REGIONAL PREVENTIVE MAINTENANCE

(RPM)

PROGRAM

April 2004
(Revised June 2004)

Table of Contents

Introduction 1
Preventive Maintenance Overview 2
Pavement Management Overview 3
Preventive Maintenance Background 5
RPM Goal 9
RPM Selection Criteria 10
Selection Process for Slurry Seal Program 13
Interim Slurry Seal Program 14
Selection Process for the Microsurfacing Program 14
RPM Program Timeline 15
Pavement Condition Survey Data Collection Procedure i

Appendix A—Michigan Study

Appendix B—Integrating Preventive Maintenance into a Pavement Management System

Appendix C—Regional Standardization and Replication Process

INTRODUCTION

Preservation and longevity of the pavements in the Truckee Meadows has always been a primary interest for Reno, Sparks, Washoe County, and the Regional Transportation Commission (RTC). Preventive pavement maintenance plays a vital role in the success or failure of long term pavement performance. Perhaps more importantly, effective preventive maintenance ensures the initial investment made in new pavement returns the 20-year life benefits expected during the pavement design process.

The issue of pavement preventive maintenance became a topic of great importance when the RTC Blue Ribbon Committee (BRC) members met in 2002. The BRC was a group of more than 40 community leaders gathered by the RTC in 2001 to find solutions to a looming transportation crisis due to the lack of funding as identified in the RTC's 2030 Regional Transportation Plan (RTP). The leaders first reviewed the 2030 RTP and later in 2002, gathered again to bring forward the funding elements to ensure that the goals of the RTP could be implemented. Preventive Maintenance was recognized by the BRC as a critical element in eliminating a $300 million backlog in pavement reconstruction needs and in preventing the backlog from returning.

As a result, the BRC formulated a revenue initiative which was placed on the November 2002 Ballot. This initiative was ballot item WC-2. With the passage of WC-2, State enabling legislation and a Washoe County ordinance approval of several revenue increases for Transit and Street and Highway work and became a reality in June 2003. One revenue source, a portion of the Sales Tax (1/16¢) that comes to RTC, is being designated, in part, to provide an enhanced street and highway preventive maintenance program.

In an effort to ensure effective, efficient, consistent, and uniform administration of the Regional Preventive Maintenance (RPM) Program, the RTC is developing preventive maintenance guidelines in close cooperation with Reno, Sparks, and Washoe County. These guidelines will foster a regional approach in the administration of the Program which focuses on identification of preventive maintenance needs, and the resultant distribution of funds for an effective application of preventive maintenance strategies to benefit all residents in the Truckee Meadows Region.

PREVENTIVE MAINTENANCE OVERVIEW

The continuing of quality performance of asphalt pavements is highly dependent upon the type, time of application, and quality of the maintenance it receives. Pavement maintenance can be classified into three activity groups which are preventive, corrective, and emergency maintenance.

- **Preventive Maintenance** is performed to improve or extend the functional life of a pavement. It is a strategy of surface treatments and operations intended to retard progressive failures and reduce the need for routine maintenance and service activities.
- **Corrective Maintenance** is performed after a deficiency occurs in the pavement, such as loss of friction, moderate to severe rutting, or extensive cracking. It may also be referred to as "reactive" maintenance.
- **Emergency Maintenance** is performed during an emergency situation, such as a blowout or severe pothole that needs repair immediately. This also describes temporary treatments designed to hold the surface together until more permanent repairs can be performed.

Research has shown that applying preventive maintenance to the regional roadway network will result in:

- Better quality transportation
- Longer pavement service lives
- Reduced customer inconveniences and delays
- Reduced life cycle costs
- Increased customer satisfaction
- Improved decision making for transportation planning and programming
- Increased uniformity and consistency in the maintenance over the entire pavement network
- More efficient use of transportation funds

As background and a case study in preventive maintenance effectiveness, an article describing the successful implementation of preventive maintenance in Michigan is included in appendix A. Michigan conducted a study to determine the effectiveness of their preventive maintenance program. The study determined that their "preventive maintenance strategy is more than six times as cost-effective as rehabilitation and reconstruction projects."

The key to implementing a successful preventive maintenance program is to identify the most cost-effective treatment and apply it to the **right** pavements at the **right** time. Therefore, government agencies commonly use pavement management tools and software programs to assess the current condition of their roadway system and to assist them with selecting appropriate preventive maintenance candidates.

PAVEMENT MANAGEMENT OVERVIEW

A pavement management system (PMS) is the name given to the tool or method that assists in optimizing strategies for providing and maintaining pavements in a serviceable condition over a given period of time. One of the key components of any PMS is the pavement rating system. These rating systems involve calculating a numerical score or index based on the visible pavement distress (cracks, patches, rutting, etc). This allows the users to make an unbiased comparison between roadway segments based on their condition to select cost-effective alternatives for pavement maintenance and rehabilitation.

The U.S. Army Corps of Engineers developed PAVER, one of the most popular pavement rating systems. This computer based system calculates a numerical index between 0 and 100 called the Pavement Condition Index (PCI). A pavement with a score of 100 is a newly constructed pavement. Pavements in worse condition would have ratings lower than 100. The PCI survey data and results can then be stored in a variety of PMS software programs, including MicroPAVER.

All three local government entities have been involved in pavement management for over 20 years and use MicroPAVER and the PCI rating procedures. These agencies have a reputation of being some of the first PMS users in the Country and are providing valuable feedback to the MicroPAVER software developers. Each agency provides feedback with direct phone calls to the software programmers and through the annual MicroPAVER User Group Meetings.

All of these agencies have routinely updated the pavement condition of their road system and have maintained an active PMS program. Each government entity maintains its own PMS databases and has collected an incredible amount of historical data for their individual pavement networks. This historical data with the continued collection of new PCI data provides each government entity with an excellent history of their pavement treatments and performance models.

Since all three local agencies use the same pavement evaluation procedures, it could be assumed that the ratings between each government agency should be comparable. To make these ratings even more comparable, it is desirable to have the local agencies score their pavements on the same cycle (ie. every 3 years) and provide a joint refresher meeting to ensure that all pavement survey teams are conducting similar survey results. And to periodically have a portion of the network cross-scored by an independent rating source. This pavement evaluation technique was validated for technical soundness by Dr. Mohamed Y. Shahin, a Principle Investigator for the Depart of the Army's CERL program. A copy of Dr. Shahin's letter is included as appendix C.

In addition, all three agencies have maintained a variety of functional classifications for their pavement networks. The PMS Subcommittee met and agreed to unify the functional classifications between all three government agencies. The regional Functional Classifications are defined below, in table 1.

Table 1. Regional functional classification definitions*.

Functional Classification	Criteria	PMS Designated Code
Arterial (Principle and Minor)	• Approximate Average Daily Traffic of 10,000 and above. • Principle arterials are roads that serve major centers of activity of urbanized areas and in rural areas function primarily form the service proved to through travel, such as Rural Highways. Minor Arterials are roads that interconnect with and augment principal arterials. • Roads which do not penetrate identifiable neighborhoods and provide connection to urban and rural collector roads.	A
Collector	• Approximate Average Daily Traffic less than 10,000. • Roads that provide both land access service and traffic circulation within residential neighborhoods and commercial areas. • Roads that collect traffic from residential streets and channels traffic into arterial roads.	B
Residential	• Approximate Average Daily Traffic less than 2,000. • Local street systems that provide direct access to residential lands.	C
Industrial	• Approximate Average Daily Traffic less than 6,000 with a high percentage of trucks (greater than 4%) • Lower volume roads that provide direct access to commercial and industrial lands.	D

** Revised June 2004*

Based on these regionalized definitions, the PCI ratings and distress information for all of the regional pavements can be compared and ranked within the region. These results can then be used to identify appropriate pavement treatments, including preventive maintenance, rehabilitation, or reconstruction. If there are any significant differences in the distress data collected and rated by each agency, the results of one agency may be erroneously inflated or deflated and skew the prioritization of the regional pavement projects. This error will reduce the cost-effectiveness of the entire regional pavement program by applying maintenance or rehabilitation treatments at inappropriate times.

PREVENTIVE MAINTENANCE BACKGROUND

The purpose of a preventive maintenance program is to protect the pavement structure, slow the rate of pavement deterioration and/or correct pavement surface deficiencies. Many studies have been conducted on preventive maintenance throughout the United States. The following criteria are typically used to select the appropriate preventive maintenance treatments:

- Pavement surface type
- Construction history, such as pavement age
- Functional classification and/or traffic level
- Pavement condition index (PCI)
- Detailed information about the type of deterioration present, in terms of load-related deterioration or the presence of a particular distress type
- Coordination of multiple maintenance activities
- Timing of utility work, planned development, etc

Several preventive maintenance alternatives should be assessed to determine the most appropriate maintenance alternative(s). These maintenance alternatives should be selected based on the most cost-effective treatment for each pavement section. While there are a wide variety of preventive maintenance treatment alternatives, the most common preventive maintenance alternatives are as follows:

- Crack seal
- Slurry seal
- Microsurfacing
- Thin hot mix overlay
- Fog seal
- Chip seal

Fog and chip seals will not be used in the RPM program because they are inappropriate for urban and higher volume roads. However, the local jurisdictions may chose to use them on lower volume streets on a case-by-case basis.

Determining the most cost-effective timing for the application of the preventive maintenance activities require a delicate balance between the type of maintenance conducted and the age of the pavement. Figure 1 illustrates that preventive maintenance activities applied early in a pavement's service life will be much less costly than applying rehabilitation or reconstruction to a pavement section as it continues to age. Likewise, figure 2 shows that applying preventive maintenance activities prematurely in the life of a pavement will result in higher annual maintenance costs in comparison to infrequent pavement maintenance. Therefore, it makes the most sense to apply pavement improvements that minimize the maintenance treatment and reconstruction costs, as shown in figure 3.

A higher priority should be given to newer constructed pavement structures. Appropriate preventive maintenance activities should employ life cycle scheduling until repair costs exceed the benefits derived from such activities or until the pavement structure needs to be reconstructed. This may require that preventive maintenance activities be performed on pavements at a more frequent interval than previous guidelines allowed. Table 2 lists the typical unit costs and the expected life for some

maintenance treatments commonly used throughout the United States. This table was developed for a National study and it is recognized that these in-place costs will be significantly different for our Regional construction environment.

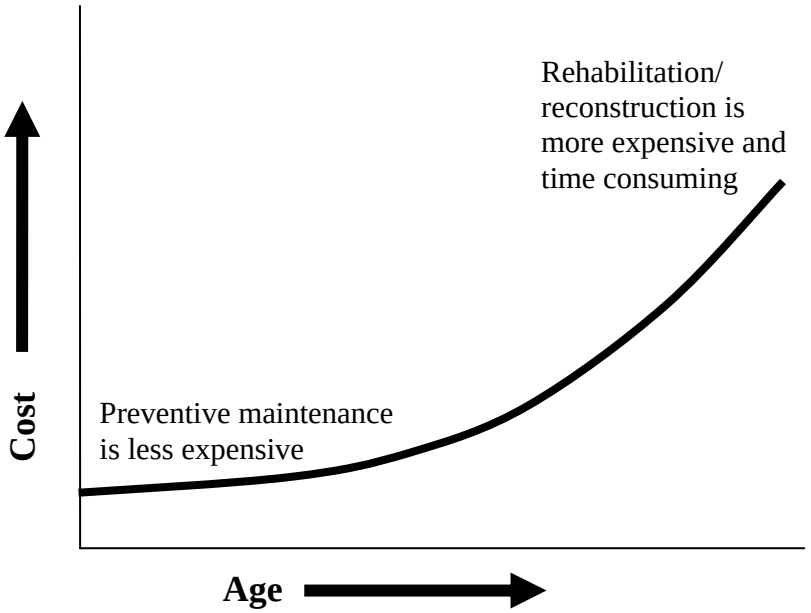

Figure 1. Cost of maintenance or rehabilitation as a function of age.

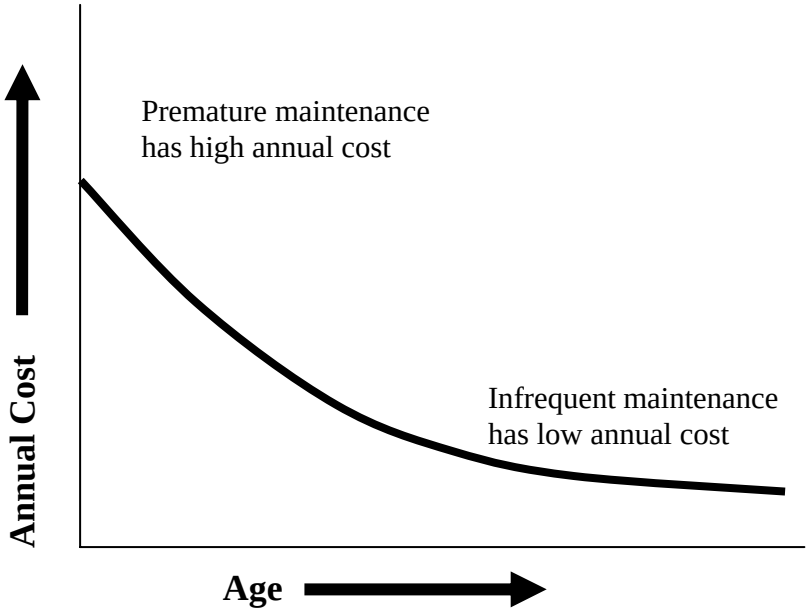

Figure 2. Annual maintenance or rehabilitation costs as a function of age.

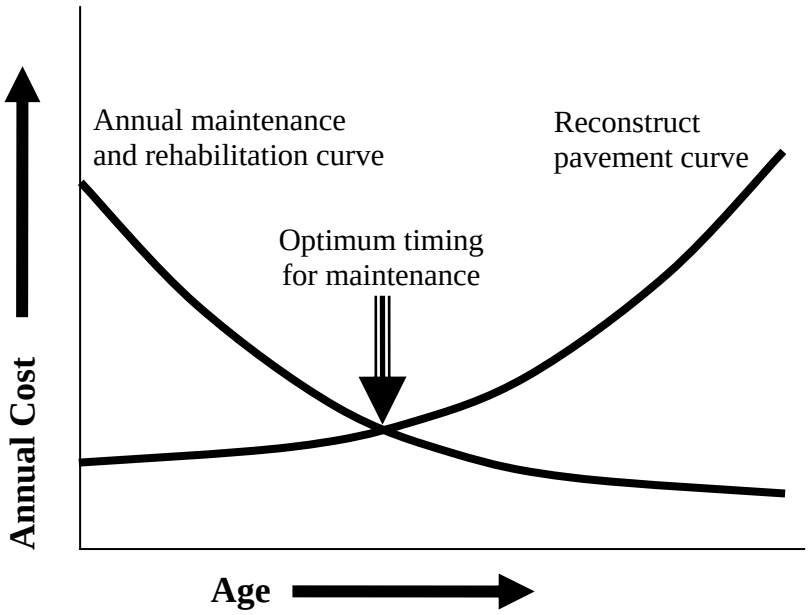

Figure 3. Optimum time to apply pavement treatments.

Table 2. Typical national unit in-place costs and expected life of typical pavement maintenance treatments.

Treatment	Cost/yd^2	Expected Life of Treatment, yrs		
		Min.	Average	Max.
Crack Seal[a]	$0.50	2	3	5
Slurry Seal[b]	$0.90	3	5	7
Microsurfacing[c]	$1.25	3	7	9
Chip Seal[d]	$0.85	3	5	7
Thin Hot-Mix Overlay[e]	$1.75	2	7	12
Fog Seal[f]	$0.45	2	3	4

Notes
[a] Assumes typical crack density of 0.25 yd/yd^2
[b] 7 kg/m^2 of ISSA Type II slurry
[c] 14 kg/m^2 of ISSA Type II microsurfacing
[d] 15 kg/m^2
[e] 30 to 44 mm/m^2
[f] 0.05 g/yd^2 of a 1:1 dilution of CSS emulsion and water

Note: The costs would be expected to vary with the size and/or location of the job. The expected lives of each treatment would also vary depending on the traffic and environmental conditions.

RPM GOAL

The intent of the Regional Preventive Maintenance Program is to select, design, and construct preventive maintenance treatments that will extend the pavement life and maintain the regional pavement surface at the highest possible level of serviceability using cost-effective maintenance techniques regardless of the governing jurisdiction.

This goal will be achieved by:

- Integrating the preventive maintenance program into the pavement management system for the regional road system.

- Having the Local Government Agencies work jointly with the RTC to submit periodic pavement condition data and proposed lists of projects to meet this goal.

- Conducting an unbiased review of all of the pavements within the regional road network. The Local Government Agencies and the RTC will annually identify preventive maintenance candidates.

- Scheduling preventive maintenance for the identified pavements, annually.

- Maintaining a 5 to 7 year cycle for preventive maintenance surface treatments of all Regional roads.

RPM SELECTION CRITERIA

The RPM selection criteria were developed to aid in the objective selection of the most appropriate pavement sections based on a needs assessment. Each agency must take into consideration the following guidelines during the selection of maintenance projects and the development of their proposed list of candidate projects. Additional criteria may be added to this list as the RPM program continues to evolve.

I. Eligible Pavements

Only pavements with current PCI ratings will be eligible for RTC's Regional maintenance selection and funding. This means that all projects included on the proposed list of candidate projects must have a PCI survey within the past 3 years.

II. Pavement Surface Type

Only asphalt concrete (AC) pavement surfaces will be included in this selection process. All portland cement concrete (PCC) pavement surfaces will be considered on an as-needed basis, independent of this selection process.

III. Functional Classification and/or Traffic Level

Higher priority will be given to the roads that are classified as arterials and collectors. Lower priority will be given to the residential and industrial roadway segments. Higher ADT streets will receive higher consideration when all other criteria result in equal need. *(Revised June 2004)*

IV. Pavement condition index (PCI)

The PCI value will be used to aid in the prioritization of project selection. Harry Lorick met with the Pavement Management representatives for all three local governments. They all agreed to the following maintenance and rehabilitation matrix.

Table 3. Maintenance and rehabilitation matrix.

Maintenance	PCI Range	Comments
Crack Fill	86-90	With 5 yr age
Fog Seal	86-90	Not used by Sparks or Washoe County
Chip Seal	70-90	Not used by Reno or Sparks
Slurry Seal	56-85	
Microsurfacing	See Note 1	
Rehabilitation		
Overlay	41-55	
Reconstruction	0-40	

Note 1: Harry Lorick and the Pavement Management representatives did not define the PCI range for microsurfacing. As a preventive maintenance treatment, microsurfacing has proven effective in the range from 56 to 80. It may prove effective in other isolated cases for pavements with PCI values lower than 56, but because microsufacing is still relatively new in our region, the long term performance of this treatment is not fully known at this time.

Based on the maintenance and rehabilitation activities that were defined in Table 2, priority levels were established for the focus of the preventive maintenance efforts. Priority Level 1 is most important, followed by Priority Level 2 and then Priority Level 3. This is a general guideline and it does not mean that all of the Level 1 projects must be selected prior to the addition of a Level 2 project.

Priority Level 1: PCI values of 56 to 85 will be targeted for preventive maintenance activities.

Priority Level 2: PCI values of 86 to 100 may be considered following the pavements rated with a PCI value of 56 to 85.

Priority Level 3: PCI values lower than 56 will typically not be considered for preventive maintenance. These pavements need major repairs and will possibly require corrective maintenance, rehabilitation, or reconstruction within a very short amount of time. Exceptions may occur if extensive cost-effective pavement repairs are completed prior to the preventive maintenance treatment.

V. Continuity of Maintenance Activities Across Jurisdictional Boundaries

Coordination of inter-agency maintenance activities will be taken into consideration across jurisdictional boundaries. For example, one segment of an agency's roadway system is scheduled for a slurry seal this year and the adjacent agency segment is scheduled to occur in the next year or two. It will be more cost-effective and will minimize traffic disruptions to slurry seal both segments at the same time. Therefore, a few road segments that cross jurisdictional boundaries may have a higher priority than the current PCI ranking indicates.

VI. "Band-Aid" Treatments

"Band-Aid" treatments are defined as those treatments that were applied to provide emergency relief to the condition of the pavement surface. Typical "band-aid" treatments are a thin overlay (approximately one inch thick) or sanded oil to fill the surface distresses and then covered with a sand seal to seal the surface and improve the riding surface.

Pavements that have received these treatments will not be eligible for maintenance activities until the underlying distresses have been addressed and the pavement is restored to a structurally sound pavement section.

VII. Local Jurisdictional Maintenance Preparation Work

A joint effort will be required to maintain the Regional roads. All roadways included in the list of the proposed candidate projects will require the local jurisdictions to conduct the preparatory maintenance prior to the RTC applied slurry seal. Preparatory maintenance includes, but it not limited to, crack sealing, pot hole repair, and patching.

VIII. Structural Distresses

Pavements that exhibit structural distresses greater than 5% of the pavement surface area will not be considered as candidate projects for the RPM program. Structural distresses may include pavements with fatigue (alligator) cracking or rutting. Pavements with structural distresses should be taken into consideration for the RTC Fuel Tax Resurfacing Program.

Pavements that contain isolated structural distresses may still be eligible for the RPM program. This situation requires that the local jurisdiction completes full depth repairs of the pavement surface and underlying base materials, provides a long-term patch, and then completes any additional maintenance preparation work within the proposed RPM section. In this situation, the pavement section may be considered for RPM.

IX. Cyclical Preventive Maintenance

Pavements that are on an existing routine maintenance cycle will be considered as candidate projects, even if these pavements do not meet the majority of the RPM Selection Criteria. These pavement sections are eligible for consideration on the candidate projects list every 5 to 8 years, depending on the surface condition of the previous RPM treatments.

X. Routine Maintenance

Regional pavements that have received routine maintenance, such as pothole repair, crack sealing, and patching will be taken into consideration during the development of the list of candidate projects. Routine maintenance should be conducted every 3 to 4 years, depending on the pavement condition.

XI. Field Verification

Each Agency should conduct a field visit to verify that the list of candidate projects meets the Selection Criteria Requirements.

SELECTION PROCESS FOR THE SLURRY SEAL PROGRAM

The RPM selection criteria will be used to prioritize candidate asphalt projects submitted by Reno, Sparks, and Washoe County on a needs basis for the slurry seal program. The following process will be used to prioritize these projects.

Step 1. Reno, Sparks, and Washoe County will submit an Excel tabular spreadsheet reporting their pavement condition information for all pavements sections.

Step 2. All pavement sections will be combined into a single master list.

Step 3. All pavements will then be sorted according to their predicted functional classification and PCI values. Pavements with a PCI value less than 56 will typically not be considered for the preventive maintenance program. Pavements with a PCI rating greater than or equal to 56 will be considered for preventive maintenance. Pavements with PCI values of 56 will have the highest priority and decrease in priority up to those with PCIs of 100 points.

Step 4. The following pavement sections will be excluded from the master list identifying potential candidate projects for the Regional Preventive Maintenance program:

- Projects with previous "Band-Aid" treatments
- Structural Distresses greater than 5% of the pavement surface area that can not be corrected prior to maintenance activities.
- Pavements that do not have a current PCI rating, within the past three years.

Step 5. Portland cement concrete (PCC) pavements will be identified and evaluated individually for preventive maintenance activities. Any preventive maintenance treatments that are recommended for the PCC pavements will then be considered in combination with the asphalt surfaced pavements.

Step 6. Engineering judgment and field verification will be considered in finalizing the list of proposed preventive maintenance slurry seal candidate projects.

Factors that will be taken into consideration will include:

- Continuity of maintenance activities across jurisdictional boundaries
- Local jurisdiction preparation efforts
- Cyclical preventive maintenance activities for collectors and arterials followed by residential and industrial roadways
- Routine maintenance of the Regional roads.
- Additional roadway segments within a reasonable proximity to the proposed candidate projects.
- Timing of known utility work and planned future developments.

INTERIM SLURRY SEAL SELECTION PROGRAM (2004-2006)

The purpose of the Interim Slurry Seal Program is to aid the local jurisdictions with their backlog of preventive maintenance requirements. Reno, Sparks, and Washoe County are encouraged to participate in the Interim RPM Program and the RPM Slurry Seal Program. The Interim program will be in effect for the next two years, followed by the RPM Slurry Seal Program discussed above.

Interim Slurry Seal Focus:

The Interim Slurry Seal Program will follow the same general guidelines as those outlined in the Slurry Seal Program, as discussed above. However, the Interim Slurry Seal Program will target pavements rated as a Priority Level 1 (PCI values between 56 and 85). Priority Level 2 pavements will be addressed if sufficient funds are available. If not, they will be addressed in year three and beyond of the Slurry Seal Program. In addition, pavements that are on an existing routine maintenance cycle will be considered as candidate projects, even if these pavements are not within the Priority Level 1 PCI values.

The RTC realizes that it is not reasonable for each government entity to complete all of the preparatory maintenance for each proposed slurry seal candidate project during this interim time frame. Therefore, all or a portion of the preparatory work may be completed as part of the Interim Slurry Seal Program, as identified on a case-by-case basis by the WC-2 SubTAC Meeting Committee.

The preparation of proposed candidate projects will follow the timeline and procedures as outlined in the standard RPM Program.

SELECTION PROCESS FOR THE MICROSURFACING PROGRAM

The current RPM selection criteria will not identify the criteria for the proposed microsurfacing candidates. Microsurfacing has only had limited applications in this region and it's cost/benefits are still being evaluated. Microsurfacing has had proven success throughout the Incline Village area and also on roadways with higher traffic volumes. Additional uses for microsurfacing have been theorized but are not proven at this time. Therefore, microsurfacing will be considered on a case-by-case basis at this time.

RPM PROGRAM TIMELINE

The timeline for the Regional Preventive Maintenance (RPM) program will parallel the Street & Highway Fuel Tax Resurfacing Program timeline. The timeline described below does not include the timeline for the interim slurry seal program.

A call for candidate projects will occur in mid-June. Reno, Sparks, and Washoe County will prepare their proposed lists of candidate projects using the RPMS Selection Criteria discussed above and submit them to the PMS Steering Committee for further review and prioritization. The PMS Steering Committee will submit a recommended priority of projects to the WC-2 TAC Subcommittee for review and approval. The RTC will submit the list of candidate projects to the Citizen's Advisory Committee (CAC) and the Technical Advisory Committee (TAC) in late August. Once approved, the RTC will submit these projects as a RTC Program of Projects (POP) at the September Board meeting. Following the approval of the proposed list of slurry seal projects, the Cities and County can begin maintenance preparation activities. It is possible that some local maintenance preparation may occur immediately after the Board's approval, however most local governments will need to budget the required preparation work into the following year's financial budget. Therefore, it is more realistic that preparation work will be conducted beginning the following July. After the Board's approval, the RTC will schedule the slurry seals for all maintenance prepared pavements for the summer and fall of the following year. This schedule is graphically represented in Table 3.

Table 3. Year prior to slurry seal placement.

Task	April	July	Oct	Jan	April	July	Oct	Jan	April	July	Oct	Jan	April	July	Oct	Jan	April	July	Oct	Jan
1. RTC Call for Candidate Projects																				
2. LG Submit Candidate Projects																				
3. RTC/LG Project Selection Meeting																				
4. Present Projects to RTC CAC																				
5. Present Projects to RTC TAC																				
6. RTC Board Approval																				
7. LG Approval of RTC ICA																				
8. Local Maintenance Preparation																				
9. Slurry Seal																				

LG = Local Governments
ICA = Interlocal Cooperative Agreement

Proposed Appendix D of the Street & Highway Program Policy

PAVEMENT CONDITION SURVEY DATA COLLECTION PROCEDURE

Proposed Appendix D of the Street & Highway Program Policy

PAVEMENT CONDITION SURVEY DATA COLLECTION PROCEDURE

1. The pavement condition survey data collection procedure will be overseen by the Pavement Management System (PMS) Steering Committee. This committee consists of the pavement management supervisor(s) from Reno, Sparks, and Washoe County and an RTC pavement engineer.
2. Pavement condition survey data will be collected using the MicroPAVER survey technique.
3. Pavement condition survey data will be collected at a maximum of every three years by each agency for their entire pavement network. *Note: Agencies will not be required to meet the three year PCI survey requirement if the pavement condition index (PCI) is below 30 and it is not a candidate project for reconstruction. However, if a pavement with a PCI below 30 is a candidate project for reconstruction, then a current PCI (within the past 3 years) must be available for regionally funded projects.*
4. At least one-third or more of the network will be surveyed annually.
5. **Annual pavement condition survey calibration and quality control meeting** will occur in March or April prior to the beginning of the annual pavement condition survey data collection.
    a. The PMS Steering Committee will annually coordinate a joint meeting and field evaluation for all three agencies to calibrate their pavement condition survey procedures.
    b. All survey crews scheduled for any annual pavement condition survey inspections must be present and participate in the one week calibration procedure.
    c. Each survey crew will conduct independent field surveys.
    d. All field surveys will be compared for consistency amongst all of the survey crews.
    e. Washoe County will bring their field laptop for field entry of survey results and calculations of the pavement condition index for all survey teams to calculate their results.

f. Consistency issues will be discussed and resolved.

g. Tentative meeting schedule

Day 1 – All survey crews and PMS Steering Committee members will conduct independent pavement condition surveys of a few selected pavement sections. These results will then be used to calculate independent PCI sample unit values. Results from all survey teams will be compared and discussed. Difference and discrepancies will be discussed and survey modifications will be made as needed by the survey teams.

Day 2 through 4 – All survey crews will be given a unique list of pavement condition survey locations that are not within their agency's local jurisdiction. These surveys will be used to provide a random cross-check to ensure that consistent pavement condition survey data has been collected throughout the region. Each crew will conduct the pavement surveys and submit their results to the PMS Steering Committee for review.

Day 5 – Data analysis for all collected pavement condition surveys will be conducted.

Once the data analysis is completed, the PMS Steering Committee will review the pavement condition survey data and MicroPAVER PCI calculations for consistency with each agency's previously inspected pavement survey results. As a general guideline, the PCI values should be $\pm$ 5 PCI points per sample unit.

h. If there is a significant difference between an agency's PCI survey and the cross-scored PCI survey, then

i. PMS Steering Committee will review the data, identify areas of improvement, and make adjustments to survey team techniques as needed.

ii. The PMS Steering Committee may recommend that additional cross-scoring pavement condition data surveys be conducted to ensure consistency amongst all three agencies within the Region.

iii. An additional Fall Calibration meeting may be necessary.

iv. A portion of one agency's surveys may need to be corrected/adjusted or resurveyed to correct these differences.

v. Additional actions may be suggested.

i. Once the consistency issues are resolved, all survey crews may continue collecting regional pavement condition survey data.

6. Each agency will submit pavement condition data semi-annually to the RTC by the end of January of each year. All PCI values will be predicted to July of that year. See attached spreadsheet for the preferred electronic format of data submissions.

7. The PMS Steering Committee will review this Pavement Condition Survey Data Collection Procedure annually during the annual pavement condition survey calibration and quality control meeting held in the Spring. Revisions to this procedure will be made as needed to maintain the quality and consistency of the PCI data collection throughout the Region.

Appendix A

Michigan Study Article

Preventive Maintenance Yields Huge Savings, Says Michigan Study

Maintenance engineers have been making the case for preventive maintenance for years—but their message has often gone unheeded. Now, a study from the Michigan Department of Transportation (DOT) provides hard evidence that preventive maintenance is a wise investment. According to the study, the DOT's preventive maintenance strategy is more than six times as cost-effective as rehabilitation and reconstruction projects.

Michigan DOT adopted its preventive maintenance strategy in 1992 as a way to keep its 15,420 km (9,580 mi) of highways in the best shape possible despite declining financial resources. Since then, preventive maintenance treatments have been applied to about 4,260 km (2,650 mi) of asphalt and portland cement concrete pavements, at a cost of $80 million.

Had the DOT not implemented its preventive maintenance strategy, the study found, the DOT would have to spend $700 million today on rehabilitation and reconstruction projects to bring pavements up to their current condition. That's more than eight times as much money as has been spent on preventive maintenance treatments.

The study was conducted by Michigan DOT's Bureau of Transportation Planning and is based on very conservative assumptions about the performance of preventive maintenance treatments. To further validate the value of preventive maintenance, Michigan DOT hired an independent consultant to verify that the pavements had actually benefited from the preventive maintenance treatments. "We wanted to see whether the treatments had worked and whether they were in fact a good value," says Larry Galehouse, pavement maintenance engineer at Michigan DOT. The consultant concluded that most preventive maintenance treatments were successful in extending the life of the pavement.

Michigan DOT makes the most of its resources by carefully timing the application of preventive maintenance treatments. Galehouse says the DOT has found that applying maintenance treatments to pavements with light to moderate distress provides a substantial improvement in pavement life; in contrast, treating a severely distressed pavement accomplishes very little.

Michigan DOT relies on a wide variety of maintenance treatments, which allows the highway agency to select the least expensive treatment that will address the problems found on a specific pavement. "We don't need an expensive fix for every road," Galehouse says.

The highway agency's preventive maintenance strategy is also designed to make yearly funding needs more predictable. The DOT classifies pavements in one of six categories, ranging from roads in need of almost immediate rehabilitation to roads expected to last for another 2 or 3 decades. Today, the amount of roads in each category varies widely. By carefully matching pavements with appropriate preventive maintenance treatments, the DOT is evening out the disparity; this will prevent huge surges in the number of pavements in need of costly rehabilitation or reconstruction in any given year.

Reprinted from *Focus*, September 1997

Appendix B

Integrating Preventive Maintenance into a Pavement Management System

TRANSPORTATION RESEARCH

RECORD

JOURNAL OF THE TRANSPORTATION RESEARCH BOARD

NO.
1827

Highway Pavements and Structures Maintenance and Security

Maintenance

TRANSPORTATION RESEARCH BOARD
OF THE NATIONAL ACADEMIES

Paper No. 03-4044

Pavement Management Perspective on Integrating Preventive Maintenance into a Pavement Management System

Kathryn A. Zimmerman and David G. Peshkin

Many transportation agencies use pavement preservation programs to manage their pavement assets cost-effectively. One important aspect of pavement preservation is the use of preventive maintenance treatments to improve the functional condition of the network and retard the overall rate of deterioration. Because preventive maintenance treatments are less expensive than resurfacing or reconstruction projects, a preventive maintenance program can provide a cost-effective means of meeting pavement performance goals. Pavement management systems support pavement preservation strategies in important ways. They assist in identifying and prioritizing preventive maintenance needs, justifying funding levels, and evaluating the long-term impacts of various preservation strategies. To date, many agencies have operated preventive maintenance activities in isolation from pavement management programs. However, many potential benefits can be gained from the closer integration of these two activities. A transportation agency that wishes to integrate preventive maintenance and pavement management might be required to make several changes. Specific technical areas in which changes might be needed include condition surveys and condition index calculations, pavement performance models, treatment rules, and program development. In addition, several institutional issues must be addressed to successfully integrate the two programs. Examples from state highway agencies illustrate possible solutions.

Pavement preservation programs incorporate the use of various maintenance and rehabilitation treatments. According to FHWA, pavement preservation incorporates "all activities undertaken to provide and maintain serviceable roadways; this includes corrective maintenance and preventive maintenance, as well as minor rehabilitation projects" (*1*). It excludes more substantial treatments such as resurfacing, restoration, and rehabilitation work that is intended to restore the serviceability of a road and to extend the service life of an existing facility. In general, pavement preservation treatments are designed to address the functional condition of a road, thus preserving the integrity of the road and delaying the development of structural deterioration. Pavement rehabilitation treatments, on the other hand, typically address the structural condition of a road; they are applied to roads with more significant levels of deterioration.

Some common types of pavement preservation treatments include the following (*2*):

- Crack filling or crack sealing;
- Joint resealing;
- Surface treatments such as fog seals, slurry seals, and chip seals;
- Microsurfacing;
- Thin hot-mix asphalt (HMA) overlays;
- Diamond grinding or diamond grooving;
- Undersealing;
- Full-depth repair of portland cement concrete pavements;
- Joint spall repair;
- Load transfer restoration; and
- Maintenance of drainage facilities.

As most road managers are aware, pavement preservation activities such as these are an important part of maintaining the serviceability of a road network. However, for these treatments to be cost-effective, they must be applied early in the life of a pavement, before more substantial (and corrective) treatments are needed. For most agencies, the early application of pavement preservation treatments differs markedly from the way road networks are usually managed. Traditionally, most agencies followed programs that applied no treatments until rehabilitation or reconstruction activities were required—in other words, only after pavement serviceability fell below an acceptable level. Some routine maintenance might have been performed, but funding for the maintenance activities was usually unreliable, and the highest priority for funding came from stopgap (or safety) maintenance needs. This philosophy was indirectly encouraged by federal agencies, because maintenance activities were not eligible for federal funding. As a result, pavement life cycles similar to the one shown in Figure 1 were common.

More recently, pavement preservation has become a part of some agencies' planning and design activities. Furthermore, efforts to improve the cost-effectiveness of maintenance and rehabilitation programs have led to the development and implementation of preventive maintenance programs for pavements that emphasize keeping roads in good condition through the planned, early application of maintenance treatments. Recent legislative changes included in the Transportation Equity Act for the 21st Century (TEA-21) support such programs by providing federal funding for up to 80% of the cost of maintenance activities.

Preventive maintenance programs are cost-effective because they slow the rate of pavement deterioration, essentially delaying the need for major rehabilitation activities by several years. The delay in rehabilitation needs is more than offset by the fairly low cost of preventive maintenance treatments, thereby resulting in dramatic cost savings for preserving the road network. The pavement life cycle for an agency practicing preventive maintenance is illustrated in Figure 2. The deferred need for rehabilitation is reflected in the modified performance curve that results from the application of preventive maintenance.

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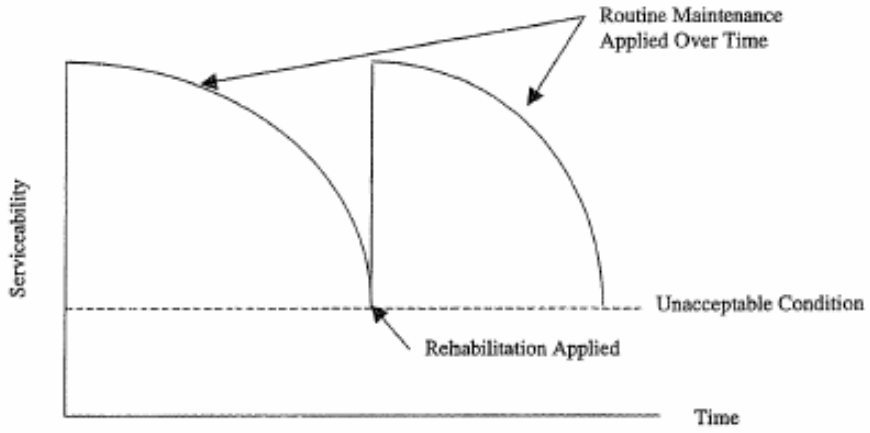

FIGURE 1 Traditional pavement life cycle without pavement preservation.

Other benefits can be realized through the use of a preventive maintenance program for pavement management. Some of the benefits documented in the literature (2) include

- Higher customer satisfaction with the road network;
- The ability to make better, more informed decisions on an objective basis;
- More appropriate use of maintenance techniques;
- Improved pavement conditions over time;
- Increased safety; and
- Reduced overall costs for maintaining the road network.

Despite these purported benefits, the implementation of a preventive maintenance strategy is not a trivial undertaking. For one thing, many agencies have a large backlog of pavements in need of major rehabilitation, but funding levels address only a small portion of the need. Agencies in this kind of situation find it difficult to implement a preventive maintenance program for pavement management that addresses good roads when so many of the agency's roads are in bad condition. Implementation is especially difficult when pressures from the public or politicians tend to support a "worst first" strategy. To overcome this challenge, agencies must use pavement management systems to demonstrate the benefits of a preventive maintenance strategy and support the agency's change in philosophy. However, because pavement management systems have primarily served as programs for identifying and prioritizing rehabilitation needs, integrating preventive maintenance and pavement management requires some modification. Some of the areas in which changes may be required are discussed in this paper: pavement condition surveys and pavement condition index calculations, pavement performance models, treatment rules, and program development. In addition, some of the institutional issues that may influence the success of implementation efforts are presented.

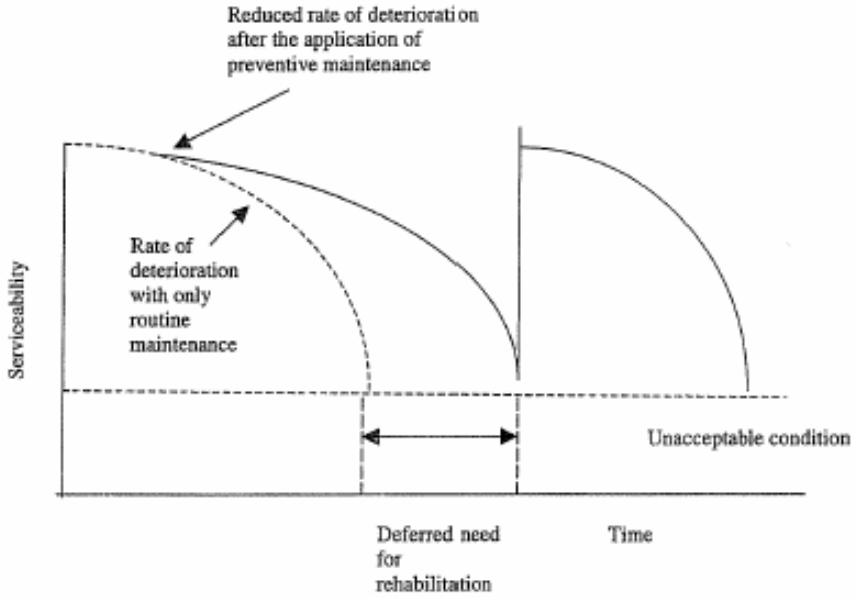

FIGURE 2 Pavement life cycle showing deferred need for rehabilitation after application of preventive maintenance.

CONDITION SURVEYS AND CONDITION INDEX CALCULATIONS

One of the most important aspects of a pavement management system is the process that is used to report the current condition of the pavement network. It is especially important because all the recommendations in a pavement management system are in some way linked to information about current condition: pavement performance models use this information to predict future conditions, treatment rules determine the feasibility of a treatment based on the current or forecasted condition, and pavement condition typically is one input in the prioritization of treatment options as part of program development. The agency should address a couple of issues regarding the conduct of pavement condition surveys: whether existing procedures provide the kind of distress information that is important for triggering preventive maintenance treatments, and whether the benefits associated with the use of preventive maintenance treatments can be defined by using the existing condition index procedures.

Preventive maintenance treatments are focused primarily on addressing functional indicators of pavement deterioration such as ride, friction, asphalt hardening, and minor cracking rather than addressing structural deterioration through the use of rehabilitation activities. Depending on the approach the agency uses to report pavement conditions, these benefits of preventive maintenance may or may not be incorporated into the survey process. For example, a composite index that incorporates both structural and functional components of condition tends to mask the functional drivers that might indicate the need for a preventive maintenance treatment. The pavement condition index (PCI) developed by the U.S. Army Corps of Engineers is a composite index that is based on the type, severity, and extent of 19 different distresses for HMA roads and streets (ASTM D-6433). A numerical rating between 0 and 100 (100 represents a pavement in excellent condition), the index provides an objective and repeatable method of reporting pavement condition. However, it is best used to help determine relative magnitudes of repair needed rather than to identify the specific treatment that may be needed, because the same PCI rating could be achieved for almost any combination of distress. In other words, the PCI gives an overall indication of the pavement condition but does not specifically indicate whether the distress is caused by rutting, longitudinal cracking, or fatigue cracking. An agency using this kind of rating may be able to identify a candidate for preventive maintenance but be unable to determine the proper course of action (e.g., a chip seal to address friction requirements, or crack sealing to prevent moisture from getting into the pavement layers).

Even agencies that use individual indexes to determine the kind of treatment required must review survey procedures to ensure that they are compatible with the needs of a preventive maintenance program. Results of a study conducted for the South Dakota Department of Transportation (DOT) indicate that several changes to the condition rating procedure might be needed to support the integration of preventive maintenance into South Dakota DOT's pavement management system (*3*).

Since 1995, South Dakota DOT has used its visual pavement distress survey to assess the condition of its road network. The survey involves the identification of pavement distress type, severity, and extent and is based on procedures outlined in *Distress Identification Manual for the Long-Term Pavement Performance Project* (*4*). The surveys are conducted by seasonal employees who rate pavement distress information on each 0.250-mi section of road. As part of the survey on flexible pavements, the reported conditions include transverse cracking, fatigue cracking, patching, and block cracking quantity and severity. The severity and extent classifications for each distress type are listed in the South Dakota DOT *Visual Distress Survey Manual* (*5*). With the use of distress information collected in the field, individual condition indices are calculated for each pavement section. In addition to the manual pavement condition surveys, information about rutting and roughness is collected and reported in separate indexes. The individual indexes also are combined into a composite index for benefit calculations and to report overall network conditions. However, the individual indexes are used to determine treatment feasibility.

One of the issues that emerged during the South Dakota DOT research project was the manner in which maintenance overlays (also called skin patches) were being reported in the condition survey procedure. Although maintenance overlays often are used as corrective treatments rather than preventive maintenance treatments in South Dakota, the relevant issues that needed to be addressed apply to either situation. In South Dakota, a patch is reported, and any individual distress that shows through a patch is also reported (as long as the entire 0.250-mi segment is not patched). The only exception to this practice in the current procedure is when the entire segment is patched using a skin patch. In such a situation, procedure guidelines for the condition survey require that the distresses appearing in the section be rated, but the patch should be rated as "perfect" (i.e., a patching index of 5.0 on a scale of 0 to 5.0). In other words, under the existing procedures, when the entire 0.25-mi segment is covered with a skin patch, the patch is not considered a patch. Another complication arises when a survey is conducted shortly after patch application, when no distress is observable. Immediately after a skin patch, all condition ratings would be reported as "perfect" (a patching index of 5.0), giving no indication that a patch had been applied as a temporary measure until rehabilitation could be performed.

This survey procedure becomes problematic in sections on which a maintenance overlay has been applied over fatigue cracking, as illustrated in Figures 3 and 4. The reported fatigue cracking index is plotted over time in Figure 3, and the patch deterioration index is plotted over time in Figure 4. From 1995 to 1997, the section apparently experienced significant amounts of fatigue cracking, because the fatigue cracking index dropped from 5.0 to 2.0 (a rating of 2.0 reflects a high extent of medium-severity fatigue cracking or a moderate extent of high-severity fatigue cracking). When the fatigue cracking index dropped below 3.5 (indicated by the dashed horizontal line), the pavement became a candidate for the resurfacing program.

The decrease in the patching index indicates that some patching occurred in 1997. (It also indicates that the entire section was not patched, or the rating would have remained at 5.0). At the same time, a corresponding jump in the fatigue cracking index is observed. As a result, both the fatigue cracking index and the patching index were

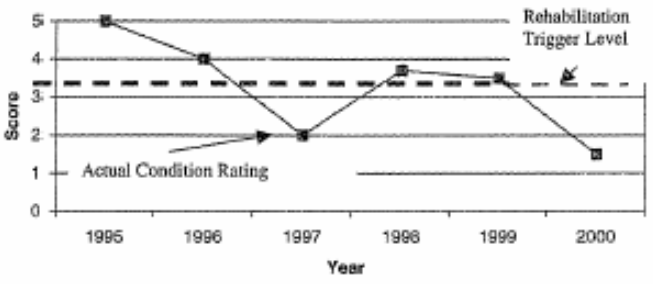

FIGURE 3 Fatigue cracking index over time (*5*).

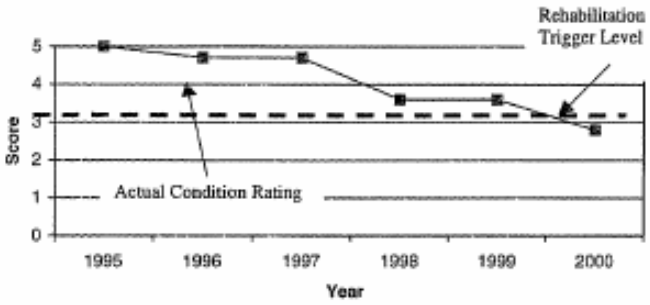

FIGURE 4 Patching index over time (5).

above the criterion for the resurfacing program in 1998 and 1999. Although not shown, if the deterioration curves for each section had been overlaid on the graphs, the predicted deterioration trends would not have reflected the actual changes in the condition indexes.

The implication for the program is far-reaching in terms of reporting current and future conditions. Depending on the timing of the patching and the condition surveys, the existing rating procedures might not provide the department of transportation with a fair representation of road conditions. In addition, existing prediction models did not reflect actual conditions in the field after maintenance patches were applied. Possible solutions include using a flag in the pavement management database to indicate that a pavement received a maintenance overlay; when the flag is on, a more severe deterioration curve could be used to reflect the expected deterioration of the patch. The survey procedure also must be modified to record the maintenance patch as extending over 100% of the area; this change will prevent the patching index from being reset to 5.0.

PERFORMANCE MODELS

Pavement performance models are used in a pavement management system to predict future conditions. The results are then used to determine future maintenance and rehabilitation needs and to report the future condition of the pavement network under various scenarios. Many transportation agencies use a "family" modeling approach that groups pavement sections with similar characteristics and uses regression techniques to determine the deterioration pattern that reflects the family performance data. Inventory features can be used to define pavement families, or "flags" can be incorporated into some databases to provide additional means of differentiating performance characteristics.

To successfully integrate preventive maintenance treatments into a pavement management system, an agency must develop performance models for these new treatments. This issue may or may not be complicated, depending on the approach used to develop the original models and the availability of sound performance data. For each preventive maintenance treatment that is incorporated into the analysis, a new set of pavement performance models must be developed. An agency must realize that a database must contain whatever information is needed to identify a pavement section as being appropriate for that performance pattern. For instance, if a chip seal curve is developed, then chip seal treatments must be identified in the pavement management database. This task requires that the pavement management section have access to the maintenance activities performed in the field and that the information reported is provided in units that are meaningful to the pavement management section.

In South Dakota, one issue that arose was between applications of chip seals for preventive purposes and as a stopgap measure for low-volume roads that were not being programmed for resurfacing. The researchers found that the first two chip seals generally were applied as preventive maintenance treatments early in the life of a pavement. The most variation occurred with the third chip seal. In some cases, field offices applied a third chip seal as a preventive measure. More often than not, however, the third chip seal was applied as a corrective technique on low-volume roads because funding levels were inadequate to address resurfacing needs. This finding led to a recommendation that flags be used in the database to identify the number of chip seals applied. The researchers did not recommend that a new set of performance models be developed because South Dakota DOT already maintained more than 100 performance curves. Instead, a rule was developed to indicate that 3 years after the chip seal was applied, the pavement would deteriorate at an accelerated rate. After the 3-year window, the original family model was used.

Another challenge in developing performance models for preventive maintenance treatments is differentiating the performance trends of some of the treatments. Without a history of performance for all the treatments that might be incorporated into a preventive maintenance program, historical data might not be available to differentiate the performances of some treatments. In such situations, agencies must develop expert models based on industry guidelines. Further complicating this issue is the fact that in many cases, the historical data are available for some of the treatments, but the treatments were used as corrective rather than preventive treatments, so performance does not reflect what might be expected in a pavement preservation program.

Finally, some agencies find that their do-nothing curves already incorporate many of the treatments that an agency might include in a preventive maintenance program. In this situation, agencies must revise their current curves to analyze the effectiveness of a preventive maintenance treatment as part of the pavement management analysis.

TREATMENT RULES

For each preventive maintenance treatment to be included in the analysis, the agency must develop treatment rules that indicate the conditions under which the treatment is considered feasible and reset rules that define the conditions that exist after the treatment has been applied. In general, setting up the treatment rules for the various preventive maintenance treatments is not difficult. The hardest part is setting up the reset rules that indicate the effect of the treatment after construction. It is slightly more complicated than for resurfacing or reconstruction projects; in those situations, the condition indexes are typically reset to the highest score because a new surface is placed on the pavement. With preventive maintenance treatments, the treatments do not necessarily return the pavements back to the highest rating. Instead, an incremental increase represented by a percentage improvement in condition or some other mathematical expression may be more appropriate. For example, an agency may set a rule that crack sealing provides a 10% improvement in pavement conditions after application.

An agency may use historical treatment information to verify that the treatment rules established for preventive maintenance treatments are reasonable. For example, in South Dakota, the researchers had access to detailed treatment histories for one region in the state. Using this information, the researchers were able to track the conditions

under which the first, second, and third chip seals were applied. Superimposing the treatment rules onto the plots of pavement condition versus age since last treatment (in this case, first chip seal) made it fairly easy to evaluate the reasonableness of treatment triggers.

Figure 5 illustrates this kind of process. The points on the plots represent the conditions of a pavement section immediately before the second chip seal was applied. A boxed area on the plot represents the conditions defined in the treatment rules for when the second chip seal is considered viable. By comparing the trigger values for each index with the conditions under which a chip seal was actually applied in the field, an agency can evaluate the reasonableness of both the trigger values and some of the decisions made in the field.

PROGRAM DEVELOPMENT

With the implementation of a preventive maintenance program, several issues arise in the area of program development. One issue concerns the agency's commitment to providing dedicated funding to support a preventive maintenance effort. Another concerns its ability to demonstrate the effectiveness of the preventive maintenance program so that support is ongoing and continuous.

The literature clearly emphasizes the importance of dedicated funding to support preventive maintenance efforts (*2*). Financial support must be at a level adequate to achieve the intended objectives and secure enough to allow long-term benefits to be realized. With regard to dedicated funding, the North Carolina DOT recently supported legislation that increased funding for maintenance line items and allowed the use of cash balances that had accumulated in the Highway Trust Fund for pavement preservation of the primary highway system (*6*). This legislation provides North Carolina DOT with $470 million to "jumpstart" a pavement preservation program by addressing the backlog of resurfacing, restoration, rehabilitation, and reconstruction projects while leveraging recurring contract resurfacing funds for thin overlays to preserve roads still in good condition. In addition, the department has committed additional funds to support pavement preservation activities such as crack sealing, chip sealing, and slurry seals (*6*). This level of effort will provide North Carolina DOT

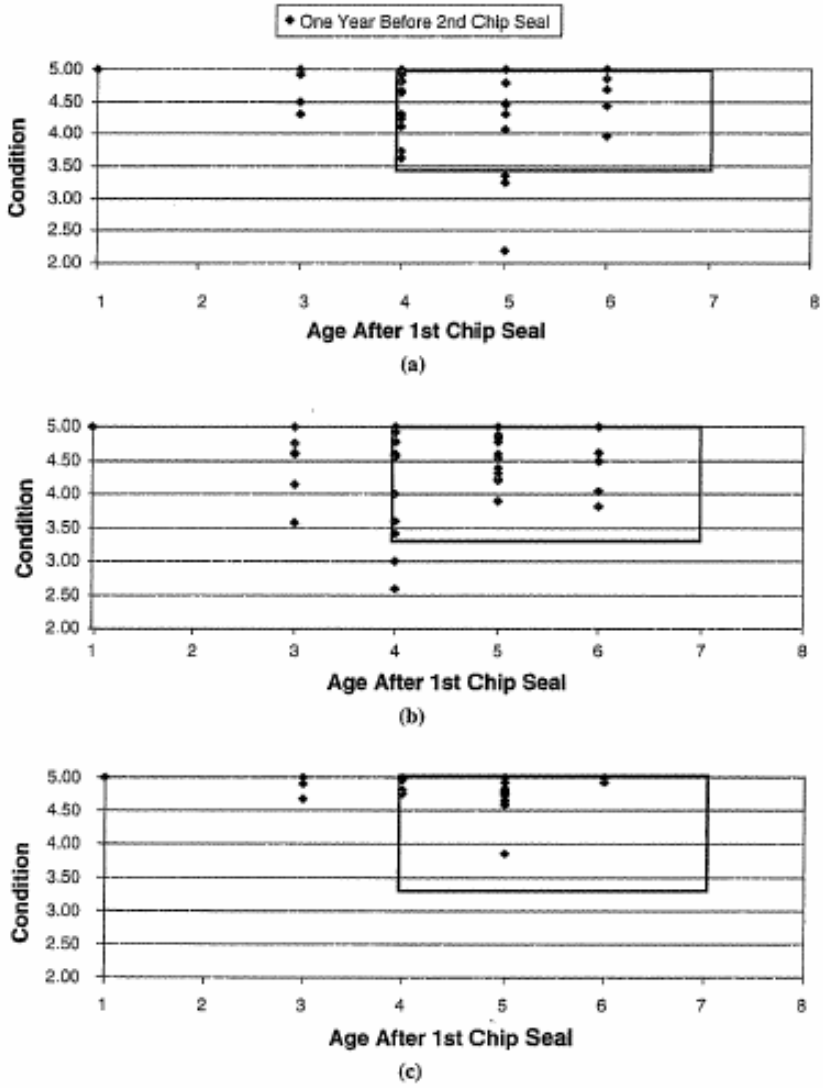

FIGURE 5 Second chip seal candidates in the Yankton, South Dakota, area (*5*): (*a*) block cracking; (*b*) fatigue cracking; (*c*) patch deterioration.

(continued)

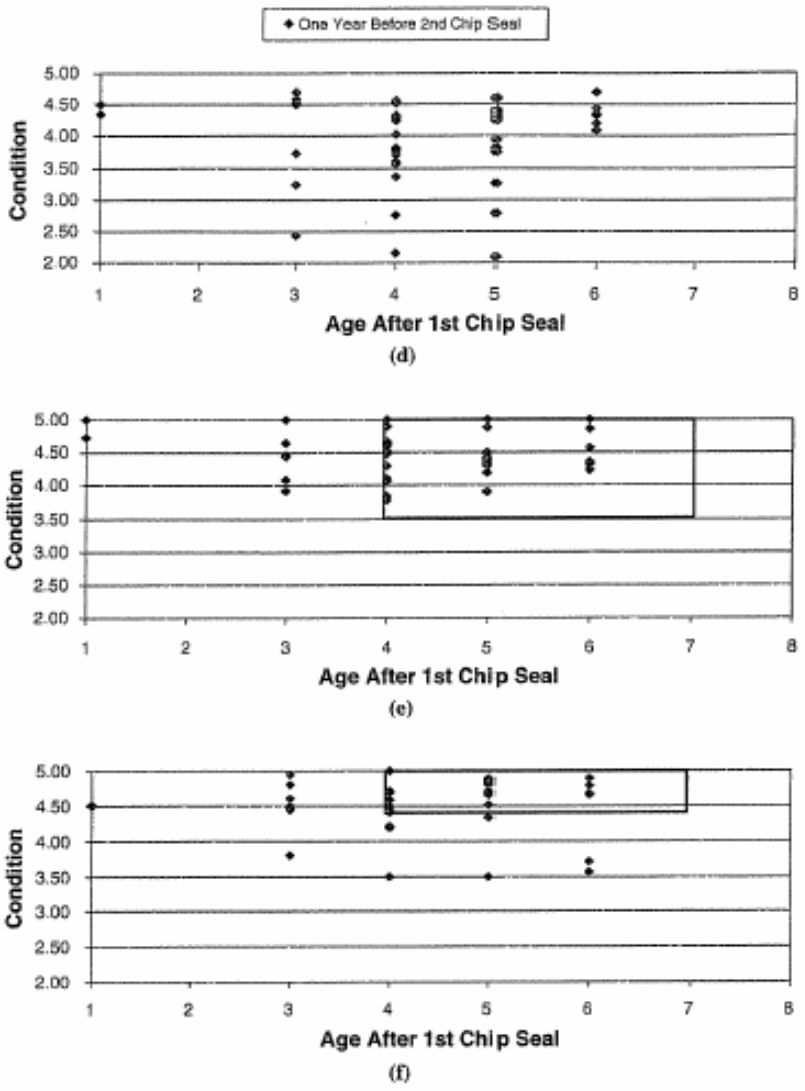

FIGURE 5 *(continued)* Second chip seal candidates in the Yankton, South Dakota, area (5): (*d*) roughness; (*e*) rutting; (*f*) transverse cracking.

with the dedicated funding required to maintain pavements in good condition.

To continue a preventive maintenance program beyond a few years, an agency must be able to track its success in moving toward the overall goals outlined at the outset of the program. For instance, an agency that intends to increase the percentage of its network in good condition by 20% over the next 5 years must track the percentages over time and report them to management. As the agency realizes the promised benefits, support should sustain the preventive maintenance efforts.

North Carolina DOT used its pavement management information to demonstrate the benefits of its preventive maintenance program. The analysis was based on a 1,000-mi network that was categorized in four condition categories based on the actual distribution of the roads in the North Carolina DOT pavement network. For instance, if 10% of the North Carolina DOT road network was in excellent condition, then 100 mi of the 1,000-mi network was assigned to the "excellent" condition category. Two strategies were evaluated: a worst-first scenario, in which 50 mi of roads in poor condition were resurfaced (this value proportionally corresponded to the actual program), and a pavement preservation (PavePres) strategy, in which 100 mi of roads in fair condition were addressed before the remaining budget was used to address roads in poor condition. Results of the analysis indicate that the benefits of the PavePres strategy take time to be realized, but the eventual impact on average network conditions is dramatic (Figure 6). North Carolina DOT is now using its pavement condition information to document the changes in conditions that result from the implementation of its preventive maintenance program.

INSTITUTIONAL FACTORS

The integration of preventive maintenance into a pavement management system is not confined to a focus on technical issues. In most organizations, institutional issues also must be addressed. One of the biggest issues concerns the programming of maintenance

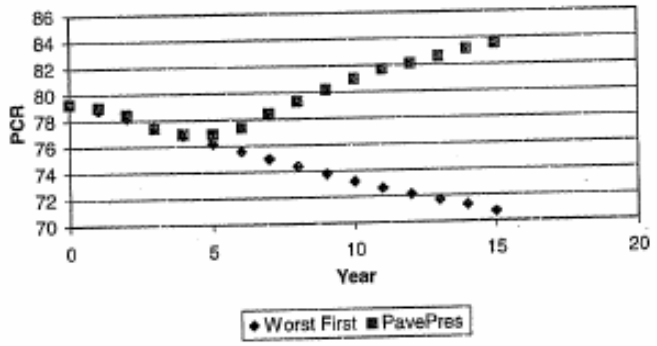

FIGURE 6 Average North Carolina network conditions under worst-first and preservation strategies. (PCR = pavement condition rating.)

activities. In most state highway agencies, maintenance is responsible for identifying and prioritizing maintenance needs on the basis of observed pavement conditions and information provided by the pavement management system. Some maintenance personnel perceive recommendations from pavement management personnel as an attempt to take away their responsibility. As a result, maintenance typically offers little cooperation to support pavement management activities.

It is also important to establish buy-in to pavement management activities with the maintenance personnel. In the South Dakota project to integrate preventive maintenance treatments into its pavement management program, this aspect became one of the most important goals of the project. A series of meetings were held with field office personnel to explain how treatments are identified in the pavement management system and to dispel some of the myths that had emerged over the years. As a result of the meetings, pavement management provides the field offices with a list of projects eligible for chip seals, formulated from the pavement management analysis; the field offices use this list as a first cut of projects to include in their program. As a result, cooperation between the field offices and the pavement management staff has much improved. The North Carolina DOT effort to initiate its pavement preservation effort also resulted from close cooperation between the state maintenance and equipment engineer and the state pavement management engineer.

CONCLUSION

As pavement preventive maintenance programs become increasingly important components of agencies' preservation strategies, agencies must address the issues that arise in trying to integrate the information into existing pavement management systems. Many technical issues must be addressed, including the condition rating procedures, performance models, treatment rules, and program development. Institutional issues also must be addressed, such as the sense of ownership that maintenance personnel have in administering the maintenance program. To be successful, an agency must address both kinds of integration issues. The examples from South Dakota DOT and North Carolina DOT presented in this paper illustrate some approaches taken to address these integration issues.

Only after a pavement preventive maintenance program is integrated into a pavement management system can an agency fully realize its benefits. With complete implementation, an agency gains a tool that can help fully evaluate the effectiveness of a preservation strategy and set performance targets for the program. The pavement management system also can be used to track the benefits associated with preventive maintenance to further promote the program, inside and outside of the organization.

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Appendix C

Regional Standardization and Replication Process

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DEPARTMENT OF THE ARMY
ENGINEER RESEARCH AND DEVELOPMENT CENTER, CORPS OF ENGINEERS
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REPLY TO
ATTENTION OF:

December 16, 2003

Facilities Division

Mr. Greg Belancio, P.E.
Washoe County
3025 Longley Lane
PO Box 11130
Reno, Nevada 89520-0027

Dear Mr. Belancio

Re: Regional standardization and replication process for PAVER condition assessment.

Pursuant our discussion, I greatly encourage your attempt to insure proper condition assessments on a regional basis for the Cites of Sparks and Reno and Washoe County. The concept of using the same inspection cycle along with proper training, methods and calibration should result in very similar results. Further, the standardization of use of the rating in similar geographical areas seems to be appropriate and beneficial.

The PAVER inspection process is used throughout the Untied States and the world. It is and can be replicated with good accuracy and consistency. The condition assessment process, as you know, is now an ASTM standard.

Good luck in this worthwhile endeavor. If you need any further information from me please let me know.

Sincerely,

Mohamed Y. Shahin, PhD, P.E.
Principal Investigator, CERL