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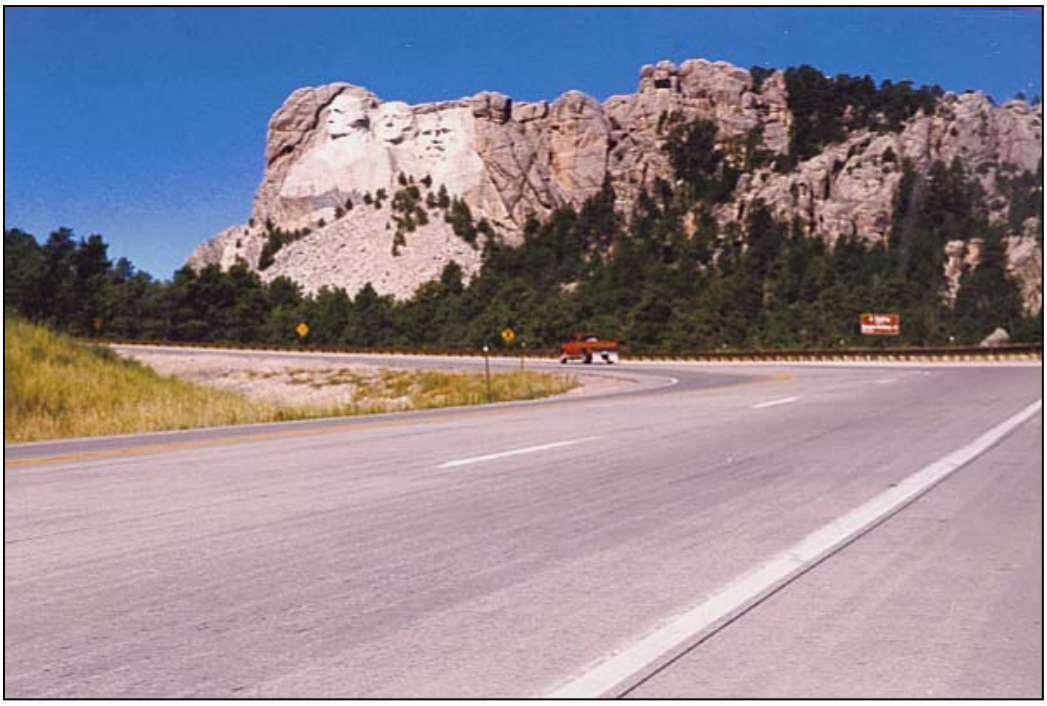

Local Road Surfacing Criteria

Study SD2002-10
Technical Brief

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A final report that provides details on the methodologies used to evaluate road sections is published as SD2002-10-F. A software tool and users guide (SD2002-10-UG), developed as part of this project, provides an advanced tool for making local road surfacing decisions and is available through the sponsoring agency.

16. Abstract

On a daily basis, local road agencies in South Dakota face the question of how to cost-effectively maintain low-volume roads. Specifically, decision makers are faced with the challenge of determining when it is most economical to maintain, upgrade, or downgrade a road's existing surface.

In order to assist decision makers with these types of decisions, the South Dakota Department of Transportation (SDDOT) initiated a research study in 2002 to investigate surfacing criteria for low-volume roads (LVR). The overall objective of this research study is to create a process that allows the user to compare the costs associated with different types of roads to provide assistance in deciding which surface type (hot-mix asphalt [HMA], blotter, gravel, or stabilized gravel) is most economical under a specific set of circumstances. In addition to incorporating economic factors into the analysis, the process also allows the user to consider other non-economic factors that are more subjective and difficult to quantify, such as political factors, growth rates, housing concentration, mail routes, and industry/truck traffic. The process used during this study is flexible enough to allow users to consider any combination of agency costs incurred by the agency for maintaining its roads, non-agency (user) cost factors such as vehicle operating costs or crash potential, and non-economic factors such as politics and housing densities.

The underlying methodology developed during this project for making road surface type decisions is based upon life-cycle cost analysis (LCCA) techniques that focus on selecting the most cost-effective road surface to meet a specific need. The methodology was created using agency cost and user cost models that were developed based upon specific road section information supplied by various local agencies in South Dakota, average daily traffic (ADT) and crash occurrence information supplied by the SDDOT, information obtained through a literature search, and input from members of the Technical Panel. The primary deliverables for this study include a Technical Brief that summarizes the manual procedure for determining the appropriate surface type for a road section based upon the average conditions, a software tool that allows the user to analyze economic and non-economic factors at specific locations to determine the appropriate surface type.

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Low-volume roads, surfacing criteria, life-cycle cost analysis, South Dakota, software tools	No restrictions. This document is available to the public from the sponsoring agency.

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LOCAL ROAD SURFACING CRITERIA
(SD2002-10)

TECHNICAL BRIEF

Introduction

On a daily basis, local road agencies in South Dakota face the challenge of how to cost-effectively maintain low-volume roads. Specifically, decision makers are faced with the challenge of determining when it is most economical to maintain, upgrade, or downgrade a road's existing surface. For example, an agency might need to determine when it is most cost-effective to convert a gravel road to a blotter road.

In order to assist decision makers with these types of questions, the South Dakota Department of Transportation (SDDOT) initiated a research study in 2002 regarding surfacing criteria for low-volume roads. The objective of this research study is to create a process that allows the user to compare the costs associated with different types of roads to provide assistance in deciding which surface type is most economical under a specific set of circumstances. In addition to incorporating the economical factors, the process must also allow the user to consider other non-economic factors that are more subjective and difficult to quantify, such as political factors, growth rates, housing concentration, mail routes, and industry/truck traffic. The process that was developed can be performed manually, as outlined in this *Technical Brief*, or through the use of a computerized tool developed under this project and available through the South Dakota Local Technical Assistance Program (SDLTAP).

The *Technical Brief* was developed to provide a step-by-step procedure for making road surface type decisions between different surface materials (hot-mix asphalt [HMA], blotter, gravel, and stabilized gravel) on low volume roadways. The approach outlined in this document is flexible enough to allow users to consider only those costs actually incurred by the agency for maintaining their roads, to include non-agency cost factors such as vehicle operating costs or crash potential, or to include non-economic factors. Whatever considerations are included in the analysis, the methodology presented in this *Technical Brief* provides a practical tool to assist agencies with decisions about the most cost-effective road surface type to be used in various situations.

Methodology

The decision of the most cost-effective surface type to be used on a road can be heavily influenced by the initial cost of constructing the road, the maintenance costs expected over its life, and the impact the road surface might have on its users. These factors have all been incorporated into the methodology outlined in this *Technical Brief*. The approach is based on an analysis of both costs and non-economic factors that might influence an agency's selection of the appropriate road surface to be used. In the process developed under this study, there are several different types of costs considered. The term *agency cost* is used to define the funds expended by the local agency to build and maintain the given roadway over its life. In addition to agency costs, the analysis may optionally consider *user costs*. User costs typically include the vehicle

operating, crash, and delay costs incurred by the users of a roadway. During an analysis, all, some, or none of the user costs may be included as selected by the agency. For this analysis, only the vehicle operating and crash components of the user costs are included as options in the cost analysis.

In order to calibrate the methodology to the local agencies in South Dakota, all counties in the state were asked to participate in providing data related to specific road sections in their county. An attempt was made to collect data for all road surface types having a full range of average daily traffic (ADT) and truck percentage levels for all terrain types. Using the data provided by participating counties, the project models were customized to reflect typical costs in South Dakota. These models, which were developed based upon an analysis of the costs incurred over the anticipated life of each road section, allow the user to determine the most cost-effective surface for a given set of roadway conditions. The method for determining the optimal surface type using a manual approach is described in the next section of this *Technical Brief.* The consideration of the time value of money is incorporated into the automated tool available through the SDLTAP but was omitted from the *Technical Brief* to keep the manual process from becoming too complex. The salvage value of treatments at the end of the analysis period is also ignored in this manual approach but may be included in the analysis conducted using the automated tool.

Procedure

This section provides the details necessary for an agency to determine the most appropriate surface type for a given pavement section based upon the average conditions observed in South Dakota. To apply the methodology developed for this study, the following steps should be followed. An example analysis (displayed in italics) is provided along with the step-by-step procedure.

Step 1. Identify the Road Section

The first step in determining the appropriate surface type for a given roadway section is to identify the road section of interest. You must decide what portion of the roadway you want to consider in your analysis. Further, for the chosen roadway section, you must also identify the corresponding average daily traffic (ADT) value associated with the entire length of the roadway section that you are considering. The ADT value may be based upon traffic counts that have been conducted on the section or estimated based upon your knowledge of the road section. Details about the section (such as road name, location, and ADT) should be added to lines 1 through 3 on the summary table (table 12) that is included on page 14 of this *Technical Brief*.

Example: County A has a 5-mile section of County Road 1 that had been gravel surfaced since it was initially constructed. Since its initial construction, the ADT has increased on the roadway section to 350 vehicles per day (based upon a recently conducted traffic count). County A is considering surfacing the pavement section. Currently, they are receiving political pressure to pave the road, but they are unsure if they should construct a blotter or HMA road. The section details were added to lines 1 through 3 on the example summary table (table 13) on page 14 of this Technical Brief.

Step 2. Determine the Agency Costs

The next step in selecting the surface type for a given roadway section is to calculate the agency component of the total costs expected to be incurred over the life of the roadway. Tables 1 through 4 allow you to determine the agency costs associated with the pavement section if it is surfaced with HMA, blotter, gravel, or stabilized gravel, respectively. Further information on filling out these tables is provided.

Table 1. Agency costs for HMA surfaced roadway section.

Column 1	**Column 2**	**Column 3**	**Column 4**	**Column 5**
Treatment	**Number of Applications Per Year (times/yr)**	**How Often the Treatment is Applied (years between applications)**	**Costs Per Application (cost/mile)**	**Costs Per Mile Per Year** **column 2* column 4** **column 3**
Line 1: Crack Sealing				
Line 2: Seal Coat				
Line 3: Overlay				
Line 4: Striping and Marking				
Line 5: Patching				
Line 6: Other _____				
Line 7: Maintenance Costs Per Mile Per Year (Sum Lines 1 through 6)				
Line 8: Analysis Period (years)				20
Line 9: Maintenance Costs Per Mile for the Analysis Period (Line 7 * Line 8)				
Line 10: Initial Construction/ Last Major Rehabilitation Costs (costs/mile)				
Line 11: Total 20-year Costs Per Mile (Line 9 + Line 10)				

Table 2. Agency costs for blotter surfaced roadway section.

Column 1	Column 2	Column 3	Column 4	Column 5
Treatment	**Number of Applications Per Year (times/yr)**	**How Often the Treatment is Applied (years between application)**	**Costs Per Application (costs/mile)**	**Costs Per Mile Per Year** **column 2* column 4** **column 3**
Line 1: Seal Coat				
Line 2: Striping and Marking				
Line 3: Patching				
Line 4: Process in place, add aggregate, and reblot				
Line 5: Other _____				
Line 6: Maintenance Costs Per Mile Per Year (Sum Lines 1 through 5)				
Line 7: Analysis Period (years)				20
Line 8: Maintenance Costs Per Mile for the Analysis Period (Line 6 * Line 7)				
Line 9: Initial Construction/ Last Major Rehabilitation Costs (costs/mile)				
Line 10: Total 20-year Costs Per Mile (Line 8 + Line 9)				

Table 3. Agency costs for gravel surfaced roadway section.

Column 1	Column 2	Column 3	Column 4	Column 5
Treatment	**Number of Applications Per Year (times/yr)**	**How Often the Treatment is Applied (years between application)**	**Costs Per Application (costs/mile)**	**Costs Per Mile Per Year** **column 2* column 4** **column 3**
Line 1: Blading				
Line 2: Regravel				
Line 3: Reshape Cross Section				
Line 4: Spot Graveling				
Line 5: Other _____				
Line 6: Maintenance Costs Per Mile Per Year (Sum Lines 1 through 5)				
Line 7: Analysis Period (years)				20
Line 8: Maintenance Costs Per Mile for the Analysis Period (Line 6 * Line 7)				
Line 9: Initial Construction/ Last Major Rehabilitation Costs (costs/mile)				
Line 10: Total 20-year Costs Per Mile (Line 8 + Line 9)				

Table 4. Agency costs for stabilized gravel surfaced roadway section.

Column 1 Treatment	Column 2 Number of Applications Per Year (times/yr)	Column 3 How Often the Treatment is Applied (years between application)	Column 4 Costs Per Application (costs/mile)	Column 5 Costs Per Mile Per Year column 2* column 4 / column 3
Line 1: Dust Control				
Line 2: Blading				
Line 3: Regravel				
Line 4: Reshape Cross Section				
Line 5: Spot Graveling				
Line 6: Other _____				
Line 7: Maintenance Costs Per Mile Per Year (Sum Lines 1 through 6)				
Line 8: Analysis Period (years)				20
Line 9: Maintenance Costs Per Mile for the Analysis Period (Line 7 * Line 8)				
Line 10: Initial Construction/ Last Major Rehabilitation Costs (costs/mile)				
Line 11: Total 20-year Costs Per Mile (Line 9 + Line 10)				

Fill out each line in tables 1 through 4 by entering the requested information regarding maintenance treatments that will be applied over a 20-year analysis period. For example, column 1 lists several treatments that are normally applied to the selected surface type. You are to enter the number of applications of the treatment that are applied each year in column 2. In column 3, enter the number of years between each application of the treatment. For example, if a treatment is applied every 4 years, you would enter a "4" in column 3. Lastly, you must enter the costs per mile for each application of the treatment into column 4. Once these values are entered, you can determine the costs per mile for each treatment on a yearly basis. This value is calculated by multiplying the value in column 2 by the value in column 4 and then dividing by the value in column 3. The resulting value is placed in column 5 for each respective treatment type. It should be noted that not all treatment types have to be utilized in the calculation. Further, if you do not know the typical costs or frequencies associated with a particular treatment, default values are provided in tables A-1 through A-4 in Appendix A of this *Technical Brief*. The default values reflect data collected from the local agencies in the state and have been supplemented with expert opinion from the Technical Panel and research team for this research project. It should be noted that the default initial/major rehabilitation costs do not reflect the costs of upgrading the road from one surface type to another. Therefore, if you wish for upgrade costs to be taken into consideration, the default costs for initial construction/major rehabilitation must be increased by the appropriate amount.

After summarizing the costs per mile per year for each treatment used, the total costs per mile per year can be calculated by summing the maintenance costs per mile per year for all treatment types (this is summarized in line 7 for tables 1 and 4 and line 6 for tables 2 and 3). The maintenance costs per mile for the analysis period can be calculated by multiplying the total costs per mile per year by the length of the analysis period listed in the table (20 years is the default value). The maintenance costs per mile are summarized in line 9 for tables 1 and 4 and line 8 for tables 2 and 3. These final total costs for each surface type can then be determined by adding the initial construction/last major rehabilitation costs (line 10 for tables 1 and 4 or line 9 for tables 2 and 3) to the maintenance costs per mile for the analysis period (line 9 for tables 1 and 4 or line 8 for tables 2 and 3). The total costs should be summarized in line 11 for tables 1 and 4 or line 10 for tables 2 and 3. Final calculated values should be listed on line 4 of the summary table (table 12) that is included on page 14 of this *Technical Brief*.

Example: Using tables 1 through 4, County A determined the agency costs for all surface types as shown in tables 5 through 8. The agency costs for each surface type were determined using the default values found in Appendix A. The agency costs for the HMA, blotter, gravel, and stabilized gravel roads were determined to be $128,400, $74,150, $143,896, and $225,656, respectively. These numbers from tables 5 through 8 have been added to line 4 of the example cost table (table 13) on page 14 of this Technical Brief.

Table 5. Example agency costs for HMA surfaced roadway section.

Column 1	**Column 2**	**Column 3**	**Column 4**	**Column 5**
Treatment	**Number of Applications Per Year (times/yr)**	**How Often the Treatment is Applied (years between applications)**	**Costs Per Application (cost/mile)**	**Costs Per Mile Per Year** **column 2* column 4 / column 3**
Line 1: Crack Sealing	1	3	$1,200	$400
Line 2: Seal Coat	1	4	$7,000	$1,750
Line 3: Overlay	1	20	$37,000	$1,850
Line 4: Striping and Marking	1	4	$280	$70
Line 5: Patching	1	1	$500	$500
Line 6: Other _____				--
Line 7: Maintenance Costs Per Mile Per Year (Sum Lines 1 through 6)				$4,570
Line 8: Analysis Period (years)				20
Line 9: Maintenance Costs Per Mile for the Analysis Period (Line 7 * Line 8)				$91,400
Line 10: Initial Construction/ Last Major Rehabilitation Costs (costs/mile)				$37,000
Line 11: Total 20-year Costs Per Mile (Line 9 + Line 10)				$128,400

Table 6. Example agency costs for blotter surfaced roadway section.

Column 1	Column 2	Column 3	Column 4	Column 5
Treatment	**Number of Applications Per Year (times/yr)**	**How Often the Treatment is Applied (years between application)**	**Costs Per Application (costs/mile)**	**Cost Per Mile Per Year** **column 2* column 4** **column 3**
Line 1: Seal Coat	1	4	$7,850	$1,962
Line 2: Striping and Marking	1	4	$370	$93
Line 3: Patching	1	1	$1,260	$1,260
Line 4: Process in place, add aggregate, and reblot				--
Line 5: Other _____				--
Line 6: Maintenance Costs Per Mile Per Year (Sum Lines 1 through 5)				$3,315
Line 7: Analysis Period (years)				20
Line 8: Maintenance Costs Per Mile for the Analysis Period (Line 6 * Line 7)				$66,300
Line 9: Initial Construction/ Last Major Rehabilitation Costs (costs/mile)				$7,850
Line 10: Total 20-year Costs Per Mile (Line 9 + Line 9)				$74,150

Table 7. Example agency costs for gravel surfaced roadway section.

Column 1 **Treatment**	Column 2 **Number of Applications Per Year (times/yr)**	Column 3 **How Often the Treatment is Applied (years between application)**	Column 4 **Costs Per Application (costs/mile)**	Column 5 **Costs Per Mile Per Year** **column 2* column 4 / column 3**
Line 1: Blading	50	1	$65	$3,250
Line 2: Regravel	1	6	$7,036	$1,173
Line 3: Reshape Cross Section				--
Line 4: Spot Graveling	1	1	$2,420	$2,420
Line 5: Other _____				--
Line 6: Maintenance Costs Per Mile Per Year (Sum Lines 1 through 5)				$6,843
Line 7: Analysis Period (years)				20
Line 8: Maintenance Costs Per Mile for the Analysis Period (Line 6 * Line 7)				$136,860
Line 9: Initial Construction/ Last Major Rehabilitation Costs (costs/mile)				$7,036
Line 10: Total 20-year Costs Per Mile (Line 8 + Line 9)				$143,896

Table 8. Example agency costs for stabilized gravel surfaced roadway section.

Column 1 **Treatment**	Column 2 **Number of Applications Per Year (times/yr)**	Column 3 **How Often the Treatment is Applied (years between application)**	Column 4 **Costs Per Application (costs/mile)**	Column 5 **Costs Per Mile Per Year** **column 2* column 4 / column 3**
Line 1: Dust Control	1	1	$2,300	$2,300
Line 2: Blading	6	1	$380	$2,280
Line 3: Regravel	1	10	$17,416	$1,742
Line 4: Reshape Cross Section	1	10	$3,400	$340
Line 5: Spot Graveling	1	1	$3,635	$3,635
Line 6: Other _____				--
Line 7: Maintenance Costs Per Mile Per Year (Sum Lines 1 through 6)				$10,297
Line 8: Analysis Period (years)				20
Line 9: Maintenance Costs Per Mile for the Analysis Period (Line 7 * Line 8)				$205,940
Line 10: Initial Construction/ Last Major Rehabilitation Costs (costs/mile)				$19,716
Line 11: Total 20-year Costs Per Mile (Line 9 + Line 10)				$225,656

Step 3. Determine the User Costs

After determining the agency cost component of the analysis, the next step involves calculating the user cost portion. In this analysis, there are two components of user costs that are considered: vehicle operating costs and crash costs. As mentioned previously, the user cost portion of the analysis may be used in full, used partially, or totally excluded from the analysis. The utilization of user costs in life cycle cost analysis is supported by many agencies including the Federal Highway Administration (FHWA 1998) and it is recommended that the users of this *Technical Brief* also consider user costs.

Step 3a. Determine the Vehicle Operating Costs

The first user costs to be determined are the vehicle operating costs. These costs represent the wear and tear on a vehicle associated with driving on various pavement surfaces. Figure 1 displays the vehicle operating costs per mile of roadway for roads with ADT values of 0 to 1000 vehicles per day. Using figure 1, enter the plot at your known ADT level and determine the corresponding vehicle operating costs for each of the four surface types being considered (HMA, blotter, gravel, and stabilized gravel). These values can be listed on *line 5* of the summary table

(table 12) that is included on page 14 of this *Technical Brief*.

Example: Using figure a, County A used an ADT of 350 and drew a line upward through the three surface type cost lines. The vehicle operating cost for the HMA, blotter, gravel and stabilized gravel roads were determined to be $310,000, $375,000, $500,000 and $420,000, respectively. The numbers from figure 1 have been added to line 5 of the example cost table (table 13) on page 14 of this Technical Brief.

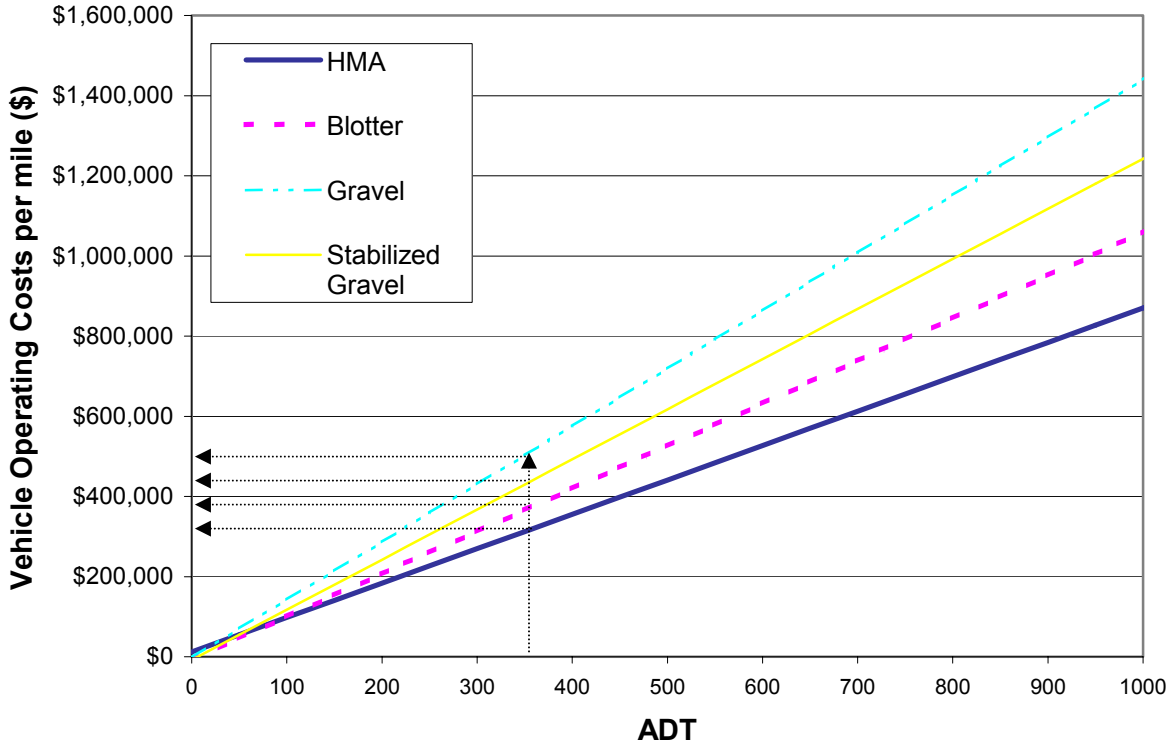

Figure 1. Cumulative 20-year vehicle operating costs per mile of roadway for roads with 0 to 1000 ADT.

Step 3b. Determine the Crash Costs

The second user costs to be determined are crash costs. The crash costs for a given roadway are based upon the frequency of fatal, injury, and personal damage crashes that occur within a given timeframe on a roadway section. Based upon your knowledge of the road section, use table 9 to determine the crash potential you expect per mile of roadway over a 10-year period. While crash potential is provided for a 10-year period, the crash costs were determined for a 20-year analysis period. The crash potential rates were provided for a 10-year period rather than a 20-year period because it is easier to estimate crash potential over a shorter time period such as 10 years versus a longer time period of 20 years. Once the crash potential level is determined for the given pavement section, table 10 can be used to determine the average accident costs for each surface type. These results can be added to *line 6* of the final summary table (table 12) that is included on page 14 of this brief.

Example: Over a 10-year time period, County A expects to have five fatalities, ten injury and ten personal damage crashes over its 5-mile roadway section. The expected crash rates correspond to one fatality, two injury, and two personal damage crashes per mile of pavement over the next 10 years (each crash figure is divided by five to convert the accidents to a per-mile basis). Using table 9, County A determines that the crash rates for their roadway section correspond to a "medium" crash potential.

Using table 10, County A determines their "medium" crash potential relates to crash costs of $181,670, $145,420, $73,430, and $38,920, for the HMA, blotter, stabilized gravel, and gravel roads, respectively. The crash costs from table 10 have been added to line 6 of the example cost table (table 12) on page 14 of this Technical Brief.

Table 9. Crash Potential.*

Crash Potential	**Expected Number of Crashes by Type over 10 Year Time Period**
None	No fatalities, injuries or personal damage only crashes
Low	No fatalities, one or no injury crashes, and fewer than four personal damage only crashes
Medium	*Option 1:* No fatalities, one to three injury crashes, and four to six personal damage only crashes
	Option 2: One fatality, one or two injury crashes, and four or fewer personal damage only crashes
High	*Option 1:* No fatalities, more than three injury crashes, and more than six personal damage only crashes
	Option 2: One fatality, more than two injury crashes, and more than four personal damage only crashes
	Option 3: More than one fatality

*Crash rates based upon 1-mile roadway section.

Table 10. Average 20-year crash costs per mile of pavement per surface type per crash potential level for rural roads.

Surface Type	**None**	**Low**	**Medium**	**High**
HMA	$ -	$ 20,110	$ 181,670	$ 398,900
Blotter	$ -	$ 14,470	$ 145,420	$ 289,860
Gravel	$ -	$ 3,800	$ 38,920	$ 222,300
Stabilized Gravel	$ -	$ 12,250	$ 73,430	$ 275,000

Step 3b. Scale the User Costs

Before adding user costs to the agency costs, it may be appropriate to adjust the user costs. Some agencies discover that during a cost analysis such as this, the very large costs associated with vehicle operating and crash costs often overwhelm the agency (construction and maintenance) costs of a specific project. Therefore, the agency may decide to exclude user costs or reduce the associated costs in order to provide costs that are more in line with expected values. This can be done by scaling the user costs calculated in the previous step with a weighting factor that is representative of the importance of user costs within the agency. A weighting factor of 1.0, for example, is representative of using the user costs as they are calculated (in other words, no scaling of user costs is conducted). A weighting factor of 0 eliminates user costs from consideration in the analysis. Therefore, a reasonable weighting factor should be selected between the values of 0 and 1.0. When selecting the weighting factor, the agency should consider the relative magnitude of the user costs to the agency costs and select a weighting factor that represents the importance of one value to the other. The final weighting factor that is selected should be added to *line 8* of the final summary table (table 12) that is included on page 14 of this brief. If you are not comfortable determining your own weighting factor, table 11 provides a recommended range of weighting factors depending upon the level of importance your agency places on the user costs. Selecting a high level of importance on user costs generally places approximately equal weight on the agency and user costs.

Example: County A wants to place a high level importance on their user costs. Using table 11 as a guide, the county decided to use 0.125 as a weighting factor for the user costs. They add this number to the line 8 of the example cost table (table 13) on page 14 of this Technical Brief.

Table 11. Recommended weighting factors for user costs.

Level of Importance Assigned to User Costs	Proposed Weighting Factor Range
Low	0 – 0.05
Medium	0.05 – 0.10
High	0.10 – 0.15

Step 4. Summarize Total Costs

The total cost of the three surface types can be determined by filling out the remainder of the cost analysis table (table 12). The total user costs (*line 7*) for each surface type can be determined by adding the vehicle operating costs (*line 5*) to the crash costs (*line 6*). Then the weighted user costs (*line 9*) can be calculated by multiplying the total user costs (*line 7*) by the weighting factor for user costs (*line 8*). Lastly, the total costs for each surface can be determined by adding the agency total costs (*line 4*) to the weighted user costs (*line 9*). The surface with the lowest costs is the most cost-effective choice based solely on economic factors.

Example: County A finalized all of its calculations by computing the total user costs (line 7), the weighted user costs (line 9), and the total costs for each surface (line 10) as shown in table 13 on page 14 of this Technical Brief. County A determined that a blotter road, with the lowest overall total costs, is the most cost-effective surface choice based solely on economical factors.

Table 12. Summary of 20-year cost analysis.

Line 1. **Road Name**	
Line 2. **Location**	
Line 3. **ADT**	

Cost Information	**HMA**	**Blotter**	**Gravel**	**Stabilized Gravel**
Line 4. **Agency total costs ($ per mile)**				
Line 5. **User average total costs– Vehicle operating costs ($ per mile)**				
Line 6. **User average total costs – Crash costs ($ per mile)**				
Line 7. **Total user costs ($ per mile) (*Line 5 + Line 6*)**				
Line 8. **Weighting factor for user costs**				
Line 9. **Weighted user costs ($ per mile) (*Line 7 * Line 8*)**				
Line 10. **Total Costs ($ per mile) (*Line 4 + Line 9*)**				

Table 13. Example summary of 20-year cost analysis.

Line 1. **Road Name**	*County Road A*
Line 2. **Location**	*5 mile section from B to C*
Line 3. **ADT**	*350 vehicles per day*

Cost Information	**HMA**	**Blotter**	**Gravel**	**Stabilized Gravel**
Line 4. **Agency total costs ($ per mile)**	*128,400*	*74,150*	*143,896*	*225,656*
Line 5. **User average total costs– Vehicle operating costs ($ per mile)**	*310,000*	*375,000*	*500,000*	*420,000*
Line 6. **User average total costs – Crash costs ($ per mile)**	*181,670*	*145,420*	*38,920*	*73,430*
Line 7. **Total user costs ($ per mile) (*Line 5 + Line 6*)**	*491,670*	*520,420*	*538,920*	*493,430*
Line 8. **Weighting factor for user costs**	*0.125*	*0.125*	*0.125*	*0.125*
Line 9. **Weighted user costs ($ per mile) (*Line 7 * Line 8*)**	*61,459*	*65,053*	*67,365*	*61,679*
Line 10. **Total Costs ($ per mile) (*Line 4 + Line 9*)**	*189,859*	*139,203*	*211,261*	*287,335*

Step 5. Evaluate Non-Economic Factors

In some cases, an agency may select a local road surface based solely on the economic factors calculated earlier. However, in most cases, there are other issues besides total costs that come into play when deciding on a roadway surface. These issues include political factors, growth rates, housing concentration/dust control needs, mail routes, and industry/truck traffic. Table 14 has been developed to allow agencies to take both the economic and non-economic factors into consideration. The following directions provide a step-by-step procedure for completing table 14. Each step of the procedure is followed in italics by an example for County A.

1. The first step in evaluating non-economic factors along with cost factors is to assign rating factors to the factor categories in table 14. In order to assign rating factors, you must comparatively weigh the importance of each of the six factor categories and assign higher ratings to those factors that are most important to your agency. The total of all rating factors must add up to 100 percent. You may use any combination of rating factors that make sense to your agency, as long as the sum does not exceed 100. For instance, an agency that places greatest importance on total costs and minor importance to the other factors might assign a rating factor of 50 to Total Costs and 10 to each of the other 5 categories. After the rating factors are selected, they should be added to the *Rating Factors* column in table 14. When applying these rating factors, remember that the same rating factors will be used for each surface type.

   Example: County A decided to weight total cost as having a 55 percent importance because it was the most important factor to them in selecting a pavement surface. However, the County was receiving some political pressure to change the gravel road to an HMA-surfaced road. Therefore, they assigned a 25 percent rating to political issues. At the same time, a 10 percent weighting was assigned to housing concentration/dust control and a 5 percent weighting was assigned to both mail routes and industry/truck traffic. No weight was assigned to growth rates because this issue was not significant to the County. These assignments are shown in table 15.

2. The next step in the evaluation is to assign scoring factors. For each of the six categories, comparatively rank the four surface types by assigning Scoring Factors (4 is highest rating and 1 is the lowest rating) in table 14 for each surface type. A rating of 4 should be assigned to the surface that does best in the given category while a rating of 1 should be assigned to the surface that does worst in that category. If two or more surface types perform equally in a given category, equal scoring factors can be assigned to each.

   Example: Based upon the results of the cost analysis, County A decided to score the Total Costs for each surface with scoring factors of 4, 3, 2, and 1 for the blotter, HMA, gravel, and stabilized gravel roads, respectively. This signified that the blotter had the lowest total cost as determined in the cost analysis (so it received the highest score) followed by the HMA, gravel, and stabilized gravel surfaces. Then, based upon the political pressure to change the given gravel roadway to an HMA-surfaced section, the highest scoring factor of 4 was assigned to the HMA surface and the lowest scoring

factor a value of 1 was assigned to both the gravel and stabilized gravel surface types under the political issues factor. Other appropriate scoring factors were assigned to the remaining factor categories as shown in table 15.

3. With rating and scoring factors assigned, the next step of the evaluation is to calculate the scores for each surface type. For each factor category within each surface type, multiply the scoring factor by the rating factor to determine the total score. For this calculation, the rating factor, which previously was given as a percentage, should now be expressed as a decimal (e.g. 5% = 0.05) when multiplying by the scoring factor. The total scores for each surface type should then be determined by adding the total score for each factor category together and recorded in the bottom row of table 14.

   Example: County A calculated its scores as shown in table 15. The result of the analysis shows that the HMA, blotter, gravel, and stabilized gravel roads had total scores of 3.45, 3.55, 1.55, and 1.45, respectively.

4. The last step in the evaluation is to determine the most appropriate surface type for the roadway section. Once the total scores for each surface type have been determined, the surface type with the highest score should be the selected surface for the given roadway section.

   Example: Since the blotter road received the highest total score as shown in table 15, County A selected it as the road surface that was most appropriate under the given set of circumstances. The analysis results provide a solid methodology for making a choice of a blotter road over HMA even with the known political influence.

Table 14. Scoring table for economic and non-economic factors.

Factor Categories	**Rating Factor (%)**	**HMA**		**Blotter**		**Gravel**		**Stabilized Gravel**	
		Scoring Factor	**Total Score** (RatingFactor* ScoringFactor)	**Scoring Factor**	**Total Score** (RatingFactor* ScoringFactor)	**Scoring Factor**	**Total Score** (RatingFactor* ScoringFactor)	**Scoring Factor**	**Total Score** (RatingFactor* ScoringFactor)
Total Costs									
Political Issues									
Growth Rates									
Housing Concentration/ Dust Control									
Mail Routes									
Industry/ Truck Traffic									
Total Score	100%								

Table 15. Example scoring table for economic and non-economic factors.

Factor Categories	Rating Factor (%)	HMA		Blotter		Gravel		Stabilized Gravel	
		Scoring Factor	Total Score (RatingFactor* ScoringFactor)	Scoring Factor	Total Score (RatingFactor* ScoringFactor)	Scoring Factor	Total Score (RatingFactor* ScoringFactor)	Scoring Factor	Total Score (RatingFactor* ScoringFactor)
Total Costs	55%	3	1.65	4	2.20	2	1.10	1	0.55
Political Issues	25%	4	1.00	3	0.75	1	0.25	2	0.50
Growth Rates	0%	4	0.00	3	0.00	1	0.00	2	0.00
Housing Concentration/ Dust Control	10%	4	0.40	3	0.30	1	0.10	2	0.20
Mail Routes	5%	4	0.20	3	0.15	1	0.05	2	0.10
Industry/ Truck Traffic	5%	4	0.20	3	0.15	1	0.05	2	0.10
Total Score	100%		**3.45**		**3.55**		**1.55**		**1.45**

Summary

The *Technical Brief* outlines a step-by-step process to assist counties in South Dakota in making road surface type decisions. This manual procedure allows the user to consider any combination of agency costs, user costs, and other non-economic factors when determining the appropriate surface type for a given roadway section. The models used as the basis of this procedure are based upon the average construction and maintenance costs, treatment timings, crash costs, and vehicle operating costs submitted by counties in South Dakota during the data collection efforts of this study with some modifications by the Technical Panel (as noted in the final report for this project). In addition to the manual procedures outlined in this document, a software tool has been developed that is also available for conducting the analysis. The software tool allows an agency to further customize the types of treatments and the costs that will be applied over the life of a road section. The basis for this manual procedure and the software tool are summarized in *Local Road Surfacing Criteria, SD2002-10, Final Report.*

References

Federal Highway Administration (FHWA). 1998. *Life-Cycle Cost Analysis in Pavement Design.* FHWA-SA-98-079. Federal Highway Administration, Washington, DC.

APPENDIX A

DEFAULT TREATMENT COSTS AND FREQUENCIES

Table A-1. Default construction and maintenance costs for HMA roadways in South Dakota based upon ADT levels.

ADT	Initial Const. or Major Rehab. Cost ($/mile)	Crack Seal		Seal Coat		Overlay		Striping and Marking		Patching/ Annual Maint. Cost ($/mile)
		Years between app.	Cost ($/ mile)	Years between app.	Cost ($/ mile)	Years between app.	Cost ($/ mile)	Years between app.	Cost ($/ mile)	
0-99	35,000	3	900	5	6,500	21	35,000	5	210	500
100-199	35,000	3	900	5	6,500	17	35,000	4	250	500
200-299	37,000	3	1,200	4	7,000	20	37,000	4	280	500
300-399	37,000	3	1,200	4	7,000	20	37,000	4	280	500
400-499	39,000	5	1,600	4	7,300	20	39,000	4	310	500
500-599	40,000	6	1,600	4	7,300	20	40,000	4	320	500
600-699	43,000	6	1,600	4	7,300	20	50,000	4	360	500
> 700	43,000	6	1,600	4	7,300	20	50,000	4	360	500

Note: All costs are per mile.

Table A-2. Default construction and maintenance costs for blotter roadways in South Dakota based upon ADT levels.

ADT	Initial Construction or Major Rehab. Cost ($/mile)	Seal Coat		Striping and Marking		Patching/Annual Maint. Cost ($/mile)
		Years between app.	Cost ($/mile)	Years between app.	Cost ($/mile)	
0-99	7,000	5	7.000	5	250	530
100-199	7,000	5	7,000	5	250	920
200-299	7,170	4	7,170	4	280	1,250
300-399	7,850	4	7,850	4	370	1,260
400-499	9,180	5	9,180	5	440	1,430
> 500	9,540	4	9,540	3	450	3,150

Note: All costs are per mile.

Table A-3. Default construction and maintenance costs for gravel roadways in South Dakota based upon ADT levels.

ADT	Initial Construction or Major Rehab. Cost ($/mile)	Blading		Regravel		Spot Gravel/ Annual Maint. Cost ($/mile)
		Times per year	Cost ($/mile)	Years between app.	Cost ($/mile)	
0-99	3,700	17	45	8	3,700	350
100-199	3,700	20	45	8	3,700	800
200-299	4,500	30	50	6	4,500	1,070
> 300	7,036	50	65	6	7,036	2,420

Note: All costs are per mile.

Table A-4. Default construction and maintenance costs for stabilized gravel roadways in South Dakota based upon ADT levels.

ADT	Initial Construction/ Major Rehab. Cost ($/mile)	Dust Control		Blading		Regravel		Reshape Cross Section		Spot Gravel/ Annual Maint. Cost ($/mile)
		Years between app.	Cost ($/ mile)	Times per year	Cost ($/ mile)	Years between app.	Cost ($/ mile)	Years between app.	Cost ($/ mile)	
0-99	5,000	1	2,700	4	40	12	2,300	--	--	500
100-199	8,154	1	3,300	4	40	5	4,854	--	--	333
200-299	8,154	1	3,300	4	40	5	4,854	--	--	333
> 300	19,716	1	2,300	6	380	10	17,416	10	3,400	3,635

Note: All costs are per mile.