MnDOT Pavement Design Manual

Chapter 7 – Pavement-Type Selection

10/31/2014

MnDOT Pavement Engineer **Date**

Contents

Introduction

Scope

This chapter contains the process to determine the pavement-type of MnDOT projects.

Background

MnDOT has had separate procedures to determine the pavement-type of new pavement projects (last documented in Technical Memorandum 10-04-MAT-01), rehabilitation projects (last documented in Technical Memorandum 09-12-MAT-03) and to determine the pavement-type through alternate bidding. This chapter replaces those procedures.

In addition, this chapter implements Minnesota State Statute 174.185. This legislation requires a life-cycle cost analysis (LCCA) to be performed for all pavement projects in the reconditioning (RD), resurfacing (RS), and road repair (RX) funding categories. The LCCA is required to compare competing paving materials using equal design lives and equal comparison periods. If the chosen alternate does not have the lowest life-cycle-cost, then the justification is required to be documented.

Overview

Pavement-type selection determines a project's pavement-type by using a LCCA or alternate bidding.

LCCA is used to calculate the low-cost alternate, among alternates with equal benefits, by comparing each alternate's combined initial and future costs. The value of future costs and benefits is converted into a present cost using a process called discounting. Discounting represents the time value of money given its ability to earn interest (i.e. a dollar today is worth more than a dollar tomorrow); this means the later a future cost occurs, the lower the value of its present cost. Initial cost is an estimate of an alternate's construction costs. The initial cost shouldn't include all construction costs, but it does need to include all costs that differ between the alternates.

Pavement-type selection requires following one of two LCCA processes, either Formal LCCA or District LCCA. The Formal LCCA process is performed to determine the low-cost alternate and to evaluate if the project is a good candidate for alternate bidding. Good candidates for alternate bidding are projects with competitive alternates that are both likely to attract bidders, which are typically projects that involve pavements with long design lives (20 years or greater). The District LCCA process is used only to determine the low-cost alternate.

Since the Formal LCCA is used to evaluate projects for alternate bidding costs must be calculated in the same manner as alternate bidding, by accounting for the length of the project, variations in pavement design and width, and variations in shoulder design and width that occur over the project's length. This involves calculating costs for multiple segments of pavement and summing the costs together to determine a total cost for each alternate.

The District LCCA process is used only to determine the low-cost alternate. The District LCCA process is simpler and not every variation in pavement design and pavement width is included in the LCCA.

Both LCCA processes use standard schedules of future activities to calculate future costs. The standard schedules specify when and what future activities will occur and the quantities needed to develop their cost. A 50-year schedule of future activities is provided for most pavement-types and design lives, which is a sufficient period to ensure that a major rehabilitation activity will occur in the schedule. Some pavement-types with short design lives (less than 20 years) only have 35-year schedules provided. These pavement-types will require multiple rehabilitations, and perhaps reconstruction, in a 50-year period and these activities are too uncertain to predict with accuracy. So that all schedules may be compared, a 35-year schedule is provided for all pavement-types and design lives.

The standard schedules of future costs were developed by the MnDOT Pavement Design Engineer and are based on preventive and rehabilitation activities as they are currently performed. Data for developing the standard schedules came from pavement management system (PMS) data and quantities from MnDOT projects. In addition, judgment and accepted MnDOT standards were used to supplement the available data when it was not sufficient. Draft schedules were distributed for review and comment to the District Materials/Soils Engineers as well as representatives of the HMA and PCC pavement industries.

User, supplemental, and other noneconomic costs are not formally evaluated by the LCCA processes or alternate bidding; however, these costs may be used to help determine applicable alternates for the LCCA processes and may be used as justification (on a case-by-case basis) for an exception to the LCCA processes or for the use of alternate bidding.

At the completion of the LCCA processes either, the low-cost alternate is selected; a different alternate is selected if an exception is granted, or the project continues to alternate bidding.

Projects in the Formal LCCA process may have their pavement-types selected using the alternate bidding process. Plans for alternate bidding projects contain two pavement-type alternates and contractors choose the alternate on which they will bid. The low-cost bidder is determined after considering the initial construction cost (the contractor's bid) and the bid adjustment factor, which is the difference in the discounted future costs between the alternates and is added to the alternate with the greater discounted future costs.

700 - Steps to Perform Pavement-Type Selection

The pavement-type selection process begins with pavement designs that were proposed during the project planning or the project scoping processes. The proposed designs and the directions given in this chapter are used to select the pavement-type.

Begin the pavement-type selection with the following steps.

STEP 1. Identify the "unique pavement designs" that were proposed in the project selection or project scoping processes.

One or more pavement design may have been proposed over the length of the project. Each of these pavement designs (not necessarily contiguous) that are consistent in pavement structure, thickness, width, material, and design life is defined as a "unique pavement design."

For example, project scoping may only propose one pavement design, such as a 4.0-inch overlay for the length of the project, and therefore the project would have only one "unique pavement design." Project scoping of another project may propose a 4.0-inch overlay for the majority of the project but also proposes reconstruction at multiple locations. The overlay would be one "unique pavement design", and the reconstruction design would be a second "unique pavement design" (if the reconstruction design is the same for all locations).

STEP 2. Categorize each "unique pavement design" using **Section 710 - Pavement Design Categories**.

STEP 3. Determine which LCCA process to follow using **Section 720 - Determination of Which LCCA Process to Follow**.

STEP 4. Follow either the Formal LCCA process, **Section 730 - Formal LCCA Process**, or the District LCCA process, **Section 740 - District LCCA Process**, as determined by **Section 720 - Determination of Which LCCA Process to Follow**.

STEP 5. Continue to the alternate bidding process, **Section 750 - Alternate Bidding**, if it was determined to do so by the Formal LCCA process.

STEP 6. 12-18 months prior to the project letting, review any previously prepared LCCA for the project, and update the LCCA if changes to costs or to the project may change the outcome.

710 - Pavement Design Categories

Use the following descriptions, or **Flowchart 710.1**, to categorize each "unique pavement design" that was proposed by the project planning or project scoping processes. Reference **Chapters 4 HMA & 5 – PCC** to determine design lives. After categorizing all of the project's "unique pavement designs", continue to **Section 720 - Determination of Which LCCA Process to Follow**.

1. **DL ≥ 20** (Design Life of 20 years or greater)

   This category includes pavement with a design life of 20 or more years.

   Examples include:

   - New/reconstructed HMA
   - New/reconstructed PCC
   - Full-depth reclamation (FDR)
   - Stabilized full-depth reclamation (SFDR)
   - Rubblization of PCC
   - Cold-in-place recycling (CIR)
   - PCC overlays (whitetopping or unbonded overlay)
   - Other

   This category does not include HMA overlays 5.0 inches thick or less. For the purpose of choosing a LCCA process all HMA overlays 5.0 inches or less but greater than 2.0 inches in thickness are included in the **DL<20** category.

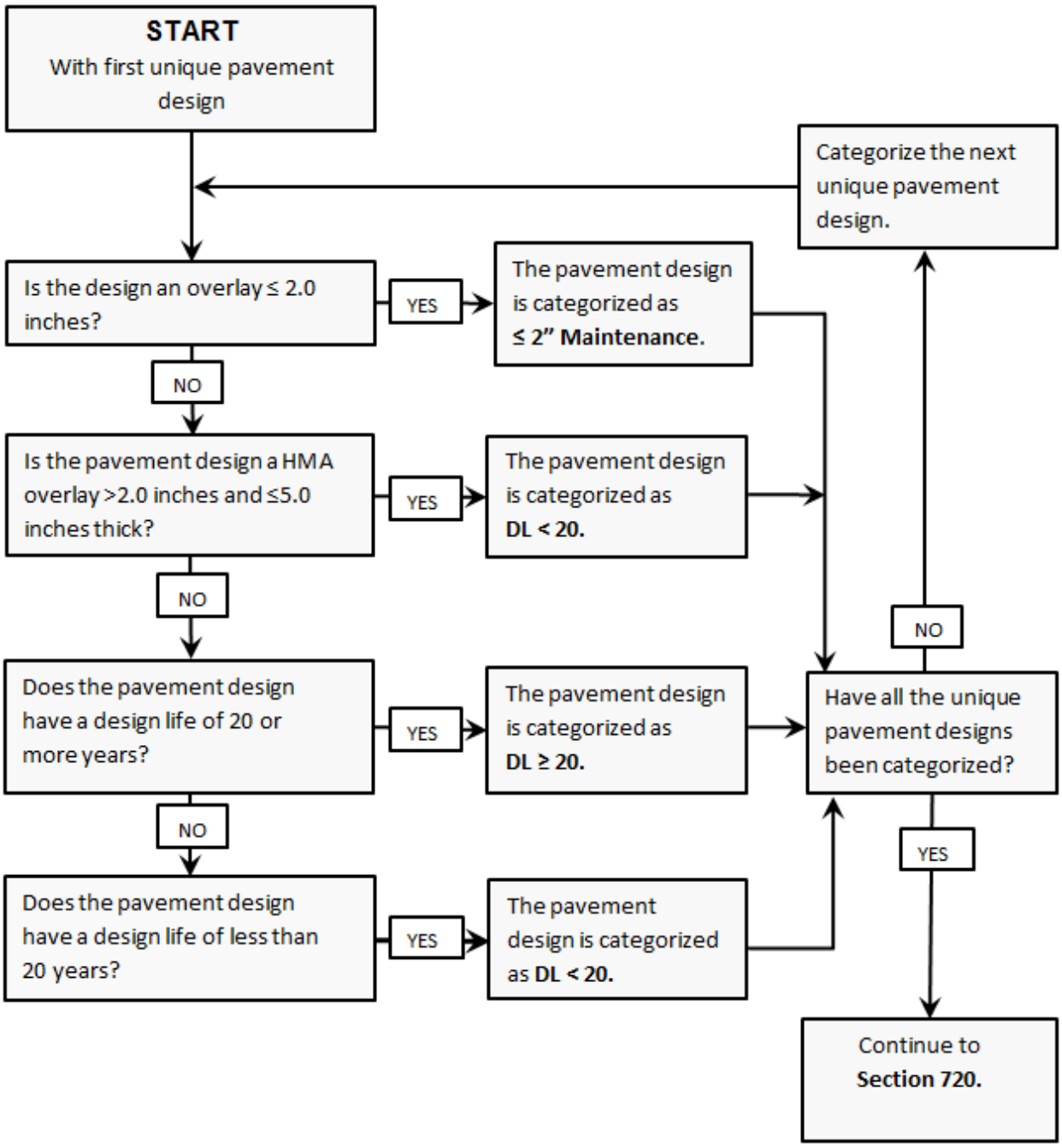
2. **DL < 20** (Design Life less than 20 years)

   This category includes pavement designs that have a design life less than 20 years and are thicker than 2.0 inches. For the purpose of choosing a LCCA process, all HMA overlays 5.0 inches or less but greater than 2.0 inches in thickness are included in this category regardless of design life.

3. **≤ 2" Maintenance**

   This category includes new pavements ≤ 2.0 inches thick. These projects are considered to be maintenance activities with no opportunity to develop an alternate pavement type.

Flowchart 710. 1 – Categorizing “unique pavement designs”



720 - Determination of Which LCCA Process to Follow

Use the following tables, or **Flowchart 720.1**, and the pavement design categories determined in **Section 710 - Pavement Design Categories** to determine which LCCA process to follow.

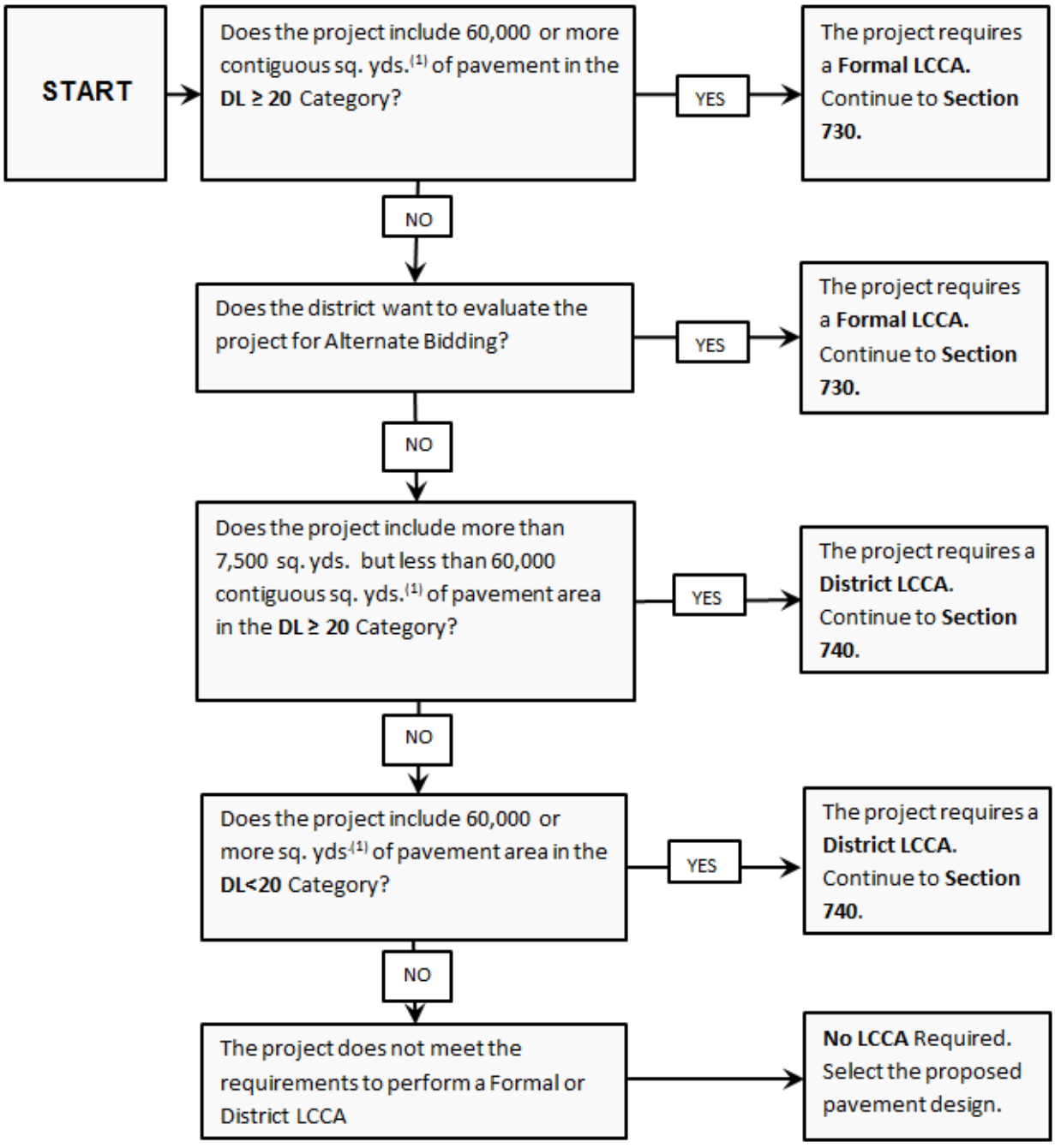
Table 720.1 – Follow Formal LCCA	
OR	Projects that have 60,000 or more contiguous sq. yds.(1) of pavement in the **DL≥ 20** Category.
	Any project that the district wants to evaluate as a potential alternate bidding candidate.

Table 720.2 – Follow District LCCA	
OR	Projects that have more than 7,500 sq. yds. but less than 60,000 contiguous sq. yds.(1) of pavement in the **DL≥ 20** Category.
	Projects that have 60,000 or more sq. yds.(1) of pavement in the **DL<20** Category.
AND	Does not meet the requirements to follow the Formal LCCA process.

Table 720.3 - No LCCA Required
Any projects that does not meet the requirements to follow the Formal LCCA process or District LCCA process. The designer should select the proposed pavement design.

(1) The pavement area is calculated using only the 12-foot wide travel lane of the mainline pavement and doesn't include shoulders, ramps, parking lanes, turn lanes, or auxiliary lanes.

Flowchart 720.1 – Determining which LCCA process to follow



(1) The pavement area is calculated using only the 12-foot wide travel lane of the mainline pavement and doesn't include shoulders, ramps, parking lanes, turn lanes, or auxiliary lanes.

730 - Formal LCCA Process

Follow this section if **Section 720 - Determination of Which LCCA Process to Follow** determined that a Formal LCCA is required.

STEP 1. For each "unique pavement design" that meets either of the following criteria (A or B below), develop pavement designs for the required alternates. **Chapter 9 - Construction and Rehabilitation Alternates** may be consulted to determine appropriate alternates that meet the requirements of the tables.

Criteria A. For each "unique pavement design" in the **DL≥ 20** Category, develop pavement designs for the required alternates in **Table 730.1**.

Table 730.1 - Required Alternates for *DL≥20* Category

Alternate Number	1	2	3
Pavement Material	HMA	PCC	PCC
Design Life	20 Years	20 Years	35 Years

Criteria B. For each "unique pavement design" in the **DL< 20** Category that is greater than 7,500 sq.yds(1), develop pavement designs for the required alternates in **Table 730.2**

Table 730.2 - Required Alternates for *DL<20* Category			
Alternate Number	1	2	3
Pavement Material	As Proposed in Scoping or Project Development(2)	HMA	PCC
Design Life	For the Pavement Design Proposed in Scoping or Project Development(2)	20 Years	20 Years

(1) The pavement area is calculated using only the 12-foot wide travel lane of the mainline pavement and doesn't include shoulders, ramps, parking lanes, turn lanes, or auxiliary lanes.

(2) The design life and pavement material of the pavement design proposed in scoping or project development process. **Chapters 4 HMA** and **5 - PCC** may be consulted to determine design life.

STEP 2. Calculate the net present cost of each alternate.

Use the most current version of the "MnLCCA" spreadsheet that contains the correct "District Standard Prices" for the district. This spreadsheet follows the LCCA standards in **Section 760 – LCCA Formulas and Standards** and **Section 770 – LCCA Maintenance Activities**. A copy of the spreadsheet (for each district) is available on the MnDOT Pavement Design website at http://www.dot.state.mn.us/materials/pvmtdesign/index.html

A. Perform a LCCA for alternates developed from **Table 730.1** and a separate LCCA for alternates developed from **Table 730.2**.

B. LCCA analysis period.

For each LCCA:

- Use a 50-year analysis period for alternates developed from **Table 730.1**.
- Use a 35-year analysis period for alternates developed from **Table 730.2**.

C. To account for multiple "unique pavement designs", the spreadsheet divides the project into segments, one segment for each "unique pavement design." For each segment, develop an initial cost of a representative one-mile segment of each alternate and enter it into the spreadsheet.
The initial cost includes the cost of constructing the pavement section between the shoulder points of intersection (PI). This includes the cost of the mainline and shoulder pavements, base, subbase, and engineered soil. Additional costs may also be included that reflect the difference in construction of the alternates, such as; different grade raises between alternates, traffic detour or no detour, constructing under traffic, or A+B contracting.

For the calculation of initial costs, use the item costs contained in the current "District Standard Prices" that are updated annually for each district. If a necessary item cost is not provided contact the MnDOT Pavement Design Engineer.

D. The spreadsheet automates the calculation of future costs using the user's inputs, **Sections Section 760 – LCCA Formulas and Standards** and **Section 770 – LCCA Maintenance Activities**, and the "District Standard Prices." For each segment, the user completes an input form with data related to that alternate's pavement design, pavement section geometry, and segment length. When the data in the input form is accepted, the Net Present Cost of that segment of the alternate are automatically calculated.

E. The "MnLCCA" spreadsheet will calculate the net present cost of each alternate by summing the individual net present costs of each segment of the alternate.

STEP 5. Either select an alternate or continue to alternate bidding.

The "MnLCCA" spreadsheet(s) will calculate the net present cost of each alternate and the percentage that it is greater than the low-cost alternate. The alternate with the least net present cost is the low-cost option.

- If a HMA alternate and a PCC alternate have net present costs within 10% (of the lower value) then the lowest cost PCC and HMA alternates will continue to be developed for alternate bidding using **Section 750 - Alternate Bidding**.*****
- Otherwise, select the low-cost option. Document the LCCA results and the selected low-cost option in an alternate bidding exception form which is considered accepted when it is signed by the MnDOT Pavement Engineer.*****

*** Exception:** The district may request an exception for the pavement-type selected or for the requirement to use alternate bidding. Reasons for an exception may include;

- A selected alternate isn't physically constructible
- Construction would cause unreasonable user delay or user hardship (e.g. construction would require unacceptable closures, long detours, or an extended construction period)
- Performance would be unacceptable
- Other supplemental costs or noneconomic factors (see **Table 960.1**)

An alternate bidding exception form must be completed and attached to the Pavement Design Memo (PDM) before it is submitted to the MnDOT Pavement Design Engineer. The alternate bidding exception form is accepted when it is signed by the MnDOT Pavement Engineer. A template for the alternate bidding exception form is located on the MnDOT Pavement Design website at http://www.dot.state.mn.us/materials/pvmtdesign/index.html.

STEP 6. Documentation, distribution and review

Complete the PDM (see **Chapter 8 - Documentation**) which details the pavement alternates and how they were developed. It also identifies which pavement was selected or identifies the alternates that will be used for alternate bidding. Attach the LCCA and any exception form. Submit the PDM to the MnDOT Pavement Design Engineer.

The MnDOT Pavement Design Engineer will review the PDM and attachments and may request that the district make changes. After any changes are made, the MnDOT Pavement Design Engineer will distribute the PDM to representatives of the Concrete Paving Association of Minnesota (CPAM) and Minnesota Asphalt Pavement Association (MAPA) for a comment period of two weeks. After the comment period, the MnDOT Pavement Design Engineer will address any comments and sign the PDM.

740 - District LCCA Process

Follow this section if **Section 720 - Determination of Which LCCA Process to Follow** indicated that a District LCCA is required.

STEP 1. For each "unique pavement design" that meets either of the following criteria (A or B below), develop the required alternate pavement designs. **Chapter 9** - **Construction and Rehabilitation Alternates** may be consulted to determine appropriate alternates that meet the requirements of the tables.

Criteria A. For each "unique pavement design" in the **DL<20** Category, that has a pavement area of 60,000 or more sq. yds (1), develop pavement designs for the alternates required in **Table 740.1**. Consult **Chapter 9 - Construction and Rehabilitation Alternates** for appropriate pavement alternates that may provide the requirements of **Table 740.1**.

If the project contains a total pavement area greater than 60,000 sq. yds (1) in the **DL<20** Category, but no individual "unique pavement design" has an area greater than 60,000 sq. yds (1), develop pavement designs for alternates of the longest design in the **DL<20** Category.

Table 740.1 - Required Alternates for *DL<20* Category

Alternate Number	1	2	3
Pavement Material	As Proposed in Scoping or Project Development(2)	HMA	PCC
Design Life	For the Pavement Design Proposed in Scoping or Project Development(2)	20 Years	20 Years

(1) The pavement area is calculated using only the 12-foot wide travel lane of the mainline pavement and doesn't include shoulders, ramps, parking lanes, turn lanes, or auxiliary lanes.

(2) The design life and pavement material of the pavement design proposed in scoping or project development process. **Chapters 4 –HMA** and **5 - PCC** may be consulted to determine design life.

Criteria B. For each "unique pavement design", **DL≥ 20** Category, that is greater than 7,500 sq. yds. but has a pavement area less than 60,000 sq. yds. (1), develop pavement designs for the alternates in **Table 740.2**. Consult **Chapter 9- Construction and Rehabilitation Alternates** for appropriate pavement alternates that may provide the requirements of **Table 740.2**.

Table 740.2 – Required Alternates for DL≥ 20 Category

Alternate Number	1	2	3
Pavement Material	HMA	PCC	PCC
Design Life	20 Years	20 Years	35 Years

(1) The pavement area is calculated using only the 12-foot wide travel lane of the mainline pavement and doesn't include shoulders, ramps, parking lanes, turn lanes, or auxiliary lanes.

STEP 2. Calculate the net present cost of each alternate.

A. Use the most current version of the "MnLCCA" spreadsheet that contains the correct "District Standard Prices" for the district. This spreadsheet follows the LCCA standards in **Section 760 – LCCA Formulas and Standards** and **Section 770 LCCA Maintenance Activities**. A copy of the spreadsheet (for each district) is available on the MnDOT Pavement Design website at http://www.dot.state.mn.us/materials/pvmtdesign/index.html

B. Perform a LCCA for alternates developed from **Table 740.1** and a separate LCCA for alternates developed from **Table 740.2**.

C. LCCA analysis period

For each LCCA:

- Use a 35-year analysis period for alternates developed from **Table 740.1**.
- Use a 50-year analysis period for alternates developed from **Table 740.2**.

D. To account for multiple "unique pavement designs", the spreadsheet divides the project into segments, one segment for each "unique pavement design." In the previous step, alternate pavement designs were developed as required by **Table 740.1** and **Table 740.2**. For each of these alternate pavement designs, develop an initial cost of a representative one-mile segment and enter it into the spreadsheet.

The initial cost includes the cost of constructing the pavement section between the shoulder points of intersection (PI). This includes the cost of the mainline and shoulder pavements, base, subbase, and engineered soil. Additional costs may also be included that reflect the difference in construction of the alternates, such as; different grade raises between alternates, traffic detour or no detour, constructing under traffic, or A+B contracting.

For the calculation of initial costs, use the item costs contained in the current "District Standard Prices" that are updated annually for each district. If a necessary item cost is not provided, then use the average bid price from the year listed on the "District Standard Prices" or other method approved by the MnDOT Pavement Engineer.

E. The "MnLCCA" spreadsheet automates the calculation of future costs using the user's inputs, **Sections 760 – LCCA Formulas and Standards** and **770 – LCCA Maintenance Activities**, and the "District Standard Prices." For each segment of an alternate, the user completes an input form with data related to the pavement design, pavement section geometry, and segment length. When the data in the input form is accepted, the Net Present Cost of that segment, of that alternate, is automatically calculated.

F. The "MnLCCA" spreadsheet will calculate the Net Present Cost of each alternate by summing the individual Net Present Costs of each segment, of each alternate.

STEP 3. Select the low-cost option.

The "MnLCCA" spreadsheet(s) will calculate the Net Present Cost of each alternate and the percentage that it is greater than the low-cost alternate. The alternate with the least Net Present Cost is the low-cost option. Select the low-cost option.*****

*** Exception:** The district may document an exception for the pavement type selected. Reasons for an exception may include;

- A selected alternate isn't physically constructible,
- Construction would cause unreasonable user delay or user hardship (e.g. construction would require unacceptable closures, long detours, or an extended construction period)
- Performance would be unacceptable
- Other supplemental costs or noneconomic factors (see **Table 960.1**)

An exception form must be completed and attached to the Materials Design Recommendation (MDR) before it is submitted to the MnDOT Pavement Design Engineer. The exception is granted when it is signed by the District Engineer.

STEP 4. Documentation

Attach the LCCA and any signed exceptions to the Materials Design Recommendation (see **Chapter 8 - Documentation**).

750 - Alternate Bidding

Follow this section if **Section 730 - Formal LCCA Process** indicated that the project should proceed to alternate bidding.

STEP 1. Design the project plans with the HMA and PCC alternates that were developed in the Formal LCCA process. Attempt to have the same pavement widths and profile grade between the alternates.

STEP 2. The MnDOT Pavement Design Engineer develops the project bid adjustment factor(s) as follows:

A. For the alternate designs presented in the final plans, perform an LCCA of all costs other than initial costs using the approach described in **Section 730 - Formal LCCA Process**.

B. The bid adjustment factor for an alternate is calculated as the difference between its net present cost and the net present cost of the alternate with the lowest net present cost. The alternate with the lowest net present cost always has a bid adjustment factor of $0.00 which doesn't need to be reported.

C. Calculate the bid adjustment factor on the alternates as presented in the final plans.

D. Develop the bid adjustment factor within 6 months of the project bid.

STEP 3. Letting and awarding for alternate bidding

The project will be advertised for bids with the bid adjustment factor(s) and plans that include the pavement alternates. Bidders may bid on either pavement alternate. The low-cost bidder will be determined after adding the appropriate bid adjustment factor to each bid.

760 - LCCA Formulas and Standards

LCCA compares pavement alternates by calculating the net present cost for each alternate. The net present cost is the initial cost plus the discounted cost of future activities minus the cost of any discounted remaining service life (RSL) value.

1. Discount rate (r)

   The discount rate is equal to the average of the 5 most recent years' real interest rate of a 30-year treasury bonds as published each year by the federal Office of Management & Budget (OMB). Each year's discount rate will be determined by the MnDOT Office of Investment & Management and distributed by July 1st.

2. Remaining service life (RSL) value

   The Remaining service life value is the residual value of an improvement when its service life extends beyond the end of the analysis period. The RSL value is calculated as the cost of the last rehabilitation or reconstruction activity multiplied by the ratio of the number of years of the activity's service life that are remaining at the end of the analysis period over the service life of the activity. The RSL value is included in the LCCA as negative cost. A remaining service life value will not be calculated for maintenance activities (e.g. surface or crack treatments, shoulder joint sealing, and shoulder fog sealing).

3. District standard prices

   This is a list of each district's item costs which are used to estimate initial and future costs. It will be updated annually by the MnDOT Pavement Design Engineer by July 1st of each year. The values will be based on each district's bid prices from the March 1st of the previous year to April 30th of the current year. The proposed price list will be made available for review by the district, CPAM, and MAPA prior to being accepted.

5. Formulas

A. Remaining service life (RSL)

$$RSL = C_{Last\ Activity} \times \frac{N_{RL}}{N_{SL}}$$

RSL	=	Remaining service life value
$C_{Last\ Activity}$	=	Cost of the last rehabilitation or reconstruction activity. This activity may include reconstruction or a rehabilitation activity such as a CPR or an overlay. This would not include maintenance activities such as surface treatments or crack treatments, shoulder joint sealing, or shoulder fog sealing.
N_{SL}	=	Service life of the last activity in years.
N_{RL}	=	Unused service life, in years, of the last activity at the end of the Analysis Period.

B. Present cost of each activity

$$PC_{Activity} = C_{Activity} \times \left[\frac{1}{(1+r)}\right]^{N_{Acivity}}$$

$PC_{Activity}$	=	Present cost of an activity (or RSL)
$C_{Activity}$	=	Cost of an activity (or RSL)
$N_{Activity}$	=	Number of years after construction that an activity is scheduled to take place
r	=	Discount rate, decimal form (**Section 760.1**)

C. Net present cost of an alternate (for one segment)

$$\sum[NPC_{ALT}]_{SEGMENT} = C_{Initial} + \sum PC_{Activity}$$

NPC_{ALT}	=	Net present cost of an alternate (for one segment)
$PC_{Activity}$	=	Present cost of activities (or RSL)
$C_{Initial}$	=	Initial cost of construction

Note: Do not include an initial cost ($C_{Initial}$) when calculating the bid adjustment factor for alternate bidding.

5) Net present cost of an alternate (for an entire project with multiple segments)

$$[NPC_{ALT}]_{PROJECT} = \sum[NPC_{ALT}]_{SEGMENT}$$

$[NPC_{ALT}]_{PROJECT}$	=	Net present cost of an alternate for the entire project when the project has multiple segments.
$[NPC_{ALT}]_{SEGMENT}$	=	Net present cost of an alternate for an individual segment.

D. Bid adjustment factor for an alternate

$$BAF_{ALTERNATE} = [NPC_{ALT}]_{PROJECT} - lowest\ [NPC_{ALT}]_{PROJECT}$$

$BAF_{ALTERNATE}$	=	Bid adjustment factor for an alternate.
$[NPC_{ALT}]_{PROJECT}$	=	The net present cost of the alternate (for all segments)
$Least\ [NPC_{ALT}]_{PROJECT}$	=	The net present cost of the alternate with the lowest net present cost

770 - LCCA Maintenance Activities

This section contains the schedules and quantities that are used by the "MnLCCA" spreadsheet for performing LCCA's and determining bid adjustment factors for use in alternate bidding.

1. The following Maintenance and Rehabilitation Schedules are presented in this section

- **Table 770.1** - PCC with 12' or 15' joint spacing - design life = 20 years
- **Table 770.2** - PCC with 12' or 15' joint spacing - design life = 35 years
- **Table 770.3** - PCC with 6' X 6' joint spacing - design life = 20 years PCC thickness = 5.5 inches or greater
- **Table 770.4** - PCC with 6' X 6' joint spacing - design life = 20 years PCC thickness = 5.0 inches or less
- **Table 770.5** - PCC with 6' X 6' joint spacing - design life = 35 years
- **Table 770.6** - New HMA pavement over aggregate base, FDR, SFDR, CIR, or rubblized PCC - design life = 20 years
- **Table 770.7** - HMA Overlay - design life (DL) = 13 to 17 years
- **Table 770.8** - HMA Overlay - design life (DL) >17 years

2. Use the following definitions:

- Thin HMA Shoulders – are less than 4.0 inches in thickness
- Thick HMA Shoulders – are 4.0 inches or greater in thickness

PCC

Table 770.1 - PCC with 12’ or 15’ Joint Spacing
Design Life = 20 years

	35 Year Analysis Period	50 Year Analysis Period
Pavement Age	Treatment	Treatment
0	Initial Construction	Initial Construction
20	1st CPR	1st CPR
35	End of Analysis Period (No Remaining Service Life)	Remove & Replace (PCC with 20-year Design Life)
50		End of Analysis Period (5/20 Remaining Service Life)

Pavement Preservation Rehabilitation Quantities

12’ or 15’ Long Panels			
Age	Treatment	Mainline Quantity	Shoulder Treatment
20	Type BA Repair	1% Surface Area	Thin Bit Shoulders: Remove & Replace Thick Bit Shoulders: 1.5” Mill & Overlay
	Type B3 Repair	2% Transverse & Longitudinal Joints	
	Type CD-HV Repair	7% Transverse Joints	
	Type CX Repair	6% Surface Area	
	Surface Grind	68% Surface Area	
35	Remove & Replace (PCC with 20-year Design Life)	100%	100%
50	End of Analysis Period	25% Remaining Service Life [5/20]	

Table 770.2 - PCC with 12’ or 15’ Joint Spacing
Design Life = 35 years

	35 Year Analysis Period	50 Year Analysis Period
Pavement Age	Treatment	Treatment
0	Initial Construction	Initial Construction
20	1st CPR	1st CPR
35	End of Analysis Period (No Remaining Service Life)	2nd CPR
50		End of Analysis Period (No Remaining Service Life)

Pavement Preservation Rehabilitation Quantities

12’ or 15’ Long Panels			
Age	Treatment	Mainline Quantity	Shoulder Treatment
20	Type BA Repair	1% Surface Area	Thin Bit Shoulders: Remove & Replace Thick Bit Shoulders: 1.5” Mill & Overlay
	Type B3 Repair	1% Transverse & Longitudinal Joints	
	Type CD-HV Repair	7% Transverse Joints	
	Type CX Repair	3% Surface Area	
	Surface Grind	23% Surface Area	
35	Type B3 Repair	2% Transverse & Longitudinal Joints	Thin Shoulders: Fog Seal Thick Shoulders: Fog Seal
	Type CD-HV Repair	7% Transverse Joints	
	Type CX Repair	6% Surface Area	
	Surface Grind	68% Surface Area	
50	End of Analysis Period	No Remaining Service Life	

Table 770.3 - PCC with 6' X 6'Joint Spacing
Design Life = 20 years
PCC thickness = 5.5 inches or Greater

	35 Year Analysis Period	50 Year Analysis Period
Pavement Age	Treatment	Treatment
0	Initial Construction	Initial Construction
20	1st CPR	1st CPR
35	End of Analysis Period (No Remaining Service Life)	Remove & Replace (PCC with a 20-year Design Life)
50		End of Analysis Period (5/20 Remaining Service Life)

Pavement Preservation Rehabilitation Quantities

6' x 6'panels			
Age	Treatment	Mainline Quantity	Shoulder Treatment
20	A2 Repair	10% Transverse & Longitudinal Joints	Thin Bit Shoulders: Remove & Replace
	CX Repair	15% Surface Area	
	Surface Grind	50% Surface Area	Thick Bit Shoulders: 1.5" Mill & Overlay
35	Replace with PCC Design Life = 20 years	100 %	100 %
50	End of Analysis Period	25% Remaining Service Life [5/20]	

Table 770.4 - PCC with 6' X 6'Joint Spacing
Design Life = 20 years
PCC thickness = 5.0" or Less

	35 Year Analysis Period	50 Year Analysis Period
Pavement Age	Treatment	Treatment
0	Initial Construction	Initial Construction
20	1st CPR	1st CPR
30	Remove & Replace (PCC with a 35-year Design Life)	Remove & Replace (PCC with a 35-year Design Life)
35	End of Analysis Period (No Remaining Service Life)	
50		End of Analysis Period (5/20 Remaining Service Life)

Pavement Preservation Rehabilitation Quantities

6' x 6'panels			
Age	Treatment	Mainline Quantity	Shoulder Treatment
20	A2 Repair	10% Transverse & Longitudinal Joints	Fog Seal 100 %
	CX Repair	25% Surface Area	
	Surface Grind	100% Surface Area	
30	Replace with PCC Design Life = 35 years	100 %	100 %
50	End of Analysis Period	43% Remaining Service Life [15/35]	

Table 770.5 - PCC with 6' X 6' Joint Spacing
Design Life = 35 years

	35 Year Analysis Period	50 Year Analysis Period
Pavement Age	Treatment	Treatment
0	Initial Construction	Initial Construction
20	1st CPR	1st CPR
35	End of Analysis Period (no remaining service life)	2nd CPR
50		End of Analysis Period (No Remaining Service Life)

Pavement Preservation Rehabilitation Quantities

6' x 6' panels			
Age	Treatment	Mainline Quantity	Shoulder Treatment
20	Type A2 Repair	5% Transverse & Longitudinal Joints	Thin Bit Shoulders: Remove & Replace Thick Bit Shoulders: 1.5" Mill & Overlay
	Type B3 Repair	1% Transverse & Longitudinal Joints	
	Type CX Repair	5% Surface Area	
	Surface Grind	23% Surface Area	
35	Type A2 Repair	10% Transverse & Longitudinal Joints	Thin Shoulders: Fog Seal Thick Shoulders: Fog Seal
	Type B3 Repair	2% Transverse & Longitudinal Joints	
	Type CX Repair	8% Surface Area	
	Surface Grind	68% Surface Area	
50	End of Analysis Period	No Remaining Service Life	

HMA

Table 770.6 - New HMA Pavement over Aggregate Base, FDR, SFDR, CIR, or Rubblized PCC

Design Life = 20 years		
	35 Year Analysis Period	**50 Year Analysis Period**
Pavement Age	Treatment	Treatment
0	Initial Construction	Initial Construction
8	Crack Treatment	Crack Treatment
12	Surface Treatment (1) (2)	Surface Treatment (1) (2)
20	Mill & Overlay (1st Overlay)	Mill & Overlay (1st Overlay)
23	Crack Treatment	Crack Treatment
27	Surface Treatment (2)	Surface Treatment (2)
35	End of Analysis Period (2/17 Remaining Service Life)	
37		Mill & Overlay (2nd Overlay)
40		Crack Treatment
44		Surface Treatment
50		End of Analysis Period (4/17 Remaining Service Life)

(1) Delete when ultra-thin bonded wearing course is used

(2) Eliminate chip seal and fog seal when 20 year BESALs are >7 million

Pavement Preservation Rehabilitation Quantities

Rural Section				
Age	Treatment	Mainline Quantity	Shoulder Treatment	Shoulder Quantity
8	Crack Treatment	16% Mainline Length		
12	Chip Seal (1) (2)	31% Mainline Length	Fog Seal (1) (2)	31% Shoulder Length
	Microsurfacing (1) (2)	9% Mainline Length	Fog Seal (1) (2)	9% Shoulder Length
20	Mill: Top lift + ½" Overlay: Mill thickness +1.5"	100% Mainline Area	1.5" Overlay	100% Shoulder Area
23	Crack Treatment	32% Mainline Length		
27	Chip Seal (1) (2)	31% Mainline Length	Fog Seal (1) (2)	31% Shoulder Length
37	Mill: 2" Overlay: 3.5"	100% Mainline Area	1.5" Overlay	100% Shoulder Area
40	Crack Treatment	32% Mainline Length		
44	Chip Seal (1) (2)	31% Mainline Length	Fog Seal (1) (2)	31% Shoulder Length
50	End of Analysis Period	4/17 Remaining Service Life		

(1) Delete when ultra-thin bonded wearing course is used

(2) Eliminate chip seal and fog seal when 20 year BESALs are >7 million

Urban Section				
Age	Treatment	Mainline Quantity	Shoulder Treatment	Shoulder Quantity
8	Crack Treatment	16% Mainline Length		
12	Chip Seal (1) (2)	31% Mainline Length	Fog Seal (1) (2)	31% Shoulder Length
	Microsurfacing (1) (2)	9% Mainline Length	Fog Seal (1) (2)	9% Shoulder Length
20	Mill & Overlay: 3”	100% Mainline Area	1.5” Mill & Overlay	100% Thick Shoulder Area
			Remove & Replace	100% Thin Shoulder Area
23	Crack Treatment	32% Mainline Length		
27	Chip Seal (1) (2)	31% Mainline Length	Fog Seal (1) (2)	31% Shoulder Length
37	Mill & Overlay: 3.5”	100% Mainline Area	2.0” Mill & Overlay	100% Thick Shoulder Area
			Remove & Replace	100% Thin Shoulder Area
40	Crack Treatment	32% Mainline Length		
44	Chip Seal (1) (2)	31% Mainline Length	Fog Seal (1) (2)	31% Shoulder Length
50	End of Analysis Period	(4/17 Remaining Service Life)		

(1) Delete when ultra-thin bonded wearing course is used

(2) Eliminate chip seal and fog seal when 20 year BESALs are >7 million

Table 770.7 - HMA Overlay
Design Life (DL) = 13 to 17 years

Pavement Age	Treatment
0	Initial Construction (1st Overlay)
3	Crack Treatment
7	Chip Seal*
DL	Mill & Overlay (2nd Overlay)
DL +3	Crack Treatment
DL +7	Chip Seal*
2*DL -1	Mill & Overlay (3rd Overlay)
2*DL +2	Crack Treatment (1)
2*DL +6	Chip Seal* (2)
35	End of Analysis Period (Remaining Life of Last Overlay = [(3*DL-38)/(DL-2)]

* Eliminate chip seal and fog seal when 20 year BESALs are >7 million

(1) Do not use when DL = 17
(2) Do not use when DL = 15, 16, 17

Pavement Preservation Rehabilitation Quantities

Rural Section				
Age	Treatment	Mainline Quantity	Shoulder Treatment	Shoulder Quantity
3	Crack Treatment	32% Mainline Length		
7	Chip Seal *	31% Mainline Length	Fog Seal*	31% Shoulder Length
DL	Mill: 2” Overlay: 3.5”	100% Mainline Area	1.5” Overlay	100% Shoulder Area
DL + 3	Crack Treatment	32% Mainline Length		
DL + 7	Chip Seal *	31% Mainline Length	Fog Seal*	31% Shoulder Length
2*DL-1	Mill: 2” Overlay: 3.5”	100% Mainline Area	1.5” Overlay	100% Shoulder Area
2*DL+2	Crack Treatment (1)	32% Mainline Length		
2*DL+6	Chip Seal * (2)	31% Mainline Length	Fog Seal*	31% Shoulder Length
35	End of Analysis Period	Remaining Service Life = [(3*DL-38)/(DL-2)])		

Urban Section				
Age	Treatment	Mainline Quantity	Shoulder Treatment	Shoulder Quantity
3	Crack Treatment	32% Mainline Length		
7	Chip Seal *	31% Mainline Length	Fog Seal*	31% Shoulder Length
DL	Mill & Overlay: 3.5”	100% Mainline Area	1.5” Mill & Overlay	100% Thick Shoulder Area
			Remove & Replace	100% Thin Shoulder Area
DL + 3	Crack Treatment	32% Mainline Length		
DL + 7	Chip Seal *	31% Mainline Length	Fog Seal*	31% Shoulder Length
2*DL-1	Mill & Overlay: 4”	100% Mainline Area	2” Mill & Overlay	100% Thick Shoulder Area
			Remove & Replace	100% Thin Shoulder Area
2*DL+2	Crack Treatment (1)	32% Mainline Length		
2*DL+6	Chip Seal * (2)	31% Mainline Length	Fog Seal*	31% Shoulder Length
35	End of Analysis Period	No Remaining Service Life		

* Eliminate chip seal and fog seal when 20 year BESALs are >7 million

(1) Do not use when DL = 17
(2) Do not use when DL = 15, 16, 17

Table 770.8 - HMA Overlay
Design Life (DL) >17 years

Pavement Age	Treatment
0	Initial Construction (1st Overlay)
3	Crack Treatment
7	Chip Seal*
DL	Mill & Overlay (2nd Overlay)
DL +3	Crack Treatment
DL +7	Chip Seal*
35	End of Analysis Period (Remaining Life of Last Overlay = [(2*DL-36)/(DL-1)]

Pavement Preservation Rehabilitation Quantities

Rural Section				
Age	Treatment	Mainline Quantity	Shoulder Treatment	Shoulder Quantity
3	Crack Treatment	32% Mainline Length		
7	Chip Seal *	31% Mainline Length	Fog Seal*	31% Shoulder Length
DL	Mill: 2” Overlay: 3.5”	100% Mainline Area	1.5” Overlay	100% Shoulder Area
DL + 3	Crack Treatment	32% Mainline Length		
DL + 7	Chip Seal *	31% Mainline Length	Fog Seal*	31% Shoulder Length
35	End of Analysis Period	Remaining service life = [(2*DL-36)/(DL-1)]		

Urban Section				
Age	Treatment	Mainline Quantity	Shoulder Treatment	Shoulder Quantity
3	Crack Treatment	32% Mainline Length		
7	Chip Seal *	31% Mainline Length	Fog Seal*	31% Shoulder Length
DL	Mill & Overlay: 3.5”	100% Mainline Area	2” Mill & Overlay	100% Thick Shoulder Area
			Remove & Replace	100% Thin Shoulder Area
DL+3	Crack Treatment	32% Mainline Length		
DL+7	Chip Seal *	31% Mainline Length	Fog Seal*	31% Shoulder Length
35	End of Analysis Period	Remaining Service Life = [(2*DL-36)/(DL-1)]		

* Eliminate chip seal and fog seal when 20 year BESALs are >7 million