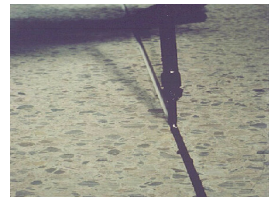


**South Dakota
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Office of Research**



**U.S. Department
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Federal Highway
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SD2006-05-F



Review of SDDOT's Pavement Management System

Study SD2006-05 Final Report

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November 2007

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The contents of this report reflect the views of the authors who are responsible for the facts and accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the South Dakota Department of Transportation, the State Transportation Commission, the South Dakota Highway Patrol, or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

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16. Abstract <p>The South Dakota Department of Transportation (SDDOT) has been using pavement management practices for nearly 30 years, when the agency established its Rural Planning Inventory System to assess needs based on a Pavement Serviceability Rating. A Pavement Management Task Force was established and new pavement management software was implemented as a result of SDDOT Research Project SD1993-14, <i>Enhancement of South Dakota's Pavement Management System</i>. Since then, a number of internal and external factors have impacted the effectiveness of the Department's pavement management process. For example, funding levels are expected to decrease dramatically in coming years. Coupled with significant increases in material costs, the Department does not expect to be able to pave as many miles of pavement as in the past. In response to this situation, the Department has initiated a pavement preservation program targeted at slowing the rate of pavement deterioration and keeping good roads in good condition for a longer period of time. While the implementation of the pavement preservation program is an important step, other enhancements to the pavement management process were sought to further improve the effectiveness of the SDDOT's decision process.</p> <p>To identify further improvements to the pavement management process, the SDDOT initiated this research study. The study recommends a strategic direction for pavement management within the SDDOT and provides specific recommendations to the pavement management process to achieve this vision. The recommendations are based on a series of workshops conducted during calendar years 2006 and 2007, involving individuals from the Executive Team, Regions, and Central Office.</p>					
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EXECUTIVE SUMMARY

Introduction

The South Dakota Department of Transportation (SDDOT) has been using pavement management practices since 1977 when the Rural Planning Inventory System was developed to assess needs based on an adjusted Pavement Serviceability Rating (PSR). In response to the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), a Pavement Management Task Force was established and changes to the pavement management system were initiated under SDDOT Research Project SD1993-14, *Enhancement of South Dakota's Pavement Management System*. Since that time, changes within the Department and in the outside environment continue to impact the ongoing effectiveness of the SDDOT pavement management activities in terms of organizational and institutional issues, policy and procedural issues, national initiatives, and technical issues.

Funding considerations are also impacting the importance of effective pavement management practices within the SDDOT. In recent years, funding levels have been adequate to address a large percentage of the State's pavement needs. However, there is a sense that this trend is changing, especially in light of increasing material costs in recent years. Although 1.4 to 2.0 million tons of asphalt could be placed under typical funding levels each year, the dramatic changes in material costs that began in 2006 have reduced the number of tons of asphalt placed to less than 800,000. In other words, even if funding levels were to remain constant, fewer miles of pavement could be addressed each year.

In recent years the SDDOT has initiated several programs to improve the effectiveness of its pavement management program. For instance, a pavement preservation program has been initiated to slow the rate of deterioration of roads in good condition. Because roads with limited amounts of deterioration can be maintained using low-cost treatments, an effective pavement preservation program has the potential to postpone the need for more expensive rehabilitation or reconstruction treatments. However, the pavement preservation treatments must be applied as *preventive* maintenance rather than as *reactive* maintenance, which is more typically used as a stop-gap measure until funding for more extensive repairs is provided. A pavement management system can help identify the appropriate time for pavement preservation treatments to be applied.

The importance of a strong pavement management program is especially important during times of reduced funding. Ironically, there is a tendency to revert to a "worst-first" strategy that provides funding for roads in poor condition during times of limited funding. As a pavement management system can demonstrate, it is especially important to follow sound pavement management practices during times of limited funding to ensure that resources are used as efficiently as possible and that the rate at which pavements deteriorate is slowed as much as possible.

In an effort to continue to improve its pavement management activities, the SDDOT initiated this research to conduct a review of its pavement management program. This report summarizes the approach that was followed to address these issues in order to fully establish the future strategic direction for pavement management at the SDDOT.

Project Approach

The project began by familiarizing the research team with the Department's existing pavement management practices as quickly as possible. In addition to reviewing existing policies and other forms of documentation, the research team interviewed nearly 100 SDDOT employees from throughout the organization to identify the strengths and weaknesses to the existing processes. The interviews were conducted in August 2006.

The interviews identified a number of important issues that needed to be addressed as part of the pavement management process. These issues were summarized into five categories and were presented in a workshop in October 2006. The comments were categorized into the following five areas:

- The Role of Pavement Management in Strategic Investment Decisions
- The Role of Pavement Management in the Project Identification and Selection Process
- Policy Issues
- Pavement Management Technical Issues
- Other Issues

The issues that were raised within each category are included in chapter 5 of this report.

A 1½-day workshop with the Executive Team (and other invited guests) was conducted to determine the future role of pavement management. After reviewing the existing procedures being used to manage pavements, a facilitated discussion was conducted to establish a strategic vision for the maintenance, preservation, and expansion of the State's highway network. This was followed by small group activities to discuss funding allocation, project selection, conflicts in existing policies, and communicating funding needs to the legislature. The workshop concluded in a consensus regarding the most important issues to be addressed during this study.

Immediately after the needs workshop, a 1-day facilitated workshop with the Executive Team (and invited participants) was conducted to begin developing the vision for making pavement management decisions and to initiate the development of processes needed to support the vision.

At the conclusion of the workshop, it became apparent that there were a significant number of issues that needed to be addressed before a recommendation could be developed for an improved pavement management process. Therefore, the Technical Panel agreed to conduct several additional workshops with the Executive Team and invited guests to further explore strategies for making investment decisions. The first of the additional workshops introduced an economic analysis tool distributed by the FHWA for making investment decisions. Mr. Robert Mooney from the FHWA and Dr. Omar Smadi from the Center for Transportation Research and Education at Iowa State University were invited to speak on the HERS-ST software and how it is used to support investment decisions for the Iowa DOT. The second additional workshop provided an opportunity to identify the advantages and disadvantages associated with some of the different approaches that could be used in making these decisions.

Both of these workshops were conducted in June 2007. A final workshop was held in August 2007 to reach consensus on the direction for conducting pavement management. The results from these workshops were instrumental in establishing the research recommendations that are provided in chapter 6.

Significant Findings and Conclusions

Several specific preferences emerged from the workshop and shaped the final vision recommended through this study. For instance, based on the feedback from the workshop participants, it became clear that a benefit analysis capable of considering a broader range of investment options (such as pavement condition, safety considerations, and capacity enhancements) would greatly assist the Executive Team in making investment decisions. This assumed that needs on low-volume roads were not ignored in instances where the benefits were insufficient when compared to needs on higher-volume facilities. It further assumes that benefits beyond improvements to pavement condition can be considered and that a statewide analysis can be conducted quickly enough to be considered responsive to the needs of the Executive Team and the State's Legislators. Some of the strongest advantages to this approach are listed below:

- Provides a dynamic approach for optimizing investment options that adjusts to actual conditions.
- Considerations such as safety, urban improvements, and corridor enhancement options can be considered with pavement condition information.
- Enables timely responses to inquiries by upper management and elected officials.
- Provides a rationale for making investment decisions.
- Quantifies the impact of different investment levels in preservation, safety improvements, and other statewide programs.
- Addresses a broader range of customer interests.

The participants recognized that although the use of a benefit analysis would provide a number of advantages, several considerations would need to be taken into account outside of the analysis. For instance, the decision to address low-volume roads to provide a minimum level of service would likely require a policy decision because these roads typically do not have the traffic levels needed in a benefit analysis. Other improvements with benefits that are difficult to quantify, where rules may be difficult to develop, or where data to calculate benefits are not available would also need to be analyzed outside the framework of this analysis. Examples include stand-alone projects such as Intelligent Transportation Systems (ITS) or Port of Entry projects. By keeping the number of exceptions to a minimum, the participants did not believe these limitations precluded the use of a benefit analysis for investment decisions.

Once the conceptual framework for making investment decisions was determined, the research team evaluated a number of economic analysis tools using the following criteria:

1. Does the analysis consider the benefits associated with alternate investment strategies in determining the optimal combination of investment options?

2. Does it consider a broad range of investment options, including pavement preservation and reconstruction, safety enhancements such as shoulder widening, capacity enhancements, and requirements under the ADA?
3. Can a network-wide strategy be conducted within a relatively short period of time (several hours rather than several weeks)?
4. Is the approach dynamic? In other words, does the analysis adjust to changes in conditions (dynamic) or does it require manual changes to weights used to prioritize needs (manual)?
5. Are the data required to run the system currently available?
6. What resources are required to implement and maintain the system over time?
7. Is this approach being used successfully in an agency similar to the SDDOT?

A variety of software options were evaluated using the selection criteria listed above. The evaluation included several pavement management software options, the FHWA's HERS-ST program, and other tools (such as Highway Development and Management System [HDM-4] originally developed by the World Bank). The results of the evaluation were disappointing in that none of the options clearly satisfied the capabilities desired by the SDDOT. In the absence of a viable tool for conducting this type of analysis, SHAs have developed at least two alternate dynamic approaches for evaluating investment options. Either the agency simplifies the definition of benefits so existing tools can be used (as the Utah DOT is attempting to do) or funding allocation decisions are based on needs rather than benefits (as in the case of the Iowa DOT). A number of state highway agencies (such as Wyoming, Colorado, and Oklahoma DOTs) are working on the development of tools to perform these types of analyses.

The Minnesota DOT uses a non-dynamic approach, in which the pavement management system is used as the first step in the project development process. Each program year, funds are allocated for safety improvements, geometric improvements, and the like, and projects are funded based on priorities established within each category of improvement. These types of scope enhancements end when funds are exhausted under these programs. Further restrictions are placed on the amount of money that can be added to a pavement preservation project beyond the surfacing requirements. For example, costs to address crash and safety issues on pavement preservation projects cannot exceed 15 percent of the surfacing costs unless funding comes from another source (such as safety funding, 3R, or maintenance). A similar type of restriction is used by the Oklahoma DOT for its pavement preservation program.

Washington State DOT makes funding allocation decisions based on an assessment of needs within each program area (e.g. bridges, pavements, and so on). The information is reported directly to the Secretary of Transportation, who makes adjustments on the level of funding that will be provided to meet these needs in conjunction with the Governor. Needs are defined in terms of work that is "due" (projects identified for rehabilitation in the specific biennium) or "past due" (projects identified for rehabilitation in a previous biennium). Each year, a policy decision is made to address a portion of the projects in the "past due" category based on the level of funding available.

In the absence of a feasible software analysis tool for conducting the benefit analysis, the research team concluded that an alternate approach should be recommended that builds on the Department's existing capabilities, addresses some of the immediate needs identified during this project, and moves the Department toward its eventual goal of developing a dynamic investment analysis approach based on benefits to the State. The research team concluded that there is not currently sufficient benefit to implement the HERS-ST program because its pavement analysis, which drives most of the projects included in the STIP, is so much less robust than what is currently available within the pavement management software. For instance, HERS-ST considers reconstruction and rehabilitation needs, but does not have the ability to consider the benefits associated with pavement preservation treatments such as the use of preventive maintenance treatments. Therefore, it cannot be used to evaluate the level of investment that should be made in pavement preservation activities, nor can it optimize the use of available funds. Instead, it allocates funds based on needs, which lends itself to more of a worst-first strategy.

Similarly, the findings did not reach the conclusion that moving to a different pavement management program provides any tangible benefits to the Department. The research team did not find any evidence of a different pavement management system that does a better job of addressing investment analysis options than the Deighton's Total Infrastructure Asset Management Solution (dTIMS) software. In fact, the Utah DOT has been exploring the use of dTIMS CT for a cross-asset analysis and officials there indicate they are optimistic about the capabilities provided within the software. The challenge is in setting up the parameters so it can be used in this manner.

Proposed Framework for Pavement Management

The proposed framework presented in figure 1-1 uses the results of a needs assessment as a first cut in setting performance targets and making investment decisions. This assumes that a database of statewide needs can be developed based on the scoping activities currently being conducted under the Department's C2C program. Pavement rehabilitation and reconstruction needs, minimum width deficiencies, and pavement preservation needs for the entire statewide system are identified using the pavement management system rules. Together with cost information, these needs assessments can provide the Executive Team with information needed to set investment levels and performance targets. For instance, at an investment level of \$10 M/yr, \$90 M in shoulder-widening projects can be eliminated in approximately 9 years. If the Executive Team feels this is not a reasonable timeframe, its members have the information needed to adjust the level of funding for these types of projects.

Ideally, a sophisticated spreadsheet tool could be developed to analyze these non-pavement-related investment options together with information exported from the pavement management system. A spreadsheet may be adequate because most of the more substantial needs remain relatively constant until they are addressed. For instance, the need for ADA enhancements remains constant and does not require different activities unless the federal requirements change. Because pavement conditions change annually, and require different treatments at different points in time, it is important that pavement needs continue to be identified using the pavement management system. However, the dollar costs associated with the needs can be imported into the spreadsheet tool for investment allocation decisions. For

the spreadsheet level analysis, the number of miles of pavement in various condition categories will be used to determine needs instead of analyzing individual road segment needs.

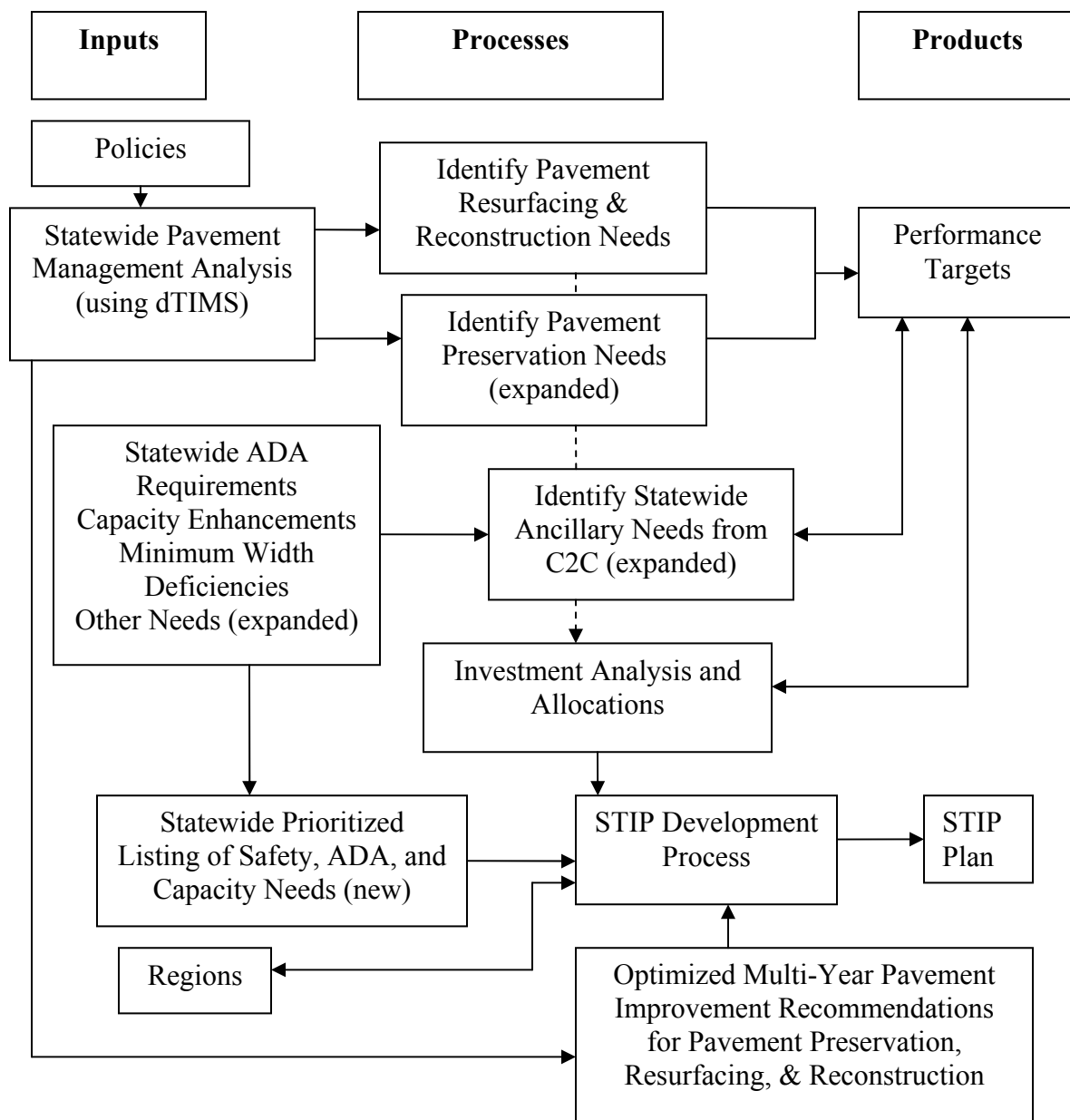


Figure 1-1. Modified Framework for the Pavement Management Process

Once the investment allocations are developed, the funding information is divided into funds for pavement preservation, resurfacing, and reconstruction as part of the STIP development. It is recommended that a formal pavement preservation program be established with stable funding so preservation treatments can be planned before substantial amounts of deterioration

are present. The pavement preservation funds should be optimized using the pavement management software to verify that the funding is being used to preserve pavement conditions (rather than be used as a stopgap repair). Pavement preservation funds must be used when a road is still in relatively good condition with little or no structural deterioration present. A series of planned pavement preservation treatments can be a very effective strategy for maintaining low-volume roads in good condition. The pavement preservation treatment recommendations must be closely coordinated with Region personnel to ensure that planned strategies are placed on a timely basis. By using the pavement management system to identify pavement preservation candidates a “check” is built into the process to verify that funds are only used on viable candidates. By analyzing pavement preservation needs in the pavement management system, the optimal level of funding for the pavement preservation program can also be determined.

The resulting recommendations from the pavement management optimization analysis provide the first cut of pavement preservation, rehabilitation, and reconstruction projects to include in the STIP. Pavement rehabilitation and reconstruction projects are matched to the prioritized list of safety, ADA, and capacity needs maintained under C2C to determine where additional scope improvements can be made. Funding for scope enhancements is provided until the limits established by the Executive Team are met. The enforcement of these limits is especially important to the success of this approach because every additional dollar spent on scope enhancements removes funding for pavement rehabilitation and/or reconstruction activities. Because performance targets will have been set based on assumptions about how much money is going toward each type of improvement, the only way to ensure that these performance targets are met is to enforce the funding allocations in accordance with the direction set by the Executive Team. One possible way to enforce that these limits are met is by establishing a Scope Consideration Committee to evaluate the impact of requests for scope changes that exceed a particular amount above the budgeted project funding. On pavement preservation projects, some state highway agencies (such as the Minnesota and Oklahoma DOTs) set a cap of 15 percent to be used on ancillary items to address safety needs.

This modified framework assumes the following changes are made to the current procedures:

- The current C2C scoping efforts are completed on the entire network and stored electronically so they can be evaluated economically.
- A process is developed to prioritize capacity, safety, and ADA needs.
- A sophisticated spreadsheet tool is developed to evaluate the consequences associated with different investments in certain needs. The spreadsheet summarizes the total needs in the areas of pavement, capacity, safety, and ADA requirements and has the ability to report the consequences of different spending levels in each area using information from the original data sources. Funding allocations to the interstate, major and minor arterials, and state secondary may be based on system allocation factors used in the past, but changes to these factors may be important to ensure that performance targets for the minor arterials are met. This decision should be made after evaluating several investment strategies using different system allocation factors.

- Performance targets are established to define the performance goals set by the Executive Team. These performance targets are linked to the investment analysis to determine funding allocations.
- Pavement preservation needs are considered in the investment analysis on a network basis. Similarly, pavement resurfacing and rehabilitation needs are considered in the investment analysis on a network basis instead of separating interstate and non-interstate activities. This will require enhanced analysis capabilities from the pavement management system, which cannot currently optimize on a network basis.
- A formal pavement preservation program is established with stable funding so Regions can plan pavement preservation treatments with the help of pavement management. Ideally, Regions will consider a broader range of treatments beyond chip seals once the pavement preservation program is formalized. The optimal funding for the program can be generated using the pavement management system software.
- Caps on the amount of money invested in safety, ADA, and capacity improvements on pavement rehabilitation and reconstruction projects are established and enforced. Limits are placed on safety and capacity enhancements associated with pavement preservation projects to limit the project size.

Recommendations

To support the pavement management framework, a number of changes are required to existing policies and practices. The recommendations included in chapter 6 address changes in each of these areas:

1. Revise the current pavement management process by adopting the recommended changes to funding allocation decisions. Section 5.6 outlines a framework for conducting an analysis of funding options that addresses many of the issues that prompted this study. The proposed approach considers investment needs in terms of pavement condition, safety and capacity enhancements, and ADA requirements. The success of the proposed framework is dependent on:
 - The development of a comprehensive statewide assessment of prioritized capacity, safety, and ADA needs through the C2C process.
 - The combined analysis of pavement preservation, resurfacing, and reconstruction needs for the interstate and non-interstate network.
 - The establishment and enforcement of caps on spending for non-pavement-related improvements.
 - The development of a sophisticated spreadsheet tool to estimate needs in support of funding allocation decisions.
 - A formal pavement preservation program based on recommendations from the pavement management system to verify funds are being used in a preventive manner.

- The use of performance targets to define strategic objectives.
2. Implement changes to the pavement management system in support of the recommended framework for investment decisions. Section 5.7 outlines a series of policy and procedural changes that are required to support the proposed framework for funding allocation decisions. Several specific changes to the pavement management system are required, including:
 - The implementation of the Enterprise version of the dTIMS software.
 - The inclusion of pavement preservation treatments into the analysis. This recommendation is already under way.
 - The development of simplified analysis models that can be used to quickly assess needs and to estimate the impact of different investment levels in pavement preservation, resurfacing, and reconstruction.
 - Modifying the treatment rules for reconstruction, especially on rural 2-lane highways, so the treatment is recommended less often on these types of roads.
 3. Address the policy conflicts that exist and eliminate their impact on assessing needs for funding allocation decisions. Section 5.7 identifies several recommended changes to existing policies. The recommendations include converting Policy RD-1998-4 from a policy to a guideline used in the scoping process and addressing the discrepancy between Policy RD-1998-4 and RD 1998-2 on rural 2-lane highways with ADT between 1501 and 2500. Although further investigation of the impact of the proposed change is recommended, the probable outcome is to modify the minimum width requirement for this category of highways used in the scoping process from 32 ft to 30 ft. The research team also recommends using the same guidelines outlined for the scoping process (those currently outlined in Policy RD-1998-4) as the factors used to estimate resurfacing and reconstruction needs for funding allocation in the pavement management system.
 4. Align the program development process. This recommendation requires earlier funding allocation decisions; the establishment and enforcement of funding caps on expenditures for capacity, safety, and ADA enhancements; a process for evaluating the impact of scope changes on pavement improvement projects; and funding allocations by system (because the current pavement management system cannot optimize project recommendations on the entire network).

2. PROBLEM DESCRIPTION

When pavement management systems were first introduced in the late 1970s and early 1980s, transportation agencies were operating under a very different environment than they are today. Early pavement management systems focused primarily on condition assessment techniques, and cumbersome computer tools were used to store, process, and retrieve information. As computer technology evolved and became more efficient and more accessible to transportation agencies, pavement management systems were increasingly used as tools to assist in the planning and programming activities associated with the identification and selection of pavement rehabilitation and reconstruction projects. Later, more sophisticated prioritization schemes and advanced performance modeling techniques were incorporated into many systems.

Today, pavement management systems need to operate in more of an integrated environment as part of an agency's asset management program. In addition, other changes in the transportation environment (such as increased accountability, an emphasis on preservation over new construction, and agency downsizing) require that pavement management systems address a broader range of demands than in the past. As a result, state highway agencies (SHAs) and other transportation agencies are re-evaluating their existing pavement management practices to help ensure that the pavement management system not only supports the agency's decision-making process but also provides the type of information needed to cost-effectively manage the agency's road network.

The South Dakota Department of Transportation (SDDOT) has been using pavement management practices since 1977 when the Rural Planning Inventory System was developed to assess needs based on an adjusted Pavement Serviceability Rating (PSR). By 1985 the system had three basic performance models available (the asphalt over concrete model was later eliminated) to predict a remaining service life, which represented the number of years until a threshold PSR was reached. Treatment needs and costs were based primarily on the year in which a pavement section fell below a PSR threshold and a priority ranking equation. Pavement needs were prioritized within each funding category in a worst-first order and were used in preparing the annual 5-year construction program.

In response to the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), a Pavement Management Task Force was established and changes to the pavement management system were initiated under SDDOT Research Project SD1993-14, *Enhancement of South Dakota's Pavement Management System*. The project resulted in a number of changes to the pavement management activities in South Dakota, including the following:

- The development of a pavement condition survey that includes pavement distress information.
- The development of individual and composite pavement condition indexes.
- The development of expert-based pavement performance curves to forecast future conditions.
- The development of revised treatment rules to reflect feasible treatment options.

- The implementation of new pavement management software that includes database storage and retrieval, as well as network optimization analysis capabilities.

That project culminated in the implementation of pavement management software provided by Deighton and Associates, LTD. The results of the implementation are presented in the final report and are summarized in SDDOT's *Enhanced Pavement Management System – Synopsis*. The pavement condition survey procedures are documented in SDDOT's *Visual Distress Survey Manual*, which was last updated in 2005.

Since the implementation of the new pavement management software, a number of subsequent research studies have addressed enhanced agency needs from the pavement management system. For example, SD1996-03, *Review of SDDOT Field Collected Roadway Data*, resulted in policies and procedures for the State's roadway data collection procedures that reflected the Department's needs, available resources, and current technology (at that time). As another example, project SD1997-05, *Statistical Methods for Pavement Performance Curve Building, Historical Analysis, Data Sampling and Storage*, resulted in the development of pavement performance models based on historical data to replace the expert models developed under SD1993-14. In addition to the development of the models, a modeling tool was developed and delivered to the SDDOT. More recently, SD2001-03, *Effects of Maintenance Treatments on Asphalt Concrete Pavement Management*, developed recommendations for better incorporating preventive maintenance treatments into the pavement management system.

Nevertheless, further changes within the Department and in the outside environment continue to impact the ongoing effectiveness of the SDDOT pavement management activities in terms of organizational and institutional issues, policy and procedural issues, national initiatives, and technical issues. For example, some of the organizational and institutional issues affecting the pavement management system include the following:

- There are conflicting priorities within the SDDOT for establishing reconstruction, resurfacing, and maintenance needs.
- The SDDOT organization continues to experience institutional restructuring, which leads to changes in the management processes, changes to the personnel available to support the pavement management activities, changes in the familiarity of agency personnel with the pavement management philosophy, and changes in the requirements of the pavement management system.
- Projections indicate future funding will be inadequate to maintain existing pavement conditions.
- The increasing emphasis on pavement preservation requires more of an interface between pavement management and highway maintenance personnel than existed when the pavement management system was implemented.

At the same time, there are several key policy and procedural issues within the SDDOT that impact the pavement management system, including the following:

- A pavement management system optimizes improvement needs across the network within imposed constraints such as budget limitations. This approach does not necessarily optimize the solution for an individual project, which may result in conflicts between treatment recommendations from the central office and field personnel. Additionally, the pavement management system optimizes the expenditure of funds based on improvements in pavement condition and traffic levels. Other factors, such as the contribution to improve safety or enhance capacity are not considered.
- Funding levels are not always sufficient for treatment recommendations to adhere to agency goals and policies.
- The SDDOT has modified its accounting and budgeting processes, which impacts the availability of funding for highway projects and results in some uncertainty in future funding levels.
- Some maintenance activities performed by field personnel are not recorded in the pavement management system, which affects the reliability of the system recommendations.

In addition to those Departmental issues, there are many national movements and initiatives that may have an effect on the SDDOT's pavement management system, such as:

- Many state highway agencies are establishing formal pavement preservation programs that incorporate the use of preventive maintenance treatments using dedicated funding to more cost-effectively manage highway networks.
- The National Cooperative Highway Research Program (NCHRP) is leading the development of a new Mechanistic-Empirical Pavement Design Guide (MEPDG) that is expected to be balloted through AASHTO later this year. The models require calibration that will demand more comprehensive pavement-related data than in the past.
- While pavement management systems have traditionally been used to support planning and programming functions, the FHWA (Federal Highway Administration) is promoting the use of pavement management systems to support engineering analyses. These types of studies, such as the investigation into the effectiveness of Superpave mixes, also place increasing demands on the availability of pavement performance, construction, design, and materials data. Anticipated changes in the reporting requirements for the FHWA's Highway Performance Monitoring System (HPMS) are also expected to increase the sophistication of the data needed from pavement management.

Finally, there are several critical technical issues that may impact the effectiveness of the pavement management system, including the following:

- The consideration of preventive maintenance treatments in a pavement management system requires that the effectiveness of these treatments be quantified in some way.

In several highway agencies, this has resulted in changes in the way pavement management systems are structured.

- The use of pavement management systems within SHAs has evolved since the implementation of the SDDOT software so that some agencies are using pavement management information to set budget allocations and to establish project match requirements. This requires a high level of confidence in the pavement management recommendations because of the degree to which they are integrated into the agency's decision-making processes.

As a result of these and other factors, the SDDOT initiated this research effort to conduct a review of its pavement management activities. This report summarizes the approach that was followed to address these issues in order to fully establish the future strategic direction for pavement management at the SDDOT.

3. OBJECTIVES

The request for proposal (RFP) for this project outlined four specific objectives to be achieved through the research effort. Each of the research objectives is discussed in this section of the report, along with a summary of how each goal was met.

Objective 1. Establish Consensus on Pavement Management Role & Functionality

Establish departmental consensus on the desired role and functionality of SDDOT's pavement management process in consideration of technical and organizational needs.

The first step in establishing the future direction for pavement management was to assess the needs of the organization through interviews with representatives of each of the various stakeholders. After first reviewing the current documentation provided by the SDDOT in task 1 and meeting with the Technical Panel during task 2, the research team conducted interview sessions that provided stakeholders an opportunity to identify their needs from the pavement management process. Individuals representing a broad range of functions within the Department were included in the sessions so the needs of both horizontal and vertical cross-sections of the agency were identified.

Consensus on the needs was developed during task 6, when the findings from tasks 1 through 5 were presented to the Technical Panel and Executive Team prior to a workshop in October 2006. At that time, Applied Pavement Technology, Inc. (APTech) submitted an agenda and content description for review as outlined in task 5. After approval from the Technical Panel, a facilitated workshop was conducted to develop recommended strategies for addressing any needed changes under task 7.

Based on the results of the facilitated workshop, a contract modification was approved to conduct a series of additional workshops that provided an opportunity to further explore options for establishing a strategic vision for pavement management. Three additional workshops were conducted to introduce economic analysis tools that are available to support investment decisions and to identify the advantages and disadvantages associated with various approaches to making investment decisions. The final workshop resulted in the identification of the strategic vision for pavement management that is recommended in this report.

Objective 2. Propose Pavement Management Policies & Procedures

Propose revised or new policies and procedures related to pavement management that are consistent with all practicable, administrative, organizational, and operational needs.

After the Department's needs were identified, specific strategies to help address the needs were developed. Inherent to these strategies is the development of new policies and procedures that support the decision process. Several tasks contributed to the successful completion of this objective. During task 4, policies and practices in other SHAs with practices similar to those needed by the SDDOT were identified and evaluated. These practices were incorporated into the October 2006 workshop conducted during task 7 to help identify feasible strategies for improving current practices.

Additional strategies were developed during the facilitated workshops conducted during task 7. A recommended strategy was developed during the series of workshops conducted in the summer of 2007. The recommended strategy was explored in more detail to determine the availability of tools to support the analysis as defined by the workshop participants. In the absence of any available tools, a modified strategy was developed. The proposed strategy and the changes to policies and procedures necessary to support the strategy are documented in this final report. Recommended changes to the existing policies are included in section 5.7 of this report.

Objective 3. Define Pavement Management System Requirements

Define the requirements of a pavement management system, including data collection, analysis, and reports, to effectively manage highway pavements in accordance with departmental philosophy.

The recommendations made during task 8 also include specific strategies that address changes to the existing funding allocation and project selection process. Where applicable, changes to the existing data collection, analysis, and reporting procedures were identified. The recommended changes are incorporated into this final report.

Objective 4. Assess Pavement Management System Capabilities

Assess the capabilities of SDDOT's current pavement management system and alternative systems to meet the newly defined functional requirements.

After the strategic direction was defined, software options to support the types of analysis required were evaluated. Several options were considered, including the implementation of new pavement management software, the use of economic analysis modeling programs (such as the Highway Economic Requirements System – State Version [HERS-ST] software provided by the FHWA) run in conjunction with pavement management software, and the reconfiguration of the Department's existing pavement management software. Recommendations for analysis capabilities to support the strategic direction developed during the workshops are included in the final report.

4. TASK DESCRIPTION

The research team conducted the project activities in accordance with the 12 tasks outlined by the SDDOT. This section of the report describes the research conducted during each task.

Task 1. Review SDDOT Pavement Management Documents

Review material furnished by the project's technical panel related to pavement management at the SDDOT, including departmental policies, the Department's strategic plan, and the current synopsis of SDDOT's enhanced pavement management system.

At the beginning of the project, a number of resources were provided to the research team to familiarize the team members with the current pavement management practices being used by the SDDOT. Under this task, the *SDDOT's Enhanced Pavement Management System – Synopsis* and the *SDDOT's Visual Distress Survey Manual* were reviewed to identify any changes since the research team's last involvement with these documents for SD2001-03, *Effects of Maintenance Treatments on Asphalt Concrete Pavement Management*. In addition, the four policy statements listed in the RFP and the 2006 SDDOT Strategic Plan were downloaded and reviewed. The policy documents provided the background for understanding the existing policies and practices within the SDDOT that impact the pavement management function. Using the results of a survey of pavement management practitioners conducted in April 2005, the research team conducted a comparison of SDDOT's existing pavement management practices to practices in other SHAs. The results of the comparison were presented to the Technical Panel during task 2.

Task 2. Meet with Project Panel

Meet with the project's Technical Panel to review the project scope and work plan.

A kick-off meeting with the SDDOT Technical Panel was conducted in August 2006 to review the scope of work and the work plan for this project. This half-day meeting provided an opportunity for APTech to discuss with the Technical Panel any recent changes that had taken place within the Department and to identify any specific areas of concern that needed to be addressed. It also provided an opportunity to verify the Panel's expectations for the project and to discuss the proposed approach for meeting the project objectives.

Several important topics were discussed with the Technical Panel during this meeting. For instance, APTech was interested in learning as much as possible about the recent organizational changes within the Department and the potential impact of these changes on the way the Department will manage pavements in the future. Additionally, the impacts of the personnel, policy, and philosophical changes that had taken place in the years since the enhanced pavement management system was implemented were discussed. The participants also identified several additional changes that might further impact the pavement management practices, such as the expected use of the pavement profiler and videolog van for conducting pavement distress surveys.

During the meeting, the research team also presented a comparison of the existing SDDOT practices to pavement management practices in other states and identified any obvious differences in practice. The survey results indicate that the data collection and analysis

procedures followed by the SDDOT are similar to practices used in other agencies. As in other SHAs, SDDOT expressed interest in expanding the range of treatments considered in the analysis to include more preventive maintenance treatments, such as chip seals.

At least two innovative concepts were presented to the meeting participants: the matching requirement used by the Colorado and Kansas DOTs and the web access to data available to employees of the Washington State DOT. The matching requirements established by both Colorado and Kansas are aimed at ensuring that projects recommended by the Districts (or Regions) provide a reasonable match to the optimal solutions recommended by pavement management. In Colorado, 70 percent of the Region's projects must match the pavement management recommendations in some manner (such as project limit, level of repair, and treatment timing). Kansas requires that 40 percent of the project miles must match the year 2 projects, 60 percent must match the year 2 or 3 projects, and 75 percent must match the year 2, 3, or 4 projects. This approach provides flexibility to the field personnel in selecting projects, but helps ensure that treatments are being used effectively on a statewide basis. It is also useful in helping to ensure that the Department's pavement preservation goals are achieved.

Task 3. Conduct SDDOT Interviews

Conduct pavement management overview and interview sessions with various groups in the SDDOT that impact, or are impacted by, pavement management activities, including: central office design personnel, central office finance and planning personnel, region/area office personnel, highway maintenance supervisors, pavement management system personnel, and the SDDOT Executive Team.

Immediately after the meeting with the Technical Panel, the research team began conducting interviews with key pavement management stakeholders to identify how the pavement management information was being used and how it is expected to be used in the future. The interviews took place August 21-30, 2006, in Pierre, Mitchell, Rapid City, and Aberdeen. A variety of participants within the Department were included in the interviews, including personnel from design, finance, planning and programming, pavement management, and regional/area offices, as well as highway maintenance supervisors and the SDDOT Executive Team.

Participants identified a number of important issues during the interviews. These issues were summarized into five categories and were presented in a workshop in October 2006. The comments were categorized into the following five areas:

- The Role of Pavement Management in Strategic Investment Decisions
- The Role of Pavement Management in the Project Identification and Selection Process
- Policy Issues
- Pavement Management Technical Issues
- Other Issues

The issues that were raised within each category are included in chapter 5 of this report. A full summary of the notes from the interviews was distributed to participants. It is also included in Appendix A to this report.

Task 4. Review Pavement Management Practices of Other State DOTs

Review pavement management practices at other state departments of transportation where needs are deemed similar to the SDDOT's and perform comparative analyses to identify pavement management practices that might be deemed distinctly practicable for South Dakota to implement.

The interviews conducted during task 3 provided the research team with a better understanding of the issues that needed to be addressed to improve the pavement management practices at the SDDOT. One of the first priorities for the research team became establishing a strategic vision for pavement management, which included aligning investment decisions, funding priorities, and Departmental policies and practices.

To assist with this activity, practices in several comparable SHAs were investigated in the following areas:

- Making decisions in a centralized versus decentralized environment.
- Establishing an effective pavement preservation program.
- Using performance targets at the strategic level.
- Addressing scoping issues that are unrelated to pavement condition needs.

After presenting the practices of several states at a workshop in October 2006, members of the Executive Team and selected SDDOT staff were provided an opportunity to discuss these types of issues in more detail to determine their appropriateness for addressing the needs identified during the earlier tasks.

Later in the study, after a strategic direction for making investment decisions was established, the research team widened its investigation into state practices to learn more about the use of economic analysis tools in selected SHAs. Specifically, practices in the Iowa DOT, the Utah DOT, and the Washington State DOT were investigated due to their reported use of economic analysis tools similar to those sought by the SDDOT. The findings from this investigation are reported in chapter 5 of this report.

Task 5. Propose Workshop Agenda & Content

Propose an agenda and content for a workshop that guides the SDDOT Executive Team and personnel involved with Pavement Management, Planning, and Design through a consensus-building process relative to the future role of pavement management at the Department.

The information compiled during the previous tasks was used in developing a 1½-day workshop agenda to determine the future role of pavement management. The proposed agenda for the first afternoon included a review of the existing procedures being used to manage pavements that provided a framework for understanding the needs identified from the interviews with the pavement management stakeholders.

The agenda for the next morning included a facilitated discussion to establish a strategic vision for the maintenance, preservation, and expansion of the State's highway network. This was followed by small group activities in the afternoon to discuss funding allocation, project selection, conflicts in existing policies, and communicating funding needs to the legislature.

Workshop materials were prepared in support of the agenda and for review by the Technical Panel as part of task 6.

Task 6. Present Findings of Tasks 1-5

Summarize the findings of tasks 1-5 and present them first to the project's Technical Panel and on the following day to the SDDOT Executive Team.

After the materials were finalized, the research team returned to Pierre, SD, to conduct the workshop with the SDDOT Executive Team and invited guests in October 2006. Immediately prior to the presentation of the material to the Executive Team, a shortened dry run of the workshop materials was conducted with the Technical Panel. This provided an opportunity to make any final revisions to the material before the presentation to the Executive Team.

The next day, the research team presented the workshop material to the Executive Team and the invited guests. The workshop was structured to both educate the participants on the capabilities of a pavement management system and to build consensus regarding the needs that must be addressed by SDDOT's pavement management system in the future. After the presentation of the various needs identified by the interviewees, the participants grouped the needs into categories and voted on the issues they felt were the highest priority for the Department to address. The results of the vote are included in chapter 5.

Task 7. Facilitate Workshops

Upon approval of the project's Technical Panel, conduct a facilitated workshop with the Executive Team and appropriate staff from the SDDOT that ultimately leads to recommended strategies for performing optimized pavement management at the Department, and that also includes illumination about any Department impacts that might result from any proposed changes.

Immediately after the needs workshop, a 1-day facilitated workshop with the Executive Team (and invited participants) was conducted to begin developing the vision for making pavement management decisions and to initiate the development of processes needed to support the vision.

At the conclusion of the workshop, it became apparent that there were a significant number of issues that needed to be addressed before a recommendation could be developed for an improved pavement management process. Therefore, the Technical Panel agreed to conduct several additional workshops with the Executive Team and invited guests to further explore strategies for making investment decisions. The first of the additional workshops introduced an economic analysis tool distributed by the FHWA for making investment decisions. Mr. Robert Mooney from the FHWA and Dr. Omar Smadi from the Center for Transportation Research and Education at Iowa State University were invited to speak on the HERS-ST software and how it is used to support investment decisions for the Iowa DOT. The second additional workshop provided an opportunity to identify the advantages and disadvantages

associated with some of the different approaches that could be used in making these decisions. Both of these workshops were conducted in June 2007. A final workshop was held in August 2007 to reach consensus on the direction for conducting pavement management. The results from these workshops were instrumental in establishing the research recommendations that are provided in chapter 6.

Task 8. Propose a Strategic Direction for Pavement Management

Propose and present, for review and approval of the Technical Panel, recommendations based upon the outcome of the facilitated workshop and sound pavement management principles, specifically laying out the strategic direction for pavement management at the SDDOT.

The series of workshops conducted during task 7 led to a vision for managing pavements that consists of two important components: an analysis of the benefits associated with various investment options and an economic analysis tool that can quickly analyze the investment options available to the Department.

Armed with an understanding of the vision, the research team investigated available tools to support the type of analysis desired. A number of options were investigated, including the feasibility of using pavement management software, the FHWA's HERS-ST tool, and other programs (such as HDM-4 developed by the World Bank). The findings from the investigation were disappointing with no obvious solution readily becoming apparent.

Therefore, the research team again met with the Technical Panel to discuss alternate strategies for meeting the objectives of this project. The results are summarized in chapters 5 and 6 of this report. Chapter 5 outlines the results of the investigation that took place, and chapter 6 presents the recommendations developed for strategically managing the State's pavement network.

Task 9. Prepare Draft Strategy, Policy, and Process Documents

Upon approval of the recommendations by the Technical Panel, prepare final drafts of the proposed SDDOT pavement management process, policy documents needed to support the process, and a recommended strategy for incorporating the pavement management working structure within the Department.

The difficulties in developing a workable pavement management strategy were discussed with the Technical Panel at a meeting on August 29, 2007. A revised approach for developing a strategy was agreed to at the meeting and the results are documented in this report. Additionally, recommendations for revisions to the Department's policies are documented in chapter 5.

Task 10. Define Pavement Management System Requirements

Based on SDDOT concurrence with the proposed pavement management process, develop a system requirements document that addresses data collection and management, analytical tools, hardware, software, and necessary training, along with estimates of costs and implementation timeframes to either upgrade SDDOT's current pavement management system or implement an alternative system.

To accomplish the desired approach to manage the State's pavement network, several analysis options were considered in terms of features such as functionality, cost, training requirements, data needs, maintainability, and resource requirements. The research team did not find any economic analysis tools that provide sufficient additional capabilities to warrant discarding the existing pavement management system and replacing it with an alternate system.

However, the current configuration of the pavement management software prevents it from easily being used to conduct the type of analysis desired by the Department for its investment analysis. Therefore, several specific recommendations for enhancing the existing pavement management software are included in chapter 6. In the absence of a recommendation to implement a specific software tool, a detailed system requirements document is not appropriate. Instead, the framework for an analysis process is provided in chapter 5.

Task 11. Prepare Final Report

Upon review and approval of the system requirements document by the Technical Panel, prepare a final report and executive summary of the research methodology, findings, conclusions, and recommendations.

This submittal represents the culmination of the research activities. The final report includes an Executive Summary and documentation of the project objectives, significant findings, and final conclusions and recommendations.

Task 12. Make Executive Presentation

Make an executive presentation to the SDDOT Research Review Board at the conclusion of the project.

The research team presented a summary of the project at a Research Review Board meeting on November 27, 2007. The presentation included a summary of the project objectives, the technical approach that was followed, significant findings from the research, and the final conclusions and recommendations.

5. FINDINGS AND CONCLUSIONS

This chapter presents the significant findings and conclusions from the study. The chapter presents the outcomes that emerged from each of the workshop sessions, which led to the development of the recommendations presented in chapter 6. The structure and organization of this chapter is outlined in table 5-1.

Table 5-1. Organization of Chapter 5

Section	Topic Discussed
5.1	Needs Assessment
5.2	Prioritized Ranking of Needs
5.3	Evaluation of Analysis Approach Options
5.4	Conceptual Framework for Managing Pavements
5.5	Systems Analysis
5.6	Modified Framework for Managing Pavements
5.7	Aligning Technical and Procedural Processes and Policies

5.1 Needs Assessment

To help assess the current operating environment within the Department, and to better understand the current role of pavement management in the identification and selection of pavement improvements, a series of interviews were conducted with more than 100 SDDOT employees in various locations throughout South Dakota. A detailed description of the issues that were raised is provided in Appendix A. This section of the report presents a brief summary of some of the issues raised during the interview sessions. The issues are categorized under the following headings:

- The Role of Pavement Management in Strategic Investment Decisions
- The Role of Pavement Management in the Project Identification and Selection Process
- Policy Issues
- Pavement Management Technical Issues
- Other Issues

The Role of Pavement Management in Strategic Investment Decisions

The following issues concerning the development of strategic investment decisions were raised:

- The long-term consequences on pavement condition of different investment levels in the interstate, major and minor arterials, and state secondary routes are not fully evaluated in making investment decisions. Similarly, the long-term consequences on pavement conditions associated with investments in capacity projects (such as interchanges) and urban/rural funding allocations are not fully evaluated.
- Current funding decisions on investments in resurfacing and reconstruction projects are based on needs in each category. Alternate investment strategies, such as optimal funding levels from a pavement management optimization analysis, are not fully considered in setting funding levels for these programs.

- Pavement needs are currently optimized by selecting projects with the highest benefit to cost ratio for the funding available (benefit is defined as the additional pavement performance provided by the treatment times a traffic factor). No other factors, such as safety enhancements, geometrics, or importance of the highway to the region, are considered in the pavement management system to prioritize recommended projects. If considered in the project selection process, these factors are taken into consideration outside the pavement management system.
- Maintenance treatments are not considered in the pavement management system so the projected impact of increases in maintenance funds on network conditions cannot easily be evaluated.
- Final budget numbers are available so late in the project selection process that it is difficult to generate and evaluate alternate investment strategies using the pavement management system.
- There is a desire for more strategic direction in terms of the Department's planned investments in reconstruction and resurfacing. For instance, if funding levels are not adequate for reconstruction projects on the secondary system, and a decision is made to limit the number of reconstruction projects on this system, then this information should be communicated to those involved in scoping and selecting projects for inclusion in the Statewide Transportation Improvement Program (STIP). It is felt that this information would help Executive Management report overall needs to the legislature and would help Region and Area personnel respond to public inquiries.
- Strategic directives are also desired so the Department has a more consistent answer to questions regarding what the network should look like and how it should be maintained.
- There is general consensus that funding levels over the past few years were adequate for addressing a large percentage of the State's pavement needs. However, there is a sense that this trend is changing, especially in light of increasing material costs in recent years. In previous years funding was adequate to allow 1.4 to 2.0 million tons of asphalt to be placed in a year. In 2006, because of dramatic increases in material costs, the State could only place 800,000 tons of asphalt. This is expected to result in a drop in average pavement conditions.
- There are differences of opinion regarding the level of investment that should be made in low-volume roads across the State. While it is recognized that roads with high traffic volumes are probably a higher priority for funding, individuals reported that some portion of the road investment should be made on factors other than average daily traffic (ADT) so a minimal acceptable condition level can be maintained on the low-volume road network within the State. Establishing minimal acceptable conditions, or performance targets, are examples of strategic decisions.
- There were varied opinions regarding the advantages and disadvantages of allocating rehabilitation and reconstruction funding to the Regions (as in a more decentralized organization). Some Region personnel indicated that this change would assist them in

planning and scheduling work and would allow them to better communicate to the public. However, a number of individuals expressed concern that by allocating funding to specific Regions, the State may be moving away from an optimized program.

- Although not well known within the agency, pavement performance measures for each functional class of highway have reportedly been established based on the percentage of the road network in certain condition categories.
- Pavement management is perceived to be more valuable in times of adequate funding than in times of limited funding because there is a tendency to revert to a “worst-first” strategy during times of limited funding. Ironically, pavement management practitioners generally consider a pavement management system more important when funding is limited to keep agencies from reverting to a worst-first philosophy.
- The Executive Team expressed interest in receiving timely outputs from the pavement management system that enables them to evaluate the impacts of various investment trade-offs. Using the information provided, strategic decisions regarding funding and performance targets could then be established.
- The current use of the term “backlog” is not well understood, and as a result it is not used in making strategic decisions. Similarly, terms like “Remaining Service Life (RSL)” are not used for this purpose.
- Several individuals reported that the Department is “overprogrammed” for future years. This is expected to have significant consequences on future STIPs.
- Region and Area personnel are more concerned with overall highway maintenance needs than functional class distinctions and level of service differences between highway classes.
- Pavement management information has the potential to diffuse political interests in funding allocations or project selection if “tolerance levels” are established for various locations or highway classes.
- The priorities within the Department vary. Some report that preventive maintenance and safety are priorities, but funding allocations indicate capacity issues and interstate conditions are the highest priorities.
- There is a perception that the level of maintenance is not consistent across the State.
- A number of low-volume roads have traffic volumes below those normally included in a state highway system, but State law mandates that towns of more than 450 must be connected to the State highway system.
- Although the Bridge Division has been able to establish a strong preventive maintenance program over the years, there is more of an emphasis on resurfacing and reconstruction on the highway side.

The Role of Pavement Management in the Project Identification and Selection Process

The following issues concerning pavement management's role in the project development process were raised:

- The pavement management system is used as the first cut in identifying project needs based on the results of the optimization. However, once project scoping occurs, project costs change dramatically due to treatment decisions, policy requirements, federal requirements, Region requests, expanded project limits, and other factors. There is currently no accepted approach for prioritizing projects once the scope has expanded beyond pavement condition requirements to include desired geometric improvements, capacity enhancements, and Americans with Disabilities Acts (ADA) requirements (for example).
- Safety and geometric issues are not incorporated into the pavement management optimization process so project recommendations are based primarily on pavement conditions and traffic volumes.
- The number of different treatment scenarios that pavement management can generate to assist with the project identification process is limited by the length of time between the update to RES and the timing of the STIP process.
- Once the pavement management system is used to identify possible interstate needs, pavement management is not involved in the programming of final treatments. Interstate programs are developed separately from programming activities for the remainder of the network.
- In general, there is agreement with the needs identified by the pavement management system. Where there are differences, they occur more in the priorities, recommendations for the appropriate treatment, and/or year when the treatment is optimized.
- There are a number of high-volume State secondary routes with traffic levels higher than some arterials that are not being funded due to the funding levels allocated to the secondary system.
- There are some inconsistencies between assigned functional class categories and peoples' perception of the road's use or importance to the State.
- Truck traffic on non-interstate routes in some Regions is increasing due to the growth in the number of grain trucks and ethanol plants in the State. The highway system around these locations is deteriorating at an increased rate, but the low traffic volumes limit these roads from inclusion in the STIP.
- The incorporation of needs identified through Concept to Contract (C2C) into the pavement management process has not been fully defined, although it is clear a primary objective is to more fully scope project needs early in the project development cycle. Of particular interest is a process for prioritizing scoped items within overall budget constraints and a method for weighing the needs against pavement priorities.

- There are a number of changes in the STIP each year caused by changes in funding, priorities, and/or pavement needs. This makes it difficult for executive management and Region personnel to communicate with the public regarding upcoming projects and to plan maintenance activities effectively. Additionally, the long-term consequences of these changes are not understood or analyzed as part of the decision process.
- There is a strong inclination on the part of the Regions and the public to do more reconstruction projects than resurfacing projects. This is especially true in light of the fact that fairly long intervals of time pass before subsequent treatments on the same road. As a result, Region and Area personnel want to address as many of their geometric (and other) concerns as possible once a project gets into the program. However, less funding for reconstruction projects is expected in future years.
- There is some concern that the Regions' maintenance practices negatively impact a project's ability to be recommended by the pavement management system. To address this concern, minimal maintenance is applied to pavement sections expected to be good candidates for the STIP. However, if a project does not make it in the program, or the year of the treatment should change, an unusually large percentage of the Region's maintenance budget could be needed to keep this section in serviceable condition.
- Some of the Region personnel have sufficient knowledge of the pavement management system to be able to overcome some of its shortcomings. For instance, some Regions ask pavement management to turn off the reconstruction option on some projects since that treatment is not likely to be funded due to low traffic volumes. As a result, these projects are only considered for resurfacing, which gives them a better chance of being included in the program.
- It is not clear to all Region managers how projects are prioritized in the pavement management system.
- There is general consensus that the Department is doing a better job in project and treatment selection with the pavement management system than before it was implemented.
- There is a desire to spread work around the State to some degree so contractors remain viable in all Regions.
- In some rural areas, there are concerns with the distance of the various sections from maintenance materials. Unless resurfacing projects are funded in the area, it is difficult for maintenance crews to get material for maintenance patching.
- Several Regions are finding success with filling ruts to address needs. The public reaction to these treatments has been positive.
- Chip seals are an important treatment strategy for low-volume roads within the State. Because of their importance, the first chip seal following a resurfacing project is often funded with construction dollars. Later chip seals are funded through contract

maintenance funding. Region personnel report that they are on a 5- to 7-year cycle for placing chip seals, but they would like to see a shorter cycle. Although additional funds were allocated for maintenance recently, most of the additional funding has been offset by rising material costs so the increased funding has not resulted in additional miles being treated.

- In South Dakota, chip seals are classified as maintenance treatments so they are not considered in the pavement management system as a preservation treatment option and cannot be funded using construction dollars. However, some states consider chip seals (and other preventive maintenance treatments) as part of a pavement preservation program, which can be funded using construction dollars.

Policy Issues

The following issues were raised with regard to existing Departmental policies.

- Current 3R policies are based on federal funding categories and traffic volumes. Exceptions to the design policies are granted in instances when funding is not available to bring sections up to standards. Exceptions to the policies are determined during the scoping process and require that an approval process is followed.
- Policies dictate shoulder widths based on traffic levels. In some cases, Region personnel feel adequate shoulder widths are provided even though existing shoulders do not match those specified in the current policy.
- The SDDOT is realizing increasing pressure from the FHWA to verify that its activities comply with internal policies.
- There are a number of instances in which low-volume roads are considered in the pavement management system as candidates for reconstruction. However, because of the low traffic volumes, a more viable strategy for inclusion in the STIP is to recommend the project for resurfacing. In some instances, Region personnel request that pavement management turn off the reconstruction option because it is not practical. These types of considerations might be taken into account more formally in the pavement management system if changes were made to existing policies.

Pavement Management Technical Issues

The following technical issues were raised with regard to the pavement management system:

- The pavement management system analyzes project lengths that are often smaller than will be constructed in the field. As a result, there are more sections to analyze, and the Regions find the information cumbersome to work with.
- The pavement management software is limited in the types of analyses that can be generated using the current number of sections, treatment options, and performance models.
- Preventive maintenance treatments such as chip seals are not incorporated into the pavement management analysis, largely due to analysis constraints. Some Regions track their chip seal cycles using spreadsheets or other tools.

- There are some concerns about the consistency and accuracy of the pavement condition ratings obtained using temporary employees. In contrast, bridge inspections are performed by permanent employees using a standardized national rating process.
- The distress data currently being collected in the pavement condition surveys are not identical to the distress types predicted in the new Mechanistic-Empirical Pavement Design Guidelines being developed by the National Cooperative Highway Research Program (NCHRP). This will impact the Department's ability to easily calibrate the performance models used in the M-E Design program. (Note: recommendations in this area were included in the final report for SD2005-01 and are not included here.)
- There is limited use of pavement management information at the Region or Area level beyond what is presented in the Needs Book. Area personnel report that the information provided to them is often cumbersome to use. Suggested improvements include maps showing optimized projects and treatments, the identification of the projected year in which recommended treatments are no longer viable (the project drops to the next condition category), the beginning and ending Mile Reference Markers (MRMs) [by projects, not segments], and so on. The timing for the delivery of this information was also mentioned because the material arrives immediately prior to the field visits so there's not sufficient time to review it.
- Unless someone from the Region alerts Pavement Management to the locations of maintenance patches, the rating crews cannot easily distinguish between maintenance patches and overlays in the field. As a result, the ratings for these sections are typically very high and may force a section to be a lower priority for consideration in the STIP.
- The pavement management software needs to be able to lock any combination of the following variables to force the optimization once certain projects have been identified and scoped: treatment year, project length, cost, or treatment type. With the exception of manually defining specific treatment rules that match the requirements for each section included in the STIP, this cannot currently be done (currently all features must be fixed). For instance, if a treatment is set for a particular project, it would be helpful to fix the treatment and re-analyze the section to determine the best year for the treatment to be done. At the present time, the pavement management system requires the treatment type, year, cost, and length to be fixed so this type of re-optimization cannot be conducted.
- At one time, there was an active Pavement Management Steering Committee to provide guidance to the Pavement Management personnel. However, because the purpose of the Committee is no longer clear, the Committee has not formally met for several years.

Other Issues

A number of other issues were raised during the interviews. These additional issues include the following:

- The Needs Book provides some useful information to the Region personnel, especially the age of last treatment. Some Region personnel expressed interest in having copies of the Needs Book available to Maintenance Supervisors. Others reported interest in

getting a condensed version of the information provided immediately prior to the scoping trips, such as map displays rather than tabular listings of data.

- Educational overviews on pavement management would be beneficial to SDDOT personnel who are impacted by its recommendations. A suggestion was made for a 1-day training course on a 2-year cycle.
- It was suggested that the Department needs an external communication plan for dealing with the public. The importance of this is expected to increase as funding availability decreases.

5.2 Prioritized Ranking of Needs

The information from the interviews was presented to the Executive Team at a workshop in October 2006. During the workshop, participants discussed a number of strategies for addressing the needs described in the previous section. To help determine the highest priorities, participants were allowed to cast two votes for their highest-priority items at the end of the meeting (a total of 34 votes were cast). This section reflects the relative importance of each item to the workshop participants and the strategies that were identified to help resolve each issue.

Address Funding Allocation Issues (9 votes)

To address the identified funding allocation issues, the following suggestions were offered by the workshop participants:

- In the current funding allocation process, interstate needs are funded first and the remaining funds are available to address the rest of the network needs. Alternatively, all highway funding for highway improvements could be combined so that the highest priority needs, regardless of system (such as interstate, major arterial, minor arterial, or state secondary), are funded first until the available funding is depleted. In this way, interstate projects will compete with the needs of other systems in accordance with priorities established by the Department. The results of this alternate funding strategy should be compared to the results of an analysis using the current funding allocation process to identify differences in the projects selected and to determine which strategy best matches the Department's priorities.
- The system importance factors that are currently used in the funding allocation formula should be revisited to ensure they reflect the current priorities within the Department.
- A reasonable funding level should be established each year for urban projects in rural towns. This will constrain the amount of money spent on these projects each year and could lead to a process for prioritizing requests from local agencies.
- The funding allocation process must accommodate special projects. However, the resulting consequences caused by reducing the amount of funding available for pavement preservation and improvement projects should be communicated to decision makers.

Establish Minimum Condition Levels (8 votes)

To better communicate funding needs, it is important to establish a minimal condition level for the pavement network. This minimum condition level is an important component of the Department's communication strategy to convey pavement needs to the legislature and the public. The following suggestions were offered by the workshop participants:

- At least two minimum condition levels should be established—one for the interstate and one for the non-interstate facilities.
- For internal purposes, the minimum condition information should be defined in terms of an index. However, for communicating outside of the Department, a less detailed method (such as a report card format with letter grades from A to F or a Good/Fair/Poor classification) should be considered.
- The minimum condition level should be considered the worst condition allowed. Funding associated with this condition level should be considered an absolute minimal level of funding. To achieve desirable conditions, a higher funding level will be required.

Incorporate Safety and Geometric Needs Into the Program (7 votes)

When asked to identify the order in which they would address highway safety, pavement condition, and capacity improvements, the workshop participants indicated that capacity improvements were their lowest priority. There was nearly equal support for highway safety and pavement condition improvements. However, the participants seemed to agree that safety improvements compare favorably to pavement condition improvements as long as pavement conditions are maintained at existing condition levels. The participants indicated that if pavement conditions were to drop, they would probably place pavement conditions above safety needs, such as inadequate shoulder widths. However, in many cases it is difficult to differentiate the two because improvements in pavement condition can address some types of safety needs. To fully represent the Department's road needs, the pavement management analysis should incorporate both safety and geometric considerations with the pavement condition information currently being considered to determine appropriate treatments and to prioritize projects. To address this need, the following suggestions were offered by the workshop participants:

- The Regions need to have some confidence in the year a project will be funded so they can more cost-effectively schedule their maintenance activities.
- A certain amount of funding should be allocated to safety and geometric needs each year to ensure these needs are being addressed.
- Minimum condition levels should be defined to identify safety and geometric needs to be funded as safety improvements. These should include minimum standards for State-maintained routes through cities. The minimum conditions established should be revisited at least every 5 years.
- The Department should evaluate whether the resurfacing/reconstruction split currently used in the funding allocation process is necessary on the non-interstate system. The

participants indicated that unless road standards change, a limited number of miles will be regraded each year.

Include the Full Range of Treatments in the Pavement Management Analysis (5 votes)

To improve the effectiveness of investment decisions, the pavement management system should consider a full range of treatments, ranging from preventive maintenance to regrading (reconstruction) activities. Because the current pavement management analysis does not consider preventive maintenance treatments, the following suggestions were offered by the workshop participants:

- The treatment options considered in the pavement management system should be expanded to include preventive maintenance treatments such as chip seals and heave repair.
- The use of structural pavement condition information in the treatment selection process should be increased to better define where more substantial treatments are needed.
- The Department should consider reclassifying chip seals as a type of pavement preservation activity rather than a maintenance activity so these projects are eligible for construction dollars. This change will not increase the amount of construction funding available, but would provide a programmed treatment option for low-volume roads.
- The Department should evaluate the feasibility of allocating pavement preservation funding directly to the Regions and allowing the Regions to manage these funds and select preventive maintenance projects.
- The pavement management system should be enhanced to demonstrate the benefits associated with increased funding in pavement preservation activities.

Define Statewide Priorities (5 votes)

The issue of establishing statewide priorities for selecting projects should be revisited to ensure that the current project selection process and the pavement management optimization process are in sync. The following suggestions were offered by the workshop participants:

- Pavement condition and safety improvements are the top priorities among workshop participants. Therefore, the optimization process used in the pavement management system for prioritizing project recommendations should be examined to ensure that both pavement condition and safety improvements are considered.
- The projects selected for funding each year should reflect the Department's priorities.
- Funds allocated to capacity improvements should be limited, as much as possible, so that pavement conditions and safety needs are not deferred.

- Flexibility must be built into the project selection process to allow the Department to respond to political demands, public pressures, and other initiatives. However, the consequences of diverting funding needed for pavement condition and safety improvements to capacity and/or economic development projects should be communicated to decision makers.

Other Recommendations

Several other suggestions were included in the discussion, but were not recognized as high priorities among the workshop participants. However, because they were identified as items to be addressed, they are included in this record. These items include the following:

- The Department should develop an effective method of communicating its funding needs to the legislature and to the public. The message should clearly communicate the Department's priorities and should present the consequences associated with diverting funds from these priorities.
- A number of policy issues should be addressed to eliminate confusion in the project selection process. Specifically, the following issues were identified:
 - A policy for gravel roads should be established.
 - Policies should set recommended maximum limits on in-slopes.
 - The minimum width criteria incorporated into Policy RD-1998-4 should be revisited.
 - The conflicts caused by using maximum roadway widths from Policy RD-1998-3 and minimum widths from RD-1998-4 for treatment selection in the pavement management system should be resolved so the recommendations better match the Department's practices.

5.3 Evaluation of Analysis Approach Options

The next step in the process of developing the new vision was to discuss the advantages and disadvantages associated with different strategies for approaching investment analysis decisions. To facilitate this discussion, a workshop with the Executive Team was conducted on June 22, 2007. The workshop was structured so that a number of options for evaluating investment decisions were presented to the participants so the advantages and disadvantages of each approach could be identified. A summary of the feedback provided by the workshop participants is provided in Appendix B.

Several specific preferences emerged from the workshop and shaped the final vision recommended through this study. For instance, based on the feedback from the workshop participants, it became clear that a benefit analysis capable of considering a broader range of investment options (such as pavement condition, safety considerations, and capacity enhancements) would greatly assist the Executive Team in making investment decisions. This assumed that needs on low-volume roads were not ignored in instances where the benefits were not sufficient to compare to needs on higher-volume facilities. It further assumes that benefits beyond improvements to pavement condition can be considered and that a statewide

analysis can be conducted quickly enough to be considered responsive to the needs of the Executive Team and the State's Legislators. Some of the strongest advantages to this approach are listed below:

- Provides a dynamic approach for optimizing investment options that adjusts to actual conditions.
- Considerations such as safety, urban improvements, and corridor enhancement options can be considered with pavement condition information.
- Enables timely responses to inquiries by upper management and elected officials.
- Provides a rationale for making investment decisions.
- Quantifies the impact of different investment levels in preservation, safety improvements, and other statewide programs.
- Addresses a broader range of customer interests.

The participants recognized that although the use of a benefit analysis would provide a number of important benefits, a number of considerations would have to be made outside of the analysis. For instance, the decision to address low-volume roads to provide a minimum level of service would likely require a policy decision because these roads typically do not have the traffic levels needed in a benefit analysis. Other improvements with benefits that are difficult to quantify, where rules may be difficult to develop, or where data to calculate benefits are not available would also need to be analyzed outside the framework of this analysis. Examples include stand-alone projects such as Intelligent Transportation Systems (ITS) or Port of Entry projects. By keeping the number of exceptions to a minimum, the participants did not believe these limitations precluded the use of a benefit analysis for investment decisions.

5.4 Conceptual Framework for Managing Pavements

The results of the June 22 workshop were further developed into a conceptual framework that could be used by the Department to identify policy and procedural changes needed to support the new analysis approach. In developing the framework, the following considerations were taken into account:

- The analysis must be able to demonstrate the benefits associated with alternate investment levels in both capital improvements and preventive maintenance strategies.
- At a minimum, funding requirements for the following scenarios are needed:
 - A minimum desired condition level for each system.
 - A targeted condition level for each system.
 - The maintenance of existing conditions on each system.
- The program should help establish maximum funding levels for capacity enhancements, ADA requirements (especially in rural towns), and state secondary safety needs to limit the amount of funding diverted from pavement condition needs.

- The Department needs methods to evaluate alternate interstate investment levels to better understand the impact of interstate projects on funding available to address the needs on the rest of the state highway system.
- There is a need for more flexibility in the funding allocation process to address priorities established during the workshop.
- A broader range of treatment options should be considered in the pavement management system.
- The complexity of the existing pavement management system may be limiting the Department's ability to run these types of analyses.
- Funding of chip seals with construction funds may be possible if chip seals are reclassified as preservation treatments rather than as maintenance treatments. This has the potential of increasing the effective use of chip seals as a programmed treatment on low-volume roads.
- The Regions are interested in having more control over funding allocated for pavement preservation activities so they can better coordinate the use of maintenance dollars.

The resulting framework encompasses an integrated approach that links policies and performance targets to data and analysis needs that facilitate the analysis of system trade-offs as shown in figure 5-1. As indicated by the workshop participants, the biggest difference between this figure and the current processes is the link between the long-term vision and the policies and performance targets. In the past, it was reported that these two components have not always been connected, which has led to conflicts in developing an improvement program.

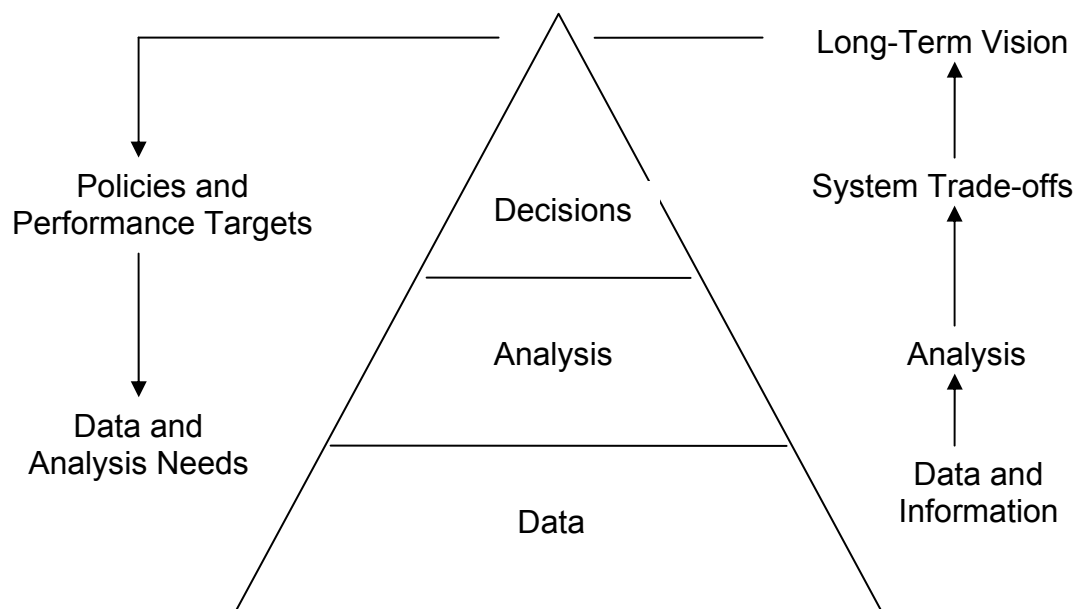


Figure 5-1. Strategic Pavement Management Decision Concept

Building on this concept, a new strategy for evaluating investment options at the SDDOT was identified. The desired strategy takes into account a broad range of needs, including those requiring resurfacing, reconstruction, lane or shoulder widening, and alignment improvements. Ideally, the benefits associated with these investment options are considered in allocating funding so investment decisions can dynamically shift as funding levels and/or network needs change. Although economic impact considerations were also determined to be important in making funding decisions, the ability to quantify economic benefits was not considered feasible at this time. However, the consideration of economic impacts associated with various investment options would enhance the Department's investment analysis as improved tools to support this type of analysis become available in the future. The current basis for making funding decisions, and the desired progression that will take place over time, are shown in table 5-2.

Table 5-2. Progression of Factors Considered in Making Funding Allocation Decisions

Timeframe	Types of Benefits Considered			
	Pavement Condition	Safety	Capacity	Economic
Currently	X			
Desired	X	X	X	
Future	X	X	X	X

This approach is different from the way business is currently conducted at the SDDOT. For one thing, it encompasses an analysis of a broader range of investment options than in the past. Previously, pavement condition and policy rules have driven most project needs. Ancillary needs, such as those required to meet ADA requirements, have been added through the Project Identification Coordinators (PIC) process. In the existing system, projects driven by something other than pavement condition cannot be easily analyzed and, as a result, there has been little basis for determining what level of investment should be made in these projects and what impact the funding decisions will have on the resulting pavement conditions. The desired approach considers the benefit of each project as the primary basis for evaluating and optimizing investment levels and for estimating the funding needs for the highway system. This creates a dynamic analysis environment that can adjust to changes in funding levels and changes in system needs that cannot easily be accounted for in the existing system. Additionally, it provides the Department flexibility in allocating funding while quickly quantifying the impact of different allocations on statewide priorities.

The desired approach for making funding allocation decisions consists of the three steps outlined below:

- Step 1: Define benefits for a broad range of investment options, including pavement preservation, widening shoulders, adding lanes, and so on. Benefits must consider factors such as safety and capacity improvements as well as the improvement to pavement condition currently considered in the analysis. Over time, as the ability to consider economic benefits to the State is addressed, these types of benefits will also be defined.

- Step 2: Conduct a network-wide analysis of investment options using project benefits and costs to optimize the expenditure of available funding on the interstate and non-interstate systems.
- Step 3: Implement the investment strategy that best meets Departmental goals and objectives.

5.5 Systems Requirements

Once the conceptual framework for making investment decisions was determined, the research team evaluated a number of economic analysis tools using the following criteria:

1. Does the analysis consider the benefits associated with alternate investment strategies in determining the optimal combination of investment options?
2. Does it consider a broad range of investment options, including pavement preservation and reconstruction, safety enhancements such as shoulder widening, capacity enhancements, and requirements under the ADA?
3. Can a network-wide strategy be conducted within a relatively short period of time (several hours rather than several weeks)?
4. Is the approach dynamic? In other words, does the analysis adjust to changes in conditions (dynamic) or does it require manual changes to weights used to prioritize needs (manual)?
5. Are the data required to run the system currently available?
6. What resources are required to implement and maintain the system over time?
7. Is this approach being used successfully in an agency similar to the SDDOT?

A variety of software options were evaluated using the selection criteria listed above. The evaluation included several pavement management software options, the FHWA's HERS-ST program, and other tools (such as Highway Development and Management System [HDM-4] originally developed by the World Bank). The results of the analysis are presented in table 5-3.

The results of the evaluation were disappointing in that none of the options clearly satisfied the capabilities desired by the SDDOT. In the absence of a viable tool for conducting this type of analysis, SHAs have developed at least two alternate dynamic approaches for evaluating investment options. Either the agency simplifies the definition of benefits so existing tools can be used (as the Utah DOT is attempting to do) or funding allocation decisions are based on needs rather than benefits (as in the case of the Iowa DOT).

The Minnesota DOT uses a non-dynamic approach, in which the pavement management system is used as the first step in the project development process. Each program year, funds are allocated for safety improvements, geometric improvements, and the like, and projects are funded based on priorities established within each category of improvement. These types of scope enhancements end when funds are exhausted under these programs. Further restrictions are placed on the amount of money that can be added to a pavement preservation project beyond the surfacing requirements. For example, costs to address crash and safety issues on

Table 5-3. Software Evaluation

Evaluation Criteria	HERS-ST	Pavement Management Software			HDM-4
		Existing Configuration	New Configuration of Existing Software	New Software	
1. Benefits used to determine optimal investment strategies?	No. Benefits are used to evaluate needs, but no optimal strategy options are considered	Yes. A benefit/cost analysis is conducted using improvements in pavement condition and traffic levels	Not yet. A modified configuration of dTIMS is being developed by the Utah DOT to consider resource allocations for pavement needs, bridge needs, and safety needs. The Asset Manager for the Utah DOT reports that this is still several years away from being developed	Not beyond the current configuration	Yes. The analysis optimizes the use of funds based on an analysis of both agency and user costs
2. Broad range of investment options considered?	Yes. Pavement rehabilitation and resurfacing, capacity enhancements, and safety enhancements are considered	No. Investment options are limited to needs based on pavement condition and minimum width requirements	Not yet. A matrix that defines benefits and risks associated with various projects needs to be developed	No. The research team is not aware of any other pavement management software that considers a broader range of investment options	In addition to pavement condition improvements, HDM-4 considers both road user and environmental effects, such as travel times, fuel consumption, and safety
3. Network strategy conducted quickly?	Yes.	No.	Yes	Depends on configuration	Unknown
4. Dynamic approach?	Yes. As needs change, the resulting recommendations change	Yes. As needs change, the resulting recommendations change	It will be. As needs change, the resulting recommendations will change	Yes. As needs change, the resulting recommendations change	Yes. As needs change, the resulting recommendations change
5. Data available within the SDDOT for this type of analysis?	Yes. According to a cursory review by the FHWA HERS-ST representative, most data needs appear to be available in existing sources	Yes.	No. Benefit and risk models will need to be developed for capacity and safety enhancements	N/A	No. The HDM-4 models use different indicators of pavement performance than currently used by the SDDOT. Additionally, parameters for the evaluation of road user effects would need to be defined
6. Resources needed?	Training in the use of the program would be required and an individual would need to be assigned responsibility for conducting the analysis, customizing the models, and maintaining the data	No additional resources are needed	Resources will be required to develop benefit and risk models. An updated version of the software needs to be acquired to run the statewide analysis. In 2006, the Enterprise version of the software was estimated to cost \$100k and a SQL server is required	Funding for the new software would be required, at a cost estimated to be between \$100k and \$200k (plus annual licensing fees). Training on the new software would be required and resources would be needed for the conversion from one program to another	A license for the software is available for \$3,000. In addition to the cost of the software, training on the use of the program would be required, as would resources to convert to the new software and customize the models to conditions in South Dakota

Evaluation Criteria	HERS-ST	Pavement Management Software			HDM-4
		Existing Configuration	New Configuration of Existing Software	New Software	
7. Used elsewhere for investment analysis?	Yes. A number of states use HERS-ST for making investment decisions, including the Iowa DOT	Similar configurations are used elsewhere to determine pavement needs	No. Although earlier reports indicate that this analysis is being used by the Utah DOT, officials there report that they are several years away from having this type of tool available	No, not in the way desired by the SDDOT	The program is used in a limited capacity by the Washington State DOT. Washington State DOT uses HDM-4 to analyze its investment options for pavement condition, using the program to help determine investment levels for rehabilitation and preventive maintenance. The user cost models are not being used. In essence, Washington State DOT is using HDM-4 as their pavement management system.
8. Other considerations?	The program is distributed at no cost by the FHWA	There is no limit placed on additions to pavement improvement recommendations	Utah DOT sees potential in the capabilities of the dTIMS CT software, but recognizes the challenge is in setting up the models	The type of investment analysis desired by the SDDOT is broader than the typical pavement management analysis so it would be unusual to find pavement management software capable of running this type of analysis. dTIMS is an exception because of the flexibility it provides in defining models	HDM-4 is used extensively by developing countries outside the U.S. The applicability of the models to conditions in the U.S. is unknown. Washington State DOT customized the performance models to conditions in their State.

pavement preservation projects cannot exceed 15 percent of the surfacing costs unless funding comes from another source (such as safety funding, 3R, or maintenance). A similar type of restriction is used by the Oklahoma DOT for its pavement preservation program.

Washington State DOT makes funding allocation decisions on an assessment of needs within each program area (e.g. bridges, pavements, and so on). The information is reported directly to the Secretary of Transportation, who makes adjustments on the level of funding that will be provided to meet these needs in conjunction with the Governor. Needs are defined in terms of work that is “due” (projects identified for rehabilitation in the specific biennium) or “past due” (projects identified for rehabilitation in a previous biennium). Each year, a policy decision is made to address a portion of the projects in the “past due” category based on the level of funding available.

In the absence of a feasible software analysis tool for conducting the benefit analysis, the research team concluded that an alternate approach should be recommended that builds on the Department's existing capabilities, addresses some of the immediate needs identified during this project, and moves the Department toward its eventual goal of developing a dynamic investment analysis approach based on benefits to the State. The research team concluded that there is not currently sufficient benefit to implement the HERS-ST program because its pavement analysis, which drives most of the projects included in the STIP, is so much less robust than what is currently available within the pavement management software. For instance, HERS-ST considers reconstruction and rehabilitation needs, but does not have the ability to consider the benefits associated with pavement preservation treatments such as the use of preventive maintenance. Therefore, it cannot be used to evaluate the level of investment that should be made in pavement preservation activities, nor can it optimize the use of available funds. Instead, it allocates funds based on needs, which lends itself to more of a worst-first strategy.

Similarly, the findings did not reach the conclusion that moving to a different pavement management program provides any tangible benefits to the Department. The research team did not find any evidence of a different pavement management system that does a better job of addressing investment analysis options than the Deighton's Total Infrastructure Asset Management Solution (dTIMS) software. In fact, the Utah DOT has been exploring the use of dTIMS CT for a cross-asset analysis and officials there indicate they are optimistic about the capabilities provided within the software. The challenge is in setting up the parameters so it can be used in this manner.

There are several risks to the SDDOT associated with the use of dTIMS CT for conducting its investment analysis. First, the current version of the software cannot conduct a network analysis because of the size limits to the Access database. An upgrade to the software that would facilitate a network analysis is expected to cost at least \$100,000 for the program (in 2006 dollars), plus additional costs for a SQL server. The second risk associated with this option is in defining the benefit functions for safety and capacity improvements. This would require a commitment of resources and further research to develop benefit functions that are representative of the appropriate features to consider in South Dakota. As they found in Utah, this can pose a challenge that takes several years to address.

5.6 Modified Framework for Managing Pavements

Because of the limitations and risks associated with the available software options, and in the absence of additional options to consider, the research team met with the Technical Panel to discuss alternate strategies to consider. The Technical Panel recommended that the research products include the following:

1. A description of the preferred approach for conducting an investment analysis and the issues that arose in finding software to conduct this type of analysis.
2. An outline of a modified approach to conducting the investment analysis using available tools. The description of the modified approach should describe keys to its success and the ways in which it deviates from the preferred approach.
3. Policy and procedural changes needed to support the modified approach.

Previous sections of this chapter outline the preferred investment analysis approach and the issues that were discovered in trying to find software to conduct an analysis that optimizes the benefits associated with various investment options. This section of the report outlines a modified framework for managing pavements that is represented graphically in figure 5-2. The policy and procedural changes needed to support the modified approach are addressed in the next section of the report.

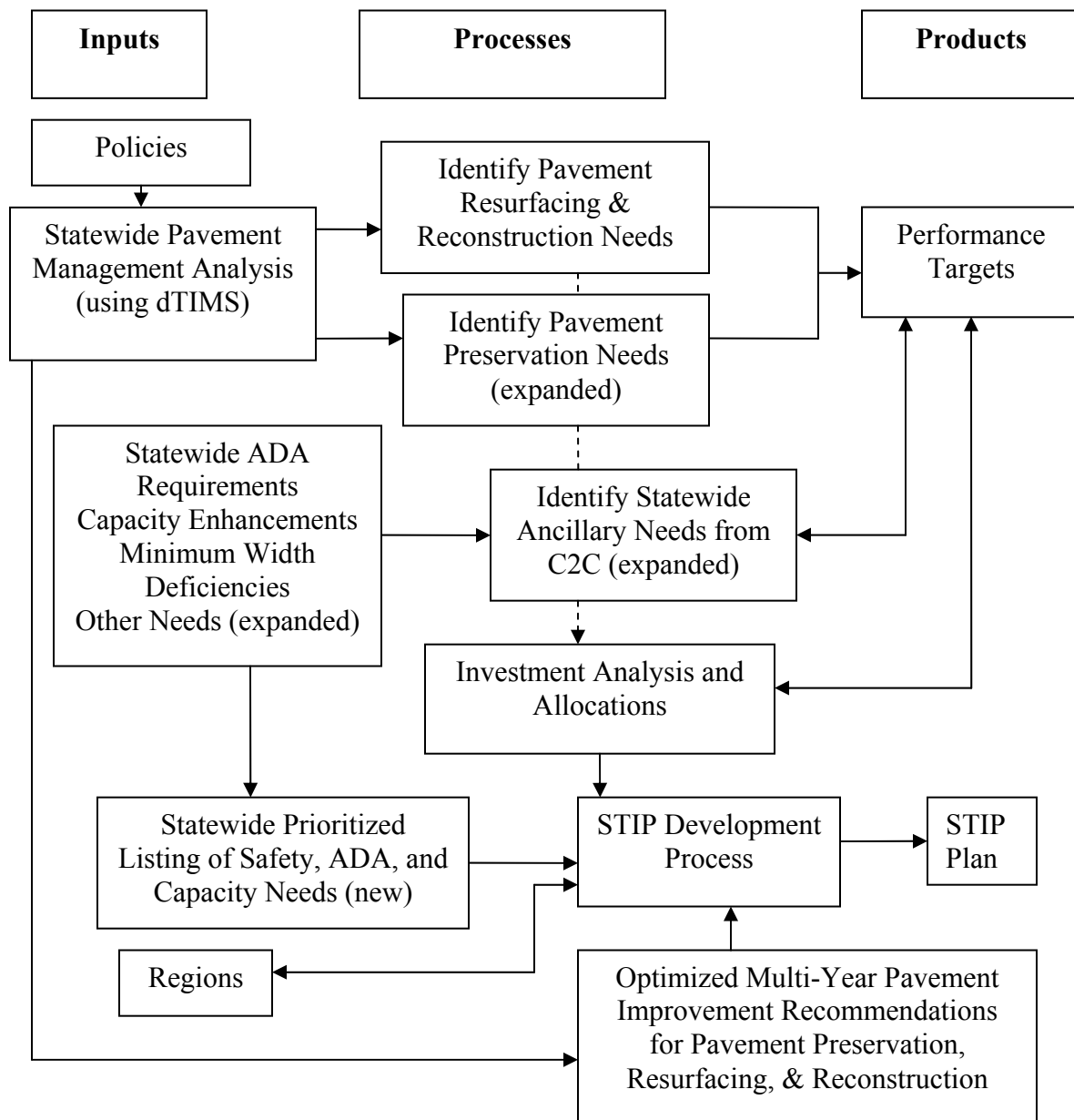


Figure 5-2. Modified Framework for the Pavement Management Process

The modified framework uses the results of a needs assessment as a first cut in setting performance targets and making investment decisions. This assumes that a database of statewide needs can be developed based on the scoping activities currently being conducted

under the Department's C2C program. Pavement rehabilitation and reconstruction needs, minimum width deficiencies, and pavement preservation needs for the entire statewide system are identified using the pavement management system rules. Together with cost information, these needs assessments can provide the Executive Team with information needed to set investment levels and performance targets. For instance, at an investment level of \$10 M/yr, \$90 M in shoulder-widening project needs can be eliminated in approximately 9 years. If the Executive Team feels this is not a reasonable timeframe, its members have the information needed to adjust the level of funding for these types of projects.

Ideally, a sophisticated spreadsheet tool could be developed to analyze these non-pavement-related investment options together with information exported from the pavement management system. A spreadsheet may be adequate because most of the more substantial needs remain relatively constant until they are addressed. For instance, the need for ADA enhancements remains constant and does not require different activities unless the federal requirements change. Because pavement conditions change annually, and require different treatments at different points in time, it is important that pavement needs continue to be identified using the pavement management system. However, the dollar costs associated with the needs can be imported into the spreadsheet tool for investment allocation decisions. For the spreadsheet level analysis, the number of miles of pavement in various condition categories will be used to determine needs instead of analyzing individual road segment needs.

Once the investment allocations are developed, the funding information is divided into funds for pavement preservation and for the STIP. Pavement preservation funds should be limited to projects in relatively good condition using low-cost treatments designed to preserve pavement conditions (rather than be used as a stopgap repair). To keep preservation treatments affordable and to ensure their timely construction, limits for expenditures to address safety and other ancillary needs should be placed at approximately 15 percent of the treatment cost. Minnesota and Oklahoma DOTs use similar rules for their pavement preservation programs to ensure the funds are being used as efficiently as possible. Utah DOT does not have these types of program limits in place, but additional funds are not provided to the Regions if they elect to address scoping activities using pavement preservation funds. In Utah, the addition of scoping items to a pavement preservation project limits the number of miles that can be addressed.

The selection of pavement preservation funds should be closely coordinated with the Regions to ensure that planned strategies are placed on a timely basis. Pavement preservation funds must be used when a road is still in relatively good condition with little or no structural deterioration present. A series of planned pavement preservation treatments can be a very effective strategy for maintaining low-volume roads in good condition. By using the pavement management system to identify pavement preservation candidates a "check" is built into the process to verify that funds are only used on viable candidates. By analyzing pavement preservation needs in the pavement management system, the optimal level of funding for the pavement preservation program can also be determined.

The recommendations from the results of a pavement management optimization analysis provide the first cut of pavement preservation, rehabilitation, and reconstruction projects to include in the STIP. Pavement rehabilitation and reconstruction projects are matched to the prioritized list of safety, ADA, and capacity needs maintained under C2C to determine where additional scope improvements can be made. Funding for scope enhancements is provided until the limits established by the Executive Team are met. The enforcement of these limits is especially important to the success of this approach because every additional dollar spent on scope enhancements removes funding for pavement rehabilitation and/or reconstruction activities. Because performance targets will have been set based on assumptions about how much money is going toward each type of improvement, the only way to ensure that these performance targets are met is to enforce the funding allocations in accordance with the direction set by the Executive Team.

This modified framework assumes the following changes are made to the current procedures:

- The current scoping efforts are completed on the entire network and stored electronically so they can be evaluated economically.
- A process is developed to prioritize capacity, safety, and ADA needs.
- A sophisticated spreadsheet tool is developed to evaluate the consequences associated with different investments in certain needs. The spreadsheet summarizes the total needs in the areas of pavement, capacity, safety, and ADA requirements and has the ability to report the consequences of different spending levels in each area using information from the original data sources. Funding allocations to the interstate, major and minor arterials, and state secondary may be based on system allocation factors used in the past, but changes to these factors may be important to ensure that performance targets for the minor arterials are met. This decision should be made after evaluating several investment strategies using different system allocation factors.
- Performance targets are established to define the performance goals set by the Executive Team. These performance targets are linked to the investment analysis to determine funding allocations.
- Pavement preservation needs are considered in the investment analysis on a network basis. Similarly, pavement resurfacing and rehabilitation needs are considered in the investment analysis on a network basis instead of separating interstate and non-interstate activities. This will require enhanced analysis capabilities from the pavement management system, which cannot currently optimize on a statewide basis.
- A formal pavement preservation program is established with stable funding so Regions can plan pavement preservation treatments with the help of pavement management. Ideally, Regions will consider a broader range of treatments beyond chip seals once the pavement preservation program is formalized. The optimal funding for the program can be generated using the pavement management system software.
- Caps on the amount of money invested in safety, ADA, and capacity improvements on rehabilitation and reconstruction projects are established and enforced. Limits are

placed on safety and capacity enhancements associated with pavement preservation projects to limit the project size.

5.7 Aligning Technical and Procedural Processes and Policies

A number of changes are required to align the technical and procedural processes and policies with the modified framework presented in the previous section of the report. Specific changes required to align three distinct areas of pavement management are outlined in this report: pavement management, policies, and program development.

Aligning the Pavement Management Analysis

The proposed framework for managing pavement investment decisions will continue to use the results of the pavement management incremental benefit/cost analysis for optimizing the use of funding based on improvements to pavement condition and traffic levels. However, several changes are needed to align the pavement management system with the capabilities outlined in the previous section. These changes include the following:

- Incorporating pavement preservation as a treatment included in the treatment rules. Based on feedback provided during the workshops, this activity is already under way within Pavement Management.
- Developing less complex models in the pavement management system for conducting the needs assessment. In order to respond quickly to funding decisions, it is feasible for the pavement management system to be run with a limited number of treatment options (such as reconstruction, resurfacing, and pavement preservation) that simplifies the determination of needs. The more complex treatment rules and performance models should be reserved for the optimization analysis that helps identify the most appropriate use of available funding.
- Using the pavement management system for identifying and optimizing treatments for both the interstate and non-interstate pavements.
- Modifying treatment rules to reduce the number of sections recommended for reconstruction because reconstruction funding is expected to be restricted in the next several years.
- Upgrading to the Enterprise version of the dTIMS software. Unfortunately, the Department's version of dTIMS uses an Access database that limits its analysis capabilities. To run the type of optimization analysis described in the previous section, the Department will have to convert to the Enterprise version of the software. This change is expected to cost more than \$100,000 and require the acquisition of a SQL server. Although the full potential of this change is not known, there is an increased probability that run times will be shortened and a statewide analysis can be accomplished with the new version. The new framework requires the ability to conduct statewide analyses that cannot be done with the version using an Access database.

Aligning Existing Policies

Early in the project, inconsistencies in existing policies were identified as a problem in the project development process that led to a lack of credibility in the pavement management recommendations and the manipulation of the system recommendations by some Regions. Because the modified framework relies on the conduct of a needs assessment for funding allocation decisions, it is important that these conflicts be resolved.

At the present time, projects are recommended for reconstruction only if the roadway width is less than the maximum widths specified in Policy RD-1998-3, as shown in table 5-4. This policy is used to identify standard widths on new and reconstruction projects.

Table 5-4. Maximum Widths in Policy RD-1998-3 (SDDOT 1998b)

Highway Type	Average Daily Traffic (ADT)	NHS Maximum Width Requirement (ft)	Non-NHS Maximum Width Requirement (ft)
Rural 2-lane highway	< 1500	36	36
	> 1500	40	40
4-lane divided highway	Non-interstate	36	36
	Interstate	38	N/A

Resurfacing only is recommended as a treatment on highways with widths that meet or exceed the requirements specified in Policy RD-1998-4, which are listed in table 5-5. This policy establishes a formal scoping process for highway construction projects to clearly identify all work items considered during the scoping process.

As a result of these two policies, there is a grey zone in which a section may be eligible for both reconstruction and resurfacing on most rural 2-lane highways where a section falls between both the minimum and maximum width requirements. Pavement management often defaults to recommending reconstruction for these sections, especially on sections with higher ADT and inadequate shoulder widths. However, the Regions often feel resurfacing is adequate on these highways and ask that the treatment be changed because there is a greater likelihood of a rural 2-lane highway being triggered for resurfacing rather than reconstruction.

A second policy conflict was identified between the minimum roadway width policy (Policy RD-1998-4) and the policy on geometric design criteria for 3R projects (Policy RD-1998-2) (SDDOT 1998a). This conflict occurs on rural 2-lane highways with ADT between 1501 and 2500.

Table 5-5. Minimum Width Requirements for Resurfacing as Specified in Policy RD-1998-4 (SDDOT 1998c)

Highway Type	Average Daily Traffic (ADT)	NHS Minimum Width Requirement (ft)	Non-NHS Minimum Width Requirement (ft)
Rural 2-lane highway	< 551	28	24
	551 – 1500	30	24
	1501 – 2500	32	26
	> 2500	36	26
4-lane divided highway	Non-interstate	36	36
	Interstate	38	N/A

Policy RD-1998-4 requires a minimum width of 32 ft although Policy RD-1998-2 requires a minimum width of 30 ft on NHS routes. This latter conflict does not interfere with the

pavement management analysis, but may pose a risk to the Department. However, because policy RD-1998-4 is used on new and reconstructed pavements and RD-1998-2 is used on 3R projects, the amount of risk is negligible.

To address these conflicts, the following changes are recommended:

- Continue to use Policy RD-1998-3 to identify standard widths to be used on new and reconstructed pavements.
- Modify the discrepancy between Policy RD-1998-4 and RD-1998-2. Without knowing the impact of such a change, it is difficult for the research team to identify which policy should be changed. The perception is that there are fewer instances of building new or reconstructed pavements in that traffic level, so it may be more appropriate to change Policy RD-1998-4 to recommend a minimum width of 30 feet on NHS highways with ADT between 1501 and 2500.
- Change Policy RD-1998-4 from a policy to a guideline to assist with the scoping process.
- Review the minimum width requirements in what is currently called Policy RD-1998-4 with the Region Engineers to verify that they are set at the appropriate levels for use as guidelines in the scoping process.
- In the pavement management system, use pavement conditions as the primary factor in differentiating between resurfacing (rehabilitation) and reconstruction. Where minimum width policies outlined in RD-1998-4 are not met, default to the reconstruction option (unless a section is on the resurfacing only list).

Aligning the Program Development Process

Changes are also needed to the program development process to ensure the success of the proposed framework. For instance:

- Funding allocation decisions are needed earlier in the program development process to provide sufficient time for all the activities to be completed. The present schedule for the development of the STIP is included as figure 5-3. Under the current approach, the funding available for non-interstate projects is dependent on first determining the amount of money that will be allocated to the interstates. Under the approach outlined in this report, interstate and non-interstate needs will be considered together in setting funding allocations. Ideally, the funding allocation analysis can be separated further from the STIP development process or conducted quickly in response to Executive Team queries. The proposed use of a spreadsheet for evaluating investment options could be inserted into the process in February. If forecasted pavement conditions were used rather than survey results, the analysis could be done even earlier.
- Establish and enforce limits on the amount of money available for capacity, safety, and ADA enhancements. These limits should be set based on existing identified needs and enforced as part of the program development process.

- Establish limits on scope enhancements allowed on pavement preservation projects. The Minnesota and Oklahoma DOTs limit these enhancements to no more than 15 percent of the cost of the pavement preservation treatment.
- For funding allocations, eliminate the use of allocating funds first on system weighting factors and then by treatment. Instead, consider network needs for pavement improvements, capacity, safety, and ADA to determine funding allocations by category. Because the current pavement management system cannot conduct a full optimization analysis for the network as a whole, funding may be allocated by system based on system needs identified using a simplified pavement management analysis. Once funding allocations are made, the pavement management system can be used to optimize the use of funding within each system.

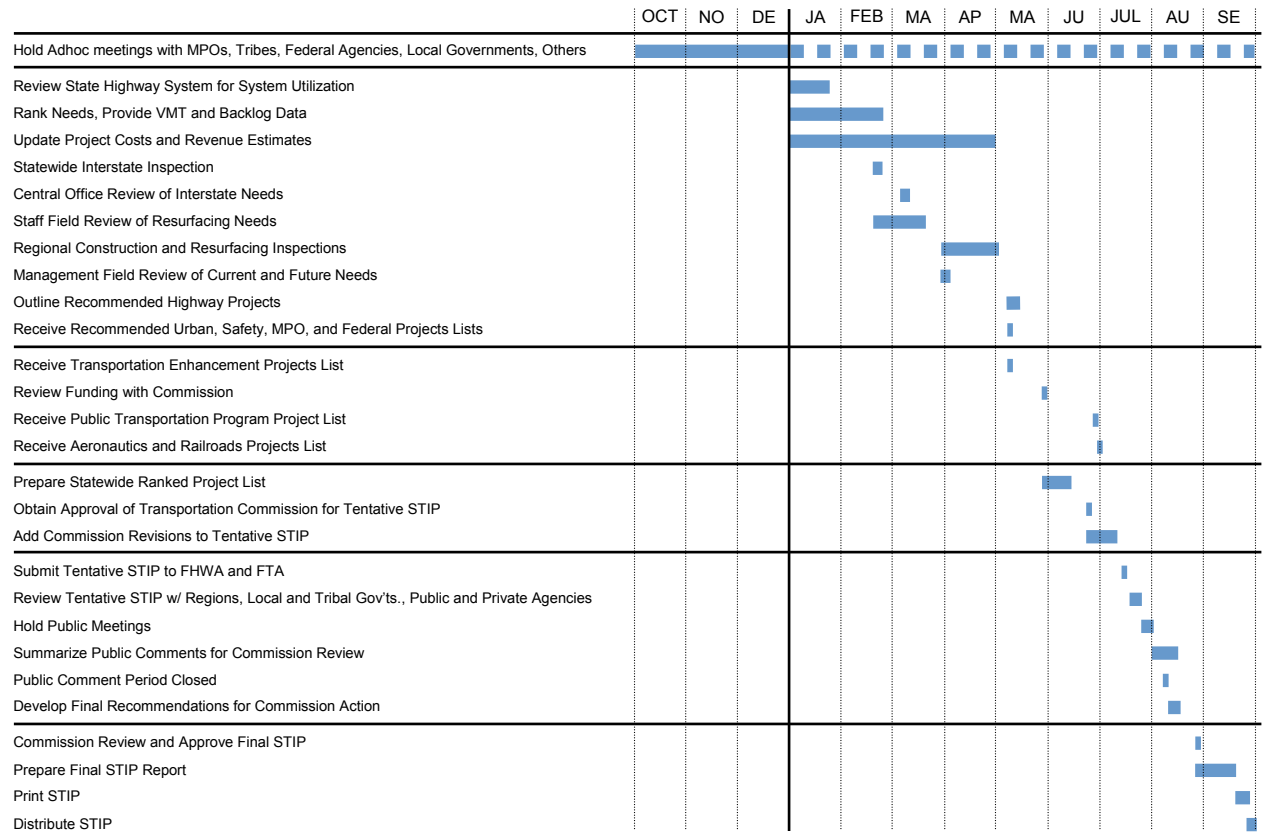


Figure 5-3. Current Schedule for the STIP Development

6. IMPLEMENTATION RECOMMENDATIONS

The success of any research project can be largely measured by the extent to which the findings from the research are incorporated into existing practices. This particular research study, to review SDDOT's pavement management process, has been initiated to examine the Department's pavement management philosophy, current software system, and related policies to determine if any inconsistencies exist in the pavement management process and to provide recommendations for reconciling them.

Chapter 5 presents the findings and conclusions that were generated from the research work during this project. In this chapter, the research team presents the resulting recommendations that will guide the SDDOT through the implementation of the research results. The following four recommendations are presented for consideration by the Technical Panel.

1. Revise the current pavement management process by adopting the recommended changes to funding allocation decisions. Section 5.6 outlines a framework for conducting an analysis of funding options that addresses many of the issues that prompted this study. The proposed approach considers investment needs in terms of pavement condition, safety and capacity enhancements, and ADA requirements. The success of the proposed framework is dependent on:
 - The development of a comprehensive statewide assessment of prioritized capacity, safety, and ADA needs through the C2C process.
 - The combined analysis of pavement preservation, resurfacing, and reconstruction needs for the interstate and non-interstate networks.
 - The establishment and enforcement of caps on spending for non-pavement-related improvements.
 - The development of a sophisticated spreadsheet tool to estimate needs in support of funding allocation decisions.
 - A formal pavement preservation program based on recommendations from the pavement management system to verify funds are being used in a preventive manner.
 - The use of performance targets to define strategic objectives.
2. Implement changes to the pavement management system in support of the recommended framework for investment decisions. Section 5.7 outlines a series of policy and procedural changes that are required to support the proposed framework for funding allocation decisions. Several specific changes to the pavement management system are required, including:
 - The implementation of the Enterprise version of the dTIMS software.
 - The inclusion of pavement preservation treatments into the analysis. This recommendation is already under way.

- The development of simplified analysis models that can be used to quickly assess needs and to estimate the impact of different investment levels in pavement preservation, resurfacing, and reconstruction.
 - Modifying the treatment rules for reconstruction, especially on rural 2-lane highways, so the treatment is recommended less often on these types of roads.
3. Address the policy conflicts that exist and eliminate their impact on assessing needs for funding allocation decisions. Section 5.7 identifies several recommended changes to existing policies. The recommendations include converting Policy RD-1998-4 from a policy to a guideline used in the scoping process and addressing the discrepancy between Policy RD-1998-4 and RD 1998-2 on rural 2-lane highways with ADT between 1501 and 2500. Although further investigation of the impact of the proposed change is recommended, the probable outcome is to modify the minimum width requirement for this category of highways used in the scoping process from 32 ft to 30 ft. The research team also recommends using the same guidelines outlined for the scoping process (those currently outlined in Policy RD-1998-4) as the factors used to estimate resurfacing and reconstruction needs for funding allocation in the pavement management system.
4. Align the program development process. This recommendation requires earlier funding allocation decisions; the establishment and enforcement of funding caps on expenditures for capacity, safety, and ADA enhancements; limits on scope enhancements on pavement preservation projects; and funding allocations by system (because the current pavement management system cannot optimize project recommendations on the entire network).

7. ANALYSIS OF RESEARCH BENEFITS

The results of this project provide specific recommendations for setting the strategic direction for pavement management in the State of South Dakota in the immediate future. The recommended framework is based on input from SDDOT personnel collected through personal interviews and a series of workshops that considered a number of diverse approaches for improving existing policies, practices, and procedures in this area. The primary benefit of this study is the development of a strategic framework for making funding allocation decisions that addresses many of the deficiencies that initiated this project. This type of improvement in the Department's management of its highway network will result in a better use of maintenance and rehabilitation funds, which is expected to lead to future reductions in pavement rehabilitation needs, improved overall network conditions, and smoother roads for the traveling public. With a total investment of more than \$2.3 billion in its transportation infrastructure, improvements in managing these assets can have a significant payback to the Department.

Several direct benefits to the SDDOT will be realized as a result of the activities conducted during this research effort. These benefits include the following:

- A clearer direction for the role of pavement management in SDDOT.
- A better understanding of the pavement management priorities within the Department.
- More effective strategies for making funding allocation decisions through improved pavement management processes, policy documents, and system requirements.
- The addition of safety, capacity, and ADA needs to the funding allocation process through a fairly dynamic analysis.
- Improved decision-making processes for pavement preservation activities.

The participation of the Executive Team, Region personnel, and Central Office personnel in the workshops also provided a benefit to the Department in the form of a better understanding of the existing pavement management process and the changes necessary to address Departmental priorities. The consensus-building exercises conducted during this study resulted in a more unified and comprehensive approach to pavement management.

8. REFERENCES

South Dakota DOT. 1998a. Standards for Resurfacing, Restoration and Rehabilitation (3R) of Highways under State Jurisdiction other than Interstate Highways. Policy Number RD-1998-02. South Dakota Department of Transportation, Pierre, SD.

South Dakota DOT. 1998b. SDDOT Highway Width and Surfacing Type Standards. Policy Number RD-1998-03. South Dakota Department of Transportation, Pierre, SD.

South Dakota DOT. 1998c. South Dakota's Scoping Process for Highway Construction Projects. Policy Number RD-1998-04. South Dakota Department of Transportation, Pierre, SD.

APPENDIX A: INTERVIEW RESULTS

A SUMMARY OF ISSUES RAISED DURING INTERVIEWS WITH SOUTH DAKOTA DOT PERSONNEL (SD2006-05)

Interviews Conducted August 21-31, 2006

Introduction

The South Dakota Department of Transportation (SDDOT) implemented its existing pavement management system under research project SD1993-14. Since that time, a number of organizational, policy and procedural, and technical changes have impacted the effectiveness of the pavement management system used by the Department. Therefore, the SDDOT initiated this research study (SD2006-05) to conduct a review of its pavement management activities to develop recommendations for defining the role of pavement management within the agency and improving the functionality of the existing software. Four specific objectives were defined by the Technical Panel for this study:

- To establish Departmental consensus on the desired role and functionality of SDDOT's pavement management process in consideration of technical and organizational needs.
- To propose revised or new policies and procedures related to pavement management that are consistent with all practical, administrative, organizational, and operational needs.
- To define the requirements of a pavement management system, including data collection, analysis, and reports, to effectively manage highway pavements in accordance with Department philosophy.
- To assess the capabilities of SDDOT's current pavement management system and alternative systems to meet the newly defined functional requirements.

To help assess the current operating environment within the Department, and to better understand the current role of pavement management in the identification and selection of pavement improvements, a series of interviews were conducted with more than 100 SDDOT employees in various locations in South Dakota.

The results of the interviews will be used during a consensus-building workshop on October 18 - 19, 2006 to develop the needs required to enhance the existing project identification and selection process. Once the needs are defined and agreed to, the workshop participants will develop strategies to address the primary needs. An agenda for the workshop will be distributed separately. This document presents a brief summary of some of the issues raised during the interview sessions. These issues will be discussed in more detail at the workshop. The issues are categorized under the following headings:

- The Role of Pavement Management in Strategic Investment Decisions
- The Role of Pavement Management in the Project Identification and Selection Process
- Policy Issues

- Pavement Management Technical Issues
- Other Issues

Issues Identified

The Role of Pavement Management in Strategic Investment Decisions

The following issues concerning the development of strategic investment decisions were raised:

- The long-term consequences on pavement condition of different investment levels in the interstate, major and minor arterials, and state secondary routes are not fully evaluated in making investment decisions. Similarly, the long-term consequences on pavement conditions associated with investments in capacity projects (such as interchanges) and urban/rural funding allocations are not fully evaluated.
- Current funding decisions on investments in resurfacing and reconstruction projects are based on needs in each category. Alternate investment strategies, such as optimal funding levels from a pavement management optimization analysis, are not fully considered in setting funding levels for these programs.
- Projects are currently optimized by selecting projects with the highest benefit to cost ratio for the funding available (benefit is defined as the additional pavement performance provided by the treatment times a traffic factor). No other factors, such as safety enhancements, geometrics, or importance of the highway to the region, are considered in the pavement management system to determine the recommended projects. If considered in the project selection process, these factors are taken into consideration outside the pavement management system.
- Maintenance treatments are not considered in the pavement management system so the projected impact of increases in maintenance funds on network conditions can not easily be evaluated.
- Final budget numbers are available so late in the project selection process that it is difficult to generate and evaluate alternate investment strategies using the pavement management system.
- There is a desire for more strategic direction in terms of the Department's planned investments in reconstruction and resurfacing. For instance, if funding levels are not adequate for reconstruction projects on the secondary system, and a decision is made to limit the number of reconstruction projects on this system, then this information should be communicated to those involved in scoping and selecting projects for inclusion in the STIP. It is felt that this information would help Executive Management report overall needs to the legislature and would help Region and Area personnel respond to public inquiries.

- Strategic directives are also desired so the Department has a more consistent answer to questions regarding what the network should look like and how it should be maintained.
- There is general consensus that funding levels over the past few years were adequate for addressing a large percentage of the State's pavement needs. However, there is a sense that this trend is changing, especially in light of increasing material costs in recent years. In previous years funding was adequate to allow 1.4 to 2.0 million tons of asphalt to be placed in a year. Last year, because of dramatic increases in material costs, the State could only place 800,000 tons of asphalt. This is expected to result in a drop in average pavement conditions.
- There are differences of opinion regarding the level of investment that should be made in low-volume roads across the State. While it is recognized that roads with high traffic volumes are probably a higher priority for funding, individuals reported that some portion of the road investment should be made on factors other than average daily traffic (ADT) so a minimal acceptable condition level can be maintained on the low-volume road network within the State. Establishing minimal acceptable conditions, or targeted condition levels, are examples of strategic decisions.
- There were varied opinions regarding the advantages and disadvantages of allocating rehabilitation and reconstruction funding to the Regions (as in a more decentralized organization). Some Region personnel indicated that this change would assist them in planning and scheduling work and would allow them to better communicate to the public. However, a number of individuals expressed concern that by allocating funding to specific Regions, the State may be moving away from an optimized program.
- Although not well known within the agency, pavement performance measures for each functional class of highway have reportedly been established based on the percentage of the road network in certain condition categories.
- Pavement management is perceived to be more valuable in times of adequate funding than in times of limited funding since there is a tendency to revert to a "worst first" strategy during times of limited funding. Ironically, pavement management practitioners generally consider a pavement management system more important when funding is limited to keep agencies from reverting to a worst first philosophy.
- The Executive Team should be provided the results of scenarios from the pavement management system based on criteria established for the network. Based on the information provided, strategic decisions regarding funding and performance targets could then be established.
- The current use of the term "backlog" is not well understood, and as a result it is not used in making strategic decisions. Similarly, terms like "Remaining Service Life (RSL)" are not used for this purpose.

- Several individuals reported that the Department is “overprogrammed” for future years. This is expected to have significant consequences on future STIPs.
- Region and Area personnel are more concerned with overall highway maintenance needs rather than functional class distinctions and level of service differences between highway classes.
- Pavement management information has the potential to diffuse political interests in funding allocations or project selection if “tolerance levels” are established for various locations or highway classes.
- The priorities within the Department vary. Some report that preventive maintenance and safety are priorities, but funding allocations indicate capacity issues and interstate conditions are the highest priorities.
- There is a perception that the level of maintenance is not consistent across the State.
- There are a number of low-volume roads that have traffic volumes below those normally included in a state highway system, but State law mandates that towns of more than 450 must be connected to the State highway system.
- Although the Bridge Division has been able to establish a strong preventive maintenance program over the years, there is more of an emphasis on resurfacing and reconstruction on the highway side.

The Role of Pavement Management in the Project Identification and Selection Process

The following issues concerning pavement management’s role in the project development process were raised:

- The pavement management system is used as the first cut in identifying project needs based on the results of the optimization. However, once project scoping occurs, project costs change dramatically due to treatment decisions, policy requirements, federal requirements, Region requests, expanded project limits, and other factors. There is currently no accepted approach for prioritizing projects once the scope has expanded beyond pavement condition requirements to include desired geometric improvements, capacity enhancements, and ADA requirements (for example).
- There are a number of high-volume state secondary routes with traffic levels higher than some arterials that are not being funded due to the funding levels allocated to the secondary system.
- There are some inconsistencies between assigned functional class categories and peoples’ perception of the road’s use or importance to the State.
- The role of C2C in the project identification and selection process has not been fully defined although it is clear that a primary objective is to more fully scope project needs early in the project development cycle. Since its role is not fully understood, its interaction with pavement management is unclear at this point in time.

- There are a number of changes in the STIP each year caused by changes in funding, priorities, and/or pavement needs. This makes it difficult for executive management and Region personnel to communicate with the public regarding upcoming projects and to plan maintenance activities effectively. Additionally, the long-term consequences of these changes are not understood or analyzed as part of the decision process.
- There is a strong inclination on the part of the Regions and the public to do more reconstruction projects than resurfacing projects. This is especially true in light of the fact that there are fairly long intervals of time that pass before subsequent treatments on the same road. As a result, Region and Area personnel want to address as many of their geometric (and other) concerns as possible once a project gets into the program. However, less funding for reconstruction projects is expected in future years.
- The number of different treatment scenarios that pavement management can generate to assist with the project identification process is limited by the length of time between the update to RES and the timing of the STIP process.
- Once the pavement management system is used to identify possible interstate needs, pavement management is not involved in the programming of final treatments. Interstate programs are developed separately from programming activities for the remainder of the network.
- Safety and geometric issues are not incorporated into the pavement management optimization process so project recommendations are based primarily on pavement conditions and traffic volumes.
- There is some concern that the Regions' maintenance practices negatively impact a project's ability to be recommended by the pavement management system. To address this concern, minimal maintenance is applied to pavement sections expected to be good candidates for the STIP. However, if the project does not make it in the program, or the year of the treatment should change, an unusually large percentage of the Region's maintenance budget could be needed to keep this section in serviceable condition.
- During the scoping process, a number of factors beyond pavement condition are taken into account, including capacity issues, bridge widths, ADA requirements, location, and other needs. There does not appear to be any formal process established for the importance of these various considerations when funding is limited. Similarly, since pavement management optimizes projects based only on pavement condition, the importance of these other factors is not formally taken into account in the pavement management system.
- There is a desire to spread work around the State to some degree so contractors remain viable in all Regions.
- Some of the Region personnel have sufficient knowledge of the pavement management system to be able to overcome some of its shortcomings. For instance,

some Regions ask pavement management to turn off the reconstruction option on some projects since that treatment is not likely to be funded due to low traffic volumes. As a result, these projects are only considered for resurfacing, which gives them a better chance of being included in the program.

- In general, there is agreement with the needs identified by the pavement management system. Where there are differences, they occur more in the priorities, recommendations for the appropriate treatment, and/or year when the treatment is optimized.
- It is not clear to all Region managers how projects are prioritized in the pavement management system.
- Several Regions are finding success with filling ruts to address needs. The public reaction to these treatments has been positive.
- In some rural areas, there are concerns with the distance of the various sections from maintenance materials. Unless resurfacing projects are funded in the area, it is difficult for maintenance crews to get material for maintenance patching.
- There is general consensus that the Department is doing a better job in project and treatment selection with the pavement management system than before it was implemented.
- Truck traffic on non-interstate routes in some Regions is increasing due to the growth in the number of grain trucks and ethanol plants in the State. The highway system around these locations is deteriorating at an increased rate, but the low traffic volumes limit these roads from inclusion in the STIP.
- Chip seals are an important treatment strategy for low volume roads within the State. Because of their importance, the first chip seal following a resurfacing project is often funded with construction dollars. Later chip seals are funded through contract maintenance funding. Region personnel report that they are on a 5- to 7-year cycle for placing chip seals, but they would like to see a shorter cycle. Although additional funds were allocated for maintenance recently, most of the additional funding has been offset by rising material costs so the increased funding has not resulted in additional miles being treated.
- In South Dakota, chip seals are classified as maintenance treatments so they are not considered in the pavement management system as a preservation treatment option and can not be funded using construction dollars. However, some states consider chip seals (and other preventive maintenance treatments) as part of a pavement preservation program, which can be funded using construction dollars.

Policy Issues

The following issues were raised with regard to existing Departmental policies.

- Current 3R policies are based on federal funding categories and traffic volumes. Exceptions to the design policies are granted in instances when funding is not

available to bring sections up to standards. Exceptions to the policies are determined during the scoping process and require that an approval process is followed.

- Policies dictate shoulder widths based on traffic levels. In some cases, Region personnel feel adequate shoulder widths are provided even though existing shoulders do not match those specified in the current policy.
- The SDDOT is realizing increasing pressure from the Federal Highway Administration (FHWA) to verify that its activities comply with internal policies.
- There are a number of instances in which low-volume roads are considered in the pavement management system as candidates for reconstruction. However, because of the low traffic volumes, a more viable strategy for inclusion in the STIP is to recommend the project for resurfacing. In some instances, Region personnel request that pavement management turn off the reconstruction option since it is not practical. These types of considerations might be taken into account more formally in the pavement management system if these changes were made to existing policies.

Pavement Management Technical Issues

The following technical issues were raised with regard to the pavement management system:

- The pavement management system analyzes project lengths that are often smaller than will be constructed in the field. As a result, there are more sections to analyze and the Regions find the information cumbersome to work with.
- The pavement management software is limited in the types of analyses that can be generated using the current number of sections, treatment options, and performance models.
- Preventive maintenance treatments such as chip seals are not incorporated into the pavement management analysis, largely due to analysis constraints. Some Regions track their chip seal cycles using spreadsheets or other tools.
- There are some concerns about the consistency and accuracy of the pavement condition ratings obtained using temporary employees. In contrast, bridge inspections are performed by permanent employees using a standardized national rating process.
- The distress data currently being collected in the pavement condition surveys are not identical to the distress types predicted in the new Mechanistic-Empirical Pavement Design Guidelines being developed by the National Cooperative Highway Research Program (NCHRP). This will impact the Department's ability to easily calibrate the performance models used in the M-E Design program.
- There is limited use of pavement management information at the Region or Area level beyond what is presented in the Needs Book. Area personnel report that the information provided to them is often cumbersome to use. Suggested improvements include maps showing optimized projects and treatments, the identification of the projected year in which recommended treatments are no longer viable (the project drops to the next condition category), the beginning and ending MRMs (by projects, not segments), and so on. The timing for the delivery of this information was also mentioned since the material arrives immediately prior to the field visits so there's not sufficient time to review it.
- Unless someone from the Region alerts Pavement Management to the locations of maintenance patches, the rating crews can not easily distinguish between maintenance patches and overlays in the field. As a result, the ratings for these sections are typically very high and may force a section to be a lower priority for consideration in the STIP.
- The pavement management software needs to be able to lock any combination of the following variables to force the optimization once certain projects have been identified and scoped: treatment year, project length, cost, or treatment type. With the exception of manually defining specific treatment rules that match the requirements for each section included in the STIP, this can not currently be done (currently all features must be fixed). For instance, if a treatment is set for a particular project, it would be helpful

to fix the treatment and re-analyze the section to determine the best year for the treatment to be done. At the present time, the pavement management system requires the treatment type, year, cost, and length to be fixed so this type of re-optimization can not be conducted.

- At one time, there was an active Pavement Management Steering Committee to provide guidance to the Pavement Management personnel. However, since the purpose of the Committee is no longer clear, the Committee has not formally met for several years.

Other Issues

A number of other issues were raised during the interviews. These additional issues include the following:

- The Needs Book provides some useful information to the Region personnel, especially the age of last treatment. Some Region personnel expressed interest in having copies of the Needs Book available to Maintenance Supervisors. Others reported interest in getting a condensed version of the information provided immediately prior to the scoping trips, such as map displays rather than tabular listings of data.
- Educational overviews on pavement management would be beneficial to SDDOT personnel who are impacted by its recommendations. A suggestion was made for a 1-day training course on a 2-year cycle.
- It was suggested that the Department needs an external communication plan for dealing with the public. The importance of this is expected to increase as funding availability decreases.

APPENDIX B: ADVANTAGES AND DISADVANTAGES TO VARIOUS ANALYSIS APPROACHES

Subject: Funding Allocations	Links to Pages:
Question 1: Should funding be allocated on the basis of benefit to the system or need?	
<p>Background & Significance: Allocations based on need differ from allocations based on benefit in a number of ways. Needs are normally identified by rules and have costs associated with them. However, on their own, needs do not consider the benefits associated with addressing the need. In the pavement management system, needs are identified using a series of rules and used to determine funding allocations for the non-Interstate systems (major and minor arterial and state secondary). Benefits are not currently used in funding allocation decisions. Benefits are considered in project prioritization within the pavement management system through a benefit/cost ratio. By allocating funds based on benefit the agency can better consider the effectiveness of its investment options. This question provided an opportunity to discuss whether funds should be allocated due to a need or whether funds should be allocated because there's a worthwhile benefit (such as a benefit/cost ratio >1) associated with the investment opportunity. As this topic was debated, the group considered that rules used to define needs might have a limited period of applicability since they are normally developed for a given set of conditions. As conditions change, the rules may no longer be applicable. If decisions are based on benefits rather than need, funding allocation decisions would adjust to the changing decisions.</p>	

Alternative	Description	Advantages	Disadvantages	Necessary Desirable Acceptable Undesirable
Current Practice	Funding is allocated based on need as defined by backlog. Benefits are not considered in funding allocation decisions, but are considered in project prioritization (using pavement condition improvements and traffic considerations only).	a.	Tends to prevent low-volume roads from getting improvements	N D A U
		b.	Doesn't account for safety benefits	N D A U
		c.	Benefits associated with investments in preventive maintenance are not accounted for	N D A U
		d.	Allocation rules can become outdated over time	N D A U
		e. Funding allocations are adjusted annually		N D A U
		f.	Allocations are not currently linked to performance goals for any of the highway systems	N D A U
		g.	Expenditures for maintenance, safety, and user costs are not considered	N D A U
Alternative 1	Funding allocated based on benefits to the State.	a.	This approach may not capture the basic level of service (or minimum responsibilities) that needs to be provided, especially on low-volume roads	N D A U
		b.	It may be difficult to account for, and quantify, safety or capacity benefits	N D A U
		c. Tools are available to analyze the potential outcomes of different investment levels		N D A U
		d. Allows us to account for the effect of other demands (such as corridor preservation and urban projects) on funds available for pavements		N D A U
		e.	May be difficult to quantify the benefits associated with investments in corridor preservation and urban projects since the benefits may be more regional than statewide	N D A U
		f. Since there is not a long-range plan for corridor preservation or by-passes, this would be a way of evaluating investments in these types of activities and estimating future requirements		N D A U
		g.	Differences in agency costs and user costs/benefits will need to be established	N D A U
		h. There may be a way to recover a portion of the benefit associated with certain investments to finance road improvements		N D A U

		i.	Differences in benefits and levels of responsibility associated with different highway systems need to be taken into account	N D A U
		j. May provide the information needed to counter economic promotion groups.		N D A U
		k. Allows the evaluation of economic impacts of different investment options in preservation, capacity, safety, and so on		N D A U

Notes: There was interest among the participants in the use of benefits to allocate funding as long as low-volume roads are not ignored and the benefits associated with certain types of improvements (like safety and capacity) can be defined. The consideration of benefit in the funding allocation process could allow the Department to respond to economic interest groups, to seek recovery for road improvements associated with regional enhancements, and to better understand the trade-offs associated with various investment options.

Subject: Funding Allocation	Links to Pages: 1
Question 1A: How should benefits be defined?	
Background & Significance: The pavement management system counts benefit as the improvement in surface condition multiplied by traffic. Presently, there is no process for quantifying the benefits associated with safety and capacity improvements. Therefore, the benefits associated with safety and capacity improvements can't be communicated. There are several tiers of benefit that should be considered, including a) pavement condition, b) safety/congestion, and c) economic benefits. Economic benefits may be further subdivided into benefits to a community, region, or to the state. During this discussion, the types of benefits that should be considered in allocating funds were discussed.	

Alternative	Description	Advantages	Disadvantages	Necessary Desirable Acceptable Undesirable
Current Practice	In the pavement management system, projects are prioritized based on benefit (in terms of pavement condition improvement and traffic).	a.	Does not account for safety or capacity benefits	N D A U
		b. This approach is simple to use and calculate		N D A U
		c. The information needed to conduct this type of analysis is available		N D A U
		d.	Does not consider economic benefit	N D A U
		e.	Does not consider user costs (especially differences in vehicle operating costs)	N D A U
		f.	Does not directly account for maintenance expenditures (including routine maintenance activities, winter maintenance, and safety exposure)	N D A U
		g. Does a good job of representing current and future priorities		N D A U
		h. There is a good correlation with the regions' needs for maintaining suitable pavement condition levels		N D A U
		i. It "ain't broke, but needs tweaking"		N D A U
		j.	May not ensure a basic level of service to all road users since roads with lower volumes may not have a high enough benefit/cost ratio	N D A U
		k.	Trigger levels are overly sensitive in some cases, which requires treatments to be forced (as with resurfacing only, for example)	N D A U
Alternative 1	Define benefit based on a broader range of operational benefits to the system. Operational benefits may include improvements in terms of capacity and safety in addition to pavement condition.	a.	Currently have no way of calculating the benefits associated with capacity improvements or safety improvements	N D A U
		b.	May require the Department to assign an objective value to something that is a subjective judgment	N D A U
		c. Having an objective value could provide a basis for analysis and decision support		N D A U
		d. This could help the Department define high-level priorities and trade-offs between investments in safety and condition		N D A U
		e. Would help to assess the trade-offs between a broader range of investment strategies		N D A U
		f. Would address a broader spectrum of customer needs and wishes		N D A U
		g. The Department would be able to identify the safety, capacity, and condition benefits realized by various projects		N D A U
		h. The Department could dynamically assess benefits, which would allow them to react to changing network conditions and needs		N D A U

Alternative	Description	Advantages	Disadvantages	Necessary Desirable Acceptable Undesirable
		i.	User costs may dominate the agency costs	N D A U
		j.	User costs are sometimes challenged	N D A U
		k.	Might require more staffing	N D A U
		l. Could help the Department identify locations of needed lane additions and capacity improvements or interchanges now and in the future		N D A U
Alternative 2	Include benefits to the community, regional, and state economy in addition to operational benefits.	a. Software is available to estimate economic benefit to the State		N D A U
		b. Provides information needed to respond to economic promotion groups		N D A U
		c. Provides an avenue for possible cost-sharing by public and private interests (including substantiation, justification, estimation of reasonable share)		N D A U
		d.	It is perceived to be a lot of work to set up the methodology to analyze these components	N D A U
		e.	May favor boom locations at the expense of static or declining locations	N D A U
		f. Could help the Department address political pressures		N D A U
		g.	Requires information and data that are not currently available and may be hard to obtain	N D A U
		h.	It is hard to anticipate individual facilities early enough in the process	N D A U
		i.	Would require additional staffing with specialized expertise in economics	N D A U
		j. Could help to identify areas needing corridor preservation and advance ROW acquisition		N D A U
		k. Could provide a rationale for explaining investment strategies and investments		N D A U
		l. Could help assess future staffing and contractor needs and allocations		N D A U
Alternative 3	Incorporate additional factors into the calculation of benefit, including political considerations, environmental considerations, and so on.	a.	Political projects will be designated, not determined by a formula	N D A U
		b. Could respond to environmental concerns, which is becoming increasingly important		N D A U
		c. Environmental factors will influence design, but might also affect the decision whether to do anything		N D A U
		d. Could help to substantiate the fact that the Department has considered environmental impacts in its decisions		N D A U
		e.	Environmental impact could be difficult to quantify since they have emotional impact and often diverse and conflicting viewpoints	N D A U

Alternative	Description	Advantages	Disadvantages	Necessary Desirable Acceptable Undesirable
				<p>Notes: The participants noted that the State has a responsibility to provide a basic, or minimum, acceptable level of service to all users of the highway network. It may be difficult to capture this responsibility if the definition of benefit includes traffic volumes, population figures, or other values that place more weight on heavily-trafficked areas. The on-going project to develop a travel demand forecasting model may help to prove or disprove some of the concerns that were raised during the workshop. One of the primary concerns regarding the use of economic models is whether the Department's internal priorities match external priorities and whether that should influence (or to what degree it should influence) investment decisions.</p> <p>Overall, the group indicated that the options presented for addressing benefit reflect increasingly sophisticated and desirable approaches. While the current approach is easy to use and does a good job of approximating Region priorities, it does not consider other operational benefits that could be meaningful. Ideally, the Department could consider economic factors in calculating benefit, but that capability is perceived as being somewhat more difficult and further away from being a practical approach to consider at this time.</p>

Subject: Funding Allocation: Funding Allocation				Links to Pages: 1
Question 1B: How much weight should traffic carry in investment decisions and project prioritization?				
Background & Significance: Benefits to users occur in proportion to the level of use for commercial and residential traffic. However, the amount of weight placed on traffic levels could significantly influence funding allocation decisions. For instance, heavily weighting traffic may favor busy roads to the possible detriment of low-volume roads (and there are many low-volume roads in South Dakota). It is possible that there are some roads in South Dakota that will never have the traffic volumes necessary to receive funding. This may conflict with a philosophy that there is a basic level of service that should be provided on State-maintained routes. There is also an issue concerning the type of traffic that should be considered. Should local traffic be considered equally with traffic moving over the entire State? Is truck traffic more important than total volumes? These issues were discussed during the workshop.				
Alternative	Description	Advantages	Disadvantages	Necessary Desirable Acceptable Undesirable
Current Practice	Traffic is used in investment allocations by highway system (for non-Interstate routes) in both the allocation formula and in the existing system weighting factors (of 1.5 for major arterials, 1.0 for minor arterials, and 0.5 for state secondary routes). It is also considered in the determination of needs (through the minimum width policies) used to further subdivide non-Interstate funding into resurfacing and reconstruction categories. Traffic is also used in calculating benefit for project prioritization in pavement management.	a.	Low volume roads often don't get programmed	N D A U
		b. Considering traffic allows the Department to get "more bang for the buck" from its projects		N D A U
		c. The use of traffic elevates the probability that high-volume routes on the minor arterial or state secondary system will be funded		N D A U
		d.	Only total volumes are considered and it may be more meaningful to classify traffic by truck volume, commuter volume, or some other factor	N D A U
		e.	The current approach may be double-counting traffic since it is used directly in the formula and is heavily correlated to the system classifications (of major arterial, minor arterial, and state secondary)	N D A U
		f.	Traffic is only used to weight pavement condition and not safety or capacity	N D A U
		g. Traffic is nationally recognized, easy to understand, and measurable		N D A U
		h.	Certain types of traffic may correlate to pavement deterioration better than other factors. For example, truck traffic may be more important than traffic volume when considering pavement deterioration	N D A U
		i.	Low-volume roads are often the only route available to an area so the regional importance of a route may not be captured by traffic count	N D A U
Alternative 1	Use traffic for investment decisions rather than use system classification (so high volumes on lower functional classifications get higher weights).	a.	Would not necessarily recognize the regional significance of a route	N D A U
		b. Would avoid the double-count effect of traffic		N D A U
		c. Responds to more users. Could allocate resources to high-traffic areas		N D A U
		d.	Would lose the ability to control system allocations	N D A U
		e.	High traffic does not determine system importance. Rather, it is only a consideration in determining system importance	N D A U
Alternative 2	Only use traffic in calculating	a. Would fit well with programming on the basis of benefit		N D A U

Alternative	Description	Advantages	Disadvantages	Necessary Desirable Acceptable Undesirable
	benefits for projects in pavement management. Use functional classifications for investment decisions.	b.	High-volume roads in lower system would not receive additional weight if traffic wasn't factored into funding allocation	N D A U
		c.	Might hurt minor or major arterials as a group, depending on the allocation formula and the relative importance of mileage versus traffic	N D A U
		d.	Would require the development of a new allocation method	N D A U
Alternative 4	Use Equivalent Single Axle Loads (ESALs) or Average Annual Daily Truck Traffic (AADTT) rather than ADT.	a.	This is only significant to structural condition	N D A U
		b. Truck traffic could affect safety and capacity benefits		N D A U
		c.	ESALs will not be used as much in the future with the proposed changes in the Mechanistic-Empirical Pavement Design Guide	N D A U
		d.	The calculation of ESALs is different for rigid and flexible pavements	N D A U
		e. The Department could better address the structural needs of the network		N D A U
		f. Routes of economic benefit generally have higher truck traffic		N D A U
		g. The use of truck traffic could be more responsive to factors such as the construction of new economic facilities (e.g. ethanol plants)		N D A U
		h.	This could excessively favor truck routes over public routes	N D A U
		i.	This could negatively impact tourist roads	N D A U
		j.	Traffic is currently incorporated by system category rather than use direct traffic counts. This approach would require the use of more direct counts, which may or may introduce more variability	N D A U
Notes: It was noted that some states allocate funds by traffic category rather than by system classification. This topic generated a lot of interest among the participants. There was recognition that the current approach places a lot of emphasis on traffic, but the results typically reflect the priorities within the Regions. There was some interest in continuing to use system classification as a factor in funding allocations and reserving traffic levels for use in prioritizing project in the pavement management system. This would place less weight on traffic overall, but might require a way of ensuring that no single classification of roads is hurt substantially by this change. There was also interest in having higher-volume routes on lower systems (such as state secondary) get weighted more than lower-volume routes on the same system in the project prioritization process. Similarly, there was interest in using factors that consider the truck volume or weights in defining needs to better represent the structural needs of the network.				

Subject: Funding Allocation Question 1C: Should investment levels for capacity improvements, safety, and rural urban projects be fixed or should the amounts be determined dynamically?				Links to Pages: 1
Background & Significance: At the present time, there is no process for setting constraints on funding allocations for these activities. Typically, significant investment levels are required to address these needs at the cost of other needs. Fixing investment levels in certain activities may result in a suboptimal improvement. This can be avoided by using a process in which investment levels are determined dynamically. However, there are some investments (e.g. ADA improvements) in which it is difficult to realize a benefit. Instead, these investments are required due to mandates or policies. The group should consider how these types of special investment considerations should be handled.				
Alternative	Description	Advantages	Disadvantages	Necessary Desirable Acceptable Undesirable
Current Practice	No limits are currently placed on capacity, safety, and rural urban projects	a.	The impact of increased expenditures on capacity, safety, and rural urban projects on pavement condition is not considered	N D A U
		b. Provides flexibility in responding to various needs		N D A U
		c.	Makes it difficult to justify why certain projects are selected and others are not	N D A U
		d. This approach doesn't try to quantify projects that are often based on political or economic considerations that are difficult (or impossible) to quantify		N D A U
		e.	May not provide sufficient funding to meet minimum performance expectations	N D A U
		f.	Can't easily plan for future needs in this area so it's difficult to estimate what funding level might be available for funding pavement conditions	N D A U
Alternative 1	Redefine major arterials to include the preferential truck network. This would, for example, put SD73 and east-river US18 into the major arterial category.	a. Would allow main truck routes to be weighted more favorably		N D A U
		b. The Department could address reconstruction needs on US18 and SD73 under the current funding allocation process if this change were made		N D A U
		c. Provides a relatively easy modification to the existing process by addressing at least one of the concerns that has been identified		N D A U
		d.	Does not help address the capacity, safety, and rural urban funding issue	N D A U
Alternative 2	Adjust the funding allocation process by creating additional categories for funding allocation decisions. For example, urban and municipal roads could be placed in a separate highway category, as could interchanges or stand-alone lighting projects.	a.	Could contribute to a sub-optimal, time-specific set of rules	N D A U
		b.	Continues the rules-based approach rather than the benefit-based approach	N D A U
		c.	Doesn't necessarily help set a limit on spending in these areas or consider the impact of spending in these areas on pavement condition	N D A U
		d.	It is difficult to coordinate rural and urban portions of projects	N D A U
		e. Could provide a means of separating urban and rural projects		N D A U
		f. Could control the amount of money going to ADA without affecting rural resurfacing		N D A U
		g. The amount allocated to urban projects would be apparent		N D A U
		h. Could result in a more appropriate way of letting certain projects compete (e.g. US 14 Brookings versus US212		N D A U

		Watertown)		
		i. Could help address ADA needs		N D A U
		j.	Might obscure the ADA transition plan	N D A U
		k. Could reduce the excessive effect of traffic (for example SD73 versus US 14 Brookings)		N D A U
		l.	Might eliminate the urban category	N D A U

Notes: This topic was discussed at the end of the workshop, so there was only a limited amount of time available to discuss these topics. Therefore, the consultant took some liberty in summarizing the discussions (especially for the current approach and alternative 1). The discussion provided some options for addressing limitations in the current funding allocation process to address the concerns that have arisen regarding urban/rural splits, heavy truck routes, and interchange projects. Ultimately, the need for these types of adjustments will be based on whether the current funding allocation equations are modified, or whether the Department moves towards a new approach for allocating funds.

Subject: Funding Allocation				Links to Pages:
Question 2: Should funding allocations be made by system classification (e.g. Interstate, major and minor arterials, state secondary routes) or across the entire statewide network as a whole?				
Background & Significance: The current process allocates funding to the Interstate first and the remaining funds are allocated to the remainder of the system based on a formula that was originally developed to improve the condition of the major arterials. By allocating funding by system, there is the possibility that the solutions may not reflect the optimal solution. The current process implies a level of importance associated with the Interstate network and provides funding to ensure a high level of performance for that network. This may or may not reflect current priorities. However, without considering other needs on a statewide basis, it is difficult to know the consequences of increased investments in the Interstate system.				
Alternative	Description	Advantages	Disadvantages	Necessary Desirable Acceptable Undesirable
Current Practice	Interstate projects are funded first and the remaining funds are allocated to the remainder of the system	a.	Classifications don't always match the level of use by the public	N D A U
		b. May need to ensure a certain level of attention to the necessary roads in all Regions (e.g. isolated roads)		N D A U
		c. Federal funding is tied to functional classifications		N D A U
		d. The current process allows "human" input to account for special priorities		N D A U
		e.	In limited funding situations, lower highway systems suffer	N D A U
		f.	The impact of Interstate allocations on the rest of the highway system is not assessed	N D A U
		g. It provides a way to emphasize the importance of certain groups of highways to the State		N D A U
		h.	Funding by subsets may sub-optimize the statewide investment	N D A U
		i. It provides a way to dedicate federal funding categories		N D A U
		j.	Other categories may be desirable (e.g. North Dakota example of the economic role of a highway)	N D A U
		k. Most states consider Interstates separately		N D A U
		l.	May lead to "pendulum swings" in system condition	N D A U
		m. Could define system standards or rules to justify or sequester funding		N D A U
			The current funding allocation process may not reflect current priorities, but if the Department falls behind on the Interstate and majors it soon will. The Secretary needs some control over this	N D A U
Alternative 1	Determine all state pavement needs for the Interstate and the remainder of the system. Use weighting factors to prioritize needs and fund projects based on priorities.	a. This approach is more dynamic and responsive to current and predicted conditions		N D A U
		b. It takes into account a more system-wide view and may avoid "crunch points" in individual highway systems		N D A U
		c.	The current pavement management system doesn't have the capacity to conduct an analysis on all roads at once. To do that, they might need to limit the number of treatments analyzed in the software.	N D A U
		d.	The Interstate highways were taken out previously because condition-driven decisions didn't meet the external needs adequately. The Department had to add money to Interstate funding to address capacity needs	N D A U

Alternative	Description	Advantages	Disadvantages	Necessary Desirable Acceptable Undesirable
		e.	The Department has to accommodate federal funding categories for Interstate highways	N D A U
		f.	The impact of the change is unknown. The appropriate value of the weighting factors would have to be determined	N D A U
		g. This approach could help the Department justify allocations to the public and to policy makers		N D A U
		h. This would be needs based rather than based on historical funding or subjective allocations		N D A U
		i.	Would need a way of quantifying needs for interchanges to be added	N D A U
Alternative 2	Allocate funds based on system priorities (for both the Interstate and the rest of the system) and prioritize projects by system	a. A defined process for determining weighting factors would be more defensible		N D A U
		b. A defined process for determining weighting factors would provide an indication of when the factors need to be updated		N D A U
		c. Systems provide a means of defining the relative importance of groups of highways		N D A U
		d.	ADT might be a suitable surrogate for system importance weighting factors in many cases	N D A U
		e.	It is possible that the Department needs to redefine its highway systems or the assignment of highways to the system categories might need to be reexamined	N D A U
		f. The use of systems allows the Department to define an acceptable condition level for each highway system		N D A U
		g.	The allocation of funding by system seems to be too volatile, especially among resurfacing and reconstruction categories	N D A U
		h.	It takes 5 to 6 years to respond to strategic direction because of the filtering (smoothing) of the allocations	N D A U
		i.	There isn't always a process in place to determine factors, so factors can become outdated or mismatched to current conditions	N D A U
		j.	The current system can promote worst-first investments, even though the Department tries to select projects on the basis of benefit/cost ratios	N D A U
		k.	The availability of alternate routes may not be considered under this approach	N D A U
		l. This approach is easy to do and explain to the public		N D A U
Alternative 3	Assess pavement, capacity, and safety needs and then allocate funding into condition, capacity, and safety categories based on these needs. Once funding has been allocated,	a.	The current pavement management system could not do this without a major reconfiguration	N D A U
		b.	It is hard to separate condition, capacity, and safety improvements because they are not mutually exclusive	N D A U
		c. The approach allows the Department the opportunity to consider a full spectrum of feasible treatments for condition, safety, and capacity		N D A U
		d.	This approach could lead to project optimization rather than network optimization	N D A U
		e.	This approach might require minimum criteria to be established	N D A U

Alternative	Description	Advantages	Disadvantages	Necessary Desirable Acceptable Undesirable
	prioritize projects by category.	f. The Department could better balance surface condition, safety, and capacity needs		N D A U
		g.	This approach would require mechanisms for prioritizing needs in each category (such as safety, capacity, and pavement condition)	N D A U
		h.	This approach might lead to a worst-first or less optimized investment approach	N D A U
		i. This approach might allow more of an emphasis or control on investment levels for safety, capacity, and condition		N D A U
		j.	The Department might lose the ability to emphasize one or more highway system	N D A U
		k.	This approach might force the Department to assign specific treatment strategies too early in the process	N D A U
		l.	If this approach leads to more project-level optimizing, it would be a disadvantage	N D A U
		m.	Not sure this approach really reflects a change from the current approach	N D A U
Alternative 4	Commit a portion of the funding to a Region or a system and then allocate the rest of the funding based on State priorities. One approach might be to allocate funding for the secondary system and the minor arterials based on Region priorities, and funding for Interstates and major arterials based on State priorities.	a.	Programming under this approach would be more difficult	N D A U
		b.	This approach may not optimize the network	N D A U
		c.	The Regions would have to have an allocation strategy for any funds allocated to them	N D A U
		d. Would give the Regions more flexibility		N D A U
		e.	Statewide consistency would be harder to maintain if this were done by Region rather than by system.	N D A U
		f. This approach would ensure a minimum amount of work each year in each Region, might reduce "feast or famine," and might promote more uniform workloads and construction quality		N D A U
		g. Regions would be better able to respond to political pressures		N D A U
		h. Could reduce the volatility in the STIP (with projects shifting from one year to another)		N D A U
		i.	This may require more Regional staff	N D A U
		j.	The approach would require more analysis by Region. In the existing pavement management system, this would require more runs for each highway class	N D A U
		k. This might be a way to slowly address low-volume roads that don't qualify for geometric improvements		N D A U
		l.	This would require the Department to establish measures of accountability for Region personnel and performance measures. There might also be an increased need for Region personnel to analyze options.	N D A U

Notes: The participants noted that additional background research into this topic might be warranted. Specific information to be checked includes the following:

1. Verify that 50 percent of the federal categories can be moved to other categories and work types.
2. Investigate whether any state highway agencies use software that would better address the needs of the SDDOT.
3. Investigate Vermont's standards that correspond to different levels of investment, allowing Vermont some flexibility in standards depending on the level of investment made in the highway system. Note further that Vermont Agency of Transportation is not responsible for managing urban roads, so there is a difference from South Dakota.

Alternative	Description	Advantages	Disadvantages	Necessary Desirable Acceptable Undesirable
				<p>4. Check whether Interstate and major arterial vehicle miles traveled (VMT) are similar.</p> <p>5. The FHWA wants states to adequately address their NHS routes. The Department would need to verify that none of the alternatives (particularly alternative 1), does anything to impact the FHWA's perception of the level of service being provided to the Interstate highways.</p> <p>6. The intent of alternative 4 needs to be described in more detail. Some questioned whether this approach would give the Regions authority for deciding how to spend their apportionment of the funding (this was not the original intention). If not, this alternative would need to be explored in more detail to differentiate between funding allocation and project selection activities. For instance, would the minimum funding to a Region be sufficient to address a minimum number of projects by type?</p> <p>The discussions of these topics led to some lively discussion. Overall, there was agreement that for the health and competitiveness of the industry, it is important for there to be competition among contractors and pavement types in the State of South Dakota. The group also seemed to agree that there is a value to the Department of determining funding allocations based on highway systems. The Regions seemed intrigued by the possibility of having a fixed amount allocated to their needs, but it sounds as if that approach might be difficult to analyze in the existing pavement management system (if it is driven by needs rather than formulas). There was interest in exploring the alternatives that provided caps on the amount being spent on capacity and safety jobs, but no consensus on how do achieve that goal.</p>

Subject: Communication	Links to Pages:
Question 3: What type of information should be communicated regarding needs, benefits, and funding levels?	
Background & Significance: Securing funds for transportation improvements is dependent on the ability to communicate the needs and/or benefits associated with various investment options. The question as to what information should be communicated must recognize that there are a number of different audiences that must be addressed (e.g. governor, legislature, and the public) and each requires information in a different manner.	

Alternative	Description	Advantages	Disadvantages	Necessary Desirable Acceptable Undesirable
Current Practice	Pavement condition needs are forecasted in the pavement management system. Minimum width rules are used to establish safety needs, along with drop-off and inslope considerations. Backlog is commonly used as a communication term.	a.	Backlog is not well understood	N D A U
		b.	Backlog is used in funding allocation, but is not meaningful in project selection	N D A U
		c.	There are multiple definitions informally used within the Department	N D A U
		d.	Backlog doesn't reflect the total needs because factors such as interchange requirements, ADA, preservation, and long-range planning needs are not represented	N D A U
		e.	It is assumed that a bridge that falls within a section counted as a pavement backlog is counted as a bridge backlog, but this may not be true	N D A U
		f.	The number of miles of backlog may be more meaningful than the dollar backlog because of price fluctuations	N D A U
		g. The dollar amount of the backlog is useful for communicating funding needs		N D A U
		h.	Backlog does not project on-going funding needed to maintain the system at a desired level	N D A U
		i.	Backlog does not anticipate future conditions	N D A U
		j. Backlog is easy to calculate		N D A U
		k. Policy makers are used to the concept of backlog		N D A U
		l.	Backlog doesn't address user costs	N D A U
		m.	Backlog doesn't relate to benefit	N D A U
		n.	The backlog number are volatile depending on the effect of funding level on optimization	N D A U
Alternative 1	In addition to pavement condition needs, predict safety and capacity (system expansion) needs	a. This approach is more proactive		N D A U
		b. This would allow the Department to better anticipate funding needs		N D A U
		c.	Need to specify a time window to define needs consistently	N D A U

Notes: The SDDOT has a project to possibly develop a travel demand model that might impact the Department's ability to forecast these demands 20 years into the future. The current 20-year forecasting factors, which result from a process already in place at SDDOT, will be validated as part of the study.

Subject: Communication	
Question 3A: What information is needed to respond to the concerns of various stakeholders?	
Background & Significance: The Department must respond to requests for information from a number of different sources. While the message conveyed to each stakeholder must be consistent, the manner in which it is presented may differ depending on the particular audience. This question provided an opportunity for the participants to identify the various audiences that must be addressed and their particular needs for information.	
Audience	Type of Information Desired
Legislature	<ul style="list-style-type: none"> Funding requirements to address needs Current and forecasted condition levels (under various funding scenarios, investment strategies, segments, and systems) Backlog in dollars Benefits (attained or not attained) in monetary terms User costs (from surface condition and others) Level of service SCI or significant individual distress Surface, safety, and capacity conditions and needs Need information that can be produced quickly in response to inquiries
Interest Groups	<ul style="list-style-type: none"> Warrants Tradeoffs (and impacts on other roads) Economic benefits
Governor	Demonstration of effectively using funding and other forms of accountability
Congressional Delegation	Accomplishments
Transportation Commission	Information on conditions in a way that is brief and concise (with pictures?)
Public	<ul style="list-style-type: none"> Project-specific information Planned project dates
Executive Team	<ul style="list-style-type: none"> Condition projections Information needs to be provided quickly to respond to requests for information
STIP Meeting Attendees	<ul style="list-style-type: none"> Pamphlet on pavement conditions, procedures, and challenges Educational material Reality checks Annual Report or fact book Information conveyed in PowerPoint slides Information on concerns of the attendees (such as debris, pavement markings, how much was spent, and so on)