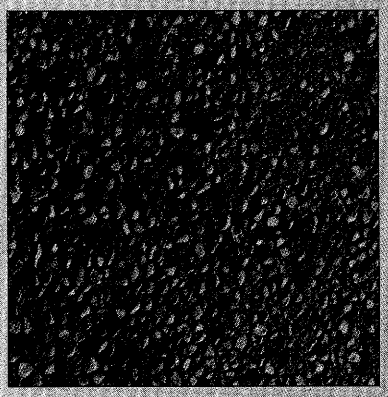

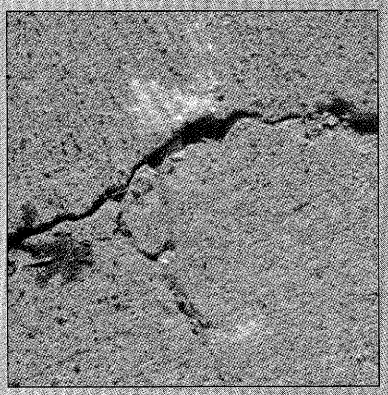

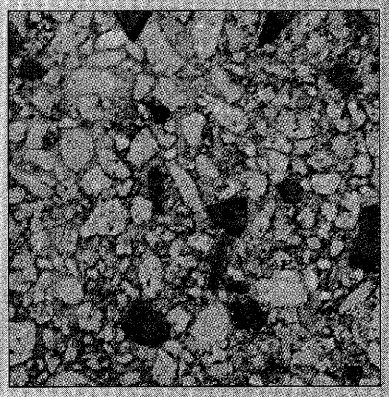

Pavement Preservation Research Problem Statements

Federal Highway Administration and The Foundation for Pavement Preservation

Research Problem Statement Workshop
Sacramento, California
JUNE 21-22, 2001

Pavement Preservation
Research Problem Statements

Research Problem Statement Workshop

Sacramento, California

June 21–22, 2001

By James S. Moulthrop, R. Gary Hicks,

and Jon A. Epps

U.S. Department
of Transportation
**Federal Highway
Administration**

December 2001

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ACKNOWLEDGMENTS

The authors would like to take this opportunity to thank all the many people involved with the planning, execution, and documentation of the Workshop.

Workshop Organization

The Research Problem Workshop was a joint effort among the Federal Highway Administration (FHWA), American Association of State Highway and Transportation Officials (AASHTO), and the Foundation for Pavement Preservation (FPP). The California Department of Transportation (DOT) agreed to host the meeting and arrange for facilities.

Meeting Participants

The organizers and participants in the Workshop are noted in Appendix A.

Document Preparation

The preparation of the Workshop report was done by Dr. Jon Epps, Dr. R. Gary Hicks, and James S. Moulthrop. The editing was done by Woodward Communications and the report was published through the auspices of FHWA.

Executive Summary

A workshop was held in Sacramento on June 21-22, 2001, to develop research problem statements related to pavement preservation. The workshop was a joint effort among the Federal Highway Administration (FHWA), American Association of State Highway and Transportation Officials (AASHTO), and the Foundation for Pavement Preservation (FPP). The California Department of Transportation hosted the 2-day meeting. Participants at the workshop included FHWA, AASHTO members, FPP members, and academia. Dr. Jon Epps of Granite Construction, Inc., facilitated the meeting.

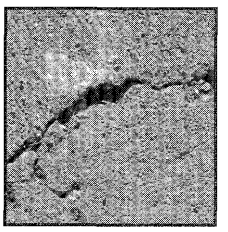
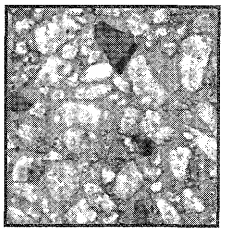
The purpose of the workshop was to gather practitioners from various maintenance disciplines around the United States to discuss research needs in the pavement preservation arena. The outcome was to be a series of problem statements that the partners could promote for funding and study.

A total of 50 research problem statements were initially identified and grouped in the following areas:

1. Construction practices,
2. Materials selection and design,
3. Treatment strategies and selection,
4. Performance evaluation,
5. Training, and
6. Policy.

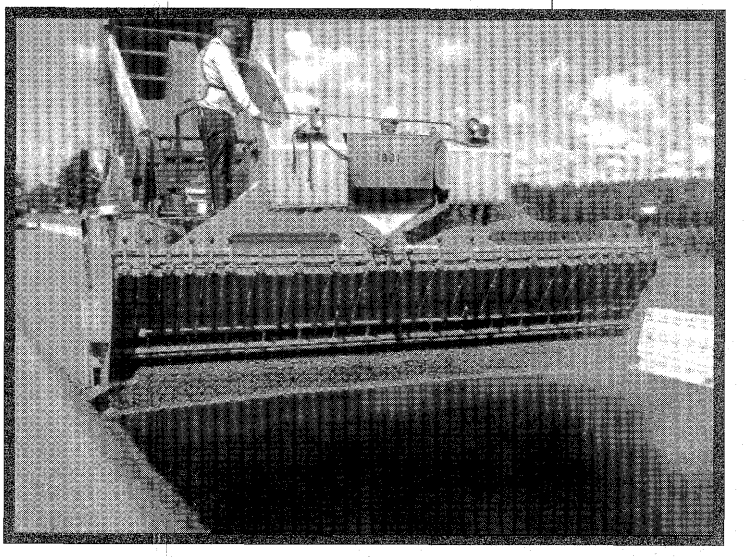
The participants prioritized the projects and the number of projects was then reduced to a total of 22. Project statements were prepared for each of these topics.

This report was prepared documenting the findings of the workshop and the resulting research project statements. The report is available from FHWA or FPP.

one — *introduction*

Very little research has been conducted recently regarding pavement preservation practices used in the United States and elsewhere. Most of the maintenance techniques have evolved through the shared experience of practitioners. In contrast, a tremendous amount of research expenditures in the past 50 years has been spent on pavement materials characterization, construction practices, and pavement management techniques. In the United States, this is due in part because of the needs associated with the planning and execution of the Interstate Highway System. During the Strategic Highway Research Program, some research funds were expended to improve techniques for patching and sealing of cracks and joints. Recently, agencies have begun to invest research and development funds into new preservation techniques and practices. This has been spurred by several surveys indicating lack of customer satisfaction with pavement conditions, safety, and congestion.



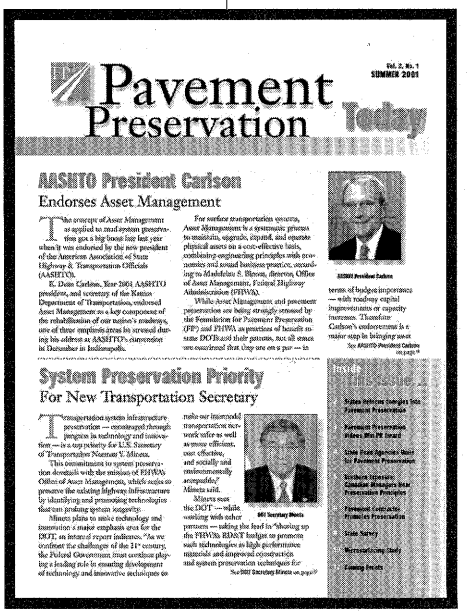
Commitment to Pavement Preservation

The importance of maintaining the U.S. highway infrastructure was first recognized by Congress in the 1978 Surface Transportation Act, which provided an emphasis on maintaining the Interstate System and permitted Federal funds to be used for such activities for the first time. More recently in the reorganization of FHWA, an Office of Asset Management was established with the clear vision, among other goals, of promoting

the benefits of pavement preservation to States. Since 1997, FHWA has partnered with the FPP and AASHTO in sponsoring seminars, training courses, publications, and other forms of outreach to emphasize the needs and benefits of a sound pavement preservation program.

Strategic Pavement Preservation Research

Studies have indicated that the funding needed to keep the current National Highway System in good condition amounts to nearly $50 billion annually, with current expenditures standing only at $25 billion. With this shortfall and the likelihood of significant increases not very good, it's obvious that new and improved treatments and techniques are required if we expect to keep the system in an acceptable condition. By wisely spending resources on research to improve practices and techniques for pavement preservation, we hopefully can close the gap between needs and condition in order to better serve the traveling public.


Pavement Preservation Today

Vol. 2, No. 1
SUMMER 2001

AASHTO President Carlson
Endorses Asset Management

System Preservation Priority
For New Transportation Secretary

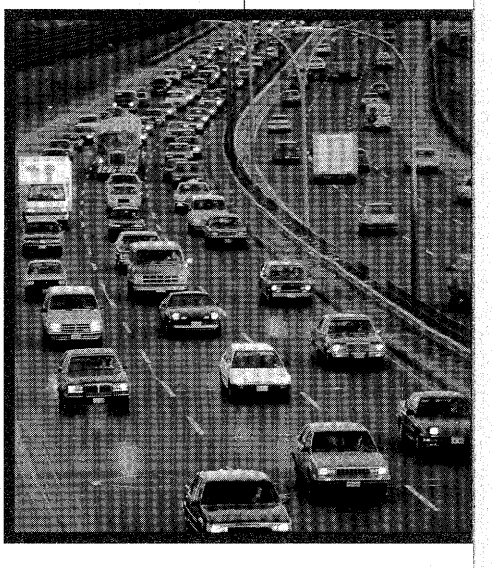
Purpose of the Workshop

The principal reason for the Workshop was to gather practitioners from various maintenance disciplines around the United States and create an atmosphere where research needs could be discussed, debated, and challenged. The outcome was envisioned to be a series of strategic problem statements that the partners could promote for funding and study.

two — *background*

Current Situation

As the Nation's transportation infrastructure carries us into the 21st century, highway officials are faced with the challenges of an ever expanding, still evolving, yet aging highway network. The nation's largest public works project—the Interstate System of National and Defense Highways—is now complete. The Federal-aid program is undergoing a significant transition from its original focus on building the Nation's highway network to one of preserving our investment in, and improving the quality of, our infrastructure. The demands on our highway network are greater than ever, and they will continue to grow. With this increasing demand comes the expectation of a higher standard of performance. A 1995 National Quality Initiative survey found that pavement condition was the number one concern of highway users. This concern translates into the general perception that highway agencies are not doing a very good job of maintaining the public's highways. Although the levels and volumes of traffic on highways today far exceed design expectancy, preventive maintenance strategies may allow us to meet the needs of the traveling public.

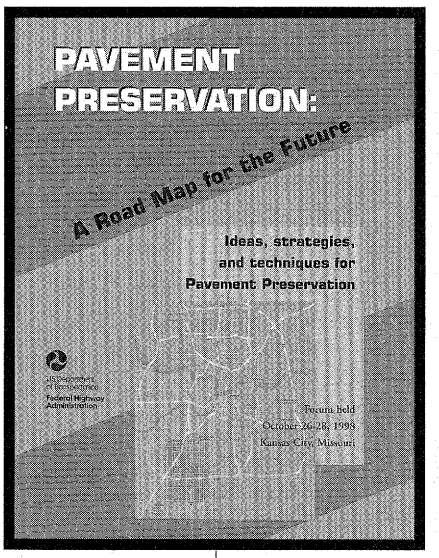


FPP-FHWA Partnership

FHWA, in partnership with other members of the highway community, AASHTO, and FPP, has been championing the need for continuous improvements to the quality, performance, and safety of the streets and highways in the United States. Until now, the primary goal of the FHWA and State highway agencies has been to complete the Interstate highway system. With the system now complete, FHWA and many States are redefining their goals to support continual improvements in quality—in terms of comfort, convenience and safety—on our Nation's highway system. Pavement preservation is key to accomplishing this goal.

Need for Coordinated Effort to Identify Research Needs

Pavement preservation is at the core of all future highway programs. It calls for a concerted effort by industry and Federal, State, and local highway agencies to generate support for a program of activities that will provide highway users with the highest level of quality and cost effectiveness. To accomplish this, all parties must clearly identify needed preservation activities, and then implement them. A key step in this effort is to identify research needs to improve upon current practices.



Forum for the Future I

This forum, held in 1998 in Kansas City, laid out a road map of ideas, strategies, and techniques for pavement preservation. Key action areas included:

- Better understanding of pavement preservation activities, which in turn will lead to more broad-based support for preventive maintenance.
- Integrated pavement performance data, including costs, benefits, and effectiveness of preventive maintenance activities.
- Greater understanding of the need for dedicated funds for pavement preservation and top management support for the same.
- Performance specifications, improved quality control/quality assurance procedures, and readily available state-of-the-practice training materials.

Research was also considered a key to the future. Appendix 1 of the forum proceedings describes some of the important research issues.

Research Workshop—Sacramento

As a result of the partnership among FHWA, AASHTO, and FPP, and the issues outlined in the proceedings of Forum for the Future I, a workshop to identify the important research needs was held in Sacramento in June 2001.

three — *mission statement/goals*

The FPP mission statement, vision, and objectives are given below. They were developed as part of a continuous strategic planning effort within the organization.

Mission Statement

To continuously improve the quality and understanding of pavement preservation technologies through outreach, education, research, public-private partnering, and international exchange.

Goals

Providing the resources and support necessary to advance knowledge and support for managing and preserving pavements.

Objectives

To support research to educate the public, government, and industry in the economic, safety, and performance advantages of pavement preservation.

The FPP and FHWA recognized the need for a coordinated approach to identify research needs and periodically publish a research needs document.

At an FPP Board of Directors meeting in San Diego, California, in early 2001, the Foundation and FHWA recognized the need for a coordinated approach to identify research needs and periodically publish a research needs document, so as to attract attention and funding to address these needs.

The research needs document is an effort that has been assigned to the research committee of the Foundation. These research needs statements will be revisited periodically and an updated research needs document will be issued.

four — *research workshop*

Introduction

The FHWA/FPP Research Planning Workshop was held on June 21 and 22, 2001, in Sacramento, California. The participants at the workshop are shown in Appendix A. Representatives from the public sector, including FHWA, State highway agencies, and local governments, as well as representatives from industry, including the FPP, materials suppliers, consultants, and contractors, attended the meeting.

The purpose of the workshop was to identify, prioritize, and draft research problem statements in the area of pavement preservation. An information package was prepared and sent to the participants prior to the meeting. Among other things this package contained background papers and potential research problem statements. The key background papers included the following:

- Moulthrop, J.S. and Hicks, R.G., *Pavement Maintenance: Preparing for the 21st Century.*
- Federal Highway Administration, *Pavement Preservation: A Road Map for the Future.*
- Transportation Research Board, *Maintenance Research Master Planning Workshop.*

Several research problem statements were then prepared and submitted for consideration. The problem statements included those prepared by the International Slurry Surfacing Association, the University of California at Berkeley, and the North Central States Consortium.

The purpose of the workshop was to identify, prioritize, and draft research problem statements in the area of pavement preservation.

General Considerations

The scope and purpose of the workshop were defined for the participants. The participants reconfirmed that the purpose of the workshop was to identify, prioritize, and prepare draft research, development, and implementation problem statements in the

pavement preservation area. Both rigid or Portland cement concrete surfaced pavements and flexible or asphalt bound materials surfaced pavements were to be considered. In addition, nonstructural activities (noise, safety, smoothness, aging, etc.) were to be considered, as well as drainage considerations and thin surfacing materials.

All participants agreed that "champions" were needed if funding was to be obtained to support the many research, development, and implementation needs. Joint funding, such as State highway agency pooled-fund studies and joint public and private sector projects, will be needed to fund and complete the research effort. Both short- and long-term research, development, and implementation projects were considered during the workshop.

The participants agreed that the Transportation Research Board research problem statement format was acceptable for use.

All participants agreed that "champions" were needed if funding was to be obtained to support the many research, development, and implementation needs.

Identification of Research, Development, and Implementation Topics

Considerable effort was devoted to identifying potential research, development, and implementation topics. Initially the topics were identified by each participant by title. Information contained in the information package was also considered. A list of 57 topics was initially identified and then narrowed down to 50. These topics are shown in Appendix B.

The 50 topics were grouped into six areas as shown below:

1.0 Construction Practices

2.0 Materials Selection and Mixture Design

3.0 Treatment Strategies and Selection

4.0 Performance Evaluation

5.0 Training

6.0 Policy

Additional discussion increased the original 57 topics by 15 as shown in Appendix B. Additional topics included training programs, field validation, paints and markings, joint sealants, and application of preventive maintenance to local roads.

Prioritized Topics

Appendix C contains a listing of the grouped and combined research topics. Shown on the listing are the votes received from the first ballot used to prioritize the topics. The first ballot votes together with the original topic number identification are shown in the Appendix.

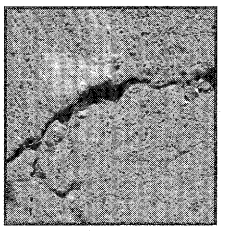
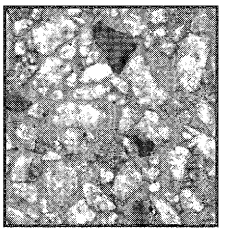
Based on the results from this first ballot, additional discussions were held relative to the elimination of topics. Those topics that received relatively low numbers of votes were then evaluated. If champions were not identified for the low vote topics, the topics were eliminated from further consideration. This process was completed for all of the research areas and the high priority topics were identified.

High priority topics for each of the research areas were identified.

Draft Problem Statements

Each of the high priority research topics identified in the process described above was assigned to one or more participants for preparation of the research problem statement. The problem statement format was revised slightly at this time in the discussions and the key outline areas used to prepare the problem statements are listed below:

1. Title
2. Introduction/Background
3. Scope/Objective
4. Work Plan
5. Proposed Deliverables (products)
6. User Community

7. Estimated Cost (range) and Duration
8. Potential Partners
9. Implementation Statement

Report Preparation

The areas used to group the problem statements were agreed upon as follows:

1.0 Construction

2.0 Materials Selection and Mix Design

3.0 Treatments and Selection Strategy

4.0 Performance

5.0 Training

6.0 Policy

7.0 Other

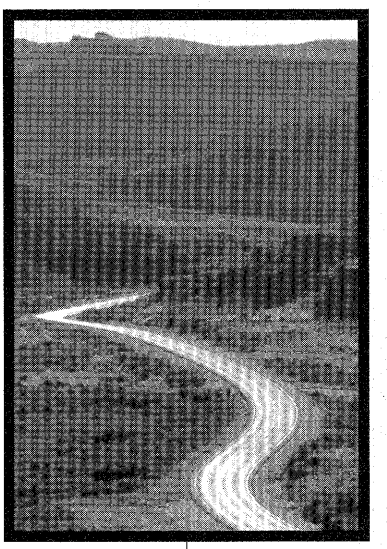
Jim Moulthrop, Gary Hicks, and Jon Epps were charged with preparing the report that resulted from the workshop. Individual problem statements were to be submitted and reviewed for inclusion in the draft report. All participants were asked to review and revise the final report from the workshop.

five — *strategic programs/projects*

Seven research, development, and implementation areas were identified by the participants at the June 2001 conference. These program areas are:

1.0 Construction

As the demands on our national highway network continue to grow, so does the need for construction and maintenance practices that will help extend the life of pavements. State highway agencies are increasingly using a variety of pavement preventive maintenance treatments to keep pavements in good condition longer, including slurry seal and microsurfacing applications. To ensure that these treatments are used to their maximum effectiveness, however, further research is needed on standardizing such practices as field sampling methods and quality control/quality assurance procedures. Standardization of field sampling methods, for example, will help agencies verify that a field mix is consistent with the laboratory mix design. Standard test methods for such procedures as using an ignition oven in preparing slurry, microsurfacing, and other emulsion mixes, meanwhile, would be a valuable quality control tool. Standardization will also help to encourage highway agencies to adopt comprehensive pavement preventive maintenance programs.



2.0 Materials Selection and Mix Design

The materials selection and mix design of a pavement preventive maintenance treatment are crucial to the success of that treatment. For example, an improperly applied chip seal can result in the early failure of the pavement and costly corrective maintenance. In other cases, such as the use of asphalt emulsion treated mixes, the lack of a standard design method can make it difficult to determine how a mix design will perform. Determining best practice materials selection and mix design procedures for these and other treatments must be a high priority if we are to achieve ultimate effectiveness for pavement preventive maintenance. This information will help highway agencies make informed, cost-effective decisions about preventive maintenance.

3.0 Treatments and Selection Strategy

To be effective, preventive maintenance treatments must be implemented at the right time. Unlike routine maintenance, which is usually performed when the pavement is failing, preventive maintenance treatments must be applied when the pavement is still in good condition, with no structural damage. In order to minimize costs, it is also important that highway agencies choose the right treatment for the right road, taking into account such variables as climate, traffic levels, and traffic delays.

In making these pavement preservation decisions, highway agencies use a broad spectrum of data that often exists in many disparate databases, such as ones for pavement and maintenance management systems, traffic volumes, and construction and materials quality assurance records. Integrating or linking these databases is increasingly critical to making informed pavement preservation decisions.

4.0 Performance

As pavement preventive maintenance treatments become more widely used, it is important to evaluate their performance. However, the evolutionary nature of new treatments that have been introduced means that performance measures and criteria are often lacking. Research is needed into developing guidelines and criteria for maintenance treatment performance evaluations. These guidelines should include procedures for collecting pavement data. Such procedures and guidelines are essential to the continued successful implementation of pavement preservation initiatives nationwide.

5.0 Training

A well-trained workforce is a more efficient and effective workforce. As highway agencies place more emphasis on using preventive maintenance treatments, it has become evident that training is needed on the design and construction of these treatments. Training courses should be modular in nature, so that highway agencies can select the modules of interest to them. This training will provide a first introduction to

those unfamiliar with the new preventive maintenance techniques, as well as serve as a refresher for those who would like to improve the performance of their maintenance treatments. Ultimately, training will improve the overall construction quality of treatments, helping to ensure that they perform for the length of or beyond their expected life span.

6.0 Policy

For pavement preservation programs to succeed, they must be sustained efforts with support and funding from all involved stakeholders. Loss of support or changing DOT or legislative priorities can result in the loss of the accumulated benefits of pavement preservation. To ensure the continued support of stakeholders, research efforts must identify and address their needs.

Another policy area that can affect the success of pavement preservation programs is specifications for preventive maintenance applications. Traditional rigid specifications can stifle the innovative approaches that often produce a better finished product. Specifications for some pavement preventative applications, therefore, need to be more flexible.

7.0 Other

An additional area of preventive maintenance research that should be considered is the effectiveness of retrofit edgedrains. These have been used by many highway agencies to reduce or prevent pumping and associated faulting in Portland cement concrete pavements. However, some questions have been raised about the need for this technique, as well as its cost effectiveness over time.

These program areas represent themes for research, development, and implementation needs in the pavement preservation industry. Based on the program areas, specific project needs were identified at the June 2001 meeting. The projects represent both short- and long-term needs (See Table 5.1 on Page 14).

Detailed discussions of each of the seven program areas, as well as detailed project descriptions, can be found in Appendix D. For ease of reference, each program is given a number and each project is given a subset project number. For example, 1.1 identifies the first project (QC/QA for Pavement Preventative Maintenance Treatments) in the Construction Program Area (1.0). Each program area and project has been prepared to be a stand-alone document.

The program areas and projects are expected to change in scope and objective, as well as priority, with time. However, the workshop participants believe the prepared document will help guide the research, development, and implementation efforts in pavement preservation over the next several years. It should also be recognized that research is underway in some of the areas identified in this document. Upon completion, some of these projects will satisfy the objectives identified by the workshop participants.

Table 5.1 *Program Areas and Project Summaries*

Program Objective	Project Number	Project Name	Project Objective
1. Construction			
Development of tests and procedures to ensure quality in all treatments.	1.1	QC/QA for Pavement Preventative Maintenance Treatments	Develop QC/QA methodology for PM treatments.
	1.2	Standardized Field Sampling Methods for Slurry Seal and Microsurfacing	Evaluate current practices and develop standards.
	1.3	Use of the Ignition Oven to Determine Percentage of Asphalt Concrete in Slurry, Microsurfacing, and Other Emulsion Mixes	Develop a standard method for determining the percentage of asphalt concrete for PM treatments.
2. Materials Selection and Mix Design			
Evaluation of a variety of PM treatments and development of improved systems, mix design methods, and specifications.	2.1	Development of a Cost-Effective Chip Seal System for Pavement Preservation	Document best practices for design of chip seals.
	2.2	Concrete Materials for Maintenance Applications	Document best practices for use of PCC materials.
	2.3	Performance and Specifications of Crack and Joint Sealants	Document effectiveness of seals and develop criteria for evaluating seals.
	2.4	Mix Design Procedures, Engineering Properties, and Performance Characteristics of Emulsion Mixes with and without RAP	Develop an improved mix design procedure for emulsion mixes.
3. Treatments and Selection Strategy			
Selection of treatments and timing based on cost effectiveness; development of guidelines/tools to make better decisions on appropriate treatments.	3.1	Timing of Preventative Maintenance Applications to Effectively Extend Pavement Service Life	Evaluate the benefits of timely PP strategies.

Table 5.1 *Program Areas and Project Summaries*

Program Objective	Project Number	Project Name	Project Objective
3. Treatments and Selection Strategy (cont'd)			
Selection of treatments and timing based on cost effectiveness; development of guidelines/tools to make better decisions on appropriate treatments.	3.2	Maximizing PP Strategies through Cost Effectiveness Research	Evaluate the cost effectiveness of PP strategies.
	3.3	Appropriate Maintenance Treatments for Urban Areas (Window of Opportunity)	Identify the most appropriate treatments for urban areas.
	3.4	Development of PM Guidelines for Pavement Blow-Ups	Document best practices for maintenance of blow-ups.
	3.5	Development of Integrated Databases To Make PP Decisions	Inventory existing database systems for making PP decisions.
4. Performance			
Evaluation of the performance and other benefits of preventive maintenance treatments.	4.1	Guidelines for Effective Maintenance Treatment Evaluation Test Sections	Develop a set of guidelines for evaluating PM treatments.
	4.2	Performance Measures/Criteria for Conventional and Warranteed Preservation Treatments	Identify performance measures for various PM treatments and guide specs.
	4.3	Treatments and Quantification for Noise Reduction and Improved Surface Characteristics	Quantify the noise reduction and improved surface characteristics for PM treatments.
	4.4	Documentation of Pavement Performance Data Based on the Application of PP Strategies	Develop procedures for collecting and documenting performance data.
5. Training			
Development and delivery of training on all aspects of pavement preservation	5.1	Design and Construction of High Quality PM Treatments	Provide training on design and construction of PM treatments.
	5.2	Training and Certification of Technicians	Improve the skill level of technicians.
	5.3	Training to Present the Results of R&D and to Facilitate Implementation	Early implementation of research findings.

Table 5.1 *Program Areas and Project Summaries*

Program Objective	Project Number	Project Name	Project Objective
6. Policy			
Development of emerging issues and guidelines for PP programs.	6.1	Innovation in PM through Performance-Based Specifications	Develop performance-based specs for all types of PM treatments.
	6.2	Implementation Guidelines for a PP Program	Develop guides for agencies wishing to develop PP programs.
7. Other			
Improvements in drainage, equipment, and other miscellaneous issues.	7.1	Effectiveness of Retrofit Edgedrains	Document current practices and develop improved guidelines for design, construction, and maintenance.

PM = Preventive Maintenance
PP = Pavement Preservation

six — *references*

1. National Asphalt Pavement Association, *Hot Mix Asphalt Research & Technology,* NAPA Special Report 178, 1999.
2. Rubber Pavements Association, *Asphalt-Rubber R&D: An Industry Commitment to Excellence,* September 2000.
3. Federal Highway Administration, *Pavement Preservation—A Road Map for the Future, Proceedings, Forum of the Future I,* October 26–28, 1998.
4. Innovative Pavement Research Foundation, *Creating a New Generation of Pavements,* August 1998.

APPENDIX A
List of Participants

LIST OF PARTICIPANTS

ATTENDEE	ROLE	AFFILIATION
Dr. R. Gary Hicks	Organizer	Foundation for Pavement Preservation
Jim Moulthrop	Organizer	Foundation for Pavement Preservation
Mike Samadian	Organizer	California Dept. of Transportation
Jim Sorenson	Organizer	Federal Highway Administration
Dr. Jon Epps	Facilitator	Granite Construction Co.
John Allison	Participant	California Dept. of Transportation
Chris Bauserman	Participant	DE County, OH [National Association of County Engineers]
John Bittermann	Participant	California Dept. of Transportation
Dr. John Harvey	Participant	University of California, Berkeley
Steve Healow	Participant	Federal Highway Administration
Keith Herbold	Participant	Federal Highway Administration
Randy Iwasaki	Participant	California Dept. of Transportation
Frank Lisle	Participant	Transportation Research Board
Roger Olson	Participant	Minnesota Dept. of Transportation
David Peshkin	Participant	Applied Pavement Technology, Inc.
Eric Reimschiissel	Participant	CPM [International Slurry Surfacing Association]
Dr. Delmar Salomon	Participant	Idaho Asphalt Supply, Inc. [Asphalt Emulsion Manufacturers Association]
Larry Scofield	Participant	Arizona Dept. of Transportation
Julie Trunk	Participant	Federal Highway Administration
Dr. Chris Williams	Participant	Michigan Tech University
Don Wise	Participant	Pennsylvania Dept. of Transportation

APPENDIX B
Research Topics

A. Original Topics

B. Additional Topics

A. Original Topics

1. Implementation strategies for R&D
2. Timing of pavement preservation
3. Pavement performance predictions using mechanistic parameter (stand alone)
4. Conduct cost allocation study
5. Conduct cost effectiveness research activity [benefit cost ratio]
6. Objective measures for warranty measures
7. Optimal crack sealing reservoir width [follow SHRP criteria]
8. Winter patching material
9. Data to support budget requests [cost vs. performance]
10. Performance measures/criteria for preservation treatments for warranty purposes
11. Marketing strategy—public [external]
12. Marketing strategy—internal
13. Integrate pavement preservation into PMS [network and project level]
14. Record maintenance activities in PMS systems
15. Threshold limits for preservation action
16. Integration of data sets [necessary elements for effective performance prediction]
    - PMS
    - Design—materials/structural
    - Construction quality
    - Construction productivity [level of detail, integration]
17. Future rehabilitation and maintenance dependence on current treatments selection—stand alone
18. PCC [hydraulic cement] slab replacement materials' influence on future rehab and maintenance alternatives
19. Experimental plan to determine maintenance effectiveness—Guides [14-14]
20. Guidelines for life-cycle construction analysis for pavement maintenance effectiveness
21. Implementation of QC in maintenance operations—organizational, materials, techniques for measuring quality
22. QC/QA specs for maintenance operations, variability, tolerance limits
23. Window of opportunity—climate, traffic, lane occupancy, duration of operation [operating strength gain], performance trade-off (industry input important)
24. Field sampling techniques for slurry seals/micro
25. Ignition oven for use in slurry/micro spec
26. Delamination—adhesion of layers [tack coat]
27. Determine appropriate maintenance activities for selected climate, traffic, materials

[guide for public agencies]

28. Treatment selection [individual operations] vs. maintenance strategy [long term with multiple treatments] [see no. 22]
29. Joint sealant [aging, adhesion, low temp. performance, etc.] performance and specs [Canada] application method
30. Traffic [high] as a criteria for selection of maintenance alternatives
31. Integrating coordination of bridge and pavement maintenance operations
32. Effectiveness of maintenance treatments on roads in "poor" condition—hold road together for a few years, local roads, non-engineered
33. Effectiveness of roadway retrofit drainage systems—stand alone
34. Effectiveness of preventive maintenance (compare treated vs. non treated pavements)
35. Use of PG binder testing and aggregate techniques to specify asphalt binder for maintenance purposes
36. Design and construction practices for long life chip seals [aggregate and asphalt specs]
37. Noise — reduce with maintenance treatment (effectiveness of treatments to reduce noise)
38. Improve mix design methods for pavement preservation materials
    - Slurry seal
    - Micro
    - Thin HMA
    - Chip seals
    - Pavement repair materials
39. Improved procedure for selection of binder for pavement preservation materials [emulsions, hydraulic cement, asphalt rubber]
40. Thin surfacing materials
41. Performance specs [to foster innovation]
42. Construction QC methods, tests, and criteria
43. Measuring existing pavement properties that will allow for adjusting "mix" designs and selection of techniques
44. Surface preparation prior to treatments
45. Criteria for grinding ruts—stand alone
46. PCC joint sealants—effectiveness
47. Patch materials for dowel bar replacement/retrofit
48. PCC slab replacement materials—early age cracking, durability issues—sulfate, ASR, strength, cost, performance
49. Techniques for load transfer—Existing slabs
50. Accelerated testing for pavement testing
    - Mix design
    - Materials selection
    - Performance

B. Additional Topics

GROUP 1

- Identify needed equipment improvements—SHRP idea
- Extraction procedures for asphalt properties—Under implementation of QC specs
- Develop Course 3—training
- Approaches for increasing production rates—integrate with MUTCD—get in, get out

GROUP 2

- Field validation should be incorporated into Topics 44, 45, 46
- Field validation of slurry/micro pooled fund study
- Add surface characteristics and friction under Topic 43

GROUP 5

- NHI course, Design and construction "best practices"
- Certification of technicians
- Training as a result of research, development, and implementation

GROUP 7

- Standardization of definitions
- Paint/Marker issues
- Drainage
- Joint sealant
- Application of preventive maintenance to local roads

APPENDIX C
First Round Balloting of Issues

Highest number of ballots listed first

Group 1.0 Construction

	Votes
• Implementation of QA/QC specs	12
• Field sampling of slurry/micro	8
• Field sampling of slurry and micros	8
• Ignition oven – slurry/micro binder	7
• Construction of long life preventive maintenance treatments [surface prep, tacks, etc.], Incorporated into Topic 2.2	5

Group 2.0 Materials Selection/Mix Design

• Tests, mix design, and construction for asphalt-based maintenance treatments—thin surfacing materials	30
• Binder and aggregate tests and procedures	
• Chip seal mix design and adjustment for existing conditions	
• Chip seal construction practices	
• Field validation of all of the above	
• Treatments and quantification for noise reduction and surface characteristics [friction and smoothness]	13
• Concrete [hydraulic cement] maintenance materials	7
• Influence of future strategies	
• Properties for DBR grout	
• Dowel bar load transfer prediction	
• Field validation	
• Crack sealant: Performance and specification	5
• Thin surfacing materials—Evaluation, Incorporated into Topic 2.2	1
• Winter patching materials	0

Group 3.0 Treatments and Strategy Selection

• Windows of Opportunity	12
• Timing—treatment vs. strategy	11
• Economic Evaluation	8
• Measurements of in-situ pavement properties for improved mix design/treatment design, Incorporated into Topic 2.2	6

Group 4.0 Performance

	Votes
• Experimental plans to determine maintenance effectiveness guide	25
• Objectives measures for warranties	20
• Data elements for performance prediction	21
• Performance measurements/criteria for preservation treatments	12

Group 5.0 Training

- NHI course 3 [design and construction of "best practices"]
- Training and certification of technicians
- Training—As a result of research, development, and implementation

Group 6.0 Policy

• Develop performance related-specs for preventive maintenance activities to foster contractor innovation and improve overall performance	17
• Develop marketing and promotional strategies both internally [such as establishing a program, implementing relevant research, obtaining funding and supporting budget requests] and externally [to public and legislature]	16
• Integrate data sets for pavement design, construction, maintenance, and performance [into something like a pavement preservation management system]	10

Group 7.0 Other Ideas

• Drainage	15
• Application of preventive maintenance to local roads	5
• Standardization of definitions	4

APPENDIX D
Draft Problem Statements

1.0 Construction

2.0 Materials Selection and Mix Design

3.0 Treatments and Selection Strategy

4.0 Performance

5.0 Training

6.0 Policy

7.0 Other

1.1 QC/QA for Pavement Preventative Maintenance (PM) Treatments

1.2 Standardized Field Sampling Methods for Slurry Seal and Microsurfacing

1.3 Use of the Ignition Oven to Determine Percentage of Asphalt Concrete (AC) in Slurry, Microsurfacing, and Other Emulsion Mixes

1.1

QC/QA for Pavement Preventative Maintenance (PM) Treatments

Introduction and Background

Existing specifications for PM treatments are method/recipe.

Scope and Objectives

This study will develop Quality Control/Quality Assurance (QC/QA) testing methodology for PM treatments. The magnitude of variability associated with this methodology will be defined.

Work Plan

Task 1. Define current practices through a literature search and survey of owner agencies and industry groups.
Task 2. Develop lab and field methodologies.
Task 3. Develop training and certification programs for sampling and testing technicians

Proposed Deliverable

A research report will present the results of the lab and field studies and propose standard methodologies. Training and certification programs are essential for owner implementation.

Potential Partners

Owner agencies, cities, counties, contractors, the Asphalt Recycling and Reclaiming Association (ARRA), International Slurry Surfacing Association (ISSA), and the Asphalt Emulsion Manufacturers Association (AEMA).

Duration and Cost

Three years at an estimated cost of $1.5 million.

User Community

1. Cities
2. Counties
3. State DOTs
4. Other: airports, agencies, contractors.

Implementation

Technical bulletins, distribution of the standard test methods for inclusion in owner agency specifications, and AASHTO and American Society for Testing and Materials (ASTM) test methods.

Standardized Field Sampling Methods for Slurry Seal and Microsurfacing

Introduction and Background

The use of slurry seal and microsurfacing applications are seeing steady growth in many States, cities, counties, and other agencies. These materials are being tested for QC/QA compliance and for monitoring project performance. There is an urgent need for a standard sampling method. This standard sampling method is crucial to verify that the field mix is consistent with the lab mix design.

Scope and Objectives

There are no existing standardized field sampling methods or procedures for microsurfacing and slurry seal aggregate, emulsion, and combined mix materials. The objective of this study is to evaluate current practices and develop a standard practice.

Work Plan

Task 1. Develop proposed standards.
Task 2. Perform round-robin testing to verify proposed standards.
Task 3. Measure laboratory variation.
Task 4. Measure field variation.

Proposed Deliverables

1. AASHTO Sampling Method.
2. Report of round-robin testing to explain lab and field studies.

Potential Partners

ISSA, AEMA, FHWA, AASHTO, Federal Aviation Administration (FAA), and CSSA.

Duration and Cost

One year at an estimated cost of $50,000—$100,000.

User Community

1. Cities
2. Counties
3. State DOTs
4. Other: airports, agencies, and contractors.

Implementation

Place into owner agency QC/QA specifications, AASHTO sampling method, and ASTM sampling method.

1.3

Use of the Ignition Oven to Determine Percentage of Asphalt Concrete (AC) in Slurry, Microsurfacing, and Other Emulsion Mixes

Introduction and Background

The ignition oven is commonly used to determine the percentage of AC in the hot-mix asphalt (HMA) industry, However, there is currently no standard procedure for the use of the ignition oven or for solvent extraction of microsurfacing, slurries, and other emulsion mixes. Initial studies involving the use of ignition ovens for slurries and microsurfacing have been inconclusive. A completed lab-field study would help define a specific procedure for slurries, microsurfacing, and other emulsion mixes. A standard test method involving the use of the ignition oven would be a valuable tool for the slurry and microsurfacing industries.

Scope and Objectives

The objective of this study is to use the experience gained in the HMA industry to develop a standard test method for determining percentage of AC for microsurfacing, slurries, and other emulsion mixes.

Work Plan

Task 1. A literature search and survey of agencies will be conducted to define the current state of the practice in the use of the ignition oven.

Task 2. A laboratory study, followed by a field verification study, will be used to compare the results of the ignition oven with solvent extraction.

Proposed Deliverable

A research report will present the results of the lab and field studies and propose a standard test method.

Potential Partners

Owner agencies, cities, counties, contractors, ARRA, ISSA, and AEMA.

Duration and Cost

One year at an estimated cost of $50,000.

User Community

1. Cities
2. Counties
3. State DOTs
4. Other: airports, agencies, and contractors.

Implementation

Technical bulletins, distribution of the standard test method for inclusion in owner agency specifications, and AASHTO and ASTM test methods.

2.1 Development of a Cost-Effective Chip Seal System for Pavement Preservation

2.2 Concrete Materials for Maintenance Applications

2.3 Performance and Specifications of Crack and Joint Sealants

2.4 Mix Design Procedures, Engineering Properties, and Performance Characteristics of Emulsion Mixes with and without RAP

2.1

Development of a Cost-Effective Chip Seal System for Pavement Preservation

Introduction and Background

Chip seals are widely used for preventative maintenance of pavements. These include emulsions for cold mix and cold-in-place recycling. However, chip sealing continues to be an art and when not properly applied can result in early failure and costly corrective maintenance for user agencies. Furthermore there is no acceptable mix design procedure that predicts the engineering properties of a cured emulsion mix.

Some systematic methodology is available for chip sealing design and application. However, in many cases it continues to be a 'trial and error' approach to chip sealing. Additional technical information is needed that defines binder selection based on climate and integrates it with aggregate properties that allow calculation of emulsion and aggregate application rates during chip seal placement. Both modified and unmodified emulsion should be considered and their relative costs associated with this particular pavement preservation strategy.

Cold-mix design has been explored in Europe (the OPTEL project) but remained inconclusive. Additionally, a workability tester was developed to measure the cohesive strength of the mix as a function of cure time. Further work is needed to relate the mix cohesive strength with its workability and emulsion rheological properties.

Scope and Objectives

The purpose of this project is to consolidate and review best practice chip seals design procedures for asphalt emulsions, including determining the rheological properties of the binder and mix design characteristics of the system.

Work Plan

1. Phase 1—Review current emulsion specifications for the purpose of converting these into more fundamental engineering units. For this purpose a correlation table shall be developed showing current specification relationship between Saybolt Furol and rotational viscometry. This would include the emulsion grade types for rapid, medium, and slow sets.
2. Phase 2—Review and consolidate the state-of-the-practice of mix design procedures for emulsion mixes.
3. Phase 3—Select two emulsion types—a modified and unmodified—and two representative aggregates to perform a mix design. Determine the cohesion properties of the mix (workability) and correlate these with the rheological properties of the emulsion.
4. Phase 4—Review emulsion residue recovery methods.

Proposed Deliverables

1. A table of emulsion specification in fundamental engineering units (mPa.s).
2. A best practice manual on chip seal design and construction practices.
3. A mix design procedure with a workability index correlated with mix properties and binder properties.
4. A standardized emulsion residue recovery method.

Potential Partners

DOTs, binder suppliers, and contractor.

Duration and Cost

1. Phase 1 will last for 4 months at a cost of $28,000, including the purchase of the necessary equipment to determine the rheological properties of the emulsion.
2. Phase 2 will have a duration of 3 months at a cost of $25,000.
3. Phase 3 will run for 24 months at a cost of $300,000.

User Community

AASHTO, FHWA, FPP, user agencies, cities, and counties.

Implementation

To be implemented by AEMA, ARRA, and AASHTO.

Introduction and Background

The repair, maintenance, and light rehabilitation of rigid pavements includes activities such as full-depth slab repair, partial-depth slab repair, slab replacement, and dowel bar retrofit. In many cases, these activities are performed in traffic closure windows of 4 to 12 hours, and therefore require hydraulic cement concrete (HCC) materials that will reach high enough strength when opened to traffic so that significant life is not used by the first several days of traffic. These materials must also have adequate chemical, environmental, and mechanical durability to last 5 to 20 years, and must not present any significant construction difficulties.

Scope and Objectives

The objectives of this project are:

1. Identify the situations in which these types of material are applicable, and for which Type I/II portland cement concrete are not applicable.
2. Identify the set of characteristics required for the types of maintenance and rehabilitation activities that these materials would be used for.
3. Identify current material types available for this kind of work, and potential future materials (tie into National Science Foundation (NSF) project on future cementitious materials).
4. Develop a set of property ranges from laboratory testing for these types of materials for the characteristics from Objective 2.
5. Develop a set of case studies from work performed using these types of materials (where available), and relate the results from the case studies to Objectives 1, 2, 3, and 4.

Work Plan

Task 1. Identify the situations in which these types of material are applicable. This includes defining the types of activities for which accelerated Type I/II materials may not be applicable, or in which other types of materials may be competitive with accelerated Type I/II. These situations should be defined in terms of variables such as the available construction windows, locations, types of pavement, construction work zone constraints, handling difficulties, and expected performance, etc.

Task 2. Identify the set of characteristics required for the types of maintenance and rehabilitation activities that these materials would be used for. These characteristics will likely include:

- early strength gain;
- long-term strength;
- sensitivity of strength gain to temperature, mix design, curing, etc.;
- thermal coefficient of expansion;
- shrinkage;
- workability;
- chemical stability;
- abrasion resistance;
- handling characteristics; and
- recyclability.

Specific tests and allowable ranges of properties should be identified for each of the characteristics applicable to these maintenance and rehabilitation activities.

Task 3. Identify current material types that may be applicable to this kind of work. There are many manufacturers of materials attempting to enter this market at this time. Many are proprietary, and do not disclose the nature of their product, which will make this task difficult to perform. At least approximate material types should be identified, such as portland cements, calcium sulfoaluminates, calcium aluminates, fly ash products, etc. This task should include consideration of materials being developed as part of the NSF study on cementitious materials.

Task 4. (This is an optional task that may be removed if it is found that there are too

many potential products, as this should not become a new product evaluation project). Select several materials from each material type category and subject them to the range of tests identified in Task 2. Compare measured properties with the range of applicable values identified in Task 3. Identify any problems with performing the set of tests from Task 3 for each type of material.

Task 5. Identify case studies using these materials. Where possible, check the values obtained in these case studies with the results of Tasks 2, 3, and 4. And where possible, evaluate the long-term performance of these projects and materials and why they worked or didn't work.

Proposed Deliverables

1. A set of tests and recommended allowable ranges for results from those tests. This also conveys to manufacturers and potential manufacturers what agencies are looking for in terms of pavement preservation activities.
2. A set of material types that may be of use for pavement preservation activities.
3. Initial set of test values typical for each material type and information for agencies regarding difficulties with material types in achieving the required properties, as well as difficulties with test methods for measuring these properties for certain materials types.
4. A set of case studies identifying problems and successful techniques for using these materials, and their long-term performance.

Potential Partners

Innovative Pavement Research Foundation (IPRF), American Concrete Pavement Association (ACPA), FHWA, and State DOTs. Material manufacturers would be partners in the evaluation process. Mix designs should be developed by manufacturers and researchers working together to optimize properties, not by the researchers alone.

Duration and Cost

Three years at an estimated cost of $500,000 to $1.5 million.

User Community

Agencies, contractors, and materials manufacturers.

Implementation

The set of tests and required properties should be transmitted to agencies. It should be written so that it can be incorporated into specifications. Any changes required to tests, or new tests, needed to measure required characteristics should be written in standard format for implementation. The case studies should be made available to the agency and contractor community.

Introduction and Background

A significant preventive maintenance practice for highway agencies is joint and crack sealing. However, there have been many questions raised about the quality and consistency of the materials being used. Premature failure of sealants in the field has also called into question the effectiveness of these materials as a treatment for pavements.

Joint filling and cracking are one of the most common maintenance activities undertaken on pavements. The purpose of sealing the pavements with an asphalt-based material is to reduce infiltration of moisture. Prevention of moisture infiltration will help mitigate the occurrence of further distresses, such as the stripping of asphalt cement from aggregate particles and the weakening of the pavement structure, which in turn will lead to further pavement distress. Many methods are currently used to seal joints and cracks, and it is not always obvious which method and material will be the most cost-effective for a given situation.

A 1982 concluded, "there has not been universal agreement among pavement maintenance engineers regarding the effectiveness of the joint and crack sealing operation. It is considered beneficial by some, whereas others question its value, contending that the operation is not cost effective because of its short life and the resultant need for frequent renewal." A national survey done by the Utah DOT found that most states believed that "some form of distress would result or be accelerated if their crack sealing program were discontinued" (Belangie and Anderson 1981).

Scope and Objectives

The objectives of the study are twofold: 1. Develop consistency and performance test criteria for evaluating and grading sealants, and 2. Document the effectiveness of joint and crack sealing methods.

Work Plan

The work plan is proposed to develop in two phases. The first phase will involve a literature search and development of a proposed experimental plan. This phase will make use of work that has been done or is in progress. The second phase will be to fulfill the experimental plan, conduct analyses, and propose test specifications for sealants.

Proposed Deliverables

The deliverables are expected to be an AASHTO format test procedure and a specification for grading and evaluating sealants.

Potential Partners

FHWA, AASHTO, State DOTs, National Association of County Engineers (NACE), and pavement industries.

Duration and Cost

Twenty-four to 30 months at an estimated cost of $300,000–$400,000.

User Community

Federal agencies, State DOTs, cities, and counties.

Implementation

It is expected that the implementation will be undertaken by highway owner agencies, which includes Federal agencies, AASHTO, State DOTs, and cities and counties.

2.4

Mix Design Procedures, Engineering Properties, and Performance Characteristics of Emulsion Mixes with and without RAP

Introduction and Background

There is increased interest in the use of asphalt emulsion treated mixes for a variety of reasons, including environmental and safety. At present there is no standard or universally accepted design method for determining the properties of asphalt emulsion treated mixes, whether or not they contain recycled asphalt pavement [RAP]. Reliable information on the engineering properties of these mixes [fatigue, permanent deformation, and plastic deformation] is not available. Without this type of information, the performance characteristics are indeterminate. The amount of money being spent in the United States on asphalt emulsion mixes is estimated to be $25 million annually. There is an urgent need to develop a rational procedure for the design of these type mixes in order to assure that this level of expenditure is not wasted.

Scope and Objectives

The purpose of this study is to develop a mechanistic-based mix design procedure for asphalt emulsion mixes, including the establishment of fundamental engineering properties. A study is currently underway at the University of Rhode Island evaluating a mix design process for asphalt emulsion mixes containing RAP. However, this study is not comprehensive enough to satisfy the needs of the public and private sectors for emulsion mixes.

Work Plan

It is possible to conduct the work in several phases, which might consist of the following:

Phase I: Literature search, documentation of the state-of-the-art, site visits, communication with practitioners, and Phase II work plan development.

Phase II: Sample accumulation, testing protocols, equipment development, testing and evaluation, and data analysis.

Phase III: Final report and recommendations, test methods and procedures in AASHTO/ASTM format, implementation plan, interactive CD, and tutorial.

Proposed Deliverables

The proposed deliverables will be a final report and recommendations, test methods and procedures in AASHTO/ASTM format, implementation plan, interactive CD, and tutorial.

Duration and Cost

It is estimated that the cost of conducting the study is $750,000. The costs are broken down as follows:

- Phase I—$75,000
- Phase II—$500,000
- Phase III—$175,000

User Community

This problem statement should be sent to AASHTO States, FHWA, APWA, NACE, and the FPP.

Implementation

As noted above, $25 million is spent annually now in producing these mixes. A new and improved design and analysis method would greatly enhance the performance of these efforts. The findings of this study could be readily implemented in the paving industry by the ARRA, AEMA, AI, and AASHTO States.

3.1 Timing of Preventative Maintenance Applications to Effectively Extend Pavement Service Life

3.2 Maximizing Pavement Preservation Strategies through Cost Effectiveness Research

3.3 Appropriate Maintenance Treatments for Urban Areas (Window of Opportunity)

3.4 Development of Preventive Maintenance Guidelines for Pavement Blow-Ups

3.5 Development of Integrated Databases To Make Pavement Preservation Decisions

3.1

Timing of Preventative Maintenance Applications to Effectively Extend Pavement Service Life

Introduction and Background

A 1995 National Quality Initiative survey found that pavement condition was the number one concern for highway users. All transportation agencies face the significant challenge of preserving the existing highway pavement structure within the allocated budgetary constraints. Preventative maintenance strategies implemented at the appropriate time are an effective way to delay accelerated pavement deterioration and to stretch the available limited funds.

Scope and Objectives

The objective of this research is to have all State and local transportation agencies recognize that the timely application of pavement preservation strategies can be an integral part of an effective pavement preservation program; to provide documented results of successful pavement preservation programs and pavement preservation treatments; and to provide implementation strategies in the form of a pavement preservation manual to duplicate results.

Work Plan

Task 1: State-of-the-Practice—Evaluate the state-of-the-practice relative to agencies that have demonstrated successful implementation of a pavement preservation program. Identify both single treatment and multi-treatment strategies.

Task 2: Field Studies—Use current and past projects as appropriate to evaluate techniques that have been successfully used to effectively extend pavement service life.

Task 3: Develop Treatment Parameters—Identify and quantify the factors that influenced the successful implementation of a preservation technique, including time of treatment application in the existing pavement life cycle.

Task 4: Develop Implementation Manual—Develop an implementation pavement preservation manual for distribution to State and local transportation agencies.

Proposed Deliverables

1. List of agencies that have successfully implemented pavement preservation programs.
2. Identification of specific successful treatments and quantified results achieved.
3. Implementation Treatment Manual.

Potential Partners

State DOTs, FHWA, NACE, and APWA.

Duration and Cost

Three years at a cost of $350,000.

User Community

State and local transportation agencies.

Implementation

Distribution of implementation manuals to user community.

Maximizing Pavement Preservation Strategies through Cost Effectiveness Research

Introduction and Background

Current preservation strategies rely on pavement condition data collected by trained observers or by the use of automated equipment, which is capable of measuring a number of different pavement characteristics. Some agencies have not developed the ability to share pavement management data and as a result, decisions regarding specific treatments are without the benefit of adequate information.

A procedure or policy is usually established by an agency in order to choose the appropriate treatment; this may include guidelines, goals, and strategies. Current practice is quite variable and ranges from choosing the treatment based on past experience to using comprehensive computer programs.

Scope and Objectives

Limited resources require the movement toward preserving our pavements by adopting the "right treatment, to the right road, at the right time" concept. This concept must be adopted if agencies are going to minimize costs while meeting customer expectations.

Work Plan

This project will use a number of different procedures to evaluate the cost effectiveness of potential preservation strategies. Procedures will include cost of treatment, life of treatment, cost of traffic control, user costs during application, maintenance and rehabilitation costs over an analysis period, and user benefits for a specific treatment.

Proposed Deliverables

Phase I: Provide cost effectiveness evaluations for each pavement strategy.

Phase II: Provide cost effectiveness evaluations for different regimes of pavement strategies over a specified time, i.e., 30 years.

Potential Partners

DOTs, universities, FHWA, local agencies, and industry.

Duration and Cost

Phase I: Three years at an estimated cost of $ 720,000.

Phase II: One year at an estimated cost of $ 240,000.

User Community

DOTs, local agencies, FHWA, and consultants.

Implementation

Publish guides and provide training.

3.3

Appropriate Maintenance Treatments for Urban Areas (Window of Opportunity)

Introduction and Background

Maintenance activities performed in urban areas are often restricted to off peak hours. This can influence the selection of the treatment and/or its short-term and long-term performance.

Scope and Objectives

The objective of this project is to identify the most appropriate maintenance treatment considering climate, traffic levels, traffic delays, etc. It is also designed to identify tradeoffs between performance and length of delay by establishing an optimum window of opportunity for different traffic levels.

Work Plan

Task 1. State of the practice. The first task is to determine current practices dealing with selecting maintenance treatments for different climates, traffic levels, etc.

Task 2. User delays per treatment. This task is to determine the traffic delays associated with the various treatments used in urban areas. The details developed to provide guidance for the engineering and construction delays are a function of the traffic volumes, the time required to complete a unit section before opening to traffic, etc.

Task 3. Windows of opportunity. This task will develop appropriate windows of opportunities for the various maintenance treatments to minimize user delays and/or maximize expected performance.

Task 4. Implementation manual. An implementation manual will be developed to provide guidance to the engineering and construction community as to the most appropriate maintenance treatments, considering climate, traffic level, and user delay.

Proposed Deliverable

The proposed deliverable will be a manual that can be used by agencies to select the most appropriate pavement maintenance treatments considering climate, traffic level, and user delays.

Potential Partners

FHWA, Pooled fund, and FPP.

Duration and Cost

Twelve months at an estimated cost of $150,000.

User Community

State and local agencies

Implementation

The findings from this workshop will be implemented through workshops that use the resulting manual.

Development of Preventive Maintenance Guidelines for Pavement Blow-Ups

Introduction and Background

The combined effect of moisture, temperature increase, incompressible materials, and deteriorating jointed concrete pavements are known to produce pavement blow-ups. In older pavements, there can be several in a single day. At the very least, blow-ups disrupt traffic and, at the worst, they may produce vehicular crashes and even cause fatalities.

Current maintenance practice regarding blow-ups is primarily reactive. There is very little research literature on the subject to provide the practitioner guidance on how to address the condition before it occurs.

Scope and Objectives

1. Synthesize existing research information.
2. Develop predictive procedures.
3. Investigate preventive techniques.
4. Develop specific research statements to address identified deficiencies in preventive maintenance techniques.
5. Develop guidelines for preventive maintenance procedures and timing.

Work Plan

Task 1. Do a literature search on jointed concrete pavement blow-ups and synthesize the results.

Task 2. Develop procedures to identify how and when preventive activities should be conducted.

Task 3. Investigate existing preventive maintenance techniques and identify where techniques are needed.

Task 4. Develop research statements to investigate new preventive maintenance techniques.

Task 5. Develop guidelines, print, and distribute.

Proposed Deliverables

The proposed deliverables are predictive procedures and guidelines for preventive maintenance procedures and timing.

Potential Partners

FHWA, APWA, NACE, AASHTO, ACPA, and State and local transportation agencies.

Duration and Cost

Eighteen months at an estimated cost of $300,000.

User Community

State and local transportation agencies.

Implementation

Publish and distribute guidelines.

3.5

Development of Integrated Databases To Make Pavement Preservation Decisions

Introduction and Background
A broad spectrum of data is used to make informed decisions about transportation spending. This data is available in various databases (e.g., pavement, bridge, and maintenance management systems; traffic records; traffic volumes; and construction and material quality assurance records) that generally exist separate and independent from one another. Integration of these various databases is becoming more and more critical in making informed spending allocation decisions.

Scope and Objectives
To survey and inventory the existing database systems to identify essential information necessary to make pavement preservation decisions.

Work Plan
Task 1. Do a literature search on data warehousing technology.
Task 2. Survey existing databases (e.g. pavement management systems, quality assurance databases, highway performance monitoring system database, maintenance management system, traffic management systems) to identify available data elements.
Task 3. Identify needed data elements that are not available to make pavement preservation decisions.
Task 4. Pilot test pavement preservation model in a minimum of two States.
Task 5. Develop a training package to assist States in implementing the decision model.
Task 6. Conduct regional workshops for interested parties.
Task 7. Write a final report documenting the research effort.

Proposed Deliverables
Pavement preservation decision model, training materials, and final report.

Potential Partners
FHWA, NACE, APWA, AASHTO, and State and local transportation agencies.

Duration and Cost
Twenty-four months at an estimated cost of $500,000.

User Community
State and local transportation agencies, consultants, and universities.

Implementation
Conduct regional workshops for interested parties.

4.1 Guidelines for Effective Maintenance Treatment Evaluation Test Sections

4.2 Performance Measures/Criteria for Conventional and Warranteed Preservation Treatments

4.3 Treatments and Quantification for Noise Reduction and Improved Surface Characteristics

4.4 Documentation of Pavement Performance Data Based on the Application of Pavement Preservation Strategies

4.1

Guidelines for Effective Maintenance Treatment Evaluation Test Sections

Introduction and Background

Maintenance treatments are often difficult to evaluate in the laboratory or with accelerated pavement testing devices because their performance is highly dependent on long-term exposure to the environment, which is difficult to accelerate artificially. Maintenance treatments are typically evaluated by placing test sections on mainline pavement sections and evaluating their performance. Closed-circuit tracks may also be efficient for the evaluation of maintenance treatments and behave much the same as mainline test sections. To obtain valid and useful conclusions, it is vital that good experimental techniques be used in these comparisons.

Scope and Objectives

The objective of this project is to develop a set of guidelines in useable form for the development of maintenance treatment comparison experiments using mainline pavement test sections or closed-circuit tracks.

Work Plan

Task 1. Identify the mechanisms by which typical maintenance treatments fail (usually a combination of environmental and traffic stresses, subject to treatment type, design variables, and construction variables).

Task 2. Identify the characteristics of existing pavement conditions and environment regions that would influence maintenance treatment performance in a set of test sections, and specific methods for measuring those characteristics. This could include items such as deflections, stiffnesses, thicknesses, pavement layer condition, temperature and rainfall variables, drainage, past traffic, etc.

Task 3. Identify the properties that should be measured for evaluation of the maintenance treatment test sections after their construction. These properties should be related to the mechanisms by which maintenance treatments fail (Task 1).

Task 4. Investigate requirements for obtaining statistically unbiased and valid experiments, incorporating the results of Task 2 with statistical principles.

Task 5. Investigate requirements for obtaining statistically unbiased and valid results from the evaluation of maintenance treatment test sections after their construction.

Task 6. Incorporate the results of Tasks 1 through 5 into an easy to use document for maintenance personnel and researchers. This document should probably also include some examples.

Proposed Deliverables

1. A report documenting the results of the project.
2. The Guidelines document from Task 6.

Potential Partners

State DOTs, FHWA, and NACE.

Duration and Cost

One year at an estimated cost of $80,000 – $120,000.

User Community

Transportation agencies and research organizations.

Implementation

The set of tests and required properties should be transmitted to transportation agencies and relevant organizations. It should be written so that it is easy to use and should have detailed and clear instructions about how to set up and run an experiment. It should be made available through various media.

Introduction and Background

Many new products are being introduced to extend the life of pavements with a minimum amount of labor and cost. Different treatments have their own failure mechanisms and their own specific characteristics required to maintain their functionality. Specifications are often lacking due to the evolutionary nature of the products. Also lacking are means of measuring properties and obtaining statistically valid measurement samples. This project will provide guidelines for quantifying the performance of preservation treatments by establishing specific guidelines and criteria. The guidelines must address both conventional construction practices and warrantee projects. They should provide guidance as to which types of measures should be applied to different types of treatments, and should be oriented to minimize and share risk between the contractor and the owner.

Scope and Objectives

The objectives of this project are:

1. Identify appropriate performance measures and specific tests for different types of preservation treatments.
2. Develop statistically sound sampling plans for conventional construction and for warranteed projects. For warranteed projects, the sampling will need to include a frequency of sampling over the warrantee period.
3. Develop guide specifications for the implementation of the results.

Work Plan

Task 1. Identify failure mechanisms and functional requirements for different classes of preservation treatment, and the relation between the two.

Task 2. Identify tests methods to measure progression of distress or, preferably, functional condition. The practicality of implementing these methods should be considered as second only to their ability to measure the required characteristic.

Task 3. Investigate sampling and testing requirements for obtaining unbiased, statistically valid measurements for each required property.

Task 4. Incorporate the results of Tasks 1 through 3 into guideline specification language.

Task 5. Use the guideline specifications and tests on several pilot projects, as a "shadow" specification if necessary. Refine specification and tests based on the results of the pilot projects.

Task 6. Produce a final report and guideline specifications.

Proposed Deliverables

1. Report documenting the results of the project.
2. Specifications that can be incorporated into construction specifications for conventional and warrantee preservation treatment projects.

Potential Partners

Most State DOTs, FHWA, and local government agencies will benefit from guidelines for surfacing treatments.

Duration and Cost

This project is expected to last 3.5 years. Creating and modifying the specifications will take 1.5 years, while 2 years will be needed to perform and evaluate the pilot projects.
Cost for Tasks 1 through 4 and Task 6 should be about $300,000. Cost for Tasks 5 and 6 should be about $40,000 per project evaluated.

User Community

Maintenance forces from State and local agencies will benefit from specifications that provide workable products and have guaranteed longevity requirements.

Implementation

State, county, and local agencies will be canvassed with the specifications developed.

4.3

Treatments and Quantification for Noise Reduction and Improved Surface Characteristics

Introduction and Background

Many urban areas are experiencing local concern over noise levels from pavements. Comprehensive studies have been completed in Europe resulting in significant changes in material selection, pavement design, and surface preparation. Very little work has been done studying noise in the United States, yet much has been done in the area of surface characteristics. Specifically, surface characteristics are skid resistance and smoothness. However, noise and surface characteristics should be studied together as the two areas generally influence each other. Preventive maintenance has a significant role in affecting and improving these highway characteristics, which in turn will improve the quality of life of people living and working near urban highways as well as the users. Further, the saving to highway agencies in potentially reducing expenditures on noise barriers could be significant, as well as the valuations on properties bordering highways.

Scope and Objectives

The project objective will be to examine the variables affecting noise and surface characteristics. This will include quantifying the variables, influences, and interaction of noise and surface characteristics. Both interior and exterior noise measurements will be made. Pavement type and the effect of the maintenance treatment on noise and surface characteristics will be quantified.

Work Plan

It is expected the study will progress in two phases. The first phase will include a literature review and a proposed experimental plan for the project. The second phase will be fulfilling the experimental plan and providing analysis in a final report.

Proposed Deliverables

The proposed deliverable will be a final report summarizing the completed research. It is expected that the report will outline the effects of preventive maintenance on noise and surface characteristics. Guidelines for effects of surface treatments on noise measurements will be provided as a deliverable.

Potential Partners

FHWA, AASHTO, State DOTs, NACE, and pavement industries.

Duration and Cost

Thirty months at an estimated cost of $400,000 to $600,000.

User Community

Federal agencies, State DOTs, cities, and counties.

Implementation

It is expected that the implementation will be undertaken by highway owner agencies, which includes Federal agencies, AASHTO, State DOTs, and cities and counties.

Documentation of Pavement Performance Data Based on the Application of Pavement Preservation Strategies

Introduction and Background

In 1996, AASHTO established the Lead State Team (LST) concept to transfer the implementation of Strategic Highway Research Program materials and technologies to the State level. One of the seven emphasis areas was pavement preventive maintenance, which later became known as pavement preservation. The primary goals of the Pavement Preservation LST were to support preservation program and technology development along with research efforts evaluating the performance and cost effectiveness of preservation strategies. Further, the LST wanted to have all State transportation agencies recognize that the timely application of pavement preservation strategies can be an integral part of an effective infrastructure asset management program. Several States have successfully implemented pavement preservation programs, and research is now needed to develop procedures for collecting and documenting pavement performance data that can be integrated into asset management programs. It is essential for the continued successful implementation of the pavement preservation initiative that this work be sponsored and funded. This research will provide critical information as States develop asset management strategies arising from the Governmental Accounting Standards Boards's Statement 34.

Scope and Objectives

The objective of this research would be to develop procedures for collecting data and documenting pavement performance resulting from the application of preventive maintenance techniques through a structured pavement preservation program. The study should give consideration to the following elements:

1. Determination of the type of data that needs to be collected, along with appropriate pavement measuring standards.
2. Integration of pavement management system data with preservation/preventive maintenance data. This would include the utilization of asset management tools such as condition assessments and next generation maintenance management systems that can capture work performed on specific sections of roadway and provide detailed history and cost analysis.
3. Development of methodologies for analyzing data on preventive maintenance strategies with respect to cost and relative benefit.

Duration and Cost

The estimated cost of this research effort is $500,000.

User Community

The principal audience for this research initiative is State and local highway agencies, FHWA, AASHTO, and the private sector.

Implementation

It is envisioned that procedures developed as part of this initiative will be disseminated through a series of publications, presentations, and specifications. National Highway Institute (NHI) courses currently under development on pavement preservation will also include this information.

Group 5.0
TRAINING

5.1 Design and Construction of High Quality Preventive Maintenance Treatments

5.2 Training and Certification of Technicians

5.3 Training to Present the Results of Research and Development (R&D) and to Facilitate Implementation

5.1

Design and Construction of High Quality Preventive Maintenance Treatments

Introduction and Background

As agencies place an increasing emphasis on the use of preventive maintenance treatments as part of their pavement preservation practice, a need for training on the design and construction of those treatments has become evident. For some, this course will provide the first exposure to the proper design and construction of new techniques; to others it will serve as a refresher and provide tools and tips to improve the performance of preventive maintenance treatments.

It is anticipated that the course will be modular in nature, consisting of approximately 4 hours of material on each of the techniques included in the training material. Agencies requesting this course will select the modules of interest to them from among those that are available, thus determining the duration of the course.

Scope and Objectives

The objective of this course is to provide training to highway agencies on the proper design and construction of preventive maintenance techniques.

Work Plan

It is expected that the material for this training course will come from industry organizations that have already developed extensive training programs on their treatments. The work in this project therefore consists of taking the material that industry provides and organizing it into a NHI format suitable for presentation by the government. As such, the following tasks are proposed:

1. Solicit information from industry organizations.
2. Outline modules to be included in course.
3. Obtain final information from industry.
4. Organize information into NHI course format.

Proposed Deliverables

The deliverables for this training course are a series of modules for each preventive maintenance treatment. The training package is likely to include videos, material samples, a package of reference material, and a PowerPoint presentation.

Potential Partners

Partners for this training program include all of the industry organizations that are involved in promoting preventive maintenance. These include FPP, AEMA, ISSA, ARRA, ACPA, and the National Asphalt Pavement Association (NAPA).

Duration and Cost

The estimated cost to develop this training material is about $15,000 to $40,000 per training module. This cost is based on industry organizations, contractors, and other agencies providing training material that they have already developed that can be incorporated into the final package. Each module will require between 1 and 3 months to develop, starting with the solicitation of materials that can be used in the course and continuing through the development of drafts, industry and expert panel review, and final approval. Work on multiple modules would proceed concurrently.

User Community

The target audience for this course includes maintenance engineers; field inspectors; and maintenance workers responsible for the design, construction, or inspection of the selected preventive maintenance treatments.

Implementation

This course is one of a series of courses on pavement preservation being offered to agencies through the NHI.

Introduction and Background

Preventive maintenance treatments are a growing part of many agencies' pavement preservation practices. One complaint about such treatments, however, is the variability of their performance. Such variability can lead to premature failure, which in turn leads agencies to turn away from the use of treatments that could be very beneficial.

Variability comes from many sources, some of which are controllable and some of which are not. One area where significant improvements can be made to reduce variability is the skill level of personnel involved in the monitoring and construction of preventive maintenance treatments. This has already been demonstrated in both the concrete and hot-mix asphalt paving industries, where certified technicians have helped to raise the skill level of critical field personnel, with the result being higher quality paving projects.

The availability of a training program for both equipment operators and Quality Control/Quality Assurance (QC/QA) technicians involved in the inspection of preventive maintenance treatments will help to improve the overall construction quality of those treatments and thereby contribute to their improved performance. Improved performance will in turn help to ensure that the treatments perform at or above their expected lives. This will become even more important as more and more agencies move toward performance specifications and warranties for their preventive maintenance treatment applications.

Training is also needed for the management level, to familiarize decisionmakers with the types of controls that are being promoted within the industry.

Scope and Objectives

The objective of this training program is to improve the skill level of all of the personnel involved in the construction of preventive maintenance treatments. This is likely to be accomplished through the development of three distinct training programs aimed at three different audiences: equipment operators, QC/QA personnel, and agency and contractor management. The training programs will lead to certification for equipment operators and QC/QA personnel.

Work Plan

The development of the training programs can mirror certification programs that have already been developed by the hot mix industry. The tasks include:

1. Define training requirements, including the types of certification that will be required.
2. Solicit information from industry organizations to determine the availability of existing training materials.
3. Outline modules to be included in the different certification programs.
4. Develop training programs.
5. Develop testing programs for final certification.
6. Obtain industry and agency review of training programs.
7. Finalize training materials.

Proposed Deliverables

The deliverables for this training course are a series of modules for each preventive maintenance treatment. The training package is likely to include videos, material samples, a package of reference material, and a PowerPoint presentation.

Potential Partners

Partners for this training program include all of the industry organizations that are involved in promoting preventive maintenance. These include FPP, AEMA, ISSA, ARRA, ACPA, and NAPA.

Duration and Cost

The estimated cost to develop this training material is about $200,000. Assistance will be required from industry organizations and contractors to identify needs and provide feedback throughout the development of the material.

User Community

The target audience for this course includes maintenance engineers, contractors, field inspectors, contractor quality control personnel, and equipment operators responsible for the construction or inspection of the selected preventive maintenance treatments. It will benefit both agencies and contractors directly, and the traveling public indirectly.

Implementation

This course could be implemented by the NHI, individual agencies, or by other groups that are able to award certification.

Introduction and Background

This document introduces a very extensive and comprehensive program of R&D in the general pavement preservation/preventive maintenance field. The document identifies areas of needed research, and it is expected that in the near future these research areas will be taken up by the agencies that are able to move from concept to reality. It is expected that some of these research topics will be performed, and that the results will be of use to the pavement maintenance community. Eventually, it is expected that additional training will be required to implement the findings of many of these different research efforts.

Until the research moves forward, identifying future training needs is purely speculative. However, it is important to recognize now that training will be an integral part of any successful research effort.

6.1 Innovation in Preventative Maintenance through Performance-Based Specifications

6.2 Implementation Guidelines for a Pavement Preservation Program

6.1

Innovation in Preventative Maintenance through Performance-Based Specifications

Introduction and Background

Specifications for preventative maintenance applications are traditionally written in a definitive and exact manner that dictate the process necessary to achieve a desired finished product. Often, the contractor performing preventative maintenance projects can offer innovative approaches to achieve the desired finished product in a manner that is more cost effective with less interruption to traffic. However, rigid specifications that dictate the process and sequence of operations can stifle and discourage this type of contractor innovation.

Work hours on pavement preventative maintenance activities are becoming more relegated to evening hours when traffic volumes are at their lowest. The window of time for these activities is very constraining and ultimately prolongs the duration of disturbance to traffic. Therefore, finding ways to increase productivity and minimize project duration is critical.

Specifications for some pavement preventative maintenance applications need to be more flexible, with more emphasis on the finished product, and less process specific. Where feasible, contractor innovation should be encouraged by the adoption of performance-based specifications.

Scope and Objectives

Specifications for the various preventative maintenance techniques should be carefully evaluated to determine the specific desired final product. Each technique should be evaluated to determine if the performance-based specifications would be feasible. Certainly this approach will lend itself to certain preventative maintenance applications more than others. Research should be conducted to develop performance-based specifications where feasible in order to increase productivity, decrease costs, minimize the disruption of the roadway for the traveling public, and improve work zone safety for workers and the traveling public.

Work Plan

Task 1. Perform a literature search on performance-based specifications. Develop a questionnaire for State and local transportation agencies and contractors to determine the extent and characteristics of the performance-based specifications that are currently being used.

Task 2. Investigate the project histories of agencies that have successfully used performance-based specifications.

Task 3. Identify the preventative maintenance activities that lend themselves to performance-based specifications. For successful activities, determine the measurable outcome or performance standard that should be used.

Task 4. Draft model performance-based specifications for various preventative maintenance techniques.

Task 5. Work with a minimum of one State and one local contracting agency to pilot test the model specifications.

Task 6. Prepare a final report summarizing the results of the research effort.

Proposed Deliverables

Model performance-based specifications should be developed for distribution to various Federal, State, and local organizations and agencies.

Potential Partners

FHWA, State DOTs, State asphalt and concrete pavement associations, APWA, NACE, ARRA, and NAPA.

Duration and Cost

Thirty months at an expected cost of $500,000.

User Community

State DOTs, Local government agencies, APWA, NACE, Consulting Engineers, American Road and Transportation Builders Association, and National and State contractors' associations.

Implementation

Model specifications should be distributed to DOTs and local agencies. FPP and other partners, through marketing and training efforts, should encourage these agencies to adopt performance-based specifications. This information could be incorporated into FHWA and Local Technical Assistance Program training programs and NACE/APWA training and technical guides.

6.2

Implementation Guidelines for a Pavement Preservation Program

Introduction and Background

Transitioning to a Pavement Preservation Program (P3) is a multi-year effort based on scientific and engineering principles that must include sustained support and funding from all involved stakeholders, including the U.S. DOT, transportation agencies' management and staff, legislators, the contracting industry, and the public. Scientific research and operational practice have confirmed and documented that "performing the right treatment at the right time on the right roadway" can reduce reactionary maintenance costs by a factor of as much as six. Many transportation agencies have initiated the journey to obtain the rewards of lower costs and higher consistent levels of service, only to be delayed by changes in DOT or legislative champions or priorities. The P3 principles must be integrated into the basic fabric of the DOTs with continual education for the ever-changing DOT staff, legislators, and public. Loss of support by any of the stakeholders, or the promoting of "deferred maintenance" or "worst first" strategies could result in loss of the accumulated benefits of a P3. The research must identify and address the needs of all stakeholders to ensure their continued support.

Scope and Objectives

The objective of this research effort is to develop implementation guidelines for transportation agencies wishing to make the multi-year transition to a P3 with all of its rewards for the stakeholders.

Work Plan

Task 1. Conduct a literature search on the topic and associated areas. Prepare questionnaires for stakeholder groups including Federal, State, and local transportation agencies; legislatures; the contracting industry; and public transportation groups.

Task 2. Prepare draft implementation guidelines with all necessary support documentation, manuals, and multi-media promotions for the transition process. These materials should identify the informational and educational needs of all stakeholders, with an emphasis on institutional and legal barriers that may delay or prohibit the transition.

Task 3. Pilot test the implementation guidelines in a minimum of two States and two localities.

Task 4. Modify the implementation guidelines and support materials based on the result of the pilot tests.

Task 5. Conduct workshops in each of the AASHTO regions for interested stakeholders.

Task 6. Modify the implementation guidelines and support materials based on the feedback from the regional workshops, and prepare a final report documenting the research effort.

Proposed Deliverables

Implementation guidelines with support documentation, manuals, and multi-media promotions to assist transportation agencies and all of the stakeholders in the transition to a P3. Post all documents and materials on the Internet for free downloading by all interested parties.

Potential Partners

AASHTO, FHWA, NACE, APWA, and the contracting industry.

Duration and Cost

Thirty-six months at an estimated cost of $900,000.

User Community

Federal, State, and local DOTs; AASHTO; contracting industry; NACE; APWA; and transportation system users.

Implementation

Implementation guidelines and support materials will be provided free of charge to all interested parties.

7.1 Effectiveness of Retrofit Edgedrains

7.1

Effectiveness of Retrofit Edgedrains

Introduction and Background

Retrofit edgedrains (both conventional and geocomposite) have been used by many SHAs to reduce or prevent pumping and associated faulting in Portland cement concrete (PCC) pavements. Some SHAs have abandoned the practice. Questions have been raised about the long-term effectiveness of this preventive maintenance technique, especially considering the lack of needed maintenance that is usually experienced.

Scope and Objectives

Document current practices in the use of PCC pavement retrofit edgedrains. Obtain and summarize information on performance, warrants for use, design, construction, maintenance details, and cost effectiveness. Develop guidelines for when to use and for proper design, construction, and maintenance practices.

Work Plan

Task 1. Prepare survey questionnaire.
Task 2. Complete survey.
Task 3. Summarize and report results.

Proposed Deliverables

1. A state-of-the-practice report on the use of retrofit edgedrains to reduce or prevent pumping in PCC pavements.

2. A document containing recommendations for warrants, design details, best construction practices, and maintenance requirements.

Potential Partners

ACPA, FHWA, Innovative Pavement Research Foundation, and NCHRP.

Duration and Cost

Nine months at an estimated cost of $75,000.

User Community

Owners of PCC pavements, industry, and trade associations.

Implementation

Prepare and disseminate a flyer summarizing the results of the survey and include guidelines for use, construction specifications, and maintenance guidelines (if it is deemed to be an acceptable, cost-effective practice).

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