Transportation Synthesis Report

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Pavement Preventive Maintenance

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Transportation Synthesis Reports (TSRs) are brief summaries of currently available information on topics of interest to WisDOT technical staff in highway development, construction and operations. Online and print sources include NCHRP and other TRB programs, AASHTO, the research and practices of other state DOTs, and related academic and industry research.

REQUEST FOR REPORT

With the nationwide highway infrastructure largely in place and transportation budgets shrinking, state agencies are focusing more of their time and money on highway maintenance and rehabilitation. One strategy for maximizing these efforts is "preventive maintenance" or "pavement preservation," the periodic application of relatively inexpensive pavement treatments to an existing roadway system in order to retard further deterioration and improve the functional condition of the system. Preventive maintenance has been recognized as a powerful tool to be used by state transportation agencies, along with restoration, rehabilitation and reconstruction (the federal 3R program). The RD&T Program was asked to identify preventive maintenance programs around the country with a focus on their cost effectiveness.

SUMMARY

Many states are investing significant sums for pavement preservation activities on the widely accepted assumption that these efforts are cost effective. We found only a few studies specifically designed to track the cost effectiveness of preventive maintenance treatments. A number of models, however, have been developed for states to use in estimating expected savings from various preventive maintenance treatments. The best retrospective study we found was completed for the Michigan Department of Transportation by an outside consultant hired to evaluate its program periodically. The Michigan study, a TRB paper on cost effectiveness of three state programs (Arizona, Montana and Pennsylvania) and other papers addressing cost effectiveness are cited below under **Cost Benefit Studies.** In general, findings indicate that:

- For every dollar spent on preventive maintenance, $4 to $10 was saved on rehabilitation.
- Rehabilitation and reconstruction costs about 14 times as much as pavement preservation projects per lane mile over the life of the project, according to Michigan engineers.

Preventive maintenance practices are gaining widespread popularity as states look for ways to preserve the existing highway system and postpone more costly rehabilitation efforts. Michigan is a leader in pavement preservation, devoting $73.5 million (a combination of both federal and state resources) in 2003 to its Capital Preventive Maintenance Program. Information about Michigan's program, the newly formed Midwestern Pavement Preservation Partnership and AASTHO efforts are provided at **State DOT Preventive Maintenance Programs.**

Research on the effectiveness of specific pavement treatments for extending pavement life and improving road quality is highlighted below under **Preventive Treatments Research**. An international scanning tour completed in 2002 is perhaps the most useful of these studies because it highlights innovative programs and state-of-the-art treatments for pavement preservation in South Africa, France, and Australia—all international leaders in pavement preservation.

We also found a number of articles describing the current state of pavement preservation programs, innovative treatments, and other useful resources. These are identified below under **Journal Articles.**

Finally, the following points appeared repeatedly during our search:

- Integration of a preventive maintenance program with a pavement management system is essential. This allows for the sharing of data and the optimal timing of treatments. There is extensive information available on how best to establish pavement management systems and how to integrate them with preventive maintenance planning.
- The timing of treatments is the key to extending pavement life and realizing savings.

COST BENEFIT STUDIES

Cost-Effective Preventive Maintenance Case Studies, **Transportation Research Record Number 1795, 2002**
Available in the WisDOT Library.
This paper discusses the state of the practice in pavement preservation through case studies of state highway agencies in Arizona, Montana, and Pennsylvania. Results indicate that the main reason for the success and cost-effectiveness of each state's preventive maintenance (PM) program is the heavy reliance on the pavement management system distress data for the selection of sections to be treated, time of treatment, and type of PM action.

A few highlights:

- Montana developed a new PM program in 1995, with $2 million of the $14 million maintenance budget used for PM. The PM budget was increased to $7 million in 1996, and after two years at this budget, the pavement management system data were analyzed to determine cost-effectiveness. The results showed that the PM program had already provided effective alternatives to extend the pavements. On the basis of the results, the PM program budget was increased to $55 million in 1998 and beyond.
- The study found that for every dollar spent in the PM program, $4 to $10 was saved in the rehabilitation program. In addition, program success was proved to depend heavily on the optimum time window. The earlier the PM action was applied, the lower the cost and the higher the benefits.

Effectiveness of the Capital Preventive Maintenance Program, **prepared for the Michigan Department of Transportation by B.T. Bellner & Associates, November 2001**
Available on CD ROM in the WisDOT Library.
In 1992, the Michigan Department of Transportation, in cooperation with the Federal Highway Administration, initiated the Capital Preventive Maintenance (CPM) Program in an effort to protect and preserve pavement structures. The program focuses on highways under the jurisdiction of MDOT with a remaining service life of more than two years. Pavements are selected for preventive maintenance using MDOT guidelines first developed in 1999. These guidelines are designed to insure that treatment selection is consistent with the overall pavement strategy. Funding for the CPM Program is provided by both federal and state transportation dollars and will reach $73.5 million in 2003.

The effectiveness of the CPM Program is evaluated every year by independent consultants hired by MDOT. Over three years (1999-2001), CPM projects were evaluated to determine the life extending value to the original pavement. In 1999, 37 projects were evaluated for work done in 1994 and 1995. In 2000, 41 projects were evaluated for work done in 1995, 1996, 1997. In 2001, 45 projects were evaluated for work done between 1995 and 2000. This study by B.T. Bellner & Associates, available on CD, is a synthesis of all of these evaluations performed between 1999 and 2001. The goal of the study is to assure that funds are properly spent on preventive maintenance activities for the right roads and that the treatments used do, in fact, extend the life of Michigan pavements. Researchers used MDOT's Pavement Management System data and the warranty threshold criteria for the CPM Program for evaluating the projects.

The following treatments for flexible and composite pavements are included in the CPM Program and were evaluated in this study: bituminous overlay, surface milling and bituminous overlay, ultra thin overlay, crack treatment, overband crack filling, micro surfacing, chip seals, bituminous shoulder ribbons, and shoulder seals.

The study determined that the CPM Program has been successful in extending pavement life and that the projects are cost-effective.

***Insights into Pavement Preservation: A Compendium,* FHWA, January 2000**
http://www.fhwa.dot.gov/infrastructure/asstmgmt/compend.pdf
This compendium provides a compilation of articles on pavement preservation from 1997 to 2000 that highlight state experiences with preventive maintenance programs.

One of the articles, "Preventive Maintenance Yields Huge Savings, Says Michigan Study," is from the September 1997 issue of *Focus,* and highlights the results of a study of the Michigan Department of Transportation's pavement maintenance program. Since Michigan adopted its preventive maintenance program in 1992, preventive maintenance treatments had been applied to about 4,260 km (2,650 mi) of asphalt and portland cement concrete pavements, at a cost of $80 million. Had they not applied the treatments, MDOT would have needed to spend $700 million in 1997 on rehabilitation and reconstruction projects to bring pavements up to their current condition—more than eight times as much money as had been spent on preventive maintenance treatments.

***Optimizing Pavement Preservation: An Urgent Demand for Every Highway Agency,* International Journal of Pavement Engineering, 2001**
Available in the WisDOT Library.
This paper presents a step-by-step procedure for selecting the appropriate preventive maintenance treatment for asphalt pavement and evaluating the optimal timing for that treatment under different pavement, traffic, and climatic conditions. It also provides a model for analyzing the cost-effectiveness of a pavement preventive maintenance program.

***Selecting a Preventive Maintenance Treatment for Flexible Pavements,* June 2000**
http://ntl.bts.gov/data/FP2.pdf
Funded by the Foundation for Pavement Preservation, this study evaluates the types of pavements that are candidates for preventive maintenance, the available treatments, where and when treatments should be used, and their cost effectiveness. The report looks at chip seals, thin cold mix seals, thin overlays, fog seals, and crack sealing and provides a methodology for determining the most effective treatment for a particular pavement. It provides formulas for determining the most cost-effective treatment and emphasizes the need to look at each case individually. The longer the maintenance is delayed, the more it will cost to repair. Alternatively, if a pavement is maintained too soon, you spend unnecessarily.

***Life-Cycle Evaluation of Highway Pavement Preventive Maintenance,* January 2003, by Kathleen T. Hall, Carlos E. Correa, and Amy L. Simpson**
Available in the WisDOT Library on the TRB 2003 Compendium of Papers CD-ROM
This study develops models for understanding the cost effectiveness of various levels of preventive maintenance and indicates the optimum levels of such maintenance for various pavement types and categories. The study also develops models for determining the relative change in cost effectiveness in response to unit or specified changes in life-cycle preventive maintenance levels.

***Pavement Maintenance Versus Reconstruction Life Cycle Cost Analysis of Various Options,* presented at the Ninth International Conference on Asphalt Pavements, August 2002**
Study available through the International Society for Asphalt Pavement for $15.
The study identifies preventive maintenance treatments and benefits and evaluates the cost-effectiveness of the treatments versus major rehabilitation strategies. The findings indicate that preventive maintenance applied at early stages in a pavement's life is cost effective in all of the scenarios studied.

STATE DOT PREVENTIVE MAINTENANCE PROGRAMS

In the last several years, many states have begun investigating and implementing preventive pavement maintenance programs in an effort to stretch shrinking transportation budgets. Michigan leads the country in innovative, proven preventive maintenance programs. Established in 1992, Michigan's Capital Preventive Maintenance Program now receives dedicated funding, on the order of $73.5 million in 2003, and is integrated with their pavement management system. For a full description of their program, refer to the *TR News* article, "Strategic Planning for Pavement Preventive Maintenance," which is highlighted below. The article includes a chart of extended service life for specific preventive maintenance treatments.

The most comprehensive information available with regard to the effectiveness of a state's preventive maintenance program is the 2001 study, *Effectiveness of the Capital Preventive Maintenance Program,* which evaluates Michigan's program. A description of this study is provided above, under **Cost Benefit Studies** and the full report is available on CD.

Pavement Preservation in the United States: Survey by Lead States on Pavement Preservation, AASHTO, 1999, http://leadstates.tamu.edu/pp/survey/survey_report.pdf
The AASHTO Lead States Team on Pavement Preservation surveyed transportation agencies in 50 states in 1999 to gain an understanding of the state-of-practice in preventive maintenance. Thirty-six states were found to have established pavement preventive maintenance programs. The report describes the results of that survey, including the nature and age of state preventive maintenance programs, specific preservation programs used, integration with pavement management systems, funding allocations, and more.

We spoke with the following individuals about their states' preventive pavement maintenance programs:
Larry Galehouse, founder of the National Center for Pavement Preservation at Michigan State University, formerly of the Michigan Department of Transportation, 517-719-8556 (cell)
Jerry Gieb, Research Project Engineer, Minnesota Department of Transportation, 651-779-5937
Aric Morse, Pavement Engineer, Ohio Department of Transportation, 614-995-5994
Steve Bauer, former Pavement Engineer, Michigan Department of Transportation, 810-227-6123 ext. 301
Kevin Kennedy, Preventive Maintenance Engineer, Michigan Department of Transportation, 517-322-6043
John Galbreath, Pavement Forecasting Specialist, Michigan Department of Transportation, 517-373-2662

Additional recommended contacts:
Larry Orcutt, Manager of the Caltrans Maintenance Program, 916-654-5849
Jim Sorenson, Federal Highway Administration, 202-366-1333

The Midwestern Pavement Preservation Partnership, which kicked off two years ago in Michigan, will be a valuable resource on pavement preservation programs and treatments in the future. Under the leadership of Larry Galehouse, the group hopes to bring states together to identify specific treatments and application methods as the standards in preventive maintenance. The group will also explore research needs in the field, the possibility of training agency staff and contractors on preventive maintenance, and establishing a certification program for contractors. About thirteen states already participate in the organization. The next meeting is tentatively scheduled for fall 2003.

In addition, Mr. Galehouse is working hard to establish the National Center for Pavement Preservation at Michigan State University. Pieces of the funding are in place for this program, and the doors are expected to open in fall 2003. The center will give states an opportunity to pool money for research, will provide an avenue for training and continuing education in the field of pavement preservation, and will serve as an outreach program to counties and cities.

The AASHTO Pavement Preservation Web Site at http://leadstates.tamu.edu/pp/index.stm was developed by the Lead States Team on Pavement Preservation before transferring its duties to the AASHTO Subcommittee on Maintenance. The Web site describes preventive maintenance strategies and provides a number of reports, guidelines and articles about preventive pavement maintenance.

PREVENTIVE TREATMENTS RESEARCH

***Pavement Preservation Technology in France, South Africa and Australia,* sponsored by the Federal Highway Administration, the American Association of State Highway Transportation Officials, and the National Cooperative Highway Research Program, Report #FHWA-PL-03-001, October 2002.**

http://international.fhwa.dot.gov/paveprestech/index.htm#toc

The Federal Highway Administration (FHWA), the American Association of State Highway and Transportation Officials (AASHTO), and the National Cooperative Highway Research Program (NCHRP) jointly sponsored this international scanning study in an effort to document and evaluate innovative techniques, materials, procedures and equipment used in other countries for pavement preservation for potential applications in the United States. The scanning team visited France, South Africa, and Australia, which had been identified as nations with innovative programs and state-of-the-art treatments for pavement preservation.

Representatives from four state DOTs, the National Association of County Engineers; FHWA; the National Park Service; the American Public Works Association; Koch Materials Company and Kristen Betty and Associates made up the scanning team, which met with government agencies and private-sector organizations involved with pavement preservation, and visited sites to observe the results of pavement preservation techniques and strategies.

Each country visited recognizes the systematic method of programming, funding, and placing preventive maintenance treatments as the most successful strategy for pavement preservation. The need to apply the right treatment to the right roadway at the right time came up on several occasions during the study. Many of the agencies deal with the same barriers facing AASHTO's member States, including dedicated funding, public and management perception, and data management. The scanning team determined from its international observations that pavement preservation in the United States is headed in the right direction and that many of the pavement preservation best practices are already in place, to some degree, in the United States.

Key Findings

The following actions taken in the host countries have had a significant impact on pavement preservation activities and program success:

- Focusing on maintenance activities on the surface to preserve the large investment in underlying layers. This promotes the use of relatively low-cost seals and thin overlays as the primary maintenance techniques, instead of more costly types of rehabilitation.
- Using only quality materials for both bitumen and aggregate, ensured through the use of rigorous specifications. Materials sources are specified and there is no inhibition to using sources a great distance away from the project site.
- Getting warranties on contracts, which cover friction, rutting, and smoothness. This has resulted in the innovation of materials and mixtures by contractors and material suppliers.
- In France, governments and industry share the risk in experiments to develop new and innovative products. Successful products are then accepted nationally for inclusion in the preventive maintenance program.

Treatments and Techniques

The team identified the following innovative and successful practices in pavement preservation in the host countries:

- Generally, crushed granite and proven polymer-modified asphalt binders are used. This is ensured through the use of rigorous specifications.
- In France, the primary preservation treatment on high-volume roadways is mill and inlay. Also, cold asphalt concrete has been used extensively with good success on low-volume roads as a riding surface (75 to 100 millimeters). The cold asphalt concrete mix process focuses on achieving good coating of the aggregates and is preferred over hot-mix asphalt for low-volume roads.
- South Africa makes extensive use of chip seals. Their pavement management system has verified that surface seals are effective treatments for preserving pavement life. In some instances, hot-mix asphalt overlays are covered immediately with chip seals to provide sufficient surface friction and, at the same time, ensure a system more impervious to water.
- In Australia, all the states visited use a treatment called geotextile-reinforced sprayed seal. The construction sequence involves spraying a tack coat, placing the geotextile, and then applying a chip seal on top. Data showed that this treatment reduced reflective cracking. In Victoria, 12 to 15 years of performance is expected from this treatment. Typically, a crumb-rubber bitumen or conventional bitumen is used for these seals.

- The technique of pre-coating aggregates for chip seals is used throughout Australia. This practice prevents or reduces the loss of aggregates on chip seals.
- All the Australian states make extensive use of polymerized asphalts. Considering the heavy and large amounts of trucks using rural roads, states believe there is a need for the best-performing bitumen possible. Styrene butadiene styrenetype polymers are predominately used in their bitumens (at twice the rate used in the United States) for both hot-mix asphalt and chip seal applications.
- Crumb rubber modifier (15 to 20 percent) is used in bitumen for chip seals. This has been effective in reducing reflecting cracking.
- Even when using full-depth hot-mix asphalt pavements, a chip seal is placed on the base material (or subbase) before the asphalt layers are placed. This prevents moisture infiltration or capillary action.
- New South Wales has been successful in placing thin (40-to-60-millimeter) asphalt overlays on existing concrete pavements by placing hydrocarbon curing and a tack coat before placing the overlay on the concrete. The overlays on more recent plain concrete pavements are done primarily for noise control, while those on older jointed reinforced concrete pavements are done for ride quality when large-scale diamond grinding equipment is not available.
- A chip seal system incorporating glass fibers is used in New South Wales to prevent reflective cracking. The process involves spraying a coat of polymer-modified bitumen emulsion, followed by blowing chopped fibers on the surface and spraying a second coat of polymer-modified bitumen emulsion, all in one operation.
- In South Africa, a stress-in-motion device to measure contact stresses in vehicles has been developed and is in regular use. Also, a crack activity meter has been developed to measure reflective cracking potential and the need to restore the surface before placing an overlay. The meter can measure both horizontal and vertical movement simultaneously and fits between the dual wheels of a test vehicle. Data is captured and processed electronically.
- In New South Wales, sandwich seals with two-coat geotextile reinforced treatment have resulted in an acceptable performance (no reflective cracking) for 11 years on roadways with traffic volumes of 1,200 vehicles per lane per day.
- In New South Wales, a pavement condition survey vehicle called Road Crackä has been developed to detect cracking on the pavement surface. This vehicle measures the full lane width at 80 kilometers per hour with real-time processing, measuring cracks down to a millimeter and classifying them as longitudinal, transverse, and crocodile. Sawn joints are identified. Alternatively, at lower speeds, a full digital image of the road surface can be retained.
- South Africa and Australia have developed innovative design procedures and application techniques for chip seals not normally seen in the U.S. Performance lives of up to 15 years are being achieved on sections with up to 60,000 vehicles per day. This outstanding performance is due in part to the deep-strength pavement designs employed.

LTPP Data Analysis: Effectiveness of Maintenance and Rehabilitation Options, **NCHRP Project 20-50 (03/04), June 2002**
http://gulliver.trb.org/publications/nchrp/nchrp_w47.pdf
This study assesses the relative performance of different pavement maintenance and rehabilitation treatments and identifies the pretreatment conditions and other factors that influence treatment effectiveness. The research does not provide an estimation of the typical lives of the treatments used. Instead it focuses on the relative effectiveness of the different treatments as influenced by pretreatment conditions.

High Volume/High Speed Asphalt Roadway Preventive Maintenance Surface Treatments, **South Dakota Department of Transportation, December 2001**
http://www.state.sd.us/Applications/HR19ResearchProjects/Projects/SD1999_09_Final_Report.PDF
This study investigates the use of chip seals in South Dakota for extending pavement life and makes recommendations for improving their performance. The report includes guidelines for the design and construction of chip seals and for selecting feasible surface treatments for a specific project.

Performance of Flexible Pavement Maintenance Treatments in the LTPP SPS-3
Available in the WisDOT Library on the TRB 2003 Compendium of Papers CD-ROM.
This paper presents the results of a study conducted to assess the relative performance of different flexible pavement maintenance treatments, including the influence of pretreatment condition and other factors. Treatments used in

study are thin overlays, slurry seals, crack seals and chip seals. Thin overlays were found to be the most effective of the treatments studied, followed by chip seals and slurry seals. Crack sealing did not demonstrate any beneficial initial or long-term effect with respect to IRI, rutting, or cracking.

***Field Evaluation of Pavement Surface Treatments,* International Journal of Pavement Engineering, 2000**
Available in the WisDOT Library.
This study evaluates the effect of aggregate and binder types on the performance of surface treatments in Wyoming. The experiment included 23 test sections monitored over five years, with efforts made to eliminate the effects of environmental and traffic variations on surface treatment performance. Results indicate that selecting the optimum combination of aggregate and asphalt binder is important for insuring good performance of surface treatments. The research revealed that frictional resistance was affected by aggregate type alone, with scoria yielding consistently superior friction values as compared to limestone. Cracking is affected by choice of binder and skidding is affected by choice of aggregate.

***Best Practices Handbook on Asphalt Pavement Maintenance,* University of Minnesota Center for Transportation Studies, February 2000**
http://www.fp2.org/pdffiles/MNasphlt.pdf
This handbook provides an overview of pavement preservation, with a focus on preventive maintenance. The guide discusses the most common flexible pavement distresses and provides best practices for the rehabilitation of each. Maintenance treatments covered include: crack sealing, crack filling, full depth crack repair, fog seal, seal coat, double chip seal, slurry seal, microsurfacing, thin hot mix overlays, and potholes and pavement patching.

RESEARCH IN PROGRESS

NCHRP 14-14, *Guide for Optimal Timing of Pavement Preventive Maintenance Treatment Applications*
http://www.fhwa.dot.gov////construction/washto02/nchrp14.htm
http://rip.trb.org/browse/dproject.asp?n=4463
The goal of this NCHRP study is to develop a methodology and guide that will assist highway agencies in determining the optimal timing for the application of preventive maintenance treatments for flexible and rigid pavements. The researchers will also develop a plan for collecting data needed to support the methodology. According to Amir Hanna, the project manager for this project, the study is somewhat behind schedule and should be complete in July.

The Effectiveness of Maintenance and Its Impact on Capital Expenditures
http://rip.trb.org/browse/dproject.asp?n=5116
The objectives of this Indiana DOT project include the design and implementation of a methodology to evaluate the cost-effectiveness of various maintenance practices, and the development of recommendations that would assist highway agencies in selecting the optimal timing for appropriate maintenance treatments in order to maximize overall cost-effectiveness. This project is complete and should be available for review soon.

JOURNAL ARTICLES

"Prevention versus Repair—Managing Your Budget," *Better Roads,* June 2003, by Ruth W. Stidger
Available in the WisDOT Library.
This article provides a brief overview of how states are meeting the funding needs of their pavement preservation maintenance programs. A few points to highlight:

- According to the National Cooperative Highway Research Program, every dollar spent on preventive maintenance saves three to four dollars in future road repairs.
- Michigan reports that it saves up to $10 for each preventive maintenance dollar spent.
- 85% of states have preventive maintenance programs and half of those have been in use for more than 10 years.
- Michigan engineers say that rehabilitation and reconstruction costs about 14 times as much as pavement preservation projects per lane mile over the life of the project.

"Pavement Preservation: A Call to Action," *Focus,* May 2003
http://www.tfhrc.gov/focus/may03/03.htm
Representatives from state highway agencies, AASHTO, TRB, and FHWA met in February 2003 to discuss the latest technologies in pavement preservation and the need for a shared commitment to preventive maintenance. This article summarizes the discussions that took place and references an updated CD, "Pavement Preservation 2: State of

the Practice," containing technical manuals on pavement evaluation, and preventive maintenance treatments and guidelines. Eight state departments of transportation contributed documents from their pavement preservation programs to the CD. RD&T has ordered a copy and will forward it to BHO when it arrives.

"Strategic Planning for Pavement Preventive Maintenance," *TR News*, March/April 2002, by Larry Galehouse
Go to http://gulliver.trb.org/publications/trnews/trnews219.pdf and select the report title from the table of contents. This article is a valuable resource for learning about Michigan's Capital Preventive Maintenance Program, including how the state combines reconstruction, rehabilitation, and preventive maintenance into a single comprehensive strategy, what criteria are used to rate pavement conditions, how the program optimizes available funding, and how data are collected and managed in the process. The article includes a table of expected life-extending benefits for sixteen different pavement treatments.

"New Practices for Managing Pavement Life," *Better Roads,* April 2002, by Ruth W. Stidger
http://www.betterroads.com/articles/apr02b.htm
This article provides a description and assessment of three effective treatments and practices that have gained recognition for achieving pavement preservation goals: whitetopping, micro-surfacing, crack sealing. The article includes an overview of performance-related specification models and the FHWA publication, *Selecting a Preventive Maintenance Treatment for Flexible Pavements.*

"Ohio: A Statewide Commitment to Pavement Preservation, Improved Construction and Maintenance Technologies," U.S. Department of Transportation and the Federal Highway Administration, October 2001
http://www.fhwa.dot.gov////construction/fs02002.pdf
Ohio issued new Pavement Preventive Maintenance Guidelines in 2001, which showcase approved pavement preventive maintenance treatments including crack sealing, ship seals, microsurfacing, concrete pavement restoration, thin hot-mix asphalt inlays and overlays, and drainage preservation. This article provides a brief overview of the guidelines, as well as the newly developed analysis queries that Ohio DOT is using to determine candidate pavement preventive maintenance projects. The new guidelines are available at www.dot.state.oh.us/pavement/publications.htm.

Pavement Preservation: Toolbox Resources, Improved Construction and Maintenance Technologies, U.S. Department of Transportation and the Federal Highway Administration, October 2001
http://www.fhwa.dot.gov/construction/fs02010.pdf
This article features the new "Pavement Preservation Toolbox," assembled by the Federal Highway Administration and Foundation for Pavement Preservation. The Toolbox contains a variety of materials designed to assist agencies in understanding preventive maintenance, selecting roads for preservation, and choosing the right treatments. The Toolbox includes the following items, some of which have been highlighted in this report:

- Pavement Preservation State of the Practice (CD-ROM)
- Protecting Our Pavements: PREVENTIVE MAINTENANCE (Video)
- Pavement Preventive Maintenance Guidelines (Report)
- Pavement Preservation Today (Newsletter)
- Recommended Performance Guidelines for Micro-Surfacing (Report)
- Selecting a Preventive Maintenance Treatment for Flexible Pavements (Report)
- A Basic Asphalt Emulsion Manual (CD-ROM)
- Pavement Preservation: The Preventive Maintenance Concept (CD-ROM)
- Asphalt Emulsion Surface Treatment Descriptions (Pamphlet)
- Micro-Surfacing, Quality Assurance and Use Guidelines for Micro-Surfacing (Report)
- Asset Management: Preserving a $1 Trillion Investment (Article in May 2000 *Focus* Newsletter)

"States Make Major Strides in Adopting Pavement Preservation Strategies," *Focus*, April 2000
http://www.tfhrc.gov////////focus/apr00/states.htm
This article provides a high level assessment of preventive maintenance programs in the United States, including the prevalence of such programs, the integration of preventive maintenance with state pavement management systems, the most commonly used treatments, and more.