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EQUIVALENT PAVEMENT DESIGNS FOR MUNICIPALITIES RIGID AND FLEXIBLE PAVEMENTS

PROVINCE OF MANITOBA

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EXECUTIVE SUMMARY

Most municipalities in the Province of Manitoba currently construct flexible pavements for their road network, while larger agencies use rigid pavements for higher volume roadways. Although flexible pavements are suitable for lower volume roadways or roadways with competent subgrade conditions, flexible pavements are always be the appropriate pavement type when designing heavier travelled pavements, nor the most cost-effective alternative when comparing life cycle costs.

To assist municipalities in the Province of Manitoba, equivalent pavement designs were developed for various traffic volumes, roadway classifications, and subgrade strengths. For each set of conditions, both flexible and rigid pavement designs were developed using the AASHTOWare *Pavement ME* software program. The pavement designs developed for this study are considered equivalent pavement designs and expected to provide comparable pavement support.

Design inputs used in the analysis were compiled from several provincial and municipal documents, supplemented with information from Concrete Manitoba, Cement Association of Canada (CAC), and local contractors. For comparison purposes, the equivalent pavement designs were evaluated with a Life Cycle Cost Analysis (LCCA) to determine the total cost to municipalities for each pavement section over a 50-year analysis period. Unit rates for both pavement types analyzed in the LCCA were provided from the local industry.

The results of the LCCA completed for this study indicate that rigid pavements provide a cost-effective option for roadways expected to support the heavier truck traffic and/or constructed on weaker subgrade conditions. As traffic volumes reduce or subgrade conditions improve, rigid pavements become less cost-effective.

Details on the pavement design analysis, the pavement design comparison matrix, and the details of the LCCA are provided in this report.

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EQUIVALENT PAVEMENT DESIGNS FOR MUNICIPALITIES RIGID AND FLEXIBLE PAVEMENTS

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1.0 INTRODUCTION

A majority of municipalities in the Province of Manitoba currently construct mostly flexible pavements for their road network, while rigid pavements (if constructed) are mainly used on higher volume facilities or overlaid with asphalt as a composite structure. However, the design and construction of concrete pavements can be a cost-effective strategy to support traffic for a variety of conditions.

Municipalities across Canada have been using rigid pavements as a viable pavement alternative for decades, particularly for roadways that support heavy truck traffic, or in areas with weak subgrade conditions. Rigid pavements can provide municipalities with an alternative pavement type that could provide a more cost-effective solution to address some of their transportation infrastructure needs. Although flexible pavements may be suitable for lower volume roadways, or areas with competent subgrade support conditions, flexible pavements may not always be the appropriate pavement type when designing heavier travelled roadways.

To assist municipalities in the Province of Manitoba, equivalent pavement designs were developed for various traffic volumes, roadway classifications, and subgrade strengths for typical conditions throughout the province. For each set of conditions, both flexible and rigid pavement designs were developed using the AASHTOWare *Pavement ME* (Pavement ME) software program. This state-of-the-practice tool for the design of new and rehabilitated pavements is based on Mechanistic-Empirical (ME) principles. This design procedure uses mechanistic models to predict the cumulative damage for both flexible and rigid pavements that have been empirically correlated to observed pavement distresses. Comparable pavement designs were evaluated using a Life Cycle Cost Analysis (LCCA), in terms of their Net Present Worth. The resulting costs represents the total cost to the municipality for each pavement type over a 50-year analysis period.

Details on the pavement design analysis, the pavement design comparison matrix, and the details of the LCCA are provided in this report.

It is a condition of this report that Thurber's performance of its professional services is subject to the attached Statement of Limitations and Conditions.

2.0 PAVEMENT DESIGN INPUT PARAMETERS

The development of the pavement design matrix required several input parameters for the design analysis. Design inputs used in the analysis were compiled from available provincial and municipal documents, supplemented with information from the local industry, as well as best practices applied by Canadian municipalities.

Inputs for the flexible and rigid pavement design analysis, as well as soil and material parameters, were obtained from information prepared by Provincial staff and included in the Transportation Associations of Canada (TAC) document, *Canadian Guide: Default parameters for AASHTOWare Pavement ME Design* [1], as well as a Draft report prepared by Applied Research Associates, Inc. (ARA) entitled *Development of Pavement Design Standards for Winnipeg Streets*[5]. Details on the design and material parameters used in the analysis are summarized in the ensuing sections.

3.1 Roadway Classifications

Upon a review of standard specifications for the City of Winnipeg, the roadway classifications used by the City of Winnipeg were generally consistent with similar municipalities across Canada. For this study, the roadway classifications have been grouped into four main categories: Minor Collector, Major Collector, Minor Arterial, and Major Arterial. All municipal roadways were assumed to comprise an urban pavement platform (with curb and gutter).

The multiple levels of Average Annual Daily Truck Traffic (AADTT) were assigned to the various road classification, which typically included an average truck volume and the highest truck volume expected for each facility. The truck volumes and design parameters associated with each roadway classification are provided in Table 1.

Table 1. Roadway Classification and Associated Truck Volumes

Roadway Classifications	AADTT	Typical Growth Rate	Lane Distribution Factor	Travel Speed
Major Arterial	5,000 & 7,500	2.0 %	80%	80 km/hr
Minor Arterial	2,000 & 2,500	2.0 %	85%	60 km/hr
Major Collector	1,000 & 1,500	2.0 %	100%	50 km/hr
Minor Collector	250 & 500	2.0 %	100%	50 km/hr

For the purposes of this analysis, the AADTT is taken to be two-way truck traffic; therefore, a directional distribution factor of 50 percent was applied. Furthermore, the roadways with AADTT greater than 1,500 were assumed to have two lanes in each direction (four lane platform), with lane distribution factors applied for the design lane as indicated in Table 1. Lower volume roadways (1,500 AADTT and less) were assumed to be two-lane roadways (Single travel lane in

each direction). Typical growth rates of 2.0% were applied to all roadway classifications, as provided in Table 1.

Travel speeds along the various roadway classifications were also taking into consideration in the Pavement ME analysis. The travel speeds for each roadway is provided in Table 1.

Although detailed *Weigh-In-Motion* (WIM) data was not available for municipal roadways, the distribution of truck traffic was determined from available information obtained from the pavement design standard for the City of Winnipeg [5] and WIM data available from the City of Edmonton. This information was supplemented with WIM data prepared by Manitoba Infrastructure for inclusion into the TAC document of Pavement ME Default parameters [1]. Truck class distributions for each road classification is provided in Table 2.

Table 2. FHWA Vehicle Class Distributions

FHWA Vehicle Classification			Minor Collector	Major Collector	Minor Arterial	Major Arterial
Class 4		2 or 3-Axle Busses	25.0 %	20.5 %	10.5 %	6.8 %
Class 5		2-Axle, 6-Tire, Single Unit Trucks	30.0%	33.8 %	19.1 %	17.0 %
Class 6		3-Axle, Single Unit	20.0 %	9.2 %	13.3 %	11.6 %
Class 7		4 or more Axles, Single Unit Trucks	5.0%	1.5 %	2.5 %	2.8 %
Class 8		4 or less Axles, Single Trailer Trucks	6.0 %	8.9 %	17.5 %	17.4 %
Class 9		5-Axle Single Trailer Trucks	12.0 %	22 %	17.0 %	17.6 %
Class 10		6 or more Axle Single Trailer Trucks	2.0 %	1.8 %	14.7 %	14.8 %
Class 11		5 or less Axle Multi-Trailer Trucks	0.0 %	0.7 %	1.0 %	1.8 %
Class 12		6-axle Multi-Trailer Trucks	0.0 %	0.2 %	1.8 %	2.1 %
Class 13		7 or more Axle Multi-Trailer Trucks	0.0 %	1.4 %	2.6 %	8.1 %

3.2 Design Reliability Levels:

Defining design reliability levels are important for pavement design purposes. For this comparison study, the following reliability levels were applied for each roadway classification.

Table 3. Design Reliability for Each Roadway Classification

Roadway Classifications	Reliability Level
Major/ Minor Arterial	90 %
Major Collector	85 %
Minor Collector	80 %

3.3 Distress Prediction Target Values

For developing comparable pavement designs, a design life of 25 years was used for all roadway classifications. To evaluate the results of the pavement design analysis, the predicted distresses were required to meet certain threshold values for each distress. The following target values were used for comparing equivalent pavement designs.

Table 4. Distress Prediction Target Values

Pavement Distresses	Target Thresholds
Flexible Pavement – Performance Criteria	
Initial IRI	0.8 m/km
Predicted Terminal IRI	Minor/Major Collector: 3.0 m/km Minor Arterial: 2.7 m/km Major Arterial: 2.5 m/km
Permanent Deformation - AC only	12 mm
Permanent Deformation - Total Pavement	19 mm
AC Bottom-up Fatigue Cracking	Minor Collector/Collector: 25% Minor/Major Arterial: 20%
AC Thermal Fracture	200 m/km
Rigid Pavement – Performance Criteria	
Initial IRI	0.9 m/km
Predicted Terminal IRI (m/km)	Minor/Major Collector: 3.0 m/km Minor Arterial: 2.7 m/km Major Arterial: 2.5 m/km
Transverse Cracking (Percent Slabs)	15 %
Mean Slab Faulting	6 mm

3.4 Climate Station Information

The Pavement ME software includes climate station information across the Province of Manitoba. As expected, climate station information throughout the province was found to be variable, with mean annual air temperatures ranging from as low as –2.8ºC in Thompson to 3.8ºC in Steinbach. A sample of the climate properties in the cities of Winnipeg and Brandon are provided in Table 5.

Table 5. Climate File Comparison

Climate Properties	Winnipeg	Brandon
Mean Annual Air Temp. (ºC)	3.2	3.1
Mean Annual Precipitation (mm)	667	584
Freezing Index (ºC-days)	1817	1686
Average Annual No. Freeze-Thaw Cycles	65	77
Number of Wet Days	308	297

The selection of climate files for this study was limited to the province's most populated areas. In comparison to the various climate properties, the climate file for the area near the City of Winnipeg was selected to best represent municipalities in the mid to southern part of the province.

3.5 Subgrade Soil Properties

Subgrade soil conditions are expected to change throughout the province, and often throughout the jurisdiction of a municipality. To capture the effects of changing subgrade soils, three different subgrade soils were used for developing pavement designs. These soils included: High Plastic Clay (CH); Low Plastic Clay (CL); and Silty Sand. Instead of assuming resilient modulus values for each of these soils, the subgrade strengths for each soil group was determined by utilizing the Level 2 Inputs in Pavement ME, which correlates the soil resilient modulus with the soil physical properties. The gradation and other engineering properties for these soils were obtained from the TAC National Guide [3] for the Province of Manitoba. The subgrade soil properties used for the Level 2 calculation are provided in Table 6.

It is important to note that there is a difference between the subgrade support value for designs completed using the AASHTWare Pavement ME software and the mean subgrade strength used in the conventional AASHTO 1993 design methodology. Although both design approaches use the resilient modulus values for the in-place soils, the AASHTO 1993 design methodology requires an average subgrade support values of the in-place soils over the year, while the Pavement ME requires the resilient modulus of the in-situ soil at optimum moisture content, which is often 2.5 to 3 times higher.

Table 6. Subgrade Soils – Input Parameters

Characteristic	High Plastic Clay	Low Plastic Clay	Silty Sand
Poisson's Ratio	0.4		
Coefficient of Lateral Earth Pressure	0.50		
Percent Passing 25 mm	*100 %*	*100 %*	*100 %*
Percent Passing 19 mm	*100 %*	*100 %*	*100 %*
Percent Passing 12.5 mm	*100 %*	*100 %*	*100 %*
Percent Passing 9.5 mm	*100 %*	*100 %*	*100 %*
Percent Passing 4.75 mm	*100 %*	*100 %*	*100 %*
Percent Passing 2.0 mm	*96 %*	*100 %*	*99 %*
Percent Passing 250 µm	*96 %*	*100 %*	*97 %*
Percent Passing 75 µm	*92 %*	*93 %*	*53 %*
Percent Passing 2 µm	*83 %*	*30 %*	*19 %*
Liquid Limit	55 %	28 %	28.5 %
Plasticity Index	28 %	15 %	9 %
Maximum Dry Unit Weight	1,560 kg/m^3	1,650 kg/m^3	1810 kg/m^3
Optimum Moisture Content	24 %	18.7 %	13.5 %
Resilient Modulus - Level 2 Calculation (at optimum moisture content)	35 MPa	60 MPa	107 MPa
Comparable AASHTO 1993 Mean Subgrade Support Value	10 MPa	25 MPa	45 MPa

3.6 Granular Properties

The properties of the granular base and subbase were obtained from recent construction projects in the Winnipeg area. The specific granular material properties used in the analysis are provided in Table 7, which includes a crushed granular base (CGB) and a granular subbase (GSB) material. Similar to the subgrade soils, a Level 2 analysis in Pavement ME was used for determining the resilient modulus for the respective granular base and subbase.

Table 7. Granular Material Default Parameters

Unbound Material Properties		**CGB**	**GSB**
Poisson's Ratio		0.4	
Coefficient of Lateral Pressure (k_0)		0.5	
Material Modulus			
Resilient Modulus (Level 2 Calculation)		*140 MPa*	*105 MPa*
Gradation and Other Engineering Properties			
Aggregate Gradation (percent passing)	75 µm	14	14
	400 µm	18	22
	2 mm	32	31
	4.75 mm	49	41
	9.5 mm	72	55
	12.5 mm	85	65
	19.0 mm	100	85
	25 mm	100	97
Liquid Limit		NA	NA
Plasticity Index		NA	NA
Maximum dry unit weight (kg/m^3)		2,170	2,220
Optimum water content (%)		8 %	8 %

3.7 Hot Mix Asphalt Properties

Typical properties for the asphalt mixes used for the flexible design analysis were provided by the local industry. The asphalt mix used in the analysis for all categories of flexible pavements was the Manitoba Bit B for all surface and base asphalt mixes. A review of the aggregate gradation of the asphalt mix shows the Manitoba Bit B is similar to a typical Superpave 12.5 mix.

A performance graded asphalt cement binder (PGAC) of PGAC 58-28 was used for design lane with AADTT of 350, and PGAC 58-34 was used for AADTT's of 350 or more. A summary of the asphalt material properties is provided in Table 8.

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Table 8. Hot Mix Asphalt – Input Parameters

Asphalt Material Type		Manitoba Bit B
Mixture Volumetric		
Unit Weight (kg/m^3)		2,293
Effective Binder Content - by Volume (%)		9.9
Field Air Voids (%)		7.0
Mechanical Properties		
Dynamic Modulus		Level 3
Aggregate Gradation	% Passing the 19 mm Sieve	100
	% Passing the 9.5 mm Sieve	79
	% Passing the 4.75 mm Sieve	62
	% Passing the 75 µm Sieve	4.1
Reference Temperature		21.1 ºC
Asphalt Binder		PG 58-28 AADT =< 350 PG 58-34 AADT> 350
Indirect Tensile Strength -10 ºC (MPa)		Calculated
Creep Compliance (1/GPa)		Calculated
Thermal Properties		
Thermal Conductivity (watt/meter-Kelvin)		1.16
Heat Capacity (joule/kg-Kelvin)		963
Thermal Contraction		Calculated

3.8 Concrete Properties

The typical material inputs for the Portland Cement Concrete material was obtained from the local industry and included the following properties:

Table 9. Portland Cement Concrete – Property Input Parameters

Unit Weight	2,320 kg/m^3
Poisson's Ratio	0.2
Thermal Properties	
PCC Coefficient of Thermal Expansion (mm/mm ^oC x 10^{-6})	8.8
PCC Thermal Conductivity (watt/meter-Kelvin)	2.16
PCC Heat Capacity (joule/kg-Kelvin)	1172.3
Concrete Mix Properties	
Cement Type	GU (Type 1)
Cementious Material Content	340 kg/m^3
Water/Cement Ratio	0.4
Aggregate Type	Limestone
Reversible Shrinkage (% of Ultimate Shrinkage)	50 %
Time to Develop 50% of Ultimate Shrinkage	35 Days
Curing Method	Curing Compound
Material Strength	
28 Day PCC Compressive Strength	32
Elastic Modulus (GPa)	28.9
JPCP Design Parameters	
PCC Surface Shortwave Absorptivity	0.85
PCC Joint Spacing (m)	4.0 m (Dowelled) 3.6 m (Undowelled)
Sealant Type	Other
Doweled Joints: AADTT > 1,000 AADTT =<1,000	 32M @ 300 mm Spacing No Dowels
Widened slab	True
Tied Shoulders	No
Load Efficiency (%)	70
Erodibility Index	Very Erodible (5)

3.9 Software Updates and Calibration

Pavement distress prediction models, or transfer functions, are the key components of any M-E design analysis procedure. The accuracy of the performance prediction models in Pavement ME depend on an effective process of calibration and subsequent validation with independent data sets. It is understood that all performance models in the Pavement ME software were calibrated on a global level to available field performance data throughout North America.

Local calibration of the performance models is a very involved and expensive exercise, which has not been fully completed by any Canadian agency to date; however, some provincial agencies such as Ontario, Manitoba, and Alberta have initiated a process to complete the required calibration. As no Canadian agency has fully completed the calibration required, the pavement design analysis completed for this study relied on the default global calibration factors, supplemented by available material test results.

Furthermore, the Pavement ME software continues to be upgraded and improved, under the direction of an AASHTO Task Force. The pavement design analysis for this study was completed using the most current version (Version 2.5.5) available.

3.0 PAVEMENT DESIGN COMPARISONS

The development of the pavement designs for both flexible and rigid pavements considered the bound and unbound pavement materials typically used in roadway construction by municipalities in the Province of Manitoba. A range of subgrade soils was used to represent the various soil conditions present within the province. The subgrade soil properties used in the design analysis were obtained from TAC Canadian Guide AASHTOWare Pavement ME Design [1] for the Province of Manitoba.

A pavement design matrix was developed, with rigid and flexible pavement designs for each combination of roadway classification, traffic volumes, and subgrade soils. In consideration of the extensive information prepared by Manitoba Infrastructure for pavement inputs for a Pavement ME analysis, this software was used to develop initial flexible and rigid pavement designs, which were verified using traditional pavement design methodologies, such as AASHTO (1993), and the ACPA StreetPave12 software.

The predicted distresses for each design were reviewed and adjusted to optimize the pavement structures required to meet the identified target thresholds. The resulting pavement design comparison matrix was reviewed to assess if the results were appropriate to local conditions and practices. A comparison of flexible and rigid pavement structures for the various roadway conditions is provided in Table 10.

It is important to note that the designs provided in the table are to be considered preliminary pavement designs developed for typical conditions throughout the province. It is strongly recommended that, before implementing these designs, a detailed analysis be completed to determine truck traffic and subgrade conditions throughout the project limits. Designers must assess the site conditions and adjust layer thicknesses to ensure that the resulting pavement structure addresses the needs of local conditions.

Furthermore, the pavement designs presented in the design comparison matrix do not consider any soil remediation treatments that may be completed prior to the placement of the pavement layers, or the placement of additional materials (such as drainage layers) required for constructability purposes. Should the need for soil stabilization techniques for improving subgrade strength be required, then the resulting pavement structure should be selected that appropriately represents the combined strength of the treated and untreated subgrade soil.

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Table 10. Equivalent Municipal Pavement Design Matrix: Province of Manitoba

Subgrade Strength*	Pavement Type	Average Annual Daily Truck Traffic (Two-Way)							
		Minor Collector Roadway		Major Collector Roadway		Minor Arterial Roadway		Major Arterial Roadway	
		250	500	1,000	1,500	2,000	2,500	5,000	7,500
10 MPa	PCC	180 mm PCC 300 mm CGB	190 mm PCC 300 mm CGB	200 mm PCC 300 mm CGB	200 mm PCC 300 mm CGB	200 mm PCC 300 mm CGB	200 mm PCC 300 mm CGB	210 mm PCC 300 mm CGB	240 mm PCC 500 mm CGB
	HMA	100 mm ACP 150 mm CGB 600 mm GSB	120 mm ACP 150 mm CGB 600 mm GSB	150 mm ACP 150 mm CGB 700 mm GSB	160 mm ACP 150 mm CGB 700 mm GSB	170 mm ACP 150 mm CGB 800 mm GSB	190 mm ACP 200 mm CGB 800 mm GSB	250 mm ACP 200 mm CGB 800 mm GSB	290 mm ACP 200 mm CGB 800 mm GSB
25 MPa	PCC	180 mm PCC 200 mm CGB	190 mm PCC 200 mm CGB	200 mm PCC 200 mm CGB	200 mm PCC 200 mm CGB	200 mm PCC 200 mm CGB	200 mm PCC 200 mm CGB	210 mm PCC 200 mm CGB	230 mm PCC 300 mm CGB
	HMA	100 mm ACP 150 mm CGB 300 mm GSB	120 mm ACP 150 mm CGB 300 mm GSB	130 mm ACP 150 mm CGB 500 mm GSB	140 mm ACP 150 mm CGB 500 mm GSB	160 mm ACP 150 mm CGB 500 mm GSB	170 mm ACP 150 mm CGB 500 mm GSB	220 mm ACP 200 mm CGB 600 mm GSB	270 mm ACP 200 mm CGB 600 mm GSB
45 MPa	PCC	170 mm PCC 200 mm CGB	190 mm PCC 200 mm CGB	200 mm PCC 200 mm CGB	200 mm PCC 200 mm CGB	200 mm PCC 200 mm CGB	200 mm PCC 200 mm CGB	210 mm PCC 200 mm CGB	220 mm PCC 300 mm CGB
	HMA	100 mm ACP 150 mm CGB 200 mm GSB	110 mm ACP 150 mm CGB 200 mm GSB	130 mm ACP 150 mm CGB 300 mm GSB	140 mm ACP 150 mm CGB 300 mm GSB	150 mm ACP 150 mm CGB 300 mm GSB	160 mm ACP 150 mm CGB 400 mm GSB	210 mm ACP 200 mm CGB 500 mm GSB	260 mm ACP 200 mm CGB 500 mm GSB
Concrete Slab Properties		No Dowel Bars Slab Length < 3.6m Tied Curb/Shoulders			32M Dowel Bar Slab Length < 4.0m Tied Curb/Shoulders				

Note: * - Subgrade Strength indicates the equivalent estimated AASHTO '93 Resilient Modulus design value.
Subgrade Strength values do not consider any soil remediation treatments

4.0 LIFE CYCLE COST ANALYSIS

Equivalent pavement structures were compared using a Life Cycle Cost Analysis (LCCA) in terms of their Net Present Worth (NPW). This LCCA approach calculates the initial construction costs for each pavement type and predicts future maintenance and rehabilitation costs while discounting any salvage value that may remain at the end of the analysis period.

The LCCA calculated the construction and maintenance costs for a typical 1 km roadway length over a 50-year analysis period. Roadways with an AADTT of 1,000 and less are considered to have a two-lane pavement platform, while pavements supporting more than 1,000 AADTT are considered to have a four-lane platform.

5.1 Initial Construction Costs

The initial construction costs in the LCCA were estimated for each pavement structure in the design matrix. Cost estimates considered the roadway platform widths, construction materials, and layer thickness required to construct each pavement type. It is important to note that the platform for rigid pavements consisted of a standard lane width of 3.7 m, with the rigid pavement tied to concrete curb/gutters.

Construction costs assumed a pavement platform constructed on grade; therefore, earth excavation will be required for the thickness of the new pavement structure. Furthermore, initial cost estimates did not consider items which would be similar to both pavement types, such as the installation of subdrains, curb and gutters, or pavement markings.

5.2 Pavement Preservation Costs

To predict future maintenance and rehabilitation costs for each pavement alternative, a pavement preservation plan is required that reflects typical activities required by an agency to extend the service life of the roadway to meet the analysis period of the LCCA.

The LCCA for comparing equivalent pavement structures was completed over a 50-year analysis period and used a typical discount rate of 4 percent. The pavement preservation plans (for both pavement types) were developed using information available from the provincial documents, supplemented by information available from similar studies completed for other Canadian municipalities, and modified for conditions and construction practices in Manitoba.

It is important to acknowledge that the application of pavement preservation treatments throughout the life of a pavement is a cost-effective approach for extending the intended design life or the service life for a particular roadway. Although some municipalities may not complete certain maintenance activities (such as crack sealing and patching), it can be expected that not performing these tasks will reduce the intended pavement design life, thereby increasing the

frequency of costlier rehabilitation treatments. For these situations, it can be expected that the life cycle cost of these pavement would be higher than if the preservation treatments were completed.

The pavement preservation plans that were used for the LCCA in this study are provided in the ensuing tables.

Table 11. Flexible Pavement Preservation Plan: Minor Collector Roadway (AADTT 250 & 500)

Expected Year	Activity Description	Estimated Quantity
10	Rout and seal	250 m
10	Spot repairs (mill 40 mm/patch 40 mm)	5%
20	Mill HMA	40 mm
20	Resurface with new surface asphalt	40 mm
25	Rout and seal	500 m
30	Spot repairs (mill 40 mm/patch 40 mm)	10%
35	Mill HMA	40 mm
35	Full-depth asphalt base repairs	10%
35	Resurface with new surface asphalt	40 mm
40	Rout and seal	500 m
43	Spot repairs (mill 40 mm/patch 40 mm)	8%
48	Mill HMA	40 mm
48	Resurface with new surface asphalt	40 mm

Table 12. Flexible Pavement Preservation Plan: Major Collector Roadway (AADTT 1,000 & 1,500)

Expected Year	Activity Description	Estimated Quantity
10	Rout and seal	250 m
10	Spot repairs (mill 40 mm/patch 40 mm)	5%
15	Spot repairs (mill 40 mm/patch 40 mm)	5%
20	Mill HMA	40 mm
20	Resurface with new surface asphalt	40 mm
25	Rout and seal	500 m
30	Spot repairs (mill 40 mm/patch 40 mm)	10%
35	Mill HMA	40 mm
35	Full-depth asphalt base repairs	10%
35	Resurface with new surface asphalt	40 mm
40	Rout and seal	500 m
43	Spot repairs (mill 40 mm/patch 40 mm)	8%
48	Mill HMA	90 mm
48	Resurfacing with new base asphalt	50 mm
48	Resurface with new surface asphalt	40 mm

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Table 13. Flexible Pavement Preservation Plan: Minor Arterial Roadways (AADTT 2,000 & 2,500)

Expected Year	Activity Description	Estimated Quantity
5	Rout and seal	250 m
10	Rout and seal	500 m
10	Spot repairs (mill 40 mm/patch 40 mm)	5%
20	Mill HMA	40 mm
20	Resurface with new surface asphalt	40 mm
25	Rout and seal	1,000 m
30	Spot repairs (mill 40 mm/patch 40 mm)	10%
35	Mill HMA	90 mm
35	Resurfacing with new base asphalt	50 mm
35	Resurface with new surface asphalt	40 mm
40	Rout and seal	1,500 m
43	Spot repairs (mill 40 mm/patch 40 mm)	10%
48	Mill HMA	40 mm
48	Full-depth asphalt base repairs	10%
48	Resurface with new surface asphalt	40 mm

Table 14. Flexible Pavement Preservation Plan: Major Arterial (AADTT 5,000 & 7,500)

Expected Year	Activity Description	Estimated Quantity
8	Rout and seal	500 m
8	Spot repairs (mill 40 mm/patch 40 mm)	5%
13	Rout and seal	1,000 m
13	Spot repairs (mill 40 mm/patch 40 mm)	10%
18	Mill HMA	50 mm
18	Full-depth asphalt base repairs	10%
18	Resurface with new surface asphalt	50 mm
23	Rout and seal	1,000 m
28	Rout and seal	1,500 m
28	Spot repairs (mill 40 mm/patch 40 mm)	10%
32	Mill HMA	90 mm
32	Resurfacing with new base asphalt	50 mm
32	Resurface with new surface asphalt	40 mm
37	Rout and seal	1,500 m
40	Spot repairs (mill 40 mm/patch 40 mm)	10%
45	Mill HMA	50 mm
45	Full-depth asphalt base repairs	10%
45	Resurface with new surface asphalt	50 mm
48	Rout and seal	1,500 m

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Table 15. Rigid Pavement Preservation Plan: Minor Collector Roadway (AADTT 250 & 500)

Expected Year	Activity Description	Estimated Quantity
12	Reseal joints	10 %
12	Partial depth PCC repairs	2 %
12	Full depth PCC repairs	5 %
25	Partial depth PCC repairs	2 %
25	Full depth PCC repairs	10 %
25	Reseal joints	20 %
40	Partial depth PCC repairs	5 %
40	Full depth PCC repairs	10 %
40	Reseal joints	20 %

Table 16. Rigid Pavement Preservation Plan: Major Collector (AADTT 1,000 & 1,500)

Expected Year	Activity Description	Estimated Quantity
12	Reseal joints	20 %
12	Partial depth PCC repairs	2 %
12	Full depth PCC repairs	5 %
25	Partial depth PCC repairs	5 %
25	Full depth PCC repairs	10 %
25	Reseal joints	25 %
40	Partial depth PCC repairs	5 %
40	Full depth PCC repairs	15 %
40	Reseal joints	25 %

Table 17. Rigid Pavement Preservation Plan: Minor Arterial Roadway (AADTT 2,000 & 2,500)

Expected Year	Activity Description	Estimated Quantity
12	Reseal Joints	25 %
12	Partial depth PCC repairs	5 %
12	Full depth PCC repairs	7 %
25	Partial depth PCC repairs	10 %
25	Full depth PCC repairs	10 %
25	Reseal joints	25 %
40	Partial depth PCC repairs	10 %
40	Full depth PCC repairs	15 %
40	Reseal joints	25 %

Table 18. Rigid Pavement Preservation Plan: Major Arterial (AADTT 5,000 & 7,500)

Expected Year	Activity Description	Estimated Quantity
12	Reseal Joints	25 %
12	Partial depth PCC repairs	7 %
12	Full depth PCC repairs	7 %
25	Partial depth PCC repairs	10 %
25	Full depth PCC repairs	10 %
25	Reseal joints	50 %
25	Texturize Surface	50 %
40	Partial depth PCC repairs	5 %
40	Full depth PCC repairs	15 %
40	Reseal joints	50 %
40	Texturize Surface	50 %

5.3 Unit Rates for LCCA

Unit rates for the various construction, maintenance, and rehabilitation activities were obtained from representatives of local cities and contractors. The cost of asphalt materials used in the LCCA were obtained from local contractors and represent the unit rate for materials at the time that this report was prepared.

As the construction of rigid pavements is not common practice for most municipalities within the province, unit rates were estimated based on the local cost of materials and expected labour rates, which were compared with recent Provincial rigid pavement construction projects. This included the cost charged by local contractors/producers for: concrete materials (per m^3); epoxy coated dowel bars; as well as transportation, equipment, and placement costs. Although not considered in this LCCA, it can be expected that the unit rates for the various construction materials and activities required for concrete pavements will decease as more rigid pavement projects are tendered, and more local contractors gain experience.

The unit rates used for calculating initial construction costs are provided in Table 19, while typical costs for the various pavement preservation treatments are provided in Table 20.

Table 19. Unit Costs of Initial Construction Activities

Pavement Layer	Description of Pavement Layer	Units	Unit Rates
ACP	Asphalt Binder Course	t	$ 105.00
	Low-Volume Asphalt Surface Course	t	$ 105.00
	High-Volume Asphalt Surface Course	t	$110.00
	Tack Coat / Prime Coat	m^2	$ 1.00
PCC	170 mm PCC, no dowels	m^2	$ 72.00
	180 mm PCC, no dowels	m^2	$ 75.00
	190 mm PCC, no dowels	m^2	$ 78.00
	200 mm PCC, no dowels	m^2	$ 80.00
	200 mm PCC, 32M dowels	m^2	$ 85.00
	210 mm PCC, 32M dowels	m^2	$ 88.00
	220 mm PCC, 32M dowels	m^2	$ 90.00
	230 mm PCC, 32M dowels	m^2	$ 95.00
	240 mm PCC, 32M dowels	m^2	$ 100.00
Base	Crushed Granular Base	m^3	$ 45.00
Subbase	Select Granular Sub-Base	m^3	$ 40.00
Subgrade	Excavation and grading	m^3	$ 20.00

Table 20. Unit Costs for Pavement Preservation Treatments

Preservation Treatments	Units	Unit Rates
Flexible Pavements		
Rout and seal	m	$ 7.50
Spot repairs (mill/patch)	m^2	$ 90.00
Full depth asphalt base repairs	m^2	$ 125.00
Mill HMA	t	$ 10.00
Rigid Pavements		
Resealing joints	m	$ 4.00
Partial depth PCC repairs	m^2	$ 150.00
Full depth PCC repairs	m^2	$ 125.00
Surface texturize	m^2	$ 12.00

5.4 LCCA Comparison

Based on the available information, a LCCA was completed to evaluate the overall cost a municipality between the two pavement types over a 50-year analysis period. Estimated life cycle costs for rigid pavements were compared with the estimated costs to construct and maintain the comparable flexible pavement. The resulting difference is an indication of the cost savings that can be expected between the comparable pavements for each of the design categories. A summary of the cost comparison is provided in the ensuing tables, while detailed results are provided in Appendix B.

It is noted that a negative cost difference in the summary tables below indicate that a rigid pavement has a lower life cycle cost than a comparable flexible pavement. A positive result indicates the opposite.

Table 21. LCCA Results for Major Arterial Roadways

Roadway Classification	Subgrade Strength	Pavement Type	Initial Construction Costs	M & R Costs	Life Cycle Cost	Cost Difference
Major Arterial (7,500)	10 MPa	PCC	$2,059,500	$185,986	$2,245,486	-18.5%
		Flexible	$2,155,556	$600,071	$2,755,627	
	25 MPa	PCC	$1,786,500	$185,986	$1,972,486	-20.9%
		Flexible	$1,894,744	$600,071	$2,494,815	
	45 MPa	PCC	$1,708,500	$185,986	$1,894,486	-19.9%
		Flexible	$1,764,338	$600,071	$2,364,408	
Major Arterial (5,000)	10 MPa	PCC	$1,675,500	$185,986	$1,861,486	-28.2%
		Flexible	$1,993,931	$600,071	$2,594,002	
	25 MPa	PCC	$1,578,000	$185,986	$1,763,986	-23.1%
		Flexible	$1,692,713	$600,071	$2,292,783	
	45 MPa	PCC	$1,578,000	$185,986	$1,763,986	-18.4%
		Flexible	$1,562,306	$600,071	$2,162,377	

The results of the LCCA for Major Arterial roadways indicate that under the various soil conditions for this roadway classification, a rigid pavement design is considered more cost-effective over a 50-year analysis period.

Table 22. LCCA Results for Minor Arterial Roadways

Roadway Classification	Subgrade Strength	Pavement Type	Initial Construction Costs	M & R Costs	Life Cycle Cost	Cost Difference
Minor Arterial (2,500)	10 MPa	PCC	$1,627,500	$131,530	$1,759,030	-14.6%
		Flexible	$1,736,494	$322,987	$2,059,480	
	25 MPa	PCC	$1,530,000	$131,530	$1,661,530	0.1%
		Flexible	$1,336,931	$322,987	$1,659,918	
	45 MPa	PCC	$1,530,000	$131,530	$1,661,530	8.6%
		Flexible	$1,206,525	$322,987	$1,529,512	
Minor Arterial (2,000)	10 MPa	PCC	$1,627,500	$131,530	$1,759,030	-12.9%
		Flexible	$1,696,088	$322,987	$2,019,074	
	25 MPa	PCC	$1,530,000	$131,530	$1,661,530	2.6%
		Flexible	$1,296,525	$322,987	$1,619,512	
	45 MPa	PCC	$1,530,000	$131,530	$1,661,530	18.8%
		Flexible	$1,076,119	$322,987	$1,399,105	

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Table 23. LCCA Results for Major Collector Roadways

Roadway Classification	Subgrade Strength	Pavement Type	Initial Construction Costs	M & R Costs	Life Cycle Cost	Cost Difference*
Major Collector (1,500)	10 MPa	PCC	$813,750	$52,749	$866,499	-11.9%
		Flexible	$730,763	$252,384	$983,146	
	25 MPa	PCC	$765,000	$52,749	$817,749	-4.1%
		Flexible	$600,356	$252,384	$852,740	
	45 MPa	PCC	$765,000	$52,749	$817,749	7.2%
		Flexible	$510,356	$252,384	$762,740	
Major Collector (1,000)	10 MPa	PCC	$776,250	$53,294	$829,544	-13.9%
		Flexible	$710,559	$252,384	$962,943	
	25 MPa	PCC	$727,500	$53,294	$780,794	-6.2%
		Flexible	$580,153	$252,384	$832,537	
	45 MPa	PCC	$727,500	$53,294	$780,794	5.2%
		Flexible	$490,153	$252,384	$742,537	

The results of the LCCA for Minor Arterial and Major Collector roadways indicate that rigid pavements offer a better cost-effective solution in areas where weaker subgrade soils are expected. This is particularly true at areas where high ground water levels complicate the excavation of the required pavement structure.

Table 24. LCCA Results for Minor Collector Roadways

Roadway Classification	Subgrade Strength	Pavement Type	Initial Construction Costs	M & R Costs	Life Cycle Cost	Cost Difference*
Minor Collector (500)	10 MPa	PCC	$759,750	$47,095	$806,845	6.8%
		Flexible	$604,950	$150,530	$755,480	
	25 MPa	PCC	$711,000	$47,095	$758,095	22.2%
		Flexible	$469,950	$150,530	$620,480	
	45 MPa	PCC	$711,000	$47,095	$758,095	36.5%
		Flexible	$404,747	$150,530	$555,277	
Minor Collector (250)	10 MPa	PCC	$735,750	$47,095	$782,845	9.5%
		Flexible	$564,544	$150,530	$715,074	
	25 MPa	PCC	$687,000	$47,095	$734,095	26.6%
		Flexible	$429,544	$150,530	$580,074	
	45 MPa	PCC	$663,000	$47,095	$710,095	32.7%
		Flexible	$384,544	$150,530	$535,074	

As truck traffic volume reduces and subgrade strength increases, the LCCA for flexible pavements are found to have a lower LCCA. However, it is noteworthy that in development areas where new pavements are constructed prior to the start of the development, the concrete pavement option will provide increased structural capacity and durability to support construction traffic and/or operation of heavier equipment.

5.0 CLOSURE

The primary purpose of this study is to provide municipalities in the Province of Manitoba with a resource for considering rigid pavements as a viable option for reconstruction of their road network. The reduced pavement thickness, and increased durability of the pavement surface make the construction of concrete pavements applicable in many urban areas, particularly for roadways experiencing heavy truck/bus movements and/or weak subgrade conditions.

The pavement design matrix developed as part of the study is intended to assist municipalities with an easy-to-use reference table for preliminary design purposes. Flexible and rigid pavement designs in this table are considered equivalent pavement structures for the range of subgrade soils, roadway classifications, and traffic conditions considered as part of this study. Pavement designs were evaluated with a LCCA, over a 50-year analysis period. The results of the analysis provided a reasonable comparison of the expected costs for each pavement type based on a 25-year design life. It can be expected that as conditions change, so will the cost to construct the selected pavement structure.

The pavement design matrix should be used for preliminary pavement design purposes. Municipalities and/or their designers must carry out detailed design analysis to review the site conditions and determine the suitability of the preliminary designs for specific site conditions. Furthermore, the long-life performance associated with rigid pavements is largely dependent on proper design and construction practices. Detailed designs for concrete pavements should be completed by an experienced Pavement Engineer, and include site specific details for the construction of this pavement, such as a joint layout plan, load transfer devices, and surface texture.

The analysis presented in this report is based on design inputs, provided by others, and supplemented by Thurber's experience with pavement engineering projects throughout the Province of Manitoba. We note that any changes in soil conditions, traffic volumes, construction materials or procedures, may have a significant impact on design assumptions used to develop the preliminary pavement designs.

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6.0 REFERENCES

1. Pavement ME Design User Group, *Canadian Guide: Default Parameters for AASHTOWare Pavement ME Design (Draft)*, September 2018.

2. AASHTO, *Mechanistic-Empirical Pavement Design Guide: A Manual of Practice, Interim Edition*. Washington, DC, July 2015.

3. Thurber Engineering Ltd., Equivalent Pavement Designs for Municipalities Rigid and Flexible Pavements. Province of Saskatchewan, July 2018.

4. Thurber Engineering Ltd., Equivalent Pavement Designs for Municipalities Rigid and Flexible Pavements. Province of Alberta, December 2014.

5. Applied Research Associates Inc., *Development of Pavement Design Standards for Winnipeg Streets, Draft Report, 2010.*

6. Hein, D., Sullivan, S., *Concrete Coefficient of Thermal Expansion (CTE) and Its Significance in Mechanistic-Empirical Pavement Design*. Transportation Association of Canada, 2012 Annual Conference, Fredericton, New Brunswick.

7. Master Municipal Construction Documents (MMCD), *Master Municipal Specifications – Hot Mix Asphalt Concrete Paving (*2009). The Master Municipal Construction Documents Association, Vancouver, British Columbia.

8. Popik M., Donovan, H., *Lessons Learned by Canadian Practitioners in Interpreting and Applying Pavement ME Design Results*. Transportation Association of Canada, 2014 Annual Conference, Montreal, Quebec.

9. The City of Winnipeg Average Daily Traffic Flow Map (2018 Traffic Counts): https://winnipeg.ca/publicworks/transportation/pdf/2018TrafficFlowMap24HR.pdf

10. Annual Average Daily Traffic (AADT) of Highway Segment, Manitoba Highway Traffic Information System (2018):

11. https://univmb.maps.arcgis.com/apps/webappviewer/index.html?id=096e4889750b44e190ca5a4f4d690392

12. Manitoba Standard Construction Specifications

13. https://www.gov.mb.ca/mit/contracts/manual.html

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1. STANDARD OF CARE

This Report has been prepared in accordance with generally accepted engineering or environmental consulting practices in the applicable jurisdiction. No other warranty, expressed or implied, is intended or made.

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a) Nature and Exactness of Soil and Contaminant Description: Classification and identification of soils, rocks, geological units, contaminant materials and quantities have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification of these factors are judgmental in nature. Comprehensive sampling and testing programs implemented with the appropriate equipment by experienced personnel may fail to locate some conditions. All investigations utilizing the standards of Paragraph 1 will involve an inherent risk that some conditions will not be detected and all documents or records summarizing such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and the Client and all other persons making use of such documents or records with our express written consent should be aware of this risk and the Report is delivered subject to the express condition that such risk is accepted by the Client and such other persons. Some conditions are subject to change over time and those making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. If special concerns exist, or the Client has special considerations or requirements, the Client should disclose them so that additional or special investigations may be undertaken which would not otherwise be within the scope of investigations made for the purposes of the Report.

b) Reliance on Provided Information: The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site inspections and on the basis of information provided to Thurber. Thurber has relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, Thurber does not accept responsibility for any deficiency, misstatement or inaccuracy contained in the Report as a result of misstatements, omissions, misrepresentations, or fraudulent acts of the Client or other persons providing information relied on by Thurber. Thurber is entitled to rely on such representations, information and instructions and is not required to carry out investigations to determine the truth or accuracy of such representations, information and instructions.

c) Design Services: The Report may form part of design and construction documents for information purposes even though it may have been issued prior to final design being completed. Thurber should be retained to review final design, project plans and related documents prior to construction to confirm that they are consistent with the intent of the Report. Any differences that may exist between the Report's recommendations and the final design detailed in the contract documents should be reported to Thurber immediately so that Thurber can address potential conflicts.

d) Construction Services: During construction Thurber should be retained to provide field reviews. Field reviews consist of performing sufficient and timely observations of encountered conditions in order to confirm and document that the site conditions do not materially differ from those interpreted conditions considered in the preparation of the report. Adequate field reviews are necessary for Thurber to provide letters of assurance, in accordance with the requirements of many regulatory authorities.

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Geotechnical engineering and environmental consulting projects often have the potential to encounter pollutants or hazardous substances and the potential to cause the escape, release or dispersal of those substances. Thurber shall have no liability to the Client under any circumstances, for the escape, release or dispersal of pollutants or hazardous substances, unless such pollutants or hazardous substances have been specifically and accurately identified to Thurber by the Client prior to the commencement of Thurber's professional services.

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APPENDIX A

EQUIVALENT MUNICIPAL PAVEMENT DESIGN MATRIX

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Province of Manitoba
Equivalent Pavement Designs Matrix for Municipalities

Subgrade Strength*	Pavement Type	Average Annual Daily Truck Traffic (Two-Way)							
		Minor Collector Roadway		Major Collector Roadway		Minor Arterial Roadway		Major Arterial Roadway	
		250	500	1,000	1,500	2,000	2,500	5,000	7,500
10 MPa	PCC	180 mm PCC 300 mm CGB	190 mm PCC 300 mm CGB	200 mm PCC 300 mm CGB	200 mm PCC 300 mm CGB	200 mm PCC 300 mm CGB	200 mm PCC 300 mm CGB	210 mm PCC 300 mm CGB	240 mm PCC 500 mm CGB
	HMA	100 mm ACP 150 mm CGB 600 mm GSB	120 mm ACP 150 mm CGB 600 mm GSB	150 mm ACP 150 mm CGB 700 mm GSB	160 mm ACP 150 mm CGB 700 mm GSB	170 mm ACP 150 mm CGB 800 mm GSB	190 mm ACP 200 mm CGB 800 mm GSB	250 mm ACP 200 mm CGB 800 mm GSB	290 mm ACP 200 mm CGB 800 mm GSB
25 MPa	PCC	180 mm PCC 200 mm CGB	190 mm PCC 200 mm CGB	200 mm PCC 200 mm CGB	200 mm PCC 200 mm CGB	200 mm PCC 200 mm CGB	200 mm PCC 200 mm CGB	210 mm PCC 200 mm CGB	230 mm PCC 300 mm CGB
	HMA	100 mm ACP 150 mm CGB 300 mm GSB	120 mm ACP 150 mm CGB 300 mm GSB	130 mm ACP 150 mm CGB 500 mm GSB	140 mm ACP 150 mm CGB 500 mm GSB	160 mm ACP 150 mm CGB 500 mm GSB	170 mm ACP 150 mm CGB 500 mm GSB	220 mm ACP 200 mm CGB 600 mm GSB	270 mm ACP 200 mm CGB 600 mm GSB
45 MPa	PCC	170 mm PCC 200 mm CGB	190 mm PCC 200 mm CGB	200 mm PCC 200 mm CGB	200 mm PCC 200 mm CGB	200 mm PCC 200 mm CGB	200 mm PCC 200 mm CGB	210 mm PCC 200 mm CGB	220 mm PCC 300 mm CGB
	HMA	100 mm ACP 150 mm CGB 200 mm GSB	110 mm ACP 150 mm CGB 200 mm GSB	130 mm ACP 150 mm CGB 300 mm GSB	140 mm ACP 150 mm CGB 300 mm GSB	150 mm ACP 150 mm CGB 300 mm GSB	160 mm ACP 150 mm CGB 400 mm GSB	210 mm ACP 200 mm CGB 500 mm GSB	260 mm ACP 200 mm CGB 500 mm GSB
Concrete Slab Properties		No Dowel Bars Slab Length < 3.6m Tied Curb/Shoulders			32M Dowel Bar Slab Length < 4.0m Tied Curb/Shoulders				

Note: * - Subgrade Strength indicates the equivalent estimated AASHTO '93 Resilient Modulus design value.
- Subgrade Strength values do not consider any soil remediation treatments.

Client: Concrete Manitoba
File No.: 26603

Date: July 24, 2020

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APPENDIX B

LIFE CYCLE COST ANALYSIS
DETAILED WORK SHEETS

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EQUIVALENT PAVEMENT DESIGNS FOR MUNICIPALITIES
PROVINCE OF MANITOBA
LIFE CYCLE COST ANALYSIS RESULTS

Roadway Classification	Subgrade Strength	Pavement Type	Initial Construction Costs	M & R Costs	Life Cycle Cost	Cost Difference*
Major Arterial (7,500)	10 MPa	PCC	$2,059,500	$185,986	$2,245,486	-18.5%
		Flexible	$2,155,556	$600,071	$2,755,627	
	25 MPa	PCC	$1,786,500	$185,986	$1,972,486	-20.9%
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	45 MPa	PCC	$1,708,500	$185,986	$1,894,486	-19.9%
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	45 MPa	PCC	$1,578,000	$185,986	$1,763,986	-18.4%
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		Flexible	$1,736,494	$322,987	$2,059,480	
	25 MPa	PCC	$1,530,000	$131,530	$1,661,530	0.1%
		Flexible	$1,336,931	$322,987	$1,659,918	
	45 MPa	PCC	$1,530,000	$131,530	$1,661,530	8.6%
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		Flexible	$1,696,088	$322,987	$2,019,074	
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		Flexible	$1,296,525	$322,987	$1,619,512	
	45 MPa	PCC	$1,530,000	$131,530	$1,661,530	18.8%
		Flexible	$1,076,119	$322,987	$1,399,105	
Major Collector (1,500)	10 MPa	PCC	$813,750	$52,749	$866,499	-11.9%
		Flexible	$730,763	$252,384	$983,146	
	25 MPa	PCC	$765,000	$52,749	$817,749	-4.1%
		Flexible	$600,356	$252,384	$852,740	
	45 MPa	PCC	$765,000	$52,749	$817,749	7.2%
		Flexible	$510,356	$252,384	$762,740	
Major Collector (1,000)	10 MPa	PCC	$776,250	$53,294	$829,544	-13.9%
		Flexible	$710,559	$252,384	$962,943	
	25 MPa	PCC	$727,500	$53,294	$780,794	-6.2%
		Flexible	$580,153	$252,384	$832,537	
	45 MPa	PCC	$727,500	$53,294	$780,794	5.2%
		Flexible	$490,153	$252,384	$742,537	
Minor Collector (500)	10 MPa	PCC	$759,750	$47,095	$806,845	6.8%
		Flexible	$604,950	$150,530	$755,480	
	25 MPa	PCC	$711,000	$47,095	$758,095	22.2%
		Flexible	$469,950	$150,530	$620,480	
	45 MPa	PCC	$711,000	$47,095	$758,095	36.5%
		Flexible	$404,747	$150,530	$555,277	
Minor Collector (250)	10 MPa	PCC	$735,750	$47,095	$782,845	9.5%
		Flexible	$564,544	$150,530	$715,074	
	25 MPa	PCC	$687,000	$47,095	$734,095	26.6%
		Flexible	$429,544	$150,530	$580,074	
	45 MPa	PCC	$663,000	$47,095	$710,095	32.7%
		Flexible	$384,544	$150,530	$535,074	

Note: * - Cost Difference calculation is the comparison of LCC of the Rigid pavement to the Flexible pavement. Negative values indicate that the Rigid pavements option is a more cost-effective alternative.

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EQUIVALENT PAVEMENT DESIGNS - PROVINCE OF MANITOBA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 4-Lane Roadway

Roadway: **Major Arterial**
Pavement Type: **Rigid Pavement**
AADTT: **7,500**
Subgrade (MPa): **10 MPa**
Lane Width (m): **3.75**
Width of Road (m): **15**

Pavement Design

240	mm	Portland Cement Concrete
500	mm	Crushed Granular Base

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface PCC	Portland Cement Concrete	240	mm	m^2	15,000	$100.00	$1,500,000
Crushed Base	Crushed Granular Base	500	mm	m^3	7,500	$45.00	$337,500
Excavation	Earth Excavation	740	mm	m^3	11,100	$20.00	$222,000
					Total Initial Pavement Construction Cost		**$2,059,500**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
12	Reseal Transverse/Longitudinal Joints (25%)	1,438	m	$4.00	$5,750.00	$3,591
	Partial Depth Joint Repairs (7%)	121	m^2	$150.00	$18,112.50	$11,313
	Full Depth Joint Repairs (7%)	525	m^2	$125.00	$65,625.00	$40,989
25	Partial Depth Joint Repairs (10%)	173	m^2	$150.00	$25,875.00	$9,706
	Full Depth Joint Repairs (10%)	750	m^2	$125.00	$93,750.00	$35,167
	Reseal Transverse/Longitudinal Joints (50%)	2,875	m	$4.00	$11,500.00	$4,314
	Texturize Surface (50%)	7,500	m^2	$12.00	$90,000.00	$33,761
40	Partial Depth Joint Repairs (5%)	86	m^2	$150.00	$12,937.50	$2,695
	Full Depth Joint Repairs (15%)	1,125	m^2	$125.00	$140,625.00	$29,291
	Reseal Transverse/Longitudinal Joints (50%)	2,875	m	$4.00	$11,500.00	$2,395
	Texturize Surface (50%)	7,500	m^2	$12.00	$90,000.00	$18,746
50	Salvage Value	2	year(s)	-$21,255.21	-$42,510.42	-$5,982
				Total Maintenance and Rehabilitation Cost		**$185,986**

THURBER

EQUIVALENT PAVEMENT DESIGNS - PROVINCE OF MANITOBA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 4-Lane Roadway

Roadway:	**Major Arterial**
Pavement Type:	**Flexible Pavement**
AADTT:	**7,500**
Subgrade (MPa):	**10 MPa**
Lane Width (m):	**3.75**
Width of Road (m):	**15**

Pavement Design

40	mm	Surface Asphalt
250	mm	Base Asphalt
200	mm	Crushed Granular Base
800	mm	Granular Subbase

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface HMA	Surface Asphalt	40	mm	t	1,440	$110.00	$158,400
Base HMA	Base Asphalt	250	mm	t	8,906	$105.00	$935,156
Tack Coat/ Prime AC	4 Applications			m^2	60,000	$1.00	$60,000
Crushed Base	Crushed Granular Base	200	mm	m^3	3,000	$45.00	$135,000
Crushed Subbase	Granular Subbase	800	mm	m^3	12,000	$40.00	$480,000
Excavation	Earth Excavation	1,290	mm	m^3	19,350	$20.00	$387,000
					Total Initial Pavement Construction Cost		**$2,155,556**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
8	Rout and Seal Cracks	500	m	$7.50	$3,750.00	$2,740
	Spot Repairs - Mill 40 mm/ Patch 40 mm (5%)	750	m^2	$90.00	$67,500.00	$49,322
13	Rout and Seal Cracks	1,000	m	$7.50	$7,500.00	$4,504
	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	1,500	m^2	$90.00	$135,000.00	$81,078
18	Mill Asphalt Surface (50 mm)	1,725	t	$10.00	$17,250.00	$8,515
	Full Depth Asphalt Base Repairs (10%)	1,500	m^2	$125.00	$187,500.00	$92,555
	Resurface with New Surface Asphalt (50 mm)	1,800	t	$110.00	$198,000.00	$97,738
	Tack Coat - 1 Layers	15,000	m^2	$1.00	$15,000.00	$7,404
23	Rout and Seal Cracks	1,000	m	$7.50	$7,500.00	$3,043
28	Rout and Seal Cracks	1,500	m	$7.50	$11,250.00	$3,752
	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	1,500	m^2	$90.00	$135,000.00	$45,019
32	Mill Asphalt Surface (90 mm)	3,105	t	$10.00	$31,050.00	$8,851
	Resurface with New Base Asphalt (50 mm)	1,781	t	$105.00	$187,031.25	$53,315
	Resurface with New Surface Asphalt (40 mm)	1,440	t	$110.00	$158,400.00	$45,153
	Tack Coat - 2 Layers	30,000	m^2	$1.00	$30,000.00	$8,552
37	Rout and Seal Cracks	1,500	m	$7.50	$11,250.00	$2,636
40	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	1,500	m^2	$90.00	$135,000.00	$28,119
45	Mill Asphalt Surface (50 mm)	1,725	t	$10.00	$17,250.00	$2,953
	Full Depth Asphalt Base Repairs (10%)	1,500	m^2	$125.00	$187,500.00	$32,100
	Resurface with New Surface Asphalt (50 mm)	1,800	t	$110.00	$198,000.00	$33,897
	Tack Coat - 1 Layers	15,000	m^2	$1.00	$15,000.00	$2,568
48	Rout and Seal Cracks	1,500	m	$90.00	$135,000.00	$20,546
50	Salvage Value	7	year(s)	-$34,812.50	-$243,687.50	-$34,290
				Total Maintenance and Rehabilitation Cost		**$600,071**

THURBER

EQUIVALENT PAVEMENT DESIGNS - PROVINCE OF MANITOBA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 4-Lane Roadway

Roadway: **Major Arterial**
Pavement Type: **Rigid Pavement**
AADTT: **7,500**
Subgrade (MPa): **25 MPa**
Lane Width (m): **3.75**
Width of Road (m): **15**

Pavement Design

230	mm	Portland Cement Concrete
300	mm	Crushed Granular Base

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface PCC	Portland Cement Concrete	230	mm	m^2	15,000	$95.00	$1,425,000
Crushed Base	Crushed Granular Base	300	mm	m^3	4,500	$45.00	$202,500
Excavation	Earth Excavation	530	mm	m^3	7,950	$20.00	$159,000
						Total Initial Pavement Construction Cost	**$1,786,500**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
12	Reseal Transverse/Longitudinal Joints (25%)	1,438	m	$4.00	$5,750.00	$3,591
	Partial Depth Joint Repairs (7%)	121	m^2	$150.00	$18,112.50	$11,313
	Full Depth Joint Repairs (7%)	525	m^2	$125.00	$65,625.00	$40,989
25	Partial Depth Joint Repairs (10%)	173	m^2	$150.00	$25,875.00	$9,706
	Full Depth Joint Repairs (10%)	750	m^2	$125.00	$93,750.00	$35,167
	Reseal Transverse/Longitudinal Joints (50%)	2,875	m	$4.00	$11,500.00	$4,314
	Texturize Surface (50%)	7,500	m^2	$12.00	$90,000.00	$33,761
40	Partial Depth Joint Repairs (5%)	86	m^2	$150.00	$12,937.50	$2,695
	Full Depth Joint Repairs (15%)	1,125	m^2	$125.00	$140,625.00	$29,291
	Reseal Transverse/Longitudinal Joints (50%)	2,875	m	$4.00	$11,500.00	$2,395
	Texturize Surface (50%)	7,500	m^2	$12.00	$90,000.00	$18,746
50	Salvage Value	2	year(s)	-$21,255.21	-$42,510.42	-$5,982
				Total Maintenance and Rehabilitation Cost		**$185,986**

THURBER

EQUIVALENT PAVEMENT DESIGNS - PROVINCE OF MANITOBA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 4-Lane Roadway

Roadway:	**Major Arterial**
Pavement Type:	**Flexible Pavement**
AADTT:	**7,500**
Subgrade (MPa):	**25 MPa**
Lane Width (m):	**3.75**
Width of Road (m):	**15**

Pavement Design

40	mm	Surface Asphalt
230	mm	Base Asphalt
200	mm	Crushed Granular Base
600	mm	Granular Subbase

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface HMA	Surface Asphalt	40	mm	t	1,440	$110.00	$158,400
Base HMA	Base Asphalt	230	mm	t	8,194	$105.00	$860,344
Tack Coat/ Prime AC	4 Applications			m^2	60,000	$1.00	$60,000
Crushed Base	Crushed Granular Base	200	mm	m^3	3,000	$45.00	$135,000
Crushed Subbase	Granular Subbase	600	mm	m^3	9,000	$40.00	$360,000
Excavation	Earth Excavation	1,070	mm	m^3	16,050	$20.00	$321,000
					Total Initial Pavement Construction Cost		**$1,894,744**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
8	Rout and Seal Cracks	500	m	$7.50	$3,750.00	$2,740
	Spot Repairs - Mill 40 mm/ Patch 40 mm (5%)	750	m^2	$90.00	$67,500.00	$49,322
13	Rout and Seal Cracks	1,000	m	$7.50	$7,500.00	$4,504
	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	1,500	m^2	$90.00	$135,000.00	$81,078
18	Mill Asphalt Surface (50 mm)	1,725	t	$10.00	$17,250.00	$8,515
	Full Depth Asphalt Base Repairs (10%)	1,500	m^2	$125.00	$187,500.00	$92,555
	Resurface with New Surface Asphalt (50 mm)	1,800	t	$110.00	$198,000.00	$97,738
	Tack Coat - 1 Layers	15,000	m^2	$1.00	$15,000.00	$7,404
23	Rout and Seal Cracks	1,000	m	$7.50	$7,500.00	$3,043
28	Rout and Seal Cracks	1,500	m	$7.50	$11,250.00	$3,752
	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	1,500	m^2	$90.00	$135,000.00	$45,019
32	Mill Asphalt Surface (90 mm)	3,105	t	$10.00	$31,050.00	$8,851
	Resurface with New Base Asphalt (50 mm)	1,781	t	$105.00	$187,031.25	$53,315
	Resurface with New Surface Asphalt (40 mm)	1,440	t	$110.00	$158,400.00	$45,153
	Tack Coat - 2 Layers	30,000	m^2	$1.00	$30,000.00	$8,552
37	Rout and Seal Cracks	1,500	m	$7.50	$11,250.00	$2,636
40	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	1,500	m^2	$90.00	$135,000.00	$28,119
45	Mill Asphalt Surface (50 mm)	1,725	t	$10.00	$17,250.00	$2,953
	Full Depth Asphalt Base Repairs (10%)	1,500	m^2	$125.00	$187,500.00	$32,100
	Resurface with New Surface Asphalt (50 mm)	1,800	t	$110.00	$198,000.00	$33,897
	Tack Coat - 1 Layers	15,000	m^2	$1.00	$15,000.00	$2,568
48	Rout and Seal Cracks	1,500	m	$90.00	$135,000.00	$20,546
50	Salvage Value	7	year(s)	-$34,812.50	-$243,687.50	-$34,290
				Total Maintenance and Rehabilitation Cost		**$600,071**

THURBER

EQUIVALENT PAVEMENT DESIGNS - PROVINCE OF MANITOBA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 4-Lane Roadway

Roadway: **Major Arterial**
Pavement Type: **Rigid Pavement**
AADTT: **7,500**
Subgrade (MPa): **45 MPa**
Lane Width (m): **3.75**
Width of Road (m): **15**

Pavement Design

220	mm	Portland Cement Concrete
300	mm	Crushed Granular Base

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface PCC	Portland Cement Concrete	220	mm	m^2	15,000	$90.00	$1,350,000
Crushed Base	Crushed Granular Base	300	mm	m^3	4,500	$45.00	$202,500
Excavation	Earth Excavation	520	mm	m^3	7,800	$20.00	$156,000
						Total Initial Pavement Construction Cost	**$1,708,500**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
12	Reseal Transverse/Longitudinal Joints (25%)	1,438	m	$4.00	$5,750.00	$3,591
	Partial Depth Joint Repairs (7%)	121	m^2	$150.00	$18,112.50	$11,313
	Full Depth Joint Repairs (7%)	525	m^2	$125.00	$65,625.00	$40,989
25	Partial Depth Joint Repairs (10%)	173	m^2	$150.00	$25,875.00	$9,706
	Full Depth Joint Repairs (10%)	750	m^2	$125.00	$93,750.00	$35,167
	Reseal Transverse/Longitudinal Joints (50%)	2,875	m	$4.00	$11,500.00	$4,314
	Texturize Surface (50%)	7,500	m^2	$12.00	$90,000.00	$33,761
40	Partial Depth Joint Repairs (5%)	86	m^2	$150.00	$12,937.50	$2,695
	Full Depth Joint Repairs (15%)	1,125	m^2	$125.00	$140,625.00	$29,291
	Reseal Transverse/Longitudinal Joints (50%)	2,875	m	$4.00	$11,500.00	$2,395
	Texturize Surface (50%)	7,500	m^2	$12.00	$90,000.00	$18,746
50	Salvage Value	2	year(s)	-$21,255.21	-$42,510.42	-$5,982
				Total Maintenance and Rehabilitation Cost		**$185,986**

THURBER

EQUIVALENT PAVEMENT DESIGNS - PROVINCE OF MANITOBA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 4-Lane Roadway

Roadway:	**Major Arterial**
Pavement Type:	**Flexible Pavement**
AADTT:	**7,500**
Subgrade (MPa):	**45 MPa**
Lane Width (m):	**3.75**
Width of Road (m):	**15**

Pavement Design

40	mm	Surface Asphalt
220	mm	Base Asphalt
200	mm	Crushed Granular Base
500	mm	Granular Subbase

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface HMA	Surface Asphalt	40	mm	t	1,440	$110.00	$158,400
Base HMA	Base Asphalt	220	mm	t	7,838	$105.00	$822,938
Tack Coat/ Prime AC	4 Applications			m^2	60,000	$1.00	$60,000
Crushed Base	Crushed Granular Base	200	mm	m^3	3,000	$45.00	$135,000
Crushed Subbase	Granular Subbase	500	mm	m^3	7,500	$40.00	$300,000
Excavation	Earth Excavation	960	mm	m^3	14,400	$20.00	$288,000
					Total Initial Pavement Construction Cost		**$1,764,338**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
8	Rout and Seal Cracks	500	m	$7.50	$3,750.00	$2,740
	Spot Repairs - Mill 40 mm/ Patch 40 mm (5%)	750	m^2	$90.00	$67,500.00	$49,322
13	Rout and Seal Cracks	1,000	m	$7.50	$7,500.00	$4,504
	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	1,500	m^2	$90.00	$135,000.00	$81,078
18	Mill Asphalt Surface (50 mm)	1,725	t	$10.00	$17,250.00	$8,515
	Full Depth Asphalt Base Repairs (10%)	1,500	m^2	$125.00	$187,500.00	$92,555
	Resurface with New Surface Asphalt (50 mm)	1,800	t	$110.00	$198,000.00	$97,738
	Tack Coat - 1 Layers	15,000	m^2	$1.00	$15,000.00	$7,404
23	Rout and Seal Cracks	1,000	m	$7.50	$7,500.00	$3,043
28	Rout and Seal Cracks	1,500	m	$7.50	$11,250.00	$3,752
	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	1,500	m^2	$90.00	$135,000.00	$45,019
32	Mill Asphalt Surface (90 mm)	3,105	t	$10.00	$31,050.00	$8,851
	Resurface with New Base Asphalt (50 mm)	1,781	t	$105.00	$187,031.25	$53,315
	Resurface with New Surface Asphalt (40 mm)	1,440	t	$110.00	$158,400.00	$45,153
	Tack Coat - 2 Layers	30,000	m^2	$1.00	$30,000.00	$8,552
37	Rout and Seal Cracks	1,500	m	$7.50	$11,250.00	$2,636
40	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	1,500	m^2	$90.00	$135,000.00	$28,119
45	Mill Asphalt Surface (50 mm)	1,725	t	$10.00	$17,250.00	$2,953
	Full Depth Asphalt Base Repairs (10%)	1,500	m^2	$125.00	$187,500.00	$32,100
	Resurface with New Surface Asphalt (50 mm)	1,800	t	$110.00	$198,000.00	$33,897
	Tack Coat - 1 Layers	15,000	m^2	$1.00	$15,000.00	$2,568
48	Rout and Seal Cracks	1,500	m	$90.00	$135,000.00	$20,546
50	Salvage Value	7	year(s)	-$34,812.50	-$243,687.50	-$34,290
				Total Maintenance and Rehabilitation Cost		**$600,071**

EQUIVALENT PAVEMENT DESIGNS - PROVINCE OF MANITOBA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 4-Lane Roadway

Roadway:	**Major Arterial**
Pavement Type:	**Rigid Pavement**
AADTT:	**5,000**
Subgrade (MPa):	**10 MPa**
Lane Width (m):	**3.75**
Width of Road (m):	**15**

Pavement Design

210	mm	Portland Cement Concrete
300	mm	Crushed Granular Base

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface PCC	Portland Cement Concrete	210	mm	m^2	15,000	$88.00	$1,320,000
Crushed Base	Crushed Granular Base	300	mm	m^3	4,500	$45.00	$202,500
Excavation	Earth Excavation	510	mm	m^3	7,650	$20.00	$153,000
						Total Initial Pavement Construction Cost	**$1,675,500**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
12	Reseal Transverse/Longitudinal Joints (25%)	1,438	m	$4.00	$5,750.00	$3,591
	Partial Depth Joint Repairs (7%)	121	m^2	$150.00	$18,112.50	$11,313
	Full Depth Joint Repairs (7%)	525	m^2	$125.00	$65,625.00	$40,989
25	Partial Depth Joint Repairs (10%)	173	m^2	$150.00	$25,875.00	$9,706
	Full Depth Joint Repairs (10%)	750	m^2	$125.00	$93,750.00	$35,167
	Reseal Transverse/Longitudinal Joints (50%)	2,875	m	$4.00	$11,500.00	$4,314
	Texturize Surface (50%)	7,500	m^2	$12.00	$90,000.00	$33,761
40	Partial Depth Joint Repairs (5%)	86	m^2	$150.00	$12,937.50	$2,695
	Full Depth Joint Repairs (15%)	1,125	m^2	$125.00	$140,625.00	$29,291
	Reseal Transverse/Longitudinal Joints (50%)	2,875	m	$4.00	$11,500.00	$2,395
	Texturize Surface (50%)	7,500	m^2	$12.00	$90,000.00	$18,746
50	Salvage Value	2	year(s)	-$21,255.21	-$42,510.42	-$5,982
				Total Maintenance and Rehabilitation Cost		**$185,986**

THURBER

EQUIVALENT PAVEMENT DESIGNS - PROVINCE OF MANITOBA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA

All Quantities and Costs are for 1km of 4-Lane Roadway

Roadway:	**Major Arterial**
Pavement Type:	**Flexible Pavement**
AADTT:	**5,000**
Subgrade (MPa):	**10 MPa**
Lane Width (m):	**3.75**
Width of Road (m):	**15**

Pavement Design

40	mm	Surface Asphalt
210	mm	Base Asphalt
200	mm	Crushed Granular Base
800	mm	Granular Subbase

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface HMA	Surface Asphalt	40	mm	t	1,440	$110.00	$158,400
Base HMA	Base Asphalt	210	mm	t	7,481	$105.00	$785,531
Tack Coat/ Prime AC	4 Applications			m^2	60,000	$1.00	$60,000
Crushed Base	Crushed Granular Base	200	mm	m^3	3,000	$45.00	$135,000
Crushed Subbase	Granular Subbase	800	mm	m^3	12,000	$40.00	$480,000
Excavation	Earth Excavation	1,250	mm	m^3	18,750	$20.00	$375,000
					Total Initial Pavement Construction Cost		**$1,993,931**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
8	Rout and Seal Cracks	500	m	$7.50	$3,750.00	$2,740
	Spot Repairs - Mill 40 mm/ Patch 40 mm (5%)	750	m^2	$90.00	$67,500.00	$49,322
13	Rout and Seal Cracks	1,000	m	$7.50	$7,500.00	$4,504
	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	1,500	m^2	$90.00	$135,000.00	$81,078
18	Mill Asphalt Surface (50 mm)	1,725	t	$10.00	$17,250.00	$8,515
	Full Depth Asphalt Base Repairs (10%)	1,500	m^2	$125.00	$187,500.00	$92,555
	Resurface with New Surface Asphalt (50 mm)	1,800	t	$110.00	$198,000.00	$97,738
	Tack Coat - 1 Layers	15,000	m^2	$1.00	$15,000.00	$7,404
23	Rout and Seal Cracks	1,000	m	$7.50	$7,500.00	$3,043
28	Rout and Seal Cracks	1,500	m	$7.50	$11,250.00	$3,752
	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	1,500	m^2	$90.00	$135,000.00	$45,019
32	Mill Asphalt Surface (90 mm)	3,105	t	$10.00	$31,050.00	$8,851
	Resurface with New Base Asphalt (50 mm)	1,781	t	$105.00	$187,031.25	$53,315
	Resurface with New Surface Asphalt (40 mm)	1,440	t	$110.00	$158,400.00	$45,153
	Tack Coat - 2 Layers	30,000	m^2	$1.00	$30,000.00	$8,552
37	Rout and Seal Cracks	1,500	m	$7.50	$11,250.00	$2,636
40	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	1,500	m^2	$90.00	$135,000.00	$28,119
45	Mill Asphalt Surface (50 mm)	1,725	t	$10.00	$17,250.00	$2,953
	Full Depth Asphalt Base Repairs (10%)	1,500	m^2	$125.00	$187,500.00	$32,100
	Resurface with New Surface Asphalt (50 mm)	1,800	t	$110.00	$198,000.00	$33,897
	Tack Coat - 1 Layers	15,000	m^2	$1.00	$15,000.00	$2,568
48	Rout and Seal Cracks	1,500	m	$90.00	$135,000.00	$20,546
50	Salvage Value	7	year(s)	-$34,812.50	-$243,687.50	-$34,290
				Total Maintenance and Rehabilitation Cost		**$600,071**

THURBER

EQUIVALENT PAVEMENT DESIGNS - PROVINCE OF MANITOBA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 4-Lane Roadway

Roadway: **Major Arterial**
Pavement Type: **Rigid Pavement**
AADTT: **5,000**
Subgrade (MPa): **25 MPa**
Lane Width (m): **3.75**
Width of Road (m): **15**

Pavement Design

210	mm	Portland Cement Concrete
200	mm	Crushed Granular Base

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface PCC	Portland Cement Concrete	210	mm	m^2	15,000	$88.00	$1,320,000
Crushed Base	Crushed Granular Base	200	mm	m^3	3,000	$45.00	$135,000
Excavation	Earth Excavation	410	mm	m^3	6,150	$20.00	$123,000
						Total Initial Pavement Construction Cost	**$1,578,000**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
12	Reseal Transverse/Longitudinal Joints (25%)	1,438	m	$4.00	$5,750.00	$3,591
	Partial Depth Joint Repairs (7%)	121	m^2	$150.00	$18,112.50	$11,313
	Full Depth Joint Repairs (7%)	525	m^2	$125.00	$65,625.00	$40,989
25	Partial Depth Joint Repairs (10%)	173	m^2	$150.00	$25,875.00	$9,706
	Full Depth Joint Repairs (10%)	750	m^2	$125.00	$93,750.00	$35,167
	Reseal Transverse/Longitudinal Joints (50%)	2,875	m	$4.00	$11,500.00	$4,314
	Texturize Surface (50%)	7,500	m^2	$12.00	$90,000.00	$33,761
40	Partial Depth Joint Repairs (5%)	86	m^2	$150.00	$12,937.50	$2,695
	Full Depth Joint Repairs (15%)	1,125	m^2	$125.00	$140,625.00	$29,291
	Reseal Transverse/Longitudinal Joints (50%)	2,875	m	$4.00	$11,500.00	$2,395
	Texturize Surface (50%)	7,500	m^2	$12.00	$90,000.00	$18,746
50	Salvage Value	2	year(s)	-$21,255.21	-$42,510.42	-$5,982
				Total Maintenance and Rehabilitation Cost		**$185,986**

THURBER

EQUIVALENT PAVEMENT DESIGNS - PROVINCE OF MANITOBA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA

All Quantities and Costs are for 1km of 4-Lane Roadway

Roadway:	**Major Arterial**
Pavement Type:	**Flexible Pavement**
AADTT:	**5,000**
Subgrade (MPa):	**25 MPa**
Lane Width (m):	**3.75**
Width of Road (m):	**15**

Pavement Design

40	mm	Surface Asphalt
180	mm	Base Asphalt
200	mm	Crushed Granular Base
600	mm	Granular Subbase

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface HMA	Surface Asphalt	40	mm	t	1,440	$110.00	$158,400
Base HMA	Base Asphalt	180	mm	t	6,413	$105.00	$673,313
Tack Coat/ Prime AC	4 Applications			m^2	60,000	$1.00	$60,000
Crushed Base	Crushed Granular Base	200	mm	m^3	3,000	$45.00	$135,000
Crushed Subbase	Granular Subbase	600	mm	m^3	9,000	$40.00	$360,000
Excavation	Earth Excavation	1,020	mm	m^3	15,300	$20.00	$306,000
					Total Initial Pavement Construction Cost		**$1,692,713**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
8	Rout and Seal Cracks	500	m	$7.50	$3,750.00	$2,740
	Spot Repairs - Mill 40 mm/ Patch 40 mm (5%)	750	m^2	$90.00	$67,500.00	$49,322
13	Rout and Seal Cracks	1,000	m	$7.50	$7,500.00	$4,504
	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	1,500	m^2	$90.00	$135,000.00	$81,078
18	Mill Asphalt Surface (50 mm)	1,725	t	$10.00	$17,250.00	$8,515
	Full Depth Asphalt Base Repairs (10%)	1,500	m^2	$125.00	$187,500.00	$92,555
	Resurface with New Surface Asphalt (50 mm)	1,800	t	$110.00	$198,000.00	$97,738
	Tack Coat - 1 Layers	15,000	m^2	$1.00	$15,000.00	$7,404
23	Rout and Seal Cracks	1,000	m	$7.50	$7,500.00	$3,043
28	Rout and Seal Cracks	1,500	m	$7.50	$11,250.00	$3,752
	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	1,500	m^2	$90.00	$135,000.00	$45,019
32	Mill Asphalt Surface (90 mm)	3,105	t	$10.00	$31,050.00	$8,851
	Resurface with New Base Asphalt (50 mm)	1,781	t	$105.00	$187,031.25	$53,315
	Resurface with New Surface Asphalt (40 mm)	1,440	t	$110.00	$158,400.00	$45,153
	Tack Coat - 2 Layers	30,000	m^2	$1.00	$30,000.00	$8,552
37	Rout and Seal Cracks	1,500	m	$7.50	$11,250.00	$2,636
40	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	1,500	m^2	$90.00	$135,000.00	$28,119
45	Mill Asphalt Surface (50 mm)	1,725	t	$10.00	$17,250.00	$2,953
	Full Depth Asphalt Base Repairs (10%)	1,500	m^2	$125.00	$187,500.00	$32,100
	Resurface with New Surface Asphalt (50 mm)	1,800	t	$110.00	$198,000.00	$33,897
	Tack Coat - 1 Layers	15,000	m^2	$1.00	$15,000.00	$2,568
48	Rout and Seal Cracks	1,500	m	$90.00	$135,000.00	$20,546
50	Salvage Value	7	year(s)	-$34,812.50	-$243,687.50	-$34,290
				Total Maintenance and Rehabilitation Cost		**$600,071**

THURBER

EQUIVALENT PAVEMENT DESIGNS - PROVINCE OF MANITOBA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 4-Lane Roadway

Roadway: **Major Arterial**
Pavement Type: **Rigid Pavement**
AADTT: **5,000**
Subgrade (MPa): **45 MPa**
Lane Width (m): **3.75**
Width of Road (m): **15**

Pavement Design

210	mm	Portland Cement Concrete
200	mm	Crushed Granular Base

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface PCC	Portland Cement Concrete	210	mm	m^2	15,000	$88.00	$1,320,000
Crushed Base	Crushed Granular Base	200	mm	m^3	3,000	$45.00	$135,000
Excavation	Earth Excavation	410	mm	m^3	6,150	$20.00	$123,000
						Total Initial Pavement Construction Cost	**$1,578,000**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
12	Reseal Transverse/Longitudinal Joints (25%)	1,438	m	$4.00	$5,750.00	$3,591
	Partial Depth Joint Repairs (7%)	121	m^2	$150.00	$18,112.50	$11,313
	Full Depth Joint Repairs (7%)	525	m^2	$125.00	$65,625.00	$40,989
25	Partial Depth Joint Repairs (10%)	173	m^2	$150.00	$25,875.00	$9,706
	Full Depth Joint Repairs (10%)	750	m^2	$125.00	$93,750.00	$35,167
	Reseal Transverse/Longitudinal Joints (50%)	2,875	m	$4.00	$11,500.00	$4,314
	Texturize Surface (50%)	7,500	m^2	$12.00	$90,000.00	$33,761
40	Partial Depth Joint Repairs (5%)	86	m^2	$150.00	$12,937.50	$2,695
	Full Depth Joint Repairs (15%)	1,125	m^2	$125.00	$140,625.00	$29,291
	Reseal Transverse/Longitudinal Joints (50%)	2,875	m	$4.00	$11,500.00	$2,395
	Texturize Surface (50%)	7,500	m^2	$12.00	$90,000.00	$18,746
50	Salvage Value	2	year(s)	-$21,255.21	-$42,510.42	-$5,982
				Total Maintenance and Rehabilitation Cost		**$185,986**

THURBER

EQUIVALENT PAVEMENT DESIGNS - PROVINCE OF MANITOBA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 4-Lane Roadway

Roadway:	**Major Arterial**
Pavement Type:	**Flexible Pavement**
AADTT:	**5,000**
Subgrade (MPa):	**45 MPa**
Lane Width (m):	**3.75**
Width of Road (m):	**15**

Pavement Design

40	mm	Surface Asphalt
170	mm	Base Asphalt
200	mm	Crushed Granular Base
500	mm	Granular Subbase

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface HMA	Surface Asphalt	40	mm	t	1,440	$110.00	$158,400
Base HMA	Base Asphalt	170	mm	t	6,056	$105.00	$635,906
Tack Coat/ Prime AC	4 Applications			m^2	60,000	$1.00	$60,000
Crushed Base	Crushed Granular Base	200	mm	m^3	3,000	$45.00	$135,000
Crushed Subbase	Granular Subbase	500	mm	m^3	7,500	$40.00	$300,000
Excavation	Earth Excavation	910	mm	m^3	13,650	$20.00	$273,000
					Total Initial Pavement Construction Cost		**$1,562,306**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
8	Rout and Seal Cracks	500	m	$7.50	$3,750.00	$2,740
	Spot Repairs - Mill 40 mm/ Patch 40 mm (5%)	750	m^2	$90.00	$67,500.00	$49,322
13	Rout and Seal Cracks	1,000	m	$7.50	$7,500.00	$4,504
	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	1,500	m^2	$90.00	$135,000.00	$81,078
18	Mill Asphalt Surface (50 mm)	1,725	t	$10.00	$17,250.00	$8,515
	Full Depth Asphalt Base Repairs (10%)	1,500	m^2	$125.00	$187,500.00	$92,555
	Resurface with New Surface Asphalt (50 mm)	1,800	t	$110.00	$198,000.00	$97,738
	Tack Coat - 1 Layers	15,000	m^2	$1.00	$15,000.00	$7,404
23	Rout and Seal Cracks	1,000	m	$7.50	$7,500.00	$3,043
28	Rout and Seal Cracks	1,500	m	$7.50	$11,250.00	$3,752
	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	1,500	m^2	$90.00	$135,000.00	$45,019
32	Mill Asphalt Surface (90 mm)	3,105	t	$10.00	$31,050.00	$8,851
	Resurface with New Base Asphalt (50 mm)	1,781	t	$105.00	$187,031.25	$53,315
	Resurface with New Surface Asphalt (40 mm)	1,440	t	$110.00	$158,400.00	$45,153
	Tack Coat - 2 Layers	30,000	m^2	$1.00	$30,000.00	$8,552
37	Rout and Seal Cracks	1,500	m	$7.50	$11,250.00	$2,636
40	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	1,500	m^2	$90.00	$135,000.00	$28,119
45	Mill Asphalt Surface (50 mm)	1,725	t	$10.00	$17,250.00	$2,953
	Full Depth Asphalt Base Repairs (10%)	1,500	m^2	$125.00	$187,500.00	$32,100
	Resurface with New Surface Asphalt (50 mm)	1,800	t	$110.00	$198,000.00	$33,897
	Tack Coat - 1 Layers	15,000	m^2	$1.00	$15,000.00	$2,568
48	Rout and Seal Cracks	1,500	m	$90.00	$135,000.00	$20,546
50	Salvage Value	7	year(s)	-$34,812.50	-$243,687.50	-$34,290
				Total Maintenance and Rehabilitation Cost		**$600,071**

THURBER

EQUIVALENT PAVEMENT DESIGNS - PROVINCE OF MANITOBA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 4-Lane Roadway

Roadway: **Minor Arterial**
Pavement Type: **Rigid Pavement**
AADTT: **2,500**
Subgrade (MPa): **10 MPa**
Lane Width (m): **3.75**
Width of Road (m): **15**

Pavement Design

200	mm	Portland Cement Concrete
300	mm	Crushed Granular Base

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface PCC	Portland Cement Concrete	200	mm	m^2	15,000	$85	$1,275,000
Crushed Base	Crushed Granular Base	300	mm	m^3	4,500	$45	$202,500
Excavation	Earth Excavation	500	mm	m^3	7,500	$20	$150,000
						Total Initial Pavement Construction Cost	**$1,627,500**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
12	Reseal Transverse/Longitudinal Joints (25%)	1,438	m	$4.00	$5,750.00	$3,591
	Partial Depth Joint Repairs (5%)	86	m^2	$150.00	$12,937.50	$8,081
	Full Depth Joint Repairs (7%)	525	m^2	$125.00	$65,625.00	$40,989
25	Partial Depth Joint Repairs (10%)	173	m^2	$150.00	$25,875.00	$9,706
	Full Depth Joint Repairs (10%)	750	m^2	$125.00	$93,750.00	$35,167
	Reseal Transverse/Longitudinal Joints (25%)	1,438	m	$4.00	$5,750.00	$2,157
40	Partial Depth Joint Repairs (10%)	173	m^2	$150.00	$25,875.00	$5,389
	Full Depth Joint Repairs (15%)	1,125	m^2	$125.00	$140,625.00	$29,291
	Reseal Transverse/Longitudinal Joints (25%)	1,438	m	$4.00	$5,750.00	$1,198
50	Salvage Value	2	year(s)	-$14,354.17	-$28,708.33	-$4,040
				Total Maintenance and Rehabilitation Cost		**$131,530**

THURBER

EQUIVALENT PAVEMENT DESIGNS - PROVINCE OF MANITOBA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 4-Lane Roadway

Roadway: **Minor Arterial**
Pavement Type: **Flexible Pavement**
AADTT: **2,500**
Subgrade (MPa): **10 MPa**
Lane Width (m): **3.75**
Width of Road (m): **15**

Pavement Design

40	mm	Surface Asphalt
150	mm	Base Asphalt
200	mm	Crushed Granular Base
800	mm	Granular Subbase

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface HMA	Surface Asphalt	40	mm	t	1,440	$110	$158,400
Base HMA	Base Asphalt	150	mm	t	5,344	$105	$561,094
Tack Coat/ Prime AC	3 Applications			m^2	45,000	$1.00	$45,000
Crushed Base	Crushed Granular Base	200	mm	m^3	3,000	$45	$135,000
Crushed Subbase	Granular Subbase	800	mm	m^3	12,000	$40	$480,000
Excavation	Earth Excavation	1,190	mm	m^3	17,850	$20	$357,000
					Total Initial Pavement Construction Cost		**$1,736,494**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
5	Rout and Seal Cracks	250	m	$7.50	$1,875.00	$1,541
10	Rout and Seal Cracks	500	m	$7.50	$3,750.00	$2,533
	Spot Repairs - Mill 40 mm/ Patch 40 mm (5%)	750	m^2	$90.00	$67,500.00	$45,601
20	Mill Asphalt Surface (40 mm)	1,380	t	$10.00	$13,800.00	$6,298
	Resurface with New Surface Asphalt (40 mm)	1,440	t	$110.00	$158,400.00	$72,292
	Tack Coat - 1 Layers	15,000	m^2	$1.00	$15,000.00	$6,846
25	Rout and Seal Cracks	1,000	m	$7.50	$7,500.00	$2,813
30	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	1,500	m^2	$90.00	$135,000.00	$41,623
35	Mill Asphalt Surface (90 mm)	3,105	t	$10.00	$31,050.00	$7,869
	Resurface with New Base Asphalt (50 mm)	1,781	t	$105.00	$187,031.25	$47,397
	Resurface with New Surface Asphalt (40 mm)	1,440	t	$110.00	$158,400.00	$40,141
	Tack Coat - 2 Layers	30,000	m^2	$1.00	$30,000.00	$7,602
40	Rout and Seal Cracks	1,500	m	$7.50	$11,250.00	$2,343
43	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	1,500	m^2	$90.00	$135,000.00	$24,998
48	Mill Asphalt Surface (40 mm)	1,380	t	$10.00	$13,800.00	$2,100
	Full Depth Asphalt Base Repairs (10%)	1,500	m^2	$125.00	$187,500.00	$28,537
	Resurface with New Surface Asphalt (40 mm)	1,440	t	$110.00	$158,400.00	$24,108
	Tack Coat - 1 Layers	15,000	m^2	$1.00	$15,000.00	$2,283
50	Salvage Value	10	year(s)	-$31,225.00	-$312,250.00	-$43,938
				Total Maintenance and Rehabilitation Cost		**$322,987**

THURBER

EQUIVALENT PAVEMENT DESIGNS - PROVINCE OF MANITOBA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 4-Lane Roadway

Roadway: **Minor Arterial**
Pavement Type: **Rigid Pavement**
AADTT: **2,500**
Subgrade (MPa): **25 MPa**
Lane Width (m): **3.75**
Width of Road (m): **15**

Pavement Design

200	mm	Portland Cement Concrete
200	mm	Crushed Granular Base

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface PCC	Portland Cement Concrete	200	mm	m^2	15,000	$85	$1,275,000
Crushed Base	Crushed Granular Base	200	mm	m^3	3,000	$45	$135,000
Excavation	Earth Excavation	400	mm	m^3	6,000	$20	$120,000
						Total Initial Pavement Construction Cost	**$1,530,000**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
12	Reseal Transverse/Longitudinal Joints (25%)	1,438	m	$4.00	$5,750.00	$3,591
	Partial Depth Joint Repairs (5%)	86	m^2	$150.00	$12,937.50	$8,081
	Full Depth Joint Repairs (7%)	525	m^2	$125.00	$65,625.00	$40,989
25	Partial Depth Joint Repairs (10%)	173	m^2	$150.00	$25,875.00	$9,706
	Full Depth Joint Repairs (10%)	750	m^2	$125.00	$93,750.00	$35,167
	Reseal Transverse/Longitudinal Joints (25%)	1,438	m	$4.00	$5,750.00	$2,157
40	Partial Depth Joint Repairs (10%)	173	m^2	$150.00	$25,875.00	$5,389
	Full Depth Joint Repairs (15%)	1,125	m^2	$125.00	$140,625.00	$29,291
	Reseal Transverse/Longitudinal Joints (25%)	1,438	m	$4.00	$5,750.00	$1,198
50	Salvage Value	2	year(s)	-$14,354.17	-$28,708.33	-$4,040
				Total Maintenance and Rehabilitation Cost		**$131,530**

THURBER

EQUIVALENT PAVEMENT DESIGNS - PROVINCE OF MANITOBA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 4-Lane Roadway

Roadway: **Minor Arterial**
Pavement Type: **Flexible Pavement**
AADTT: **2,500**
Subgrade (MPa): **25 MPa**
Lane Width (m): **3.75**
Width of Road (m): **15**

Pavement Design

40	mm	Surface Asphalt
130	mm	Base Asphalt
150	mm	Crushed Granular Base
500	mm	Granular Subbase

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface HMA	Surface Asphalt	40	mm	t	1,440	$110	$158,400
Base HMA	Base Asphalt	130	mm	t	4,631	$105	$486,281
Tack Coat/ Prime AC	3 Applications			m^2	45,000	$1.00	$45,000
Crushed Base	Crushed Granular Base	150	mm	m^3	2,250	$45	$101,250
Crushed Subbase	Granular Subbase	500	mm	m^3	7,500	$40	$300,000
Excavation	Earth Excavation	820	mm	m^3	12,300	$20	$246,000
					Total Initial Pavement Construction Cost		**$1,336,931**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
5	Rout and Seal Cracks	250	m	$7.50	$1,875.00	$1,541
10	Rout and Seal Cracks	500	m	$7.50	$3,750.00	$2,533
	Spot Repairs - Mill 40 mm/ Patch 40 mm (5%)	750	m^2	$90.00	$67,500.00	$45,601
20	Mill Asphalt Surface (40 mm)	1,380	t	$10.00	$13,800.00	$6,298
	Resurface with New Surface Asphalt (40 mm)	1,440	t	$110.00	$158,400.00	$72,292
	Tack Coat - 1 Layers	15,000	m^2	$1.00	$15,000.00	$6,846
25	Rout and Seal Cracks	1,000	m	$7.50	$7,500.00	$2,813
30	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	1,500	m^2	$90.00	$135,000.00	$41,623
35	Mill Asphalt Surface (90 mm)	3,105	t	$10.00	$31,050.00	$7,869
	Resurface with New Base Asphalt (50 mm)	1,781	t	$105.00	$187,031.25	$47,397
	Resurface with New Surface Asphalt (40 mm)	1,440	t	$110.00	$158,400.00	$40,141
	Tack Coat - 2 Layers	30,000	m^2	$1.00	$30,000.00	$7,602
40	Rout and Seal Cracks	1,500	m	$7.50	$11,250.00	$2,343
43	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	1,500	m^2	$90.00	$135,000.00	$24,998
48	Mill Asphalt Surface (40 mm)	1,380	t	$10.00	$13,800.00	$2,100
	Full Depth Asphalt Base Repairs (10%)	1,500	m^2	$125.00	$187,500.00	$28,537
	Resurface with New Surface Asphalt (40 mm)	1,440	t	$110.00	$158,400.00	$24,108
	Tack Coat - 1 Layers	15,000	m^2	$1.00	$15,000.00	$2,283
50	Salvage Value	10	year(s)	-$31,225.00	-$312,250.00	-$43,938
				Total Maintenance and Rehabilitation Cost		**$322,987**

THURBER

EQUIVALENT PAVEMENT DESIGNS - PROVINCE OF MANITOBA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 4-Lane Roadway

Roadway: **Minor Arterial**
Pavement Type: **Rigid Pavement**
AADTT: **2,500**
Subgrade (MPa): **45 MPa**
Lane Width (m): **3.75**
Width of Road (m): **15**

Pavement Design

200	mm	Portland Cement Concrete
200	mm	Crushed Granular Base

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface PCC	Portland Cement Concrete	200	mm	m^2	15,000	$85	$1,275,000
Crushed Base	Crushed Granular Base	200	mm	m^3	3,000	$45	$135,000
Excavation	Earth Excavation	400	mm	m^3	6,000	$20	$120,000
						Total Initial Pavement Construction Cost	**$1,530,000**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
12	Reseal Transverse/Longitudinal Joints (25%)	1,438	m	$4.00	$5,750.00	$3,591
	Partial Depth Joint Repairs (5%)	86	m^2	$150.00	$12,937.50	$8,081
	Full Depth Joint Repairs (7%)	525	m^2	$125.00	$65,625.00	$40,989
25	Partial Depth Joint Repairs (10%)	173	m^2	$150.00	$25,875.00	$9,706
	Full Depth Joint Repairs (10%)	750	m^2	$125.00	$93,750.00	$35,167
	Reseal Transverse/Longitudinal Joints (25%)	1,438	m	$4.00	$5,750.00	$2,157
40	Partial Depth Joint Repairs (10%)	173	m^2	$150.00	$25,875.00	$5,389
	Full Depth Joint Repairs (15%)	1,125	m^2	$125.00	$140,625.00	$29,291
	Reseal Transverse/Longitudinal Joints (25%)	1,438	m	$4.00	$5,750.00	$1,198
50	Salvage Value	2	year(s)	-$14,354.17	-$28,708.33	-$4,040
				Total Maintenance and Rehabilitation Cost		**$131,530**

THURBER

EQUIVALENT PAVEMENT DESIGNS - PROVINCE OF MANITOBA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 4-Lane Roadway

Roadway: **Minor Arterial**
Pavement Type: **Flexible Pavement**
AADTT: **2,500**
Subgrade (MPa): **45 MPa**
Lane Width (m): **3.75**
Width of Road (m): **15**

Pavement Design

40	mm	Surface Asphalt
120	mm	Base Asphalt
150	mm	Crushed Granular Base
400	mm	Granular Subbase

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface HMA	Surface Asphalt	40	mm	t	1,440	$110	$158,400
Base HMA	Base Asphalt	120	mm	t	4,275	$105	$448,875
Tack Coat/ Prime AC	3 Applications			m^2	45,000	$1.00	$45,000
Crushed Base	Crushed Granular Base	150	mm	m^3	2,250	$45	$101,250
Crushed Subbase	Granular Subbase	400	mm	m^3	6,000	$40	$240,000
Excavation	Earth Excavation	710	mm	m^3	10,650	$20	$213,000
					Total Initial Pavement Construction Cost		**$1,206,525**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
5	Rout and Seal Cracks	250	m	$7.50	$1,875.00	$1,541
10	Rout and Seal Cracks	500	m	$7.50	$3,750.00	$2,533
	Spot Repairs - Mill 40 mm/ Patch 40 mm (5%)	750	m^2	$90.00	$67,500.00	$45,601
20	Mill Asphalt Surface (40 mm)	1,380	t	$10.00	$13,800.00	$6,298
	Resurface with New Surface Asphalt (40 mm)	1,440	t	$110.00	$158,400.00	$72,292
	Tack Coat - 1 Layers	15,000	m^2	$1.00	$15,000.00	$6,846
25	Rout and Seal Cracks	1,000	m	$7.50	$7,500.00	$2,813
30	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	1,500	m^2	$90.00	$135,000.00	$41,623
35	Mill Asphalt Surface (90 mm)	3,105	t	$10.00	$31,050.00	$7,869
	Resurface with New Base Asphalt (50 mm)	1,781	t	$105.00	$187,031.25	$47,397
	Resurface with New Surface Asphalt (40 mm)	1,440	t	$110.00	$158,400.00	$40,141
	Tack Coat - 2 Layers	30,000	m^2	$1.00	$30,000.00	$7,602
40	Rout and Seal Cracks	1,500	m	$7.50	$11,250.00	$2,343
43	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	1,500	m^2	$90.00	$135,000.00	$24,998
48	Mill Asphalt Surface (40 mm)	1,380	t	$10.00	$13,800.00	$2,100
	Full Depth Asphalt Base Repairs (10%)	1,500	m^2	$125.00	$187,500.00	$28,537
	Resurface with New Surface Asphalt (40 mm)	1,440	t	$110.00	$158,400.00	$24,108
	Tack Coat - 1 Layers	15,000	m^2	$1.00	$15,000.00	$2,283
50	Salvage Value	10	year(s)	-$31,225.00	-$312,250.00	-$43,938
				Total Maintenance and Rehabilitation Cost		**$322,987**

THURBER

EQUIVALENT PAVEMENT DESIGNS - PROVINCE OF MANITOBA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 4-Lane Roadway

Roadway: **Minor Arterial**
Pavement Type: **Rigid Pavement**
AADTT: **2,000**
Subgrade (MPa): **10 MPa**
Lane Width (m): **3.75**
Width of Road (m): **15**

Pavement Design

200	mm	Portland Cement Concrete
300	mm	Crushed Granular Base

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface PCC	Portland Cement Concrete	200	mm	m^2	15,000	$85	$1,275,000
Crushed Base	Crushed Granular Base	300	mm	m^3	4,500	$45	$202,500
Excavation	Earth Excavation	500	mm	m^3	7,500	$20	$150,000
						Total Initial Pavement Construction Cost	**$1,627,500**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
12	Reseal Transverse/Longitudinal Joints (25%)	1,438	m	$4.00	$5,750.00	$3,591
	Partial Depth Joint Repairs (5%)	86	m^2	$150.00	$12,937.50	$8,081
	Full Depth Joint Repairs (7%)	525	m^2	$125.00	$65,625.00	$40,989
25	Partial Depth Joint Repairs (10%)	173	m^2	$150.00	$25,875.00	$9,706
	Full Depth Joint Repairs (10%)	750	m^2	$125.00	$93,750.00	$35,167
	Reseal Transverse/Longitudinal Joints (25%)	1,438	m	$4.00	$5,750.00	$2,157
40	Partial Depth Joint Repairs (10%)	173	m^2	$150.00	$25,875.00	$5,389
	Full Depth Joint Repairs (15%)	1,125	m^2	$125.00	$140,625.00	$29,291
	Reseal Transverse/Longitudinal Joints (25%)	1,438	m	$4.00	$5,750.00	$1,198
50	Salvage Value	2	year(s)	-$14,354.17	-$28,708.33	-$4,040
				Total Maintenance and Rehabilitation Cost		**$131,530**

EQUIVALENT PAVEMENT DESIGNS - PROVINCE OF MANITOBA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 4-Lane Roadway

Roadway:	**Minor Arterial**
Pavement Type:	**Flexible Pavement**
AADTT:	**2,000**
Subgrade (MPa):	**10 MPa**
Lane Width (m):	**3.75**
Width of Road (m):	**15**

Pavement Design

40	mm	Surface Asphalt
130	mm	Base Asphalt
150	mm	Crushed Granular Base
800	mm	Granular Subbase

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface HMA	Surface Asphalt	40	mm	t	1,440	$110	$158,400
Base HMA	Base Asphalt	140	mm	t	4,988	$105	$523,688
Tack Coat/ Prime AC	3 Applications			m^2	45,000	$1.00	$45,000
Crushed Base	Crushed Granular Base	200	mm	m^3	3,000	$45	$135,000
Crushed Subbase	Granular Subbase	800	mm	m^3	12,000	$40	$480,000
Excavation	Earth Excavation	1,180	mm	m^3	17,700	$20	$354,000
					Total Initial Pavement Construction Cost		**$1,696,088**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
5	Rout and Seal Cracks	250	m	$7.50	$1,875.00	$1,541
10	Rout and Seal Cracks	500	m	$7.50	$3,750.00	$2,533
	Spot Repairs - Mill 40 mm/ Patch 40 mm (5%)	750	m^2	$90.00	$67,500.00	$45,601
20	Mill Asphalt Surface (40 mm)	1,380	t	$10.00	$13,800.00	$6,298
	Resurface with New Surface Asphalt (40 mm)	1,440	t	$110.00	$158,400.00	$72,292
	Tack Coat - 1 Layers	15,000	m^2	$1.00	$15,000.00	$6,846
25	Rout and Seal Cracks	1,000	m	$7.50	$7,500.00	$2,813
30	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	1,500	m^2	$90.00	$135,000.00	$41,623
35	Mill Asphalt Surface (90 mm)	3,105	t	$10.00	$31,050.00	$7,869
	Resurface with New Base Asphalt (50 mm)	1,781	t	$105.00	$187,031.25	$47,397
	Resurface with New Surface Asphalt (40 mm)	1,440	t	$110.00	$158,400.00	$40,141
	Tack Coat - 2 Layers	30,000	m^2	$1.00	$30,000.00	$7,602
40	Rout and Seal Cracks	1,500	m	$7.50	$11,250.00	$2,343
43	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	1,500	m^2	$90.00	$135,000.00	$24,998
48	Mill Asphalt Surface (40 mm)	1,380	t	$10.00	$13,800.00	$2,100
	Full Depth Asphalt Base Repairs (10%)	1,500	m^2	$125.00	$187,500.00	$28,537
	Resurface with New Surface Asphalt (40 mm)	1,440	t	$110.00	$158,400.00	$24,108
	Tack Coat - 1 Layers	15,000	m^2	$1.00	$15,000.00	$2,283
50	Salvage Value	10	year(s)	-$31,225.00	-$312,250.00	-$43,938
				Total Maintenance and Rehabilitation Cost		**$322,987**

THURBER

EQUIVALENT PAVEMENT DESIGNS - PROVINCE OF MANITOBA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 4-Lane Roadway

Roadway: **Minor Arterial**
Pavement Type: **Rigid Pavement**
AADTT: **2,000**
Subgrade (MPa): **25 MPa**
Lane Width (m): **3.75**
Width of Road (m): **15**

Pavement Design

200	mm	Portland Cement Concrete
200	mm	Crushed Granular Base

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface PCC	Portland Cement Concrete	200	mm	m^2	15,000	$85	$1,275,000
Crushed Base	Crushed Granular Base	200	mm	m^3	3,000	$45	$135,000
Excavation	Earth Excavation	400	mm	m^3	6,000	$20	$120,000
						Total Initial Pavement Construction Cost	**$1,530,000**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
12	Reseal Transverse/Longitudinal Joints (25%)	1,438	m	$4.00	$5,750.00	$3,591
	Partial Depth Joint Repairs (5%)	86	m^2	$150.00	$12,937.50	$8,081
	Full Depth Joint Repairs (7%)	525	m^2	$125.00	$65,625.00	$40,989
25	Partial Depth Joint Repairs (10%)	173	m^2	$150.00	$25,875.00	$9,706
	Full Depth Joint Repairs (10%)	750	m^2	$125.00	$93,750.00	$35,167
	Reseal Transverse/Longitudinal Joints (25%)	1,438	m	$4.00	$5,750.00	$2,157
40	Partial Depth Joint Repairs (10%)	173	m^2	$150.00	$25,875.00	$5,389
	Full Depth Joint Repairs (15%)	1,125	m^2	$125.00	$140,625.00	$29,291
	Reseal Transverse/Longitudinal Joints (25%)	1,438	m	$4.00	$5,750.00	$1,198
50	Salvage Value	2	year(s)	-$14,354.17	-$28,708.33	-$4,040
				Total Maintenance and Rehabilitation Cost		**$131,530**

THURBER

EQUIVALENT PAVEMENT DESIGNS - PROVINCE OF MANITOBA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 4-Lane Roadway

Roadway:	**Minor Arterial**
Pavement Type:	**Flexible Pavement**
AADTT:	**2,000**
Subgrade (MPa):	**25 MPa**
Lane Width (m):	**3.75**
Width of Road (m):	**15**

Pavement Design

40	mm	Surface Asphalt
120	mm	Base Asphalt
150	mm	Crushed Granular Base
500	mm	Granular Subbase

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface HMA	Surface Asphalt	40	mm	t	1,440	$110	$158,400
Base HMA	Base Asphalt	120	mm	t	4,275	$105	$448,875
Tack Coat/ Prime AC	3 Applications			m^2	45,000	$1.00	$45,000
Crushed Base	Crushed Granular Base	150	mm	m^3	2,250	$45	$101,250
Crushed Subbase	Granular Subbase	500	mm	m^3	7,500	$40	$300,000
Excavation	Earth Excavation	810	mm	m^3	12,150	$20	$243,000
					Total Initial Pavement Construction Cost		**$1,296,525**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
5	Rout and Seal Cracks	250	m	$7.50	$1,875.00	$1,541
10	Rout and Seal Cracks	500	m	$7.50	$3,750.00	$2,533
	Spot Repairs - Mill 40 mm/ Patch 40 mm (5%)	750	m^2	$90.00	$67,500.00	$45,601
20	Mill Asphalt Surface (40 mm)	1,380	t	$10.00	$13,800.00	$6,298
	Resurface with New Surface Asphalt (40 mm)	1,440	t	$110.00	$158,400.00	$72,292
	Tack Coat - 1 Layers	15,000	m^2	$1.00	$15,000.00	$6,846
25	Rout and Seal Cracks	1,000	m	$7.50	$7,500.00	$2,813
30	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	1,500	m^2	$90.00	$135,000.00	$41,623
35	Mill Asphalt Surface (90 mm)	3,105	t	$10.00	$31,050.00	$7,869
	Resurface with New Base Asphalt (50 mm)	1,781	t	$105.00	$187,031.25	$47,397
	Resurface with New Surface Asphalt (40 mm)	1,440	t	$110.00	$158,400.00	$40,141
	Tack Coat - 2 Layers	30,000	m^2	$1.00	$30,000.00	$7,602
40	Rout and Seal Cracks	1,500	m	$7.50	$11,250.00	$2,343
43	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	1,500	m^2	$90.00	$135,000.00	$24,998
48	Mill Asphalt Surface (40 mm)	1,380	t	$10.00	$13,800.00	$2,100
	Full Depth Asphalt Base Repairs (10%)	1,500	m^2	$125.00	$187,500.00	$28,537
	Resurface with New Surface Asphalt (40 mm)	1,440	t	$110.00	$158,400.00	$24,108
	Tack Coat - 1 Layers	15,000	m^2	$1.00	$15,000.00	$2,283
50	Salvage Value	10	year(s)	-$31,225.00	-$312,250.00	-$43,938
				Total Maintenance and Rehabilitation Cost		**$322,987**

THURBER

EQUIVALENT PAVEMENT DESIGNS - PROVINCE OF MANITOBA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 4-Lane Roadway

Roadway: **Minor Arterial**
Pavement Type: **Rigid Pavement**
AADTT: **2,000**
Subgrade (MPa): **45 MPa**
Lane Width (m): **3.75**
Width of Road (m): **15**

Pavement Design

200	mm	Portland Cement Concrete
200	mm	Crushed Granular Base

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface PCC	Portland Cement Concrete	200	mm	m^2	15,000	$85	$1,275,000
Crushed Base	Crushed Granular Base	200	mm	m^3	3,000	$45	$135,000
Excavation	Earth Excavation	400	mm	m^3	6,000	$20	$120,000
						Total Initial Pavement Construction Cost	**$1,530,000**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
12	Reseal Transverse/Longitudinal Joints (25%)	1,438	m	$4.00	$5,750.00	$3,591
	Partial Depth Joint Repairs (5%)	86	m^2	$150.00	$12,937.50	$8,081
	Full Depth Joint Repairs (7%)	525	m^2	$125.00	$65,625.00	$40,989
25	Partial Depth Joint Repairs (10%)	173	m^2	$150.00	$25,875.00	$9,706
	Full Depth Joint Repairs (10%)	750	m^2	$125.00	$93,750.00	$35,167
	Reseal Transverse/Longitudinal Joints (25%)	1,438	m	$4.00	$5,750.00	$2,157
40	Partial Depth Joint Repairs (10%)	173	m^2	$150.00	$25,875.00	$5,389
	Full Depth Joint Repairs (15%)	1,125	m^2	$125.00	$140,625.00	$29,291
	Reseal Transverse/Longitudinal Joints (25%)	1,438	m	$4.00	$5,750.00	$1,198
50	Salvage Value	2	year(s)	-$14,354.17	-$28,708.33	-$4,040
				Total Maintenance and Rehabilitation Cost		**$131,530**

THURBER

EQUIVALENT PAVEMENT DESIGNS - PROVINCE OF MANITOBA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 4-Lane Roadway

Roadway: **Minor Arterial**
Pavement Type: **Flexible Pavement**
AADTT: **2,000**
Subgrade (MPa): **45 MPa**
Lane Width (m): **3.75**
Width of Road (m): **15**

Pavement Design

40	mm	Surface Asphalt
110	mm	Base Asphalt
150	mm	Crushed Granular Base
300	mm	Granular Subbase

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface HMA	Surface Asphalt	40	mm	t	1,440	$110	$158,400
Base HMA	Base Asphalt	110	mm	t	3,919	$105	$411,469
Tack Coat/ Prime AC	3 Applications			m^2	45,000	$1.00	$45,000
Crushed Base	Crushed Granular Base	150	mm	m^3	2,250	$45	$101,250
Crushed Subbase	Granular Subbase	300	mm	m^3	4,500	$40	$180,000
Excavation	Earth Excavation	600	mm	m^3	9,000	$20	$180,000
					Total Initial Pavement Construction Cost		**$1,076,119**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
5	Rout and Seal Cracks	250	m	$7.50	$1,875.00	$1,541
10	Rout and Seal Cracks	500	m	$7.50	$3,750.00	$2,533
	Spot Repairs - Mill 40 mm/ Patch 40 mm (5%)	750	m^2	$90.00	$67,500.00	$45,601
20	Mill Asphalt Surface (40 mm)	1,380	t	$10.00	$13,800.00	$6,298
	Resurface with New Surface Asphalt (40 mm)	1,440	t	$110.00	$158,400.00	$72,292
	Tack Coat - 1 Layers	15,000	m^2	$1.00	$15,000.00	$6,846
25	Rout and Seal Cracks	1,000	m	$7.50	$7,500.00	$2,813
30	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	1,500	m^2	$90.00	$135,000.00	$41,623
35	Mill Asphalt Surface (90 mm)	3,105	t	$10.00	$31,050.00	$7,869
	Resurface with New Base Asphalt (50 mm)	1,781	t	$105.00	$187,031.25	$47,397
	Resurface with New Surface Asphalt (40 mm)	1,440	t	$110.00	$158,400.00	$40,141
	Tack Coat - 2 Layers	30,000	m^2	$1.00	$30,000.00	$7,602
40	Rout and Seal Cracks	1,500	m	$7.50	$11,250.00	$2,343
43	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	1,500	m^2	$90.00	$135,000.00	$24,998
48	Mill Asphalt Surface (40 mm)	1,380	t	$10.00	$13,800.00	$2,100
	Full Depth Asphalt Base Repairs (10%)	1,500	m^2	$125.00	$187,500.00	$28,537
	Resurface with New Surface Asphalt (40 mm)	1,440	t	$110.00	$158,400.00	$24,108
	Tack Coat - 1 Layers	15,000	m^2	$1.00	$15,000.00	$2,283
50	Salvage Value	10	year(s)	-$31,225.00	-$312,250.00	-$43,938
				Total Maintenance and Rehabilitation Cost		**$322,987**

THURBER

EQUIVALENT PAVEMENT DESIGNS - PROVINCE OF MANITOBA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 2-Lane Roadway

Roadway: **Collector**
Pavement Type: **Rigid Pavement**
AADTT: **1,500**
Subgrade (MPa): **10 MPa**
Lane Width (m): **3.75**
Width of Road (m): **7.5**

Pavement Design

200	mm	Portland Cement Concrete
300	mm	Crushed Granular Base

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface PCC	Portland Cement Concrete	200	mm	m^2	7,500	$85	$637,500
Crushed Base	Crushed Granular Base	300	mm	m^3	2,250	$45	$101,250
Excavation	Earth Excavation	500	mm	m^3	3,750	$20	$75,000
						Total Initial Pavement Construction Cost	**$813,750**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
12	Reseal Transverse/Longitudinal Joints (20%)	575	m	$4.00	$2,300.00	$1,437
	Partial Depth Joint Repairs (2%)	17	m^2	$150.00	$2,587.50	$1,616
	Full Depth Joint Repairs (5%)	188	m^2	$125.00	$23,437.50	$14,639
25	Partial Depth Joint Repairs (5%)	43	m^2	$150.00	$6,468.75	$2,427
	Full Depth Joint Repairs (10%)	375	m^2	$125.00	$46,875.00	$17,584
	Reseal Transverse/Longitudinal Joints (25%)	216	m	$4.00	$862.50	$324
40	Partial Depth Joint Repairs (5%)	43	m^2	$150.00	$6,468.75	$1,347
	Full Depth Joint Repairs (15%)	563	m^2	$125.00	$70,312.50	$14,645
	Reseal Transverse/Longitudinal Joints (25%)	719	m	$4.00	$2,875.00	$599
50	Salvage Value	2	year(s)	-$6,638.02	-$13,276.04	-$1,868
					Total Maintenance and Rehabilitation Cost	**$52,749**

THURBER

EQUIVALENT PAVEMENT DESIGNS - PROVINCE OF MANITOBA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 2-Lane Roadway

Roadway: **Major Collector**
Pavement Type: **Flexible Pavement**
AADTT: **1,500**
Subgrade (MPa): **10 MPa**
Lane Width (m): **3.75**
Width of Road (m): **7.5**

Pavement Design

40	mm	Surface Asphalt
120	mm	Base Asphalt
150	mm	Crushed Granular Base
700	mm	Granular Subbase

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface HMA	Surface Asphalt	40	mm	t	720	$110	$79,200
Base HMA	Base Asphalt	120	mm	t	2,138	$105	$224,438
Tack Coat/ Prime AC	2 Applications			m^2	15,000	$1.00	$15,000
Crushed Base	Crushed Granular Base	150	mm	m^3	1,125	$45	$50,625
Crushed Subbase	Granular Subbase	700	mm	m^3	5,250	$40	$210,000
Excavation	Earth Excavation	1,010	mm	m^3	7,575	$20	$151,500
					Total Initial Pavement Construction Cost		**$730,763**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
10	Rout and Seal Cracks	250	m	$7.50	$1,875.00	$1,267
	Spot Repairs - Mill 40 mm/ Patch 40 mm (5%)	375	m^2	$90.00	$33,750.00	$22,800
15	Spot Repairs - Mill 40 mm/ Patch 40 mm (5%)	375	m^2	$90.00	$33,750.00	$18,740
20	Mill Asphalt Surface (40 mm)	690	t	$10.00	$6,900.00	$3,149
	Resurface with New Surface Asphalt (40 mm)	720	t	$110.00	$79,200.00	$36,146
	Tack Coat - 1 Layers	7,500	m^2	$1.00	$7,500.00	$3,423
25	Rout and Seal Cracks	500	m	$7.50	$3,750.00	$1,407
30	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	750	m^2	$90.00	$67,500.00	$20,812
35	Mill Asphalt Surface (40 mm)	690	t	$10.00	$6,900.00	$1,749
	Full Depth Asphalt Base Repairs (10%)	750	m^2	$125.00	$93,750.00	$23,758
	Resurface with New Surface Asphalt (40 mm)	720	t	$110.00	$79,200.00	$20,071
	Tack Coat - 1 Layers	7,500	m^2	$1.00	$7,500.00	$1,901
40	Rout and Seal Cracks	500	m	$7.50	$3,750.00	$781
43	Spot Repairs - Mill 40 mm/ Patch 40 mm (8%)	600	m^2	$90.00	$54,000.00	$9,999
48	Mill Asphalt Surface (90 mm)	1,553	t	$10.00	$15,525.00	$2,363
	Resurface with New Binder Asphalt (50 mm)	891	t	$105.00	$93,515.63	$93,516
	Resurface with New Surface Asphalt (40 mm)	720	t	$110.00	$79,200.00	$12,054
	Tack Coat - 2 Layers	15,000	m^2	$1.00	$15,000.00	$2,283
50	Salvage Value	10	year(s)	-$16,936.72	-$169,367.19	-$23,832
				Total Maintenance and Rehabilitation Cost		**$252,384**

THURBER

EQUIVALENT PAVEMENT DESIGNS - PROVINCE OF MANITOBA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 2-Lane Roadway

Roadway: **Major Collector**
Pavement Type: **Rigid Pavement**
AADTT: **1,500**
Subgrade (MPa): **25 MPa**
Lane Width (m): **3.75**
Width of Road (m): **7.5**

Pavement Design

200	mm	Portland Cement Concrete
200	mm	Crushed Granular Base

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface PCC	Portland Cement Concrete	200	mm	m^2	7,500	$85	$637,500
Crushed Base	Crushed Granular Base	200	mm	m^3	1,500	$45	$67,500
Excavation	Earth Excavation	400	mm	m^3	3,000	$20	$60,000
						Total Initial Pavement Construction Cost	**$765,000**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
12	Reseal Transverse/Longitudinal Joints (20%)	575	m	$4.00	$2,300.00	$1,437
	Partial Depth Joint Repairs (2%)	17	m^2	$150.00	$2,587.50	$1,616
	Full Depth Joint Repairs (5%)	188	m^2	$125.00	$23,437.50	$14,639
25	Partial Depth Joint Repairs (5%)	43	m^2	$150.00	$6,468.75	$2,427
	Full Depth Joint Repairs (10%)	375	m^2	$125.00	$46,875.00	$17,584
	Reseal Transverse/Longitudinal Joints (25%)	216	m	$4.00	$862.50	$324
40	Partial Depth Joint Repairs (5%)	43	m^2	$150.00	$6,468.75	$1,347
	Full Depth Joint Repairs (15%)	563	m^2	$125.00	$70,312.50	$14,645
	Reseal Transverse/Longitudinal Joints (25%)	719	m	$4.00	$2,875.00	$599
50	Salvage Value	2	year(s)	-$6,638.02	-$13,276.04	-$1,868
					Total Maintenance and Rehabilitation Cost	**$52,749**

THURBER

EQUIVALENT PAVEMENT DESIGNS - PROVINCE OF MANITOBA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 2-Lane Roadway

Roadway: **Major Collector**
Pavement Type: **Flexible Pavement**
AADTT: **1,500**
Subgrade (MPa): **25 MPa**
Lane Width (m): **3.75**
Width of Road (m): **7.5**

Pavement Design

40	mm	Surface Asphalt
100	mm	Base Asphalt
150	mm	Crushed Granular Base
500	mm	Granular Subbase

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface HMA	Surface Asphalt	40	mm	t	720	$110	$79,200
Base HMA	Base Asphalt	100	mm	t	1,781	$105	$187,031
Tack Coat/ Prime AC	2 Applications			m^2	15,000	$1.00	$15,000
Crushed Base	Crushed Granular Base	150	mm	m^3	1,125	$45	$50,625
Crushed Subbase	Granular Subbase	500	mm	m^3	3,750	$40	$150,000
Excavation	Earth Excavation	790	mm	m^3	5,925	$20	$118,500
					Total Initial Pavement Construction Cost		**$600,356**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
10	Rout and Seal Cracks	250	m	$7.50	$1,875.00	$1,267
	Spot Repairs - Mill 40 mm/ Patch 40 mm (5%)	375	m^2	$90.00	$33,750.00	$22,800
15	Spot Repairs - Mill 40 mm/ Patch 40 mm (5%)	375	m^2	$90.00	$33,750.00	$18,740
20	Mill Asphalt Surface (40 mm)	690	t	$10.00	$6,900.00	$3,149
	Resurface with New Surface Asphalt (40 mm)	720	t	$110.00	$79,200.00	$36,146
	Tack Coat - 1 Layers	7,500	m^2	$1.00	$7,500.00	$3,423
25	Rout and Seal Cracks	500	m	$7.50	$3,750.00	$1,407
30	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	750	m^2	$90.00	$67,500.00	$20,812
35	Mill Asphalt Surface (40 mm)	690	t	$10.00	$6,900.00	$1,749
	Full Depth Asphalt Base Repairs (10%)	750	m^2	$125.00	$93,750.00	$23,758
	Resurface with New Surface Asphalt (40 mm)	720	t	$110.00	$79,200.00	$20,071
	Tack Coat - 1 Layers	7,500	m^2	$1.00	$7,500.00	$1,901
40	Rout and Seal Cracks	500	m	$7.50	$3,750.00	$781
43	Spot Repairs - Mill 40 mm/ Patch 40 mm (8%)	600	m^2	$90.00	$54,000.00	$9,999
48	Mill Asphalt Surface (90 mm)	1,553	t	$10.00	$15,525.00	$2,363
	Resurface with New Binder Asphalt (50 mm)	891	t	$105.00	$93,515.63	$93,516
	Resurface with New Surface Asphalt (40 mm)	720	t	$110.00	$79,200.00	$12,054
	Tack Coat - 2 Layers	15,000	m^2	$1.00	$15,000.00	$2,283
50	Salvage Value	10	year(s)	-$16,936.72	-$169,367.19	-$23,832
				Total Maintenance and Rehabilitation Cost		**$252,384**

THURBER

EQUIVALENT PAVEMENT DESIGNS - PROVINCE OF MANITOBA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 2-Lane Roadway

Roadway: **Major Collector**
Pavement Type: **Rigid Pavement**
AADTT: **1,500**
Subgrade (MPa): **45 MPa**
Lane Width (m): **3.75**
Width of Road (m): **7.5**

Pavement Design

200	mm	Portland Cement Concrete
200	mm	Crushed Granular Base

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface PCC	Portland Cement Concrete	200	mm	m^2	7,500	$85	$637,500
Crushed Base	Crushed Granular Base	200	mm	m^3	1,500	$45	$67,500
Excavation	Earth Excavation	400	mm	m^3	3,000	$20	$60,000
						Total Initial Pavement Construction Cost	**$765,000**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
12	Reseal Transverse/Longitudinal Joints (20%)	575	m	$4.00	$2,300.00	$1,437
	Partial Depth Joint Repairs (2%)	17	m^2	$150.00	$2,587.50	$1,616
	Full Depth Joint Repairs (5%)	188	m^2	$125.00	$23,437.50	$14,639
25	Partial Depth Joint Repairs (5%)	43	m^2	$150.00	$6,468.75	$2,427
	Full Depth Joint Repairs (10%)	375	m^2	$125.00	$46,875.00	$17,584
	Reseal Transverse/Longitudinal Joints (25%)	216	m	$4.00	$862.50	$324
40	Partial Depth Joint Repairs (5%)	43	m^2	$150.00	$6,468.75	$1,347
	Full Depth Joint Repairs (15%)	563	m^2	$125.00	$70,312.50	$14,645
	Reseal Transverse/Longitudinal Joints (25%)	719	m	$4.00	$2,875.00	$599
50	Salvage Value	2	year(s)	-$6,638.02	-$13,276.04	-$1,868
					Total Maintenance and Rehabilitation Cost	**$52,749**

THURBER

EQUIVALENT PAVEMENT DESIGNS - PROVINCE OF MANITOBA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 2-Lane Roadway

Roadway: **Major Collector**
Pavement Type: **Flexible Pavement**
AADTT: **1,500**
Subgrade (MPa): **45 MPa**
Lane Width (m): **3.75**
Width of Road (m): **7.5**

Pavement Design

40	mm	Surface Asphalt
100	mm	Base Asphalt
150	mm	Crushed Granular Base
300	mm	Granular Subbase

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface HMA	Surface Asphalt	40	mm	t	720	$110	$79,200
Base HMA	Base Asphalt	100	mm	t	1,781	$105	$187,031
Tack Coat/ Prime AC	2 Applications			m^2	15,000	$1.00	$15,000
Crushed Base	Crushed Granular Base	150	mm	m^3	1,125	$45	$50,625
Crushed Subbase	Granular Subbase	300	mm	m^3	2,250	$40	$90,000
Excavation	Earth Excavation	590	mm	m^3	4,425	$20	$88,500
					Total Initial Pavement Construction Cost		**$510,356**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
10	Rout and Seal Cracks	250	m	$7.50	$1,875.00	$1,267
	Spot Repairs - Mill 40 mm/ Patch 40 mm (5%)	375	m^2	$90.00	$33,750.00	$22,800
15	Spot Repairs - Mill 40 mm/ Patch 40 mm (5%)	375	m^2	$90.00	$33,750.00	$18,740
20	Mill Asphalt Surface (40 mm)	690	t	$10.00	$6,900.00	$3,149
	Resurface with New Surface Asphalt (40 mm)	720	t	$110.00	$79,200.00	$36,146
	Tack Coat - 1 Layers	7,500	m^2	$1.00	$7,500.00	$3,423
25	Rout and Seal Cracks	500	m	$7.50	$3,750.00	$1,407
30	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	750	m^2	$90.00	$67,500.00	$20,812
35	Mill Asphalt Surface (40 mm)	690	t	$10.00	$6,900.00	$1,749
	Full Depth Asphalt Base Repairs (10%)	750	m^2	$125.00	$93,750.00	$23,758
	Resurface with New Surface Asphalt (40 mm)	720	t	$110.00	$79,200.00	$20,071
	Tack Coat - 1 Layers	7,500	m^2	$1.00	$7,500.00	$1,901
40	Rout and Seal Cracks	500	m	$7.50	$3,750.00	$781
43	Spot Repairs - Mill 40 mm/ Patch 40 mm (8%)	600	m^2	$90.00	$54,000.00	$9,999
48	Mill Asphalt Surface (90 mm)	1,553	t	$10.00	$15,525.00	$2,363
	Resurface with New Binder Asphalt (50 mm)	891	t	$105.00	$93,515.63	$93,516
	Resurface with New Surface Asphalt (40 mm)	720	t	$110.00	$79,200.00	$12,054
	Tack Coat - 2 Layers	15,000	m^2	$1.00	$15,000.00	$2,283
50	Salvage Value	10	year(s)	-$16,936.72	-$169,367.19	-$23,832
				Total Maintenance and Rehabilitation Cost		**$252,384**

THURBER

EQUIVALENT PAVEMENT DESIGNS - PROVINCE OF MANITOBA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 2-Lane Roadway

Roadway: **Major Collector**
Pavement Type: **Rigid Pavement**
AADTT: **1,000**
Subgrade (MPa): **10 MPa**
Lane Width (m): **3.75**
Width of Road (m): **7.5**

Pavement Design

200	mm	Portland Cement Concrete (Undowelled)
300	mm	Crushed Granular Base

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface PCC	Portland Cement Concrete (Undowelled)	200	mm	m^2	7,500	$80	$600,000
Crushed Base	Crushed Granular Base	300	mm	m^3	2,250	$45	$101,250
Excavation	Earth Excavation	500	mm	m^3	3,750	$20	$75,000
						Total Initial Pavement Construction Cost	**$776,250**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
12	Reseal Transverse/Longitudinal Joints (20%)	617	m	$4.00	$2,466.67	$1,541
	Partial Depth Joint Repairs (2%)	19	m^2	$150.00	$2,775.00	$1,733
	Full Depth Joint Repairs (5%)	188	m^2	$125.00	$23,437.50	$14,639
25	Partial Depth Joint Repairs (5%)	46	m^2	$150.00	$6,937.50	$2,602
	Full Depth Joint Repairs (10%)	375	m^2	$125.00	$46,875.00	$17,584
	Reseal Transverse/Longitudinal Joints (25%)	231	m	$4.00	$925.00	$347
40	Partial Depth Joint Repairs (5%)	46	m^2	$150.00	$6,937.50	$1,445
	Full Depth Joint Repairs (15%)	563	m^2	$125.00	$70,312.50	$14,645
	Reseal Transverse/Longitudinal Joints (25%)	771	m	$4.00	$3,083.33	$642
50	Salvage Value	2	year(s)	-$6,694.44	-$13,388.89	-$1,884
				Total Maintenance and Rehabilitation Cost		**$53,294**

THURBER

EQUIVALENT PAVEMENT DESIGNS - PROVINCE OF MANITOBA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 2-Lane Roadway

Roadway: **Major Collector**
Pavement Type: **Flexible Pavement**
AADTT: **1,000**
Subgrade (MPa): **10 MPa**
Lane Width (m): **3.75**
Width of Road (m): **7.5**

Pavement Design

40	mm	Surface Asphalt
110	mm	Base Asphalt
150	mm	Crushed Granular Base
700	mm	Granular Subbase

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface HMA	Surface Asphalt	40	mm	t	720	$110	$79,200
Base HMA	Base Asphalt	110	mm	t	1,959	$105	$205,734
Tack Coat/ Prime AC	2 Applications			m^2	15,000	$1.00	$15,000
Crushed Base	Crushed Granular Base	150	mm	m^3	1,125	$45	$50,625
Crushed Subbase	Granular Subbase	700	mm	m^3	5,250	$40	$210,000
Excavation	Earth Excavation	1,000	mm	m^3	7,500	$20	$150,000
					Total Initial Pavement Construction Cost		**$710,559**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
10	Rout and Seal Cracks	250	m	$7.50	$1,875.00	$1,267
	Spot Repairs - Mill 40 mm/ Patch 40 mm (5%)	375	m^2	$90.00	$33,750.00	$22,800
15	Spot Repairs - Mill 40 mm/ Patch 40 mm (5%)	375	m^2	$90.00	$33,750.00	$18,740
20	Mill Asphalt Surface (40 mm)	690	t	$10.00	$6,900.00	$3,149
	Resurface with New Surface Asphalt (40 mm)	720	t	$110.00	$79,200.00	$36,146
	Tack Coat - 1 Layers	7,500	m^2	$1.00	$7,500.00	$3,423
25	Rout and Seal Cracks	500	m	$7.50	$3,750.00	$1,407
30	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	750	m^2	$90.00	$67,500.00	$20,812
35	Mill Asphalt Surface (40 mm)	690	t	$10.00	$6,900.00	$1,749
	Full Depth Asphalt Base Repairs (10%)	750	m^2	$125.00	$93,750.00	$23,758
	Resurface with New Surface Asphalt (40 mm)	720	t	$110.00	$79,200.00	$20,071
	Tack Coat - 1 Layers	7,500	m^2	$1.00	$7,500.00	$1,901
40	Rout and Seal Cracks	500	m	$7.50	$3,750.00	$781
43	Spot Repairs - Mill 40 mm/ Patch 40 mm (8%)	600	m^2	$90.00	$54,000.00	$9,999
48	Mill Asphalt Surface (90 mm)	1,553	t	$10.00	$15,525.00	$2,363
	Resurface with New Binder Asphalt (50 mm)	891	t	$105.00	$93,515.63	$93,516
	Resurface with New Surface Asphalt (40 mm)	720	t	$110.00	$79,200.00	$12,054
	Tack Coat - 2 Layers	15,000	m^2	$1.00	$15,000.00	$2,283
50	Salvage Value	10	year(s)	-$16,936.72	-$169,367.19	-$23,832
				Total Maintenance and Rehabilitation Cost		**$252,384**

THURBER

EQUIVALENT PAVEMENT DESIGNS - PROVINCE OF MANITOBA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 2-Lane Roadway

Roadway: **Major Collector**
Pavement Type: **Rigid Pavement**
AADTT: **1,000**
Subgrade (MPa): **25 MPa**
Lane Width (m): **3.75**
Width of Road (m): **7.5**

Pavement Design

200	mm	Portland Cement Concrete (Undowelled)
200	mm	Crushed Granular Base

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface PCC	Portland Cement Concrete (Undowelled)	200	mm	m^2	7,500	$80	$600,000
Crushed Base	Crushed Granular Base	200	mm	m^3	1,500	$45	$67,500
Excavation	Earth Excavation	400	mm	m^3	3,000	$20	$60,000
						Total Initial Pavement Construction Cost	**$727,500**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
12	Reseal Transverse/Longitudinal Joints (20%)	617	m	$4.00	$2,466.67	$1,541
	Partial Depth Joint Repairs (2%)	19	m^2	$150.00	$2,775.00	$1,733
	Full Depth Joint Repairs (5%)	188	m^2	$125.00	$23,437.50	$14,639
25	Partial Depth Joint Repairs (5%)	46	m^2	$150.00	$6,937.50	$2,602
	Full Depth Joint Repairs (10%)	375	m^2	$125.00	$46,875.00	$17,584
	Reseal Transverse/Longitudinal Joints (25%)	231	m	$4.00	$925.00	$347
40	Partial Depth Joint Repairs (5%)	46	m^2	$150.00	$6,937.50	$1,445
	Full Depth Joint Repairs (15%)	563	m^2	$125.00	$70,312.50	$14,645
	Reseal Transverse/Longitudinal Joints (25%)	771	m	$4.00	$3,083.33	$642
50	Salvage Value	2	year(s)	-$6,694.44	-$13,388.89	-$1,884
					Total Maintenance and Rehabilitation Cost	**$53,294**

THURBER

EQUIVALENT PAVEMENT DESIGNS - PROVINCE OF MANITOBA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 2-Lane Roadway

Roadway: **Major Collector**
Pavement Type: **Flexible Pavement**
AADTT: **1,000**
Subgrade (MPa): **25 MPa**
Lane Width (m): **3.75**
Width of Road (m): **7.5**

Pavement Design

40	mm	Surface Asphalt
90	mm	Base Asphalt
150	mm	Crushed Granular Base
500	mm	Granular Subbase

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface HMA	Surface Asphalt	40	mm	t	720	$110	$79,200
Base HMA	Base Asphalt	90	mm	t	1,603	$105	$168,328
Tack Coat/ Prime AC	2 Applications			m^2	15,000	$1.00	$15,000
Crushed Base	Crushed Granular Base	150	mm	m^3	1,125	$45	$50,625
Crushed Subbase	Granular Subbase	500	mm	m^3	3,750	$40	$150,000
Excavation	Earth Excavation	780	mm	m^3	5,850	$20	$117,000
					Total Initial Pavement Construction Cost		**$580,153**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
10	Rout and Seal Cracks	250	m	$7.50	$1,875.00	$1,267
	Spot Repairs - Mill 40 mm/ Patch 40 mm (5%)	375	m^2	$90.00	$33,750.00	$22,800
15	Spot Repairs - Mill 40 mm/ Patch 40 mm (5%)	375	m^2	$90.00	$33,750.00	$18,740
20	Mill Asphalt Surface (40 mm)	690	t	$10.00	$6,900.00	$3,149
	Resurface with New Surface Asphalt (40 mm)	720	t	$110.00	$79,200.00	$36,146
	Tack Coat - 1 Layers	7,500	m^2	$1.00	$7,500.00	$3,423
25	Rout and Seal Cracks	500	m	$7.50	$3,750.00	$1,407
30	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	750	m^2	$90.00	$67,500.00	$20,812
35	Mill Asphalt Surface (40 mm)	690	t	$10.00	$6,900.00	$1,749
	Full Depth Asphalt Base Repairs (10%)	750	m^2	$125.00	$93,750.00	$23,758
	Resurface with New Surface Asphalt (40 mm)	720	t	$110.00	$79,200.00	$20,071
	Tack Coat - 1 Layers	7,500	m^2	$1.00	$7,500.00	$1,901
40	Rout and Seal Cracks	500	m	$7.50	$3,750.00	$781
43	Spot Repairs - Mill 40 mm/ Patch 40 mm (8%)	600	m^2	$90.00	$54,000.00	$9,999
48	Mill Asphalt Surface (90 mm)	1,553	t	$10.00	$15,525.00	$2,363
	Resurface with New Binder Asphalt (50 mm)	891	t	$105.00	$93,515.63	$93,516
	Resurface with New Surface Asphalt (40 mm)	720	t	$110.00	$79,200.00	$12,054
	Tack Coat - 2 Layers	15,000	m^2	$1.00	$15,000.00	$2,283
50	Salvage Value	10	year(s)	-$16,936.72	-$169,367.19	-$23,832
				Total Maintenance and Rehabilitation Cost		**$252,384**

THURBER

EQUIVALENT PAVEMENT DESIGNS - PROVINCE OF MANITOBA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 2-Lane Roadway

Roadway: **Major Collector**
Pavement Type: **Rigid Pavement**
AADTT: **1,000**
Subgrade (MPa): **45 MPa**
Lane Width (m): **3.75**
Width of Road (m): **7.5**

Pavement Design

200	mm	Portland Cement Concrete (Undowelled)
200	mm	Crushed Granular Base

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface PCC	Portland Cement Concrete (Undowelled)	200	mm	m^2	7,500	$80	$600,000
Crushed Base	Crushed Granular Base	200	mm	m^3	1,500	$45	$67,500
Excavation	Earth Excavation	400	mm	m^3	3,000	$20	$60,000
						Total Initial Pavement Construction Cost	**$727,500**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
12	Reseal Transverse/Longitudinal Joints (20%)	617	m	$4.00	$2,466.67	$1,541
	Partial Depth Joint Repairs (2%)	19	m^2	$150.00	$2,775.00	$1,733
	Full Depth Joint Repairs (5%)	188	m^2	$125.00	$23,437.50	$14,639
25	Partial Depth Joint Repairs (5%)	46	m^2	$150.00	$6,937.50	$2,602
	Full Depth Joint Repairs (10%)	375	m^2	$125.00	$46,875.00	$17,584
	Reseal Transverse/Longitudinal Joints (25%)	231	m	$4.00	$925.00	$347
40	Partial Depth Joint Repairs (5%)	46	m^2	$150.00	$6,937.50	$1,445
	Full Depth Joint Repairs (15%)	563	m^2	$125.00	$70,312.50	$14,645
	Reseal Transverse/Longitudinal Joints (25%)	771	m	$4.00	$3,083.33	$642
50	Salvage Value	2	year(s)	-$6,694.44	-$13,388.89	-$1,884
				Total Maintenance and Rehabilitation Cost		**$53,294**

THURBER

EQUIVALENT PAVEMENT DESIGNS - PROVINCE OF MANITOBA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 2-Lane Roadway

Roadway: **Major Collector**
Pavement Type: **Flexible Pavement**
AADTT: **1,000**
Subgrade (MPa): **45 MPa**
Lane Width (m): **3.75**
Width of Road (m): **7.5**

Pavement Design

40	mm	Surface Asphalt
90	mm	Base Asphalt
150	mm	Crushed Granular Base
300	mm	Granular Subbase

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface HMA	Surface Asphalt	40	mm	t	720	$110	$79,200
Base HMA	Base Asphalt	90	mm	t	1,603	$105	$168,328
Tack Coat/ Prime AC	2 Applications			m^2	15,000	$1.00	$15,000
Crushed Base	Crushed Granular Base	150	mm	m^3	1,125	$45	$50,625
Crushed Subbase	Granular Subbase	300	mm	m^3	2,250	$40	$90,000
Excavation	Earth Excavation	580	mm	m^3	4,350	$20	$87,000
					Total Initial Pavement Construction Cost		**$490,153**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
10	Rout and Seal Cracks	250	m	$7.50	$1,875.00	$1,267
	Spot Repairs - Mill 40 mm/ Patch 40 mm (5%)	375	m^2	$90.00	$33,750.00	$22,800
15	Spot Repairs - Mill 40 mm/ Patch 40 mm (5%)	375	m^2	$90.00	$33,750.00	$18,740
20	Mill Asphalt Surface (40 mm)	690	t	$10.00	$6,900.00	$3,149
	Resurface with New Surface Asphalt (40 mm)	720	t	$110.00	$79,200.00	$36,146
	Tack Coat - 1 Layers	7,500	m^2	$1.00	$7,500.00	$3,423
25	Rout and Seal Cracks	500	m	$7.50	$3,750.00	$1,407
30	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	750	m^2	$90.00	$67,500.00	$20,812
35	Mill Asphalt Surface (40 mm)	690	t	$10.00	$6,900.00	$1,749
	Full Depth Asphalt Base Repairs (10%)	750	m^2	$125.00	$93,750.00	$23,758
	Resurface with New Surface Asphalt (40 mm)	720	t	$110.00	$79,200.00	$20,071
	Tack Coat - 1 Layers	7,500	m^2	$1.00	$7,500.00	$1,901
40	Rout and Seal Cracks	500	m	$7.50	$3,750.00	$781
43	Spot Repairs - Mill 40 mm/ Patch 40 mm (8%)	600	m^2	$90.00	$54,000.00	$9,999
48	Mill Asphalt Surface (90 mm)	1,553	t	$10.00	$15,525.00	$2,363
	Resurface with New Binder Asphalt (50 mm)	891	t	$105.00	$93,515.63	$93,516
	Resurface with New Surface Asphalt (40 mm)	720	t	$110.00	$79,200.00	$12,054
	Tack Coat - 2 Layers	15,000	m^2	$1.00	$15,000.00	$2,283
50	Salvage Value	10	year(s)	-$16,936.72	-$169,367.19	-$23,832
				Total Maintenance and Rehabilitation Cost		**$252,384**

THURBER

EQUIVALENT PAVEMENT DESIGNS - PROVINCE OF MANITOBA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 2-Lane Roadway

Roadway: **Minor Collector**
Pavement Type: **Rigid Pavement**
AADTT: **500**
Subgrade (MPa): **10 MPa**
Lane Width (m): **3.75**
Width of Road (m): **7.5**

Pavement Design

190	mm	Portland Cement Concrete (Undowelled)
300	mm	Crushed Granular Base

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface PCC	Portland Cement Concrete (Undowelled)	190	mm	m^2	7,500	$78	$585,000
Crushed Base	Crushed Granular Base	300	mm	m^3	2,250	$45	$101,250
Excavation	Earth Excavation	490	mm	m^3	3,675	$20	$73,500
						Total Initial Pavement Construction Cost	**$759,750**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
12	Reseal Transverse/Longitudinal Joints (10%)	308	m	$4.00	$1,233.33	$770
	Partial Depth Joint Repairs (2%)	19	m^2	$150.00	$2,775.00	$1,733
	Full Depth Joint Repairs (5%)	188	m^2	$125.00	$23,437.50	$14,639
25	Partial Depth Joint Repairs (2%)	19	m^2	$150.00	$2,775.00	$1,041
	Full Depth Joint Repairs (10%)	375	m^2	$125.00	$46,875.00	$17,584
	Reseal Transverse/Longitudinal Joints (20%)	617	m	$4.00	$2,466.67	$925
40	Partial Depth Joint Repairs (5%)	46	m^2	$150.00	$6,937.50	$1,445
	Full Depth Joint Repairs (10%)	375	m^2	$125.00	$46,875.00	$9,764
	Reseal Transverse/Longitudinal Joints (20%)	617	m	$4.00	$2,466.67	$514
50	Salvage Value	2	year(s)	-$4,689.93	-$9,379.86	-$1,320
				Total Maintenance and Rehabilitation Cost		**$47,095**

THURBER

EQUIVALENT PAVEMENT DESIGNS - PROVINCE OF MANITOBA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 2-Lane Roadway

Roadway: **Minor Collector**
Pavement Type: **Flexible Pavement**
AADTT: **500**
Subgrade (MPa): **10 MPa**
Lane Width (m): **3.75**
Width of Road (m): **7.5**

Pavement Design

40	mm	Surface Asphalt
80	mm	Base Asphalt
150	mm	Crushed Granular Base
600	mm	Granular Subbase

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface HMA	Surface Asphalt	40	mm	t	720	$110	$79,200
Base HMA	Base Asphalt	80	mm	t	1,425	$105	$149,625
Tack Coat/ Prime AC	2 Applications			m^2	15,000	$1.00	$15,000
Crushed Base	Crushed Granular Base	150	mm	m^3	1,125	$45	$50,625
Crushed Subbase	Granular Subbase	600	mm	m^3	4,500	$40	$180,000
Excavation	Earth Excavation	870	mm	m^3	6,525	$20	$130,500
					Total Initial Pavement Construction Cost		**$604,950**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
10	Rout and Seal Cracks	250	m	$7.50	$1,875.00	$1,267
	Spot Repairs - Mill 40 mm/ Patch 40 mm (5%)	375	m^2	$90.00	$33,750.00	$22,800
20	Mill Asphalt Surface (40 mm)	690	t	$10.00	$6,900.00	$3,149
	Resurface with New Surface Asphalt (40 mm)	720	t	$110.00	$79,200.00	$36,146
	Tack Coat - 1 Layers	7,500	m^2	$1.00	$7,500.00	$3,423
25	Rout and Seal Cracks	500	m	$7.50	$3,750.00	$1,407
30	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	750	m^2	$90.00	$67,500.00	$20,812
35	Mill Asphalt Surface (40 mm)	690	t	$10.00	$6,900.00	$1,749
	Full Depth Asphalt Base Repairs (10%)	750	m^2	$125.00	$93,750.00	$23,758
	Resurface with New Surface Asphalt (40 mm)	720	t	$110.00	$79,200.00	$20,071
	Tack Coat - 1 Layers	7,500	m^2	$1.00	$7,500.00	$1,901
40	Rout and Seal Cracks	500	m	$7.50	$3,750.00	$781
43	Spot Repairs - Mill 40 mm/ Patch 40 mm (8%)	600	m^2	$90.00	$54,000.00	$9,999
48	Mill Asphalt Surface (40 mm)	690	t	$10.00	$6,900.00	$1,050
	Resurface with New Surface Asphalt (40 mm)	720	t	$110.00	$79,200.00	$12,054
	Tack Coat - 1 Layers	7,500	m^2	$1.00	$7,500.00	$1,141
50	Salvage Value	10	year(s)	-$7,800.00	-$78,000.00	-$10,976
				Total Maintenance and Rehabilitation Cost		**$150,530**

THURBER

EQUIVALENT PAVEMENT DESIGNS - PROVINCE OF MANITOBA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 2-Lane Roadway

Roadway: **Minor Collector**
Pavement Type: **Rigid Pavement**
AADTT: **500**
Subgrade (MPa): **25 MPa**
Lane Width (m): **3.75**
Width of Road (m): **7.5**

Pavement Design

190	mm	Portland Cement Concrete (Undowelled)
200	mm	Crushed Granular Base

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface PCC	Portland Cement Concrete (Undowelled)	190	mm	m^2	7,500	$78	$585,000
Crushed Base	Crushed Granular Base	200	mm	m^3	1,500	$45	$67,500
Excavation	Earth Excavation	390	mm	m^3	2,925	$20	$58,500
						Total Initial Pavement Construction Cost	**$711,000**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
12	Reseal Transverse/Longitudinal Joints (10%)	308	m	$4.00	$1,233.33	$770
	Partial Depth Joint Repairs (2%)	19	m^2	$150.00	$2,775.00	$1,733
	Full Depth Joint Repairs (5%)	188	m^2	$125.00	$23,437.50	$14,639
25	Partial Depth Joint Repairs (2%)	19	m^2	$150.00	$2,775.00	$1,041
	Full Depth Joint Repairs (10%)	375	m^2	$125.00	$46,875.00	$17,584
	Reseal Transverse/Longitudinal Joints (20%)	617	m	$4.00	$2,466.67	$925
40	Partial Depth Joint Repairs (5%)	46	m^2	$150.00	$6,937.50	$1,445
	Full Depth Joint Repairs (10%)	375	m^2	$125.00	$46,875.00	$9,764
	Reseal Transverse/Longitudinal Joints (20%)	617	m	$4.00	$2,466.67	$514
50	Salvage Value	2	year(s)	-$4,689.93	-$9,379.86	-$1,320
				Total Maintenance and Rehabilitation Cost		**$47,095**

THURBER

EQUIVALENT PAVEMENT DESIGNS - PROVINCE OF MANITOBA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 2-Lane Roadway

Roadway: **Minor Collector**
Pavement Type: **Flexible Pavement**
AADTT: **500**
Subgrade (MPa): **25 MPa**
Lane Width (m): **3.75**
Width of Road (m): **7.5**

Pavement Design

40	mm	Surface Asphalt
80	mm	Base Asphalt
150	mm	Crushed Granular Base
300	mm	Granular Subbase

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface HMA	Surface Asphalt	40	mm	t	720	$110	$79,200
Base HMA	Base Asphalt	80	mm	t	1,425	$105	$149,625
Tack Coat/ Prime AC	2 Applications			m^2	15,000	$1.00	$15,000
Crushed Base	Crushed Granular Base	150	mm	m^3	1,125	$45	$50,625
Crushed Subbase	Granular Subbase	300	mm	m^3	2,250	$40	$90,000
Excavation	Earth Excavation	570	mm	m^3	4,275	$20	$85,500
					Total Initial Pavement Construction Cost		**$469,950**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
10	Rout and Seal Cracks	250	m	$7.50	$1,875.00	$1,267
	Spot Repairs - Mill 40 mm/ Patch 40 mm (5%)	375	m^2	$90.00	$33,750.00	$22,800
20	Mill Asphalt Surface (40 mm)	690	t	$10.00	$6,900.00	$3,149
	Resurface with New Surface Asphalt (40 mm)	720	t	$110.00	$79,200.00	$36,146
	Tack Coat - 1 Layers	7,500	m^2	$1.00	$7,500.00	$3,423
25	Rout and Seal Cracks	500	m	$7.50	$3,750.00	$1,407
30	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	750	m^2	$90.00	$67,500.00	$20,812
35	Mill Asphalt Surface (40 mm)	690	t	$10.00	$6,900.00	$1,749
	Full Depth Asphalt Base Repairs (10%)	750	m^2	$125.00	$93,750.00	$23,758
	Resurface with New Surface Asphalt (40 mm)	720	t	$110.00	$79,200.00	$20,071
	Tack Coat - 1 Layers	7,500	m^2	$1.00	$7,500.00	$1,901
40	Rout and Seal Cracks	500	m	$7.50	$3,750.00	$781
43	Spot Repairs - Mill 40 mm/ Patch 40 mm (8%)	600	m^2	$90.00	$54,000.00	$9,999
48	Mill Asphalt Surface (40 mm)	690	t	$10.00	$6,900.00	$1,050
	Resurface with New Surface Asphalt (40 mm)	720	t	$110.00	$79,200.00	$12,054
	Tack Coat - 1 Layers	7,500	m^2	$1.00	$7,500.00	$1,141
50	Salvage Value	10	year(s)	-$7,800.00	-$78,000.00	-$10,976
				Total Maintenance and Rehabilitation Cost		**$150,530**

THURBER

EQUIVALENT PAVEMENT DESIGNS - PROVINCE OF MANITOBA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 2-Lane Roadway

Roadway: **Minor Collector**
Pavement Type: **Rigid Pavement**
AADTT: **500**
Subgrade (MPa): **45 MPa**
Lane Width (m): **3.75**
Width of Road (m): **7.5**

Pavement Design

190	mm	Portland Cement Concrete (Undowelled)
200	mm	Crushed Granular Base

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface PCC	Portland Cement Concrete (Undowelled)	190	mm	m^2	7,500	$78	$585,000
Crushed Base	Crushed Granular Base	200	mm	m^3	1,500	$45	$67,500
Excavation	Earth Excavation	390	mm	m^3	2,925	$20	$58,500
						Total Initial Pavement Construction Cost	**$711,000**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
12	Reseal Transverse/Longitudinal Joints (10%)	308	m	$4.00	$1,233.33	$770
	Partial Depth Joint Repairs (2%)	19	m^2	$150.00	$2,775.00	$1,733
	Full Depth Joint Repairs (5%)	188	m^2	$125.00	$23,437.50	$14,639
25	Partial Depth Joint Repairs (2%)	19	m^2	$150.00	$2,775.00	$1,041
	Full Depth Joint Repairs (10%)	375	m^2	$125.00	$46,875.00	$17,584
	Reseal Transverse/Longitudinal Joints (20%)	617	m	$4.00	$2,466.67	$925
40	Partial Depth Joint Repairs (5%)	46	m^2	$150.00	$6,937.50	$1,445
	Full Depth Joint Repairs (10%)	375	m^2	$125.00	$46,875.00	$9,764
	Reseal Transverse/Longitudinal Joints (20%)	617	m	$4.00	$2,466.67	$514
50	Salvage Value	2	year(s)	-$4,689.93	-$9,379.86	-$1,320
				Total Maintenance and Rehabilitation Cost		**$47,095**

THURBER

EQUIVALENT PAVEMENT DESIGNS - PROVINCE OF MANITOBA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 2-Lane Roadway

Roadway: **Minor Collector**
Pavement Type: **Flexible Pavement**
AADTT: **500**
Subgrade (MPa): **45 MPa**
Lane Width (m): **3.75**
Width of Road (m): **7.5**

Pavement Design

40	mm	Surface Asphalt
70	mm	Base Asphalt
150	mm	Crushed Granular Base
200	mm	Granular Subbase

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface HMA	Surface Asphalt	40	mm	t	720	$110	$79,200
Base HMA	Base Asphalt	70	mm	t	1,247	$105	$130,922
Tack Coat/ Prime AC	2 Applications			m^2	15,000	$1.00	$15,000
Crushed Base	Crushed Granular Base	150	mm	m^3	1,125	$45	$50,625
Crushed Subbase	Granular Subbase	200	mm	m^3	1,500	$40	$60,000
Excavation	Earth Excavation	460	mm	m^3	3,450	$20	$69,000
					Total Initial Pavement Construction Cost		**$404,747**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
10	Rout and Seal Cracks	250	m	$7.50	$1,875.00	$1,267
	Spot Repairs - Mill 40 mm/ Patch 40 mm (5%)	375	m^2	$90.00	$33,750.00	$22,800
20	Mill Asphalt Surface (40 mm)	690	t	$10.00	$6,900.00	$3,149
	Resurface with New Surface Asphalt (40 mm)	720	t	$110.00	$79,200.00	$36,146
	Tack Coat - 1 Layers	7,500	m^2	$1.00	$7,500.00	$3,423
25	Rout and Seal Cracks	500	m	$7.50	$3,750.00	$1,407
30	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	750	m^2	$90.00	$67,500.00	$20,812
35	Mill Asphalt Surface (40 mm)	690	t	$10.00	$6,900.00	$1,749
	Full Depth Asphalt Base Repairs (10%)	750	m^2	$125.00	$93,750.00	$23,758
	Resurface with New Surface Asphalt (40 mm)	720	t	$110.00	$79,200.00	$20,071
	Tack Coat - 1 Layers	7,500	m^2	$1.00	$7,500.00	$1,901
40	Rout and Seal Cracks	500	m	$7.50	$3,750.00	$781
43	Spot Repairs - Mill 40 mm/ Patch 40 mm (8%)	600	m^2	$90.00	$54,000.00	$9,999
48	Mill Asphalt Surface (40 mm)	690	t	$10.00	$6,900.00	$1,050
	Resurface with New Surface Asphalt (40 mm)	720	t	$110.00	$79,200.00	$12,054
	Tack Coat - 1 Layers	7,500	m^2	$1.00	$7,500.00	$1,141
50	Salvage Value	10	year(s)	-$7,800.00	-$78,000.00	-$10,976
				Total Maintenance and Rehabilitation Cost		**$150,530**

THURBER

EQUIVALENT PAVEMENT DESIGNS - PROVINCE OF MANITOBA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 2-Lane Roadway

Roadway: **Minor Collector**
Pavement Type: **Rigid Pavement**
AADTT: **250**
Subgrade (MPa): **10 MPa**
Lane Width (m): **3.75**
Width of Road (m): **7.5**

Pavement Design

180	mm	Portland Cement Concrete (Undowelled)
300	mm	Crushed Granular Base

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface PCC	Portland Cement Concrete (Undowelled)	180	mm	m^2	7,500	$75	$562,500
Crushed Base	Crushed Granular Base	300	mm	m^3	2,250	$45	$101,250
Excavation	Earth Excavation	480	mm	m^3	3,600	$20	$72,000
						Total Initial Pavement Construction Cost	**$735,750**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
12	Reseal Transverse/Longitudinal Joints (10%)	308	m	$4.00	$1,233.33	$770
	Partial Depth Joint Repairs (2%)	19	m^2	$150.00	$2,775.00	$1,733
	Full Depth Joint Repairs (5%)	188	m^2	$125.00	$23,437.50	$14,639
25	Partial Depth Joint Repairs (2%)	19	m^2	$150.00	$2,775.00	$1,041
	Full Depth Joint Repairs (10%)	375	m^2	$125.00	$46,875.00	$17,584
	Reseal Transverse/Longitudinal Joints (20%)	617	m	$4.00	$2,466.67	$925
40	Partial Depth Joint Repairs (5%)	46	m^2	$150.00	$6,937.50	$1,445
	Full Depth Joint Repairs (10%)	375	m^2	$125.00	$46,875.00	$9,764
	Reseal Transverse/Longitudinal Joints (20%)	617	m	$4.00	$2,466.67	$514
50	Salvage Value	2	year(s)	-$4,689.93	-$9,379.86	-$1,320
				Total Maintenance and Rehabilitation Cost		**$47,095**

THURBER

EQUIVALENT PAVEMENT DESIGNS - PROVINCE OF MANITOBA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 2-Lane Roadway

Roadway: **Minor Collector**
Pavement Type: **Flexible Pavement**
AADTT: **250**
Subgrade (MPa): **10 MPa**
Lane Width (m): **3.75**
Width of Road (m): **7.5**

Pavement Design

40	mm	Surface Asphalt
60	mm	Base Asphalt
150	mm	Crushed Granular Base
600	mm	Granular Subbase

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface HMA	Surface Asphalt	40	mm	t	720	$110	$79,200
Base HMA	Base Asphalt	60	mm	t	1,069	$105	$112,219
Tack Coat/ Prime AC	2 Applications			m^2	15,000	$1.00	$15,000
Crushed Base	Crushed Granular Base	150	mm	m^3	1,125	$45	$50,625
Crushed Subbase	Granular Subbase	600	mm	m^3	4,500	$40	$180,000
Excavation	Earth Excavation	850	mm	m^3	6,375	$20	$127,500
					Total Initial Pavement Construction Cost		**$564,544**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
10	Rout and Seal Cracks	250	m	$7.50	$1,875.00	$1,267
	Spot Repairs - Mill 40 mm/ Patch 40 mm (5%)	375	m^2	$90.00	$33,750.00	$22,800
20	Mill Asphalt Surface (40 mm)	690	t	$10.00	$6,900.00	$3,149
	Resurface with New Surface Asphalt (40 mm)	720	t	$110.00	$79,200.00	$36,146
	Tack Coat - 1 Layers	7,500	m^2	$1.00	$7,500.00	$3,423
25	Rout and Seal Cracks	500	m	$7.50	$3,750.00	$1,407
30	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	750	m^2	$90.00	$67,500.00	$20,812
35	Mill Asphalt Surface (40 mm)	690	t	$10.00	$6,900.00	$1,749
	Full Depth Asphalt Base Repairs (10%)	750	m^2	$125.00	$93,750.00	$23,758
	Resurface with New Surface Asphalt (40 mm)	720	t	$110.00	$79,200.00	$20,071
	Tack Coat - 1 Layers	7,500	m^2	$1.00	$7,500.00	$1,901
40	Rout and Seal Cracks	500	m	$7.50	$3,750.00	$781
43	Spot Repairs - Mill 40 mm/ Patch 40 mm (8%)	600	m^2	$90.00	$54,000.00	$9,999
48	Mill Asphalt Surface (40 mm)	690	t	$10.00	$6,900.00	$1,050
	Resurface with New Surface Asphalt (40 mm)	720	t	$110.00	$79,200.00	$12,054
	Tack Coat - 1 Layers	7,500	m^2	$1.00	$7,500.00	$1,141
50	Salvage Value	10	year(s)	-$7,800.00	-$78,000.00	-$10,976
				Total Maintenance and Rehabilitation Cost		**$150,530**

THURBER

EQUIVALENT PAVEMENT DESIGNS - PROVINCE OF MANITOBA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 2-Lane Roadway

Roadway: **Minor Collector**
Pavement Type: **Rigid Pavement**
AADTT: **250**
Subgrade (MPa): **25 MPa**
Lane Width (m): **3.75**
Width of Road (m): **7.5**

Pavement Design

180	mm	Portland Cement Concrete (Undowelled)
200	mm	Crushed Granular Base

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface PCC	Portland Cement Concrete (Undowelled)	180	mm	m^2	7,500	$75	$562,500
Crushed Base	Crushed Granular Base	200	mm	m^3	1,500	$45	$67,500
Excavation	Earth Excavation	380	mm	m^3	2,850	$20	$57,000
						Total Initial Pavement Construction Cost	**$687,000**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
12	Reseal Transverse/Longitudinal Joints (10%)	308	m	$4.00	$1,233.33	$770
	Partial Depth Joint Repairs (2%)	19	m^2	$150.00	$2,775.00	$1,733
	Full Depth Joint Repairs (5%)	188	m^2	$125.00	$23,437.50	$14,639
25	Partial Depth Joint Repairs (2%)	19	m^2	$150.00	$2,775.00	$1,041
	Full Depth Joint Repairs (10%)	375	m^2	$125.00	$46,875.00	$17,584
	Reseal Transverse/Longitudinal Joints (20%)	617	m	$4.00	$2,466.67	$925
40	Partial Depth Joint Repairs (5%)	46	m^2	$150.00	$6,937.50	$1,445
	Full Depth Joint Repairs (10%)	375	m^2	$125.00	$46,875.00	$9,764
	Reseal Transverse/Longitudinal Joints (20%)	617	m	$4.00	$2,466.67	$514
50	Salvage Value	2	year(s)	-$4,689.93	-$9,379.86	-$1,320
				Total Maintenance and Rehabilitation Cost		**$47,095**

THURBER

EQUIVALENT PAVEMENT DESIGNS - PROVINCE OF MANITOBA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 2-Lane Roadway

Roadway: **Minor Collector**
Pavement Type: **Flexible Pavement**
AADTT: **250**
Subgrade (MPa): **25 MPa**
Lane Width (m): **3.75**
Width of Road (m): **7.5**

Pavement Design

40	mm	Surface Asphalt
60	mm	Base Asphalt
150	mm	Crushed Granular Base
300	mm	Granular Subbase

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface HMA	Surface Asphalt	40	mm	t	720	$110	$79,200
Base HMA	Base Asphalt	60	mm	t	1,069	$105	$112,219
Tack Coat/ Prime AC	2 Applications			m^2	15,000	$1.00	$15,000
Crushed Base	Crushed Granular Base	150	mm	m^3	1,125	$45	$50,625
Crushed Subbase	Granular Subbase	300	mm	m^3	2,250	$40	$90,000
Excavation	Earth Excavation	550	mm	m^3	4,125	$20	$82,500
					Total Initial Pavement Construction Cost		**$429,544**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
10	Rout and Seal Cracks	250	m	$7.50	$1,875.00	$1,267
	Spot Repairs - Mill 40 mm/ Patch 40 mm (5%)	375	m^2	$90.00	$33,750.00	$22,800
20	Mill Asphalt Surface (40 mm)	690	t	$10.00	$6,900.00	$3,149
	Resurface with New Surface Asphalt (40 mm)	720	t	$110.00	$79,200.00	$36,146
	Tack Coat - 1 Layers	7,500	m^2	$1.00	$7,500.00	$3,423
25	Rout and Seal Cracks	500	m	$7.50	$3,750.00	$1,407
30	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	750	m^2	$90.00	$67,500.00	$20,812
35	Mill Asphalt Surface (40 mm)	690	t	$10.00	$6,900.00	$1,749
	Full Depth Asphalt Base Repairs (10%)	750	m^2	$125.00	$93,750.00	$23,758
	Resurface with New Surface Asphalt (40 mm)	720	t	$110.00	$79,200.00	$20,071
	Tack Coat - 1 Layers	7,500	m^2	$1.00	$7,500.00	$1,901
40	Rout and Seal Cracks	500	m	$7.50	$3,750.00	$781
43	Spot Repairs - Mill 40 mm/ Patch 40 mm (8%)	600	m^2	$90.00	$54,000.00	$9,999
48	Mill Asphalt Surface (40 mm)	690	t	$10.00	$6,900.00	$1,050
	Resurface with New Surface Asphalt (40 mm)	720	t	$110.00	$79,200.00	$12,054
	Tack Coat - 1 Layers	7,500	m^2	$1.00	$7,500.00	$1,141
50	Salvage Value	10	year(s)	-$7,800.00	-$78,000.00	-$10,976
				Total Maintenance and Rehabilitation Cost		**$150,530**

THURBER

EQUIVALENT PAVEMENT DESIGNS - PROVINCE OF MANITOBA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 2-Lane Roadway

Roadway: **Minor Collector**
Pavement Type: **Rigid Pavement**
AADTT: **250**
Subgrade (MPa): **45 MPa**
Lane Width (m): **3.75**
Width of Road (m): **7.5**

Pavement Design

170	mm	Portland Cement Concrete (Undowelled)
200	mm	Crushed Granular Base

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface PCC	Portland Cement Concrete (Undowelled)	170	mm	m^2	7,500	$72	$540,000
Crushed Base	Crushed Granular Base	200	mm	m^3	1,500	$45	$67,500
Excavation	Earth Excavation	370	mm	m^3	2,775	$20	$55,500
						Total Initial Pavement Construction Cost	**$663,000**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
12	Reseal Transverse/Longitudinal Joints (10%)	308	m	$4.00	$1,233.33	$770
	Partial Depth Joint Repairs (2%)	19	m^2	$150.00	$2,775.00	$1,733
	Full Depth Joint Repairs (5%)	188	m^2	$125.00	$23,437.50	$14,639
25	Partial Depth Joint Repairs (2%)	19	m^2	$150.00	$2,775.00	$1,041
	Full Depth Joint Repairs (10%)	375	m^2	$125.00	$46,875.00	$17,584
	Reseal Transverse/Longitudinal Joints (20%)	617	m	$4.00	$2,466.67	$925
40	Partial Depth Joint Repairs (5%)	46	m^2	$150.00	$6,937.50	$1,445
	Full Depth Joint Repairs (10%)	375	m^2	$125.00	$46,875.00	$9,764
	Reseal Transverse/Longitudinal Joints (20%)	617	m	$4.00	$2,466.67	$514
50	Salvage Value	2	year(s)	-$4,689.93	-$9,379.86	-$1,320
				Total Maintenance and Rehabilitation Cost		**$47,095**

THURBER

EQUIVALENT PAVEMENT DESIGNS - PROVINCE OF MANITOBA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 2-Lane Roadway

Roadway: **Minor Collector**
Pavement Type: **Flexible Pavement**
AADTT: **250**
Subgrade (MPa): **45 MPa**
Lane Width (m): **3.75**
Width of Road (m): **7.5**

Pavement Design

40	mm	Surface Asphalt
60	mm	Base Asphalt
150	mm	Crushed Granular Base
200	mm	Granular Subbase

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface HMA	Surface Asphalt	40	mm	t	720	$110	$79,200
Base HMA	Base Asphalt	60	mm	t	1,069	$105	$112,219
Tack Coat/ Prime AC	2 Applications			m^2	15,000	$1.00	$15,000
Crushed Base	Crushed Granular Base	150	mm	m^3	1,125	$45	$50,625
Crushed Subbase	Granular Subbase	200	mm	m^3	1,500	$40	$60,000
Excavation	Earth Excavation	450	mm	m^3	3,375	$20	$67,500
					Total Initial Pavement Construction Cost		**$384,544**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
10	Rout and Seal Cracks	250	m	$7.50	$1,875.00	$1,267
	Spot Repairs - Mill 40 mm/ Patch 40 mm (5%)	375	m^2	$90.00	$33,750.00	$22,800
20	Mill Asphalt Surface (40 mm)	690	t	$10.00	$6,900.00	$3,149
	Resurface with New Surface Asphalt (40 mm)	720	t	$110.00	$79,200.00	$36,146
	Tack Coat - 1 Layers	7,500	m^2	$1.00	$7,500.00	$3,423
25	Rout and Seal Cracks	500	m	$7.50	$3,750.00	$1,407
30	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	750	m^2	$90.00	$67,500.00	$20,812
35	Mill Asphalt Surface (40 mm)	690	t	$10.00	$6,900.00	$1,749
	Full Depth Asphalt Base Repairs (10%)	750	m^2	$125.00	$93,750.00	$23,758
	Resurface with New Surface Asphalt (40 mm)	720	t	$110.00	$79,200.00	$20,071
	Tack Coat - 1 Layers	7,500	m^2	$1.00	$7,500.00	$1,901
40	Rout and Seal Cracks	500	m	$7.50	$3,750.00	$781
43	Spot Repairs - Mill 40 mm/ Patch 40 mm (8%)	600	m^2	$90.00	$54,000.00	$9,999
48	Mill Asphalt Surface (40 mm)	690	t	$10.00	$6,900.00	$1,050
	Resurface with New Surface Asphalt (40 mm)	720	t	$110.00	$79,200.00	$12,054
	Tack Coat - 1 Layers	7,500	m^2	$1.00	$7,500.00	$1,141
50	Salvage Value	10	year(s)	-$7,800.00	-$78,000.00	-$10,976
				Total Maintenance and Rehabilitation Cost		**$150,530**