21	South End	0.23	75	*Preventative Maintenance*	*$0*	10	20	100

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

- 26.9 km of paved roads (HCB).
- Assume that cracksealing will be applied, on average, once per resurfacing cycle.
- Annual cracksealing of 1.3 km / year.
- **Annual budget $5,200** (1.3 km x $4,000 / km **Cracksealing**).

Slurry Seal / Microsurfacing

- 26.9 km of paved roads (HCB).
- 181.6 km of surface treated roads (LCB).
- Assume that slurry seal / microsurfacing will be applied, on average, once per resurfacing cycle.
- 27.2 km of road to preserve per year (1.3 km HCB and 25.9 km of LCB).
- **Annual budget $599,760** (27.2 km x $22,050 / 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.

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 dedicated to these important activities.

7.0 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 $41.6 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.

8.0 Summary

D.M. Wills Associates (Wills) undertook a review of the Township of Cavan Monaghan'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 May of 2020. 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 14.1/20. The current average surface condition rating for the Township's road network is 7.5/10.

5% (~12 km) of the road network has a Structural "NOW" need, 11% (~26 km) has a Structural "1-5" year need, and 30% (~70 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 $1,082,350 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", 1 - 5 year, or 6 – 10 year need have been included in the capital improvement plan for reconstruction.

A total length of 55.6 km of roads were identified as having structural needs in the "NOW", 1 – 5 or 6-10 year periods. The estimated cost to improve these roads is approximately $ 4.5 M.

A fully funded 10 year plan following the recommendations in this report includes $1.1M/year for resurfacing needs and $4.6M ($0.5M/year) for the capital needs over ten years.

An additional length of approximately 40 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. Additional guidance regarding road surface types is discussed within the document.

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 May 2020, by which time of "spring break-up" was not clearly 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.

TK/ESP/ms

Statement of Limitations

This report has been prepared by D.M. Wills Associates on behalf of the Township of Cavan Monaghan. 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 2020 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 2020 Road Needs Study Report findings.

Appendix A

Unit Price Form

ROAD IMPROVEMENT COSTS
Township of Cavan Monaghan

Unit Costs	Units	Unit Cost
Granular A	t	$10.50
Granular B	t	$10.00
Hot Mix	t	$150.00
Earth Excavation	m3	$10.00
Asphalt Removal	m2	$6.00
Asphalt Removal - Partial Depth	m2	$3.00
Removal of Concrete Curb & Gutter	m	$25.00
Concrete Curb & Gutter	m	$75.00
In-Place Full Depth Reclamation	m2	$3.50
Surface Treatment - Single	m2	$3.50
Surface Treatment - Double	m2	$5.65
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	$10.50	$ 12
							G	**12**

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	$10.00	$ 3
Granular A	7.0	150	2.2	t		115.5	$10.50	$ 1
Granular B	8.0	650	2	t		520	$10.00	$ 5
							FT	**10**

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**

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	$5.65	$ 40
							ST2	**40**

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	$5.65	$ 40
Removal Asphalt Pavement	7.0	16		m2		7000	$6.00	$ 42
							ST2R	**82**

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	$5.65	$ 40
Granular A	7.0	150	2.2	t		2310	$10.50	$ 24
							ST2A	**64**

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	$5.65	$ 40
Granular A	7.0	150	2.2	t		2310	$10.50	$ 24
Pulverizing	7.0			m2		7000.0	$3.50	$ 25
Minor Items @ 25%								$ 6
							ST2PA	**94**

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	$5.65	$ 40
Granular A	7.0	150	2.2	t		2310	$10.50	$ 24
Pulverizing	7.0			m2		7000.0	$3.50	$ 25
Earth Excavation	2	450		m3		900	$10.00	$ 9
Granular B	1	450	2	t		900	$10.00	$ 9
Minor Items @ 25%								$ 11
							ST2PAW	**117**

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	$150.00	$ 66
Granular A	1.5	50	2.2	t		165	$10.50	$ 2
Minor Items @ 15%								$ 10
							RO1	**78**

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	$150.00	$ 109
Granular A	1.5	90	2.2	t		297	$10.50	$ 3
Minor Items @ 15%								$ 17
							RO2	**129**

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	$150.00	$ 78
Remove Curb and Gutter				m		200	$25.00	$ 5.00
Curb and Gutter - 20%				m		200	$75.00	$ 15.00
Milling	4.25			m2		4250	$3.00	$ 12.75
Minor Items @ 25%								$ 28
							RMP1	**139**

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	$150.00	$ 141
Remove Curb and Gutter				m		200	$25.00	$ 5.00
Curb and Gutter - 20%				m		200	$75.00	$ 15.00
Milling	4.25			m2		4250	$3.00	$ 12.75
Minor Items @ 25%								$ 43
							RMP2	**217**

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	$150.00	$ 55
Granular A	1.5	50	2.2	t		165	$10.50	$ 2
Pulverize	3			m2		3000	$3.50	$ 10.50
Minor Items @ 25%								$ 17
							PP1	**84**

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	$150.00	$ 99
Granular A	1.5	90	2.2	t		297	$10.50	$ 3
Pulverize	3			m2		3000	$3.50	$ 11
Minor Items @ 25%								$ 28
							PP2	**141**

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	$10.00	$ 12
Granular A	5	150	2.2	t		1650	$10.50	$ 17
Granular B	5	450	2	t		4500	$10.00	$ 45
Hot Mix	8	50	2.45	t	196	1176	$150.00	$ 176
Milling	4			m2		4000	$3.00	$ 12
Minor Items @ 25%								$ 66
							RW1	**328**

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	$10.00	$ 12
Granular A	5	150	2.2	t		1650	$10.50	$ 17
Granular B	5	450	2	t		4500	$10.00	$ 45
Hot Mix	8	90	2.45	t	353	2117	$150.00	$ 318
Milling	4			m2		4000	$3.00	$ 12
Minor Items @ 25%								$ 101
							RW2	**505**

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	$10.00	$ 12
Granular A	1	150	2.2	t		330	$10.50	$ 3
Granular B	1	450	2	t		900	$10.00	$ 9
Minor Items @ 25%								$ 6
							GW	**31**

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	$10.00	$ 30
Granular A	3	150	2.2	t		990	$10.50	$ 10
Granular B	5	450	2	t		4500	$10.00	$ 45
Minor Items @ 25%								$ 21
							Recon G	**107**

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	$10.00	$ 30
Granular A	4	150	2.2	t		1320	$10.50	$ 14
Granular B	5	450	2	t		4500	$10.00	$ 45
Hot Mix	3	50	2.45	t		368	$150.00	$ 55
Minor Items @ 25%								$ 40
							Recon 1R	**202**

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	$10.00	$ 30
Granular A	4	150	2.2	t		1320	$10.50	$ 14
Granular B	5	450	2	t		4500	$10.00	$ 45
Hot Mix	3	50	2.45	t		368	$150.00	$ 55
Minor Items @ 25%								$ 40
							Recon 1S	**202**

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	$10.00	$ 30
Granular A	4	150	2.2	t		1320	$10.50	$ 14
Granular B	5	450	2	t		4500	$10.00	$ 45
Hot Mix	3	90	2.45	t		662	$150.00	$ 99
Minor Items @ 25%								$ 52
							Recon 2S	**258**

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	$10.00	$ 41
Granular A	4.5	150	2.2	t		1485	$10.50	$ 16
Granular B	5.5	600	2	t		6600	$10.00	$ 66
Hot Mix	4.25	90	2.45	t		937	$150.00	$ 141
Remove Curb and Gutter				m		1000	$25.00	$ 25.00
Curb and Gutter				m		1000	$75.00	$ 75.00
Minor Items @ 25%								$ 72
							Recon 2U	**461**

Rout and Seal

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

Slurry Seal

Item	Width - m			Unit		Quantity	Unit Cost	Cost/km (x 1000)
Slurry Seal	7			m2		7000	$3.15	$ 22
							SS	**22**

Microsurfacing

Item	Width - m			Unit		Quantity	Unit Cost	Cost/km (x 1000)
Microsurfacing	7			m2		7000	$6.00	$ 42
							MS	**42**

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	$10.00	$ 33
Granular A	4.5	150	2.2	t		1485	$10.50	$ 16
Granular B	5.5	450	2	t		4950	$10.00	$ 50
Hot Mix	4.25	90	2.45	t		937	$150.00	$ 141
Curb and Gutter				m		1000	$75.00	$ 75.00
Minor Items @ 25%								$ 66
							Recon 2U	**405**

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	$10.00	$ 23
Granular A	4	150	2.2	t		1320	$10.50	$ 14
Granular B	6	1000	2	t		12000	$10.00	$ 120
Minor Items @ 25%								$ 39
							Recon G	**195**