



FY2011 Annual Report

January through June 2011

Minnesota
Department of
Transportation

RESEARCH SERVICES

Office of
Policy Analysis,
Research &
Innovation



Your Destination...Our Priority



The purpose of this report is to meet the requirements set forth by the Code of Federal Regulations,
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MnDOT Library: www.dot.state.mn.us/library

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Minnesota Department of Transportation

RESEARCH SERVICES

FY2011 Annual Report

January through June 2011



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Acknowledgments

The Minnesota Department of Transportation's research and implementation efforts involve many researchers and transportation practitioners throughout Minnesota and other states. We would like to recognize their ongoing efforts toward improving Minnesota's transportation system.

Thank you to the following individuals for contributing their time and knowledge to the project Technical Summaries and other elements in the *Minnesota Department of Transportation Research Services FY2011 Annual Report: January through June 2011*.

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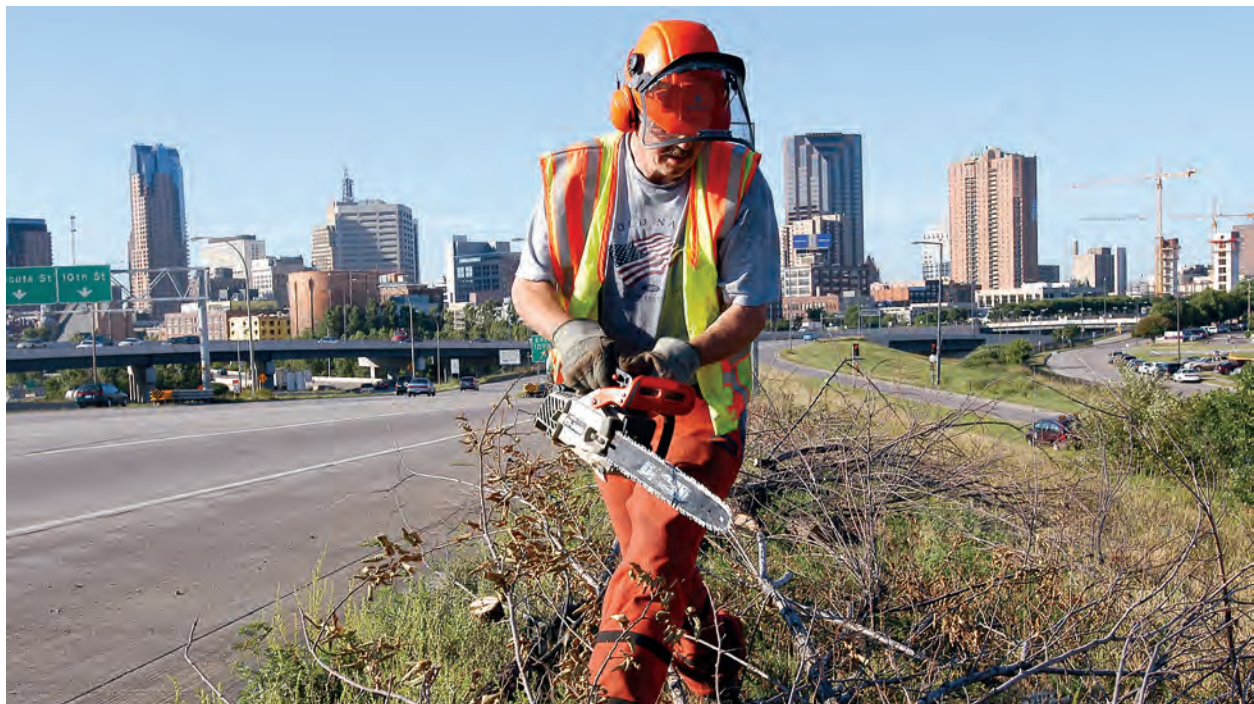
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Director's Message

We are pleased to present the *Minnesota Department of Transportation FY2011 Research Report* describing Research Services and Library activities from January through June 2011. This report fulfills a federal requirement to account for the research program's finances, progress and results. It also supports MnDOT's goal to provide transparency in our operations and represents our accountability to Commissioner Thomas K. Sorel, MnDOT's leaders and district offices, the Local Road Research Board, state government, the Legislature and Minnesota taxpayers. We hope that this information will promote sound research investments and continued improvement of the state's transportation system.

This document marks a transition in our reporting from calendar to state fiscal year to better reflect MnDOT's research cycle and in accord with Department record-keeping practices. While future reports will reflect the entire fiscal year, this half-year report is intended to supplement the *2010 Annual Report* by providing:

- Key accomplishments, including research and library highlights, for the first half of 2011
- Our vision and goals for FY2012
- A Research Services staff directory
- FY2011 financial statistics, detailing the distribution of research funds across projects and topic areas
- In the *FY2011 At-A-Glance*, a table of all completed and ongoing research in FY2011 supported by Minnesota State Planning & Research funds, MnDOT and LRRB
- Expanded reporting for enhanced accountability regarding Federal Highway Administration SP&R funds
- Two-page Technical Summaries describing a number of research projects whose reports were issued during the first half of 2011

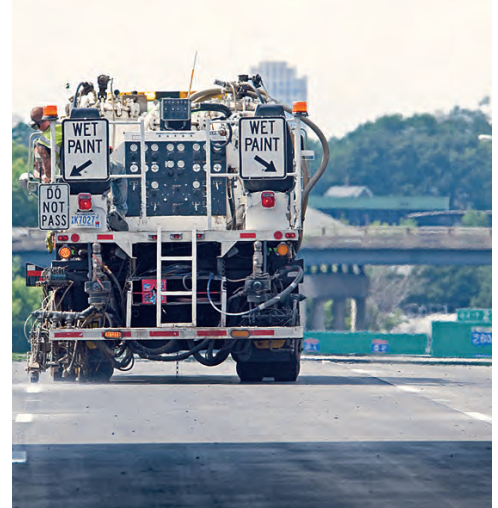
For your convenience, we have also provided summary descriptions of our processes and funding sources, and a list of our partners. For more detailed information about these topics, please consult the *2010 Annual Report*.

Please feel free to contact me or any Research Services staff for additional information about our products or projects. We would be happy to help you identify research needs and implementation opportunities. I encourage everyone to take advantage of our updated library facilities and services. Our research program will continue to bring innovation to MnDOT and to the state of Minnesota with the support and contributions of MnDOT staff, the LRRB, FHWA and our partners at universities and other public and private organizations. We welcome your comments, questions and suggestions.

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Linda Taylor,
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"Research Services is a key component in helping Minnesota evolve to meet the transportation needs of the future."

—Thomas K. Sorel,
MnDOT Commissioner

Research Services Half-Year Update

Our Mission

MnDOT Research Services supports Minnesota's transportation industry by meeting the innovation and information needs of transportation practitioners and the transportation community.

Research Services has continued to support the Department's vision and strategic plan by enabling innovations that improve the safety and cost-effectiveness of Minnesota's transportation infrastructure, improve Department operations, expand our multimodal facilities and protect the environment.



The first half of 2011 included a number of challenges for Research Services:

- Preparations were required to accommodate the impending government shutdown in June. All contracts and services were suspended for three weeks. Numerous research contracts required adjustment, and some projects were rescheduled altogether.
- A new accounting system was implemented July 1, requiring extensive work to optimize its operations. The new system, once linked to our Automated Research Tracking System (ARTS) research database, will allow us to streamline our financial operations.
- 2011 marked the expiration of our University Master Contracts that govern the many individual contracts between Research Services and university researchers, and the Transportation Research Assistance Program (TRAP), which establishes a list of preapproved consultants.
- We have experienced turnover in key staff positions due to early retirement incentives, the government shutdown and the conclusion of MnDOT Leadership Exchanges. See "Research Services Organization" on page 12 for details.

In light of these issues, we have set the following goals for FY2012:

- Re-establish our University Master Agreements and TRAP contracting mechanisms and get all research contracts back on track.
- Assess and rectify the year-end budget impacts and put in place accounting mechanisms to enhance fiscal responsibility.
- Establish a Research Services communications plan that meets the needs of the organization and customers, and develop associated strategies and marketing materials.
- Continue to expand our marketing efforts to promote and educate our customers on how to better use our services and implement our program results.
- Update the Research Services website, making it more user friendly so that program information and services, materials, reports and forms are readily accessible.

Program Highlights

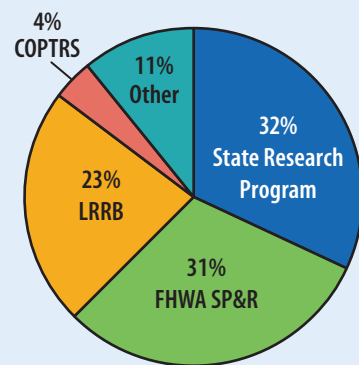
- The MnDOT Library continues to update and expand its services by partnering with the University of Minnesota's Center for Transportation Studies on a shared staff position, adding e-readers and wireless printing, and enhancing the Library website. The Minnesota Highway digitizing project was also completed. The library is capitalizing on its remodeled space by hosting events including the monthly Commissioner's Reading Corner. For more library information, see the "MnDOT Library Update" on page 16 of this report.
- Research Services is using innovative technologies to reach our customers and streamline research processes. For example, we released a new Minnesota Transportation Research Proposal Evaluation website to solicit and review problem statements in a more automated, streamlined fashion.
- Research Services took a customer services-oriented approach to improve our research processes through the development of flowcharts and a one-stop shop for forms.
- Finance and contracting dealt with fiscal year-end purchases and contracting issues, and prepared for a new accounting system and the government shutdown.
- Marketing and outreach activities are expanding through the use of social media tools, allowing us to reach our customers.



FY2011 Research Services Statistics

The two pie charts below provide an overview of the sources and allocations of the more than \$10 million in research funds that Research Services managed in FY2011. The first chart identifies the various federal, state and local funding sources that make the research possible and includes an explanation of each funding source. The second chart shows how research funds were invested across the different areas of transportation.

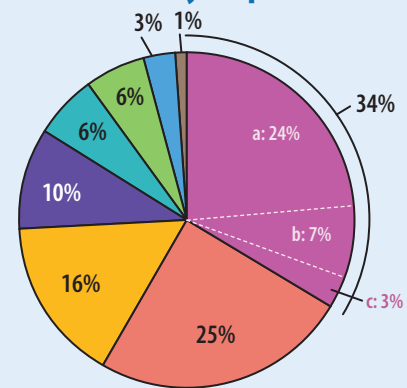
Figure 1. FY2011 Research Funds by Funding Source



State Research Program	\$3,245,222
FHWA State Planning and Research (Part II)	\$3,190,840
Local Road Research Board	\$2,308,800
Cooperative Program for Transportation Research and Studies	\$357,929
Other*	\$1,117,087
Total	\$10,219,878

*Includes contributions from other MnDOT offices (Maintenance, Traffic, Materials, Investment Management and Policy Analysis, Research & Innovation) and districts along with the Twin Cities Metropolitan Council and the University of Minnesota Intelligent Transportation Systems Institute.

Figure 2. FY2011 Research Allocated by Topic Area*



Administrative	
a: Dedicated Programs (CTS & LTAP)	\$ 1,731,505
b: Research Administration	\$ 501,374
c: LRRB/RIC Administration	\$ 244,303
	\$ 2,477,182
Materials & Construction	\$ 1,813,507
Traffic & Safety	\$ 1,135,410
Policy & Planning	\$ 727,182
Bridge & Structures	\$ 435,308
Environmental	\$ 406,888
Maintenance Operations & Security	\$ 224,353
Multimodal	\$ 91,650
Total	\$ 7,311,480

*Includes only projects with contracts maintained by MnDOT Research Services.

The *FY2011 At-A-Glance* lists all active research contracts managed by Research Services in FY2011, organized by topic area. The following tables provide a quantitative account of our research and financial management during this time.

Research Services Funding Sources

Research Services provides leadership, financial management, information services and administrative support to the following programs:

State Planning and Research Program (SP&R). SP&R funds come from the FHWA, and at least 25 percent of the money goes to state-specific research needs. This amount, referred to as SP&R Part II funding, constituted 31 percent of the FY2011 research funds we administered (as shown in Figure 1). These funds are used for participation in cooperative research efforts with other stakeholders (states, universities, industry and other public agencies) through FHWA's pooled fund program. MnDOT currently is involved in 53 multi-state pool fund projects and leads 10 of these studies. SP&R funds also are used to support local, statewide, regional, national and international research activities, committees and organizations such as AASHTO, the AASHTO Research Advisory Committee and TRB. Our participation in these programs ensures that Minnesota's interests are well-represented and that MnDOT staff members are made aware of the latest innovations and best practices for improving safety, exceeding customer expectations and saving taxpayer money.

To fulfill FHWA requirements, this report includes descriptions and status updates on all single-state SP&R efforts and MnDOT-led multi-state pooled funds as well as financial commitments information about other pooled fund efforts to which MnDOT contributes. See "FHWA State Planning and Research Reporting" on page 23 for details.



In Report 2011-13, MPR-8(002): Usability Evaluation of a Smartphone-Based Novice Teen Driver Support System (TDSS), co-funded by SP&R and SRP, researchers developed and tested a system to reduce teen car crash fatalities. The system provides real-time, in-vehicle feedback to teens about risky driving behaviors and immediately communicates with parents if these behaviors continue.

MnDOT's State Research Program (SRP). SRP funds, representing 32 percent of the research dollars we managed in FY2011, come from Minnesota state government to ensure that agency research needs are addressed and to support MnDOT's strategic directions: safety, mobility, innovation, leadership and transparency. Research Services assists MnDOT and other public agencies in identifying and developing needs statements, manages and provides technical assistance and support for research projects, assists in the implementation and deployment of research results, and promotes technology transfer and marketing of research products and services. SRP funds are often used to match dollars from other funding sources, including FHWA SP&R, CTS and the Intelligent Transportation Systems (ITS) Institute. These funds are also used to promote, support and complement MnDOT's other research programs.

Some 2011 research highlights include:

- Report 2011-02, "Allowable Axle Loads on Pavements," co-funded by SRP and LRRB, documented the development of a more accurate software program for estimating pavement axle load capacities on Minnesota low-volume roads. This software is expected to be widely used and will save money by helping to avoid the over- and underdesign of Minnesota roads.
- Report 2011-09, "Advancing Public Interest in Public-Private Partnership of State Highway Development," explained public-private partnership options to help Minnesota transportation stakeholders to leverage private funding while protecting the public interest.
- Report 2011-10, "Minnesota Department of Transportation Traffic Safety Analysis Software State of the Art," involved an assessment of crash analysis software used throughout the country to inform an update of MnDOT's system. This update will help MnDOT increase the safety of its transportation system by determining with greater precision where and how roadways need to be improved.

As part of the ongoing project Development of a Weigh-Pad Based Portable WIM System, investigators demonstrated an innovative system designed to record vehicle weights much more conveniently and inexpensively than a proprietary weigh-in-motion solution.



TRANSPORTATION RESEARCH INNOVATION GROUP (TRIG) DIVISION REPRESENTATIVES

MnDOT's TRIG is the governing board for SRP. TRIG is composed of representatives from each MnDOT office and district and meets quarterly to recommend research investments.

Name	Office	Notes
Central Office		
Jim Close	Information and Technology Services	Replaced Kathy Hofstedt
Nancy Daubenberger	Bridges and Structures	Replaced Duane Hill
Mike Ginnaty	Construction and Innovative Contracting	Replaced Jon Chiglo
Susan Groth	Traffic, Safety and Technology	
Steve Lund	Maintenance Operations	
Mark Nelson	Statewide Multimodal Planning	Replaced Jonette Kreideweis
Frank Pafko	Environmental Stewardship	
Keith Shannon	Materials and Road Research	
Linda Taylor	Research Services	
Jean Wallace	Policy Analysis, Research and Innovation	Replaced Nick Thompson
District		
Lee Berget	District 4	
Amr Jabr	Metro District	
Nelrae Succio	District 6	Replaced Mike Robinson
Jim Swanson	District 7	
FHWA		
Bill Lohr		
Research Services Support Staff		
<ul style="list-style-type: none"> • Nicole Peterson—Research Engineer • Ann McLellan— Finance & Contract Services • Bruce Holdhusen, Alan Rindels, Farideh Amiri—Roadmap Managers 		

Local Road Research Board (LRRB). Research Services administers the budget and research program for the LRRB, an organization created to facilitate transportation research and information sharing among Minnesota city and county engineers. LRRB funds constituted 23 percent of the research funds we managed in FY2011. Some of the services that we provide include contract administration, financial management (at both the program level and of individual projects), communications and logistics management (arranging meetings, record keeping, purchase orders), reporting and technology transfer. We apply our full research management methodology from identifying research needs and facilitating proposals to guiding LRRB projects to closeout and implementation. For more information on the LRRB, see “LRRB Overview” on page 21.

Cooperative Program for Transportation Research and Studies (COPTRS). In addition to these three major programs, 4 percent of our budget is dedicated to the University of Minnesota through COPTRS. This program, whose level of funding is determined by legislative action, was established in 1983 to foster cooperation in basic and applied sciences and engineering to solve transportation problems, speed technology transfer, and stimulate new ideas and areas of research.

Other Funding. As Figure 1 indicates, 11 percent of our research budget comes from funding sources other than those listed above. These funds are contributed by other public agencies as well as MnDOT offices and districts. These contributions clearly demonstrate the commitment and support for our statewide research program.

Research Services receives assistance from several internal and external stakeholders in pursuing practical innovations that will be useful to transportation practitioners throughout Minnesota: FHWA; Consultant Agreements; Business Services; Finance; Capital Programs and Performance Measures; other departments of transportation; and other agency, university and consultant partners.

Research Topic Areas

The *FY2011 At-A-Glance* organizes all of the research we manage by topic area. These designations were developed with input from MnDOT’s Transportation Research Innovation Group (TRIG) to allow our customers to better understand and access information related to specific topic areas.

Administrative

- Program Administration
- Research Management
- Technology Transfer

Bridge & Structures

- Structures Management
- Structural Design & Analysis
- Structural Materials
- Bridge Rails & Transitions
- Geotechnical Issues
- High Mast Illumination Poles
- Hydraulics & Hydrology
- Overhead Sign Bridges
- Structures Construction

Environmental

- Cultural Resources
- Social and Economic Issues & Impacts
- Noise Analysis
- Erosion Control
- Wetlands
- Air & Water Quality
- Contaminated Properties

- Regulated Materials & Waste
- Forestry
- Wetlands
- Wildlife & Fisheries

Maintenance Operations & Security

- Vegetation Management
- Rest Areas
- Winter Operations
- Pavement Maintenance
- Maintenance Contracting
- Emergency Management
- Pavement Preservation

Materials & Construction

- Geotechnical
- Pavement Design
- Construction Materials
- Construction Operations
- Innovative Contracting
- Pavement Management

Multimodal

- Aviation
- Multi-Modal & Inter-Modal Freight

- Public/Mass Transit
- Ports & Waterways
- Railroads
- Airport
- Commercial Vehicles
- Bicycles

Policy & Planning

- Right of Way Planning, Acquisition & Management
- Statewide Regional & Local Transportation System Planning
- Roadway Planning
- Traffic Data Collection/WIM
- Twin Cities Mobility Modal Plans

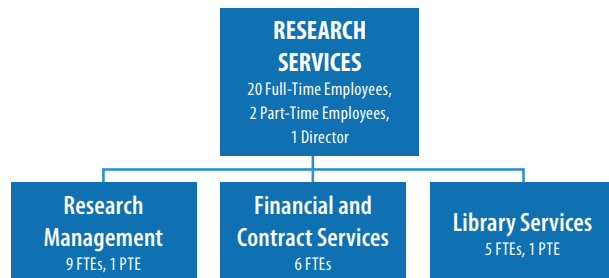
Traffic & Safety

- Geometric Design
- Signal Operations
- Pavement Marking
- Railroad Crossing Safety
- Roadside Safety Roadway
- Signing & Delineation

Research Services Organization

As Figure 3 illustrates, Research Services is responsible for the management of individual research projects, the financial and contract services involved in supporting the contracts necessary to carry out these projects, and management of MnDOT's Transportation Library.

Figure 3.



For a directory of current employees and their roles, please see “Research and Library Services Staff” on page 15 of this report. For more information about the responsibilities of various Research Services units, please see our *2010 Annual Report*.

Research Services has undergone several recent staff changes:

- Ben Worel completed his leadership exchange and returned to MnROAD/Office of Materials and Road Research.
- Nicole Peterson joined as research management engineer.
- Ann McLellan returned to MnDOT Research Services as the contract & research financial services manager.
- Our communication and marketing specialist was recruited away prior to the shutdown.
- The section was restructured to better fulfill its primary functions and to expand staff responsibilities and accountability:
 - The SP&R coordinator was moved under the Financial and Contract Services group.
 - Roadmap managers were assigned staff and are responsible for specific research initiatives.

“We fund research to improve the durability, longevity and safety of Minnesota’s roadways and to expand multimodal options in Minnesota.”



—Jean Wallace, Director, MnDOT Office of Policy Analysis, Research & Innovation

Our Vision

Research Services fosters a professional and productive environment that leads to innovative research through global and regional collaboration.

Research Services Vision

Research Services’ methodology in managing our projects, funds and staff is designed to align with the Department’s core values:

- Maintaining safety as a priority
- Enhancing trust with transparency and accountability
- Promoting collaboration, research and innovation
- Valuing diversity and cultural capital through inclusion and opportunity
- Committing to employee well-being, development and success
- Recognizing that employees are integral to MnDOT’s success

The operating plan adopted for FY2011-FY2013 defines the key services we provide and states the specific values and goals that will determine our activities through the coming years. These principles and commitments were formulated to further MnDOT’s strategic directions for improving transportation in our state.

MnDOT's Strategic Directions

For more information, see www.dot.state.mn.us/strategicvision/directions.html.

- **Safety**—Promote and maintain a safe, reliable and modern transportation system.
- **Mobility**—Improve access and enhance the movement of people and freight.
- **Innovation**—Promote a culture of innovation in the organization.
- **Leadership**—Become the transportation leader and employer of choice for Minnesota's diverse population.
- **Transparency**—Build public trust in MnDOT.



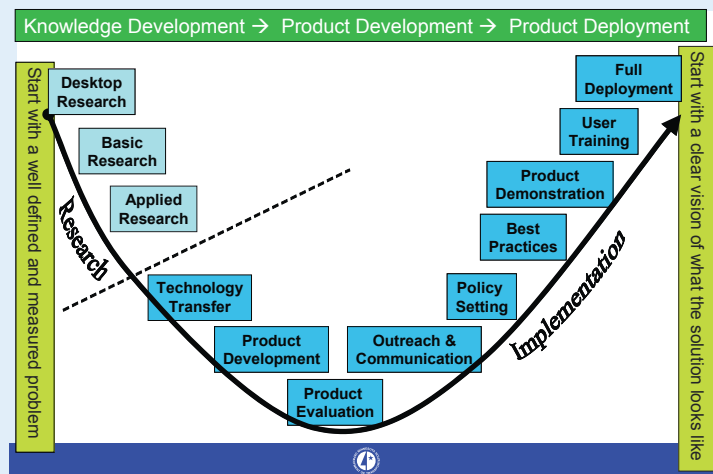
Managing Research

Key elements of our research process are summarized below.

- **Identifying research needs.** Research Services staff members help to identify innovation needs using completed research findings and communication with our customers. The Department solicits proposals for research projects in the fall of each year. Needs are not pursued without a state or local champion because without this leadership, projects are less likely to be incorporated into practice once the project is completed. MnDOT and the LRRB welcome your research ideas for improving transportation in Minnesota. You can contact us or request research support through our website (www.research.dot.state.mn.us).
- **Roadmapping.** MnDOT Roadmap Managers create and monitor roadmaps to help guide research investments, ensuring that MnDOT and LRRB priorities are adhered to and that parallel efforts within a given area are not duplicative or in conflict.
- **Contract development and monitoring.** A Research Services Roadmap Manager works with customers to develop needs into research contracts and monitors the progress of the study. An Administrative Liaison is also assigned to ensure that contract provisions are followed and to manage project activities throughout the project's life cycle, conducting the final closeout when it is complete. A Technical Liaison and Technical Advisory Panel are appointed to guide the overall direction of the contract and ensure that deliverables are satisfactory.
- **Research implementation.** Implementation is a key component of Research Services' contribution in managing a project. Minnesota focuses on implementation projects each spring to enable us to gain the full benefits of past research investments, not only by MnDOT and LRRB but also by other states and national programs. Figure 4 shows the overall development of ideas into research implementation for our customers.
- **Marketing, outreach and technology transfer.** Research Services produces and disseminates project Technical Summaries (see the "January through June 2011 Technical Summaries" section of this report on page 45), annual reports, Transportation Research Synthesis reports, brochures, manuals, videos and research presentations to ensure that the innovations we enable are effectively communicated to practitioners at MnDOT districts and in Minnesota's cities and counties. We have increased our social media presence; made our research available on the Web; and participated in committees, panels and conferences.

RESEARCH MANAGEMENT

Total active contracts for research and implementation managed by MnDOT	205
Completed reports	40
Technical Summaries	53
Transportation Research Synthesis reports	5
Research Services website hits	210,133

Figure 4. Innovation Roadmap

This diagram illustrates the cycle of innovation activities from research to deployment. Research is only the first step in ensuring deployment of a usable end-user product with a measurable benefit to transportation in Minnesota.



Financial and Contract Services

Research Services' Financial Services staff members provide contractual and financial management, planning, implementation and oversight to the federal, state and local road research programs. This unit is responsible for developing, planning and managing the contractual and financial activities for the statewide research program and Library. The staff coordinates research contracts and agreements; workflow and funding processes, including contract creation; budget management; and local, state and national research funding coordination. Please see "FY2011 Research Services Statistics" on page 8 for an overview of current activities.

Financial and Contract Services staff also serves as experts on available funding sources for research and helps MnDOT and local practitioners and managers to determine the most appropriate contracting method and funding source. This unit administers the LRRB and Research Innovation Committee (RIC) budget and programs.

FINANCIAL AND CONTRACT SERVICES

Contract closeouts	54
New contracts	65
Contract amendments	39
Interoffice agreements	13
Interagency or partnership agreements	7
Purchase orders	27
Total SP&R funded projects	51



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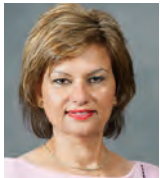
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Ben Worel returned to the Office of Materials and Road Research. Clark Moe is on a Leadership Exchange in Maintenance Operations. Jake Akervik served as Communication Coordinator through May 2011.

MnDOT Library Update



MnDOT Library staff members are experts in helping customers find the information they need on a range of transportation-related subjects, from engineering and construction to management and training. The Library staff includes (front row, from left) Christie Schultz, Anne Shelley, Qin Tang; (back row) Jim Byerly, Karen Neinstadt, Sheila Hatchell and Pam Gonzalez.

This year the MnDOT Library continued the busy pace of 2010 when it introduced new technologies, created and implemented a marketing and communications plan, and remodeled its current space for the first time in 12 years. The Library is building on these efforts by conducting presentations, using the new space to hold events, enhancing its use of new technologies and supporting MnDOT initiatives such as the Commissioner's Reading Corner. These efforts—and the Library's continuing tradition of excellent service—are helping it reach more MnDOT staff, city and county engineers, and consultants than ever to assist them in improving Minnesota's transportation system.

Outreach and Presentations

As a result of last year's marketing and communications efforts, the Library received requests this year for presentations or information booths from several MnDOT offices, including the Office of Technical Support, and Consultant Services for the American Council of Engineering Companies conference. The Library also developed a new video marketing its services (<http://www.youtube.com/watch?v=ZRdntai1M6o>), extended a standing offer to present at MnDOT's new employee orientation training and gave the following presentations:

- At the CTS/RSS partnership meeting, librarians explained how to find pertinent transportation information online and how to set up information alerts.
- Sheila Hatchell described library services available to city and county engineers at an LRRB meeting and highlighted benefits of LRRB participation in the Minnesota Transportation Libraries program.

LIBRARY STATISTICS

Estimated for Calendar Year 2011

Library materials circulated	17,045
New materials acquired	556
Questions answered	1,457
Literature searches	640
Interlibrary loans	687
Library website hits	205,401

Awards:

- 2011 Northern Lights merit award in visual design
- Special Libraries Association Innovation in Action award

Events

Last year's remodeling was put to good use in 2011. The new space not only offers a more comfortable work area for Library customers, but allows the Library to host more events, including:

- Commissioner's Reading Corner, now held monthly
- Osher Lifelong Learning Institute, for which Library staff gave a presentation in April on special libraries in general and the MnDOT Library in particular
- Diversity Program, hosted in June as part of Asian Pacific American Heritage Month and the Leaders in Transportation Series

Website and Technology

Building on last year's website redesign, the Library continues to enhance the site's ease of use and expand content, including updates on new videos, photos and other resources. A new page features Web 2.0 tools including online meeting schedulers, free access to e-books, online tutorial creation and help for creating visual displays of data (<http://mndotlibrarystaff.pbworks.com/w/page/28092280/Library-Technologies>). The Library has also added wireless printing and two additional Kindle e-readers.

Minnesota Highways Digitization Project

This year the Library is working on the latest in a series of digitization projects in partnership with the Minnesota Digital Library. This project involves digitizing issues of *Minnesota Highways* published from 1951 to 1976 by the Minnesota Department of Highways, the predecessor to MnDOT. With the digitization now complete, Library staff is creating metadata for individual issues to enhance searching capabilities. Previous projects have digitized Minnesota state highway maps, annual reports of the Minnesota State Highway Commission and Registered Minnesota Auto Trails. The MnDOT Library's contributions to the Minnesota Digital Library can be viewed at <http://reflections.mndigital.org/cdm4/browse.php?CISOROOT=%2Fmdt>.

Supporting MnDOT Initiatives

The Library continues to support MnDOT initiatives, including:

- Commissioner's Reading Corner, a monthly discussion about leadership books. Library staff coordinates presenters and book selection, interviews upper management presenters and moderates discussions. For more information, see the article in [the SLA Spring 2011 newsletter](#).
- Activities of MnDOT's Diversity Council, for which the Library has conducted literature searches on Asian-Americans in transportation, women in transportation and African-Americans in transportation.
- Research on employers along I-494 and I-35E, to market forthcoming MnPass lanes to prospective employers.
- Heroes of MnDOT, in which Commissioner Thomas K. Sorel and Minnesota Gov. Mark Dayton honored MnDOT staff.
- The CTS/RSS partnership, which continues to thrive and support excellence in customer service through sharing of information resources. The Library catalogs Center for Transportation Studies research reports and makes them available worldwide through WorldCat, and the partnership makes possible the services of a contract librarian and student worker.

Other Milestones

- Staff members were elected to leadership positions within the Special Libraries Association Transportation Division.
- Library staff worked on the Transportation 101 Committee, a MnDOT project that led to the creation of a brochure and DVD aimed at increasing employee understanding of the organization and its priorities, and encouraging employees to serve as key ambassadors for the agency.
- With many early retirements, the Library is receiving a large number of book and periodical donations.

Library Services

Now in its 55th year, the MnDOT Library is a vital resource for staff members, saving time by helping them find materials and by performing literature searches critical to their work. Services include:

- **Research assistance**, delivering facts, data or other information to customers
- **Literature searches**, providing customers with summaries of the latest published books, reports, articles and other materials for a specified topic or area of best practices in a given field
- **Document delivery and interlibrary loan services**, acquiring resources for customers from libraries worldwide
- **Periodicals routing**, maintaining a database of every magazine or journal received by the Library and loaning materials upon request
- **Online catalog access**, providing a searchable online database of all titles held by the Library
- **New Library Materials**, producing a newsletter that informs customers of new titles added to the Library collection
- **Ask a Librarian**, allowing customers to request research assistance or materials using a simple online form

Satisfied Customers

“MnDOT employees are fortunate to have a terrific library with great staff. The collection is broad and deep. Staff members are happy to make interlibrary loans for hard-to-find materials. The Library itself is serene and attractive, and improves my productivity and quality of work.”

**—John Gostovich
Principal Program Administrator**

“I sent off my request [for information about crash data and research] thinking I’d be directed to reading material. Much to my surprise the response comprised a compilation of statistics with the sources and an offer to do more digging! I was able to use the referenced source material to begin to delve into policy development. ... [The Library] is a resource that I wish I’d found out about as part of my orientation to MnDOT!”

—MnDOT Senior Engineer



Commissioner’s Reading Corner book discussions are well attended by MnDOT employees, with 15 discussions held since the program’s launch in April 2010.

Partnerships and Programs

Research Services maintains partnerships with MnDOT offices and staff as well as with academia, industry, federal and local government agencies, other state transportation agencies, AASHTO and TRB. For more information about these affiliations, please see our *2010 Annual Report*.

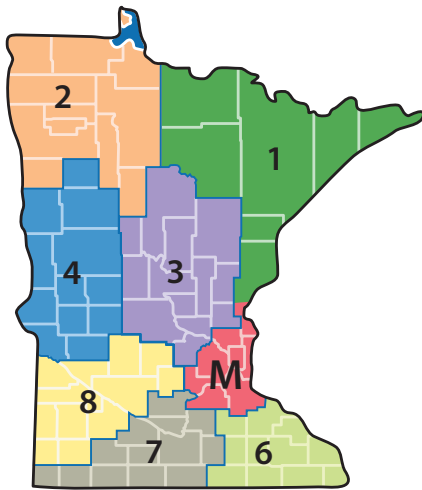


Figure 5. MnDOT Districts

■ District 1: Duluth	■ District 6: Rochester
■ District 2: Bemidji	■ District 7: Mankato
■ District 3: Brainerd	■ District 8: Willmar
■ District 4: Detroit Lakes	■ Metro District

MnDOT Internal Partnerships

Partnerships with Our Districts

Research Services receives direction and support for research from the MnDOT districts, shown in Figure 5. Many MnDOT offices also request and facilitate our research. MnDOT's organizational chart, which lists current offices and their managers, is available at <http://www.dot.state.mn.us/information/orgchart/mndotorgchart.pdf>.

In addition, Research Services works with a few MnDOT offices that have research programs of their own:

- Materials and Road Research
www.dot.state.mn.us/materials
- MnROAD Cold Weather Research
www.dot.state.mn.us/mnroad
- Minnesota Guidestar—Office of Traffic, Safety and Technology
www.dot.state.mn.us/guidestar
- Maintenance Operations Research—Office of Maintenance
www.dot.state.mn.us/maintenance/research/index.html

MnDOT's Academic Contractors

University of Minnesota

- Twin Cities campus
www1.umn.edu/twincities/index.php
- Duluth campus
<http://www.d.umn.edu/>
- Center for Transportation Studies (CTS)
www.cts.umn.edu
- Humphrey School of Public Affairs
www.hhh.umn.edu
- Center for Excellence in Rural Safety (CERS)
www.ruralsafety.umn.edu
- Intelligent Transportation Systems (ITS) Institute
www.its.umn.edu

Minnesota State University

- Minnesota State University, Mankato
www.mnsu.edu
- Minnesota State Colleges & Universities
www.mnscu.edu

Out-of-State University Partners (The following list expired June 30, 2011.)

- Iowa State University
- Michigan State University
- Michigan Technological University
- Pennsylvania State University
- University of Illinois
- University of North Dakota
- University of Northern Iowa
- University of Wisconsin–Madison

MnDOT External Partnerships

Federal Highway Administration (FHWA)

- Turner-Fairbank Highway Research Center (TFHRC)
www.tfhrc.gov
- FHWA Minnesota Division Research/Technology Transfer
www.fhwa.dot.gov/mndiv/programs/research.htm
- FHWA Transportation Pooled Fund Program (TPF)
www.pooledfund.org

Transportation Research Board (TRB)

www.trb.org

- National Cooperative Highway Research Program (NCHRP)
www.trb.org/CRP/NCHRP/NCHRP.asp

American Association of State Highway and Transportation Officials Research Advisory Committee (AASHTO RAC)

research.transportation.org

Transportation Engineering and Road Research Alliance (TERRA)

www.terraroalliance.org

Minnesota Local Technical Assistance Program (LTAP)

www.mnltap.umn.edu

Operational Research Assistance Program (OPERA)

www.cts.umn.edu/Research/ProjectDetail.html?id=2008034



“MnDOT Research brings together the strengths of Minnesota’s great universities and MnDOT and local engineers to improve all aspects of transportation in Minnesota.”

**—Nick Thompson,
Director, MnDOT Division
of Policy, Safety & Strategic
Initiatives**



LRRB Overview

Since 1959, the LRRB has facilitated both new transportation research and the sharing of the latest knowledge among Minnesota city and county engineers. In the last 15 years, it has sponsored more than 200 projects on topics ranging from cold in-place recycling with foamed asphalt to the use of pervious concrete for stormwater management.

Each year, the LRRB's 10-member board, including city and county engineers and key MnDOT decision-makers, approves and funds the most innovative research projects addressing the needs of local transportation practitioners. Once projects are approved, research is conducted by investigators from universities, consulting firms or the MnDOT Office of Materials, with the LRRB monitoring its progress and MnDOT providing administrative support and technical assistance.

A key LRRB research highlight involved helping protect the environment with stormwater management solutions:

- A **decision tree tool** to assist practitioners in selecting appropriate best management practices for stormwater management. **Report 2011RIC01, "Decision Tree for Stormwater BMPs,"** includes information about the BMPs most commonly used in Minnesota and provides a step-by-step decision-making process that narrows BMP choices according to physical constraints, the regulatory environment, capital costs and other factors. As the number of stormwater management practices continue to expand, this tool will help practitioners select the most cost-effective measures for protecting the environment.
- A project exploring the use of **pervious pavement mixtures**, which can provide a solution for stormwater runoff management in urban areas, reducing runoff pollution by allowing water to filter through pavements and the underlying soil. **Report 2010-16, "Drainable Pavements at MnROAD: Pervious Concrete and Porous Concrete Overlay Cells 39, 85, and 89,"** details the results to date, which show that pervious mixtures are performing well, have fewer freeze-thaw cycles and can be significantly quieter than impervious pavements while maintaining comparable friction.

The LRRB's products were recognized in an article, "**12 Tools for Budget-Challenged Road Engineers,**" in the July 2011 issue of *Public Works* magazine.

LRRB Mission

The mission of the LRRB is to serve local road transportation practitioners through the development of new initiatives, the acquisition and application of new knowledge, and the exploration and implementation of new technologies.

LRRB Strategic Goals

The LRRB sponsors research projects that improve Minnesota's local government road system with regard to:

- 1. Design—the determination of the need for and nature of a proposed road system project**
- 2. Construction—the implementation of the plans and specifications from the road system design process**
- 3. Maintenance/Operations—the operation and maintenance of the road system investment**
- 4. Environmental Compatibility—the integration of the local road system into the community to minimize adverse environmental impacts while contributing to economic and social well-being**

Benefiting Transportation Practitioners

Transportation practitioners involved with LRRB projects have benefited by:

- **Networking outside of the office and working with those who share similar interests**
- **Keeping up-to-date on current topics within their area of expertise and learning about cutting-edge technologies**
- **Working on real problems they otherwise wouldn't have the resources to address**

LRRB Board Members

2012

Rick West (Chair), Otter Tail County

Julie Skallman, State Aid Division

Thomas Ravn, MnDOT Construction & Innovative Contracting Division

Linda Taylor, MnDOT Research Services

Bruce Hasbargen, Beltrami County

Lyndon Robjert, Carver County

Tim Stahl, Jackson County

Steve Koehler, City of New Ulm

John Powell, City of Savage

Laurie McGinnis, University of Minnesota CTS

2011

Rick West (Chair), Otter Tail County

Julie Skallman, State Aid Division

Thomas Ravn, MnDOT Construction & Innovative Contracting Division

Linda Taylor, MnDOT Research Services

Mitch Anderson, Stearns County

Bruce Hasbargen, Beltrami County

Sue Miller, Freeborn County

Deb Bloom, City of Roseville

Steve Koehler, City of New Ulm

Laurie McGinnis, University of Minnesota CTS

Research Implementation Committee (RIC) Members

2012

Rich Sanders, (Chair), Polk County

Jeff Hulsether, City of Brainerd

Dave Robley, Douglas County

Tim Stahl, Jackson County

Walter Leu, MnDOT

Rick Kjonaas, MnDOT

Maureen Jensen, MnDOT

Nicole Peterson, MnDOT

Farideh Amiri, MnDOT

Jim Grothaus, University of Minnesota

2011

Rich Sanders, (Chair), Polk County

Tom Colbert, City of Eagan

Jeff Hulsether, City of Brainerd

Mitch Rasmussen, Scott County

Tim Stahl, Jackson County

Susan Miller, Freeborn County

Walter Leu, MnDOT

Rick Kjonaas, MnDOT

Maureen Jensen, MnDOT

Ben Worel, MnDOT

Farideh Amiri, MnDOT

Jim Grothaus, University of Minnesota



Using MnROAD test cells such as this one, researchers are monitoring pervious pavements for stormwater volume, mechanical and structural properties, surface characteristics, noise and durability.

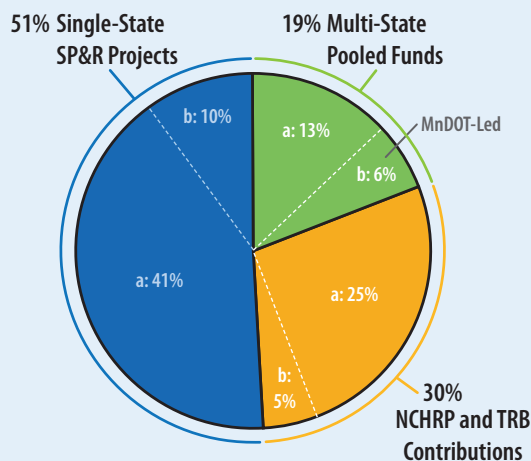


FHWA State Planning and Research Reporting

State Planning and Research (SP&R) funds, which comprised 32 percent (\$3,245,222) of MnDOT's FY2011 budget (see Figure 1, page 8), are received from the Federal Highway Administration for MnDOT planning and research activities. The most recent transportation authorization act—the Safe, Accountable, Flexible, Efficient Transportation Equity Act—requires that a minimum of 25 percent of these funds are to be used specifically for research (designated SP&R Part II) to address state-specific research needs, with the remaining portion going to planning, administration and other needs (SP&R Part I). This publication covers only Part II funds, though it should be noted that unlike most state research programs, MnDOT Research Services oversees Part I spending as well.

As Figure 6 illustrates, 2011 SP&R Part II funds were committed to multi-state pooled fund projects, single-state projects, NCHRP efforts and TRB programs. Note that SP&R accounting has been tracked by calendar year, not fiscal year. A number of amendments to MnDOT's yearly SP&R plan are typically released throughout the year, so additional commitments may be entered into before the end of 2011.

Figure 6. 2011 SP&R Part II Funding Distribution



Single-State SP&R Projects

a: Implementation	\$ 1,127,764
b: Program and Administrative Support	\$ 272,000
	<u>\$ 1,399,764</u>

Multi-State Pooled Funds

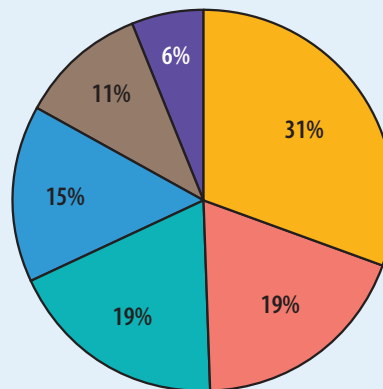
a: Participation in Pooled Funds	
Led by Other States	\$ 368,710
b: MnDOT-Led Pooled Funds	\$ 151,700
	<u>\$ 520,410</u>

NCHRP and TRB Contributions

a: NCHRP Contributions	\$ 701,958
b: TRB Contributions	\$ 127,705
	<u>\$ 829,690</u>

Total \$ 2,749,864

Figure 7. 2011 SP&R Part II Nonadministrative Funding Distribution by Topic Area*



Traffic & Safety	\$ 543,628
Materials & Construction	\$ 332,500
Bridge & Structures	\$ 329,000
Maintenance Operations & Security	\$ 255,000
Multimodal	\$ 189,000
Policy & Planning	\$ 108,000
Total	<u>\$ 1,757,128</u>

Administrative: \$1,155,440 (including NCHRP and TRB Contributions)

* Though no projects with 2011 commitments have been assigned to the Environmental category, a number of projects assigned to other areas serve to support MnDOT's stewardship of the environment.

The National Cooperative Highway Research Program

The National Cooperative Highway Research Program (NCHRP) received \$701,985 in commitments from MnDOT in 2011 (25 percent of the total SP&R Part II budget). NCHRP addresses the national need for research into highway planning, design, construction, operations and maintenance. NCHRP research includes the evaluation of fundamental new technologies and techniques, and sharing of best practices between states.

In 2011, MnDOT issued a report for NCHRP Project 25-25, Task 69: “Defining Community Context in Transportation Project Planning and Development Process.” This project collected information about tools for gathering and organizing community data relevant to transportation planning such as demographics, mobility, natural and built environment, economic conditions, housing and education, public health and safety, and cultural factors. Investigators created a searchable database of these tools for planning and project development professionals.

MnDOT staff actively participates on many NCHRP technical panels (35 in 2011) as well as on panels for other cooperative programs such as the Transit Cooperative Research Program (TCRP) and the Strategic Highway Research Program 2 (SHRP 2). A list of these memberships can be found in this report on pages 31–33.

Figure 7 shows the allocation of funding to nonadministrative funds over MnDOT’s research topic areas (described on page 11). Of administrative funds, \$829,690 goes to NCHRP and TRB dues. Multi-state administrative programs supported include TPF-5(209): Support of the Transportation Curriculum Coordination Council and TPF-5(237): Transportation Library Connectivity and Development.

MnDOT currently contributes to 34 multi-state pooled funds with 19 percent (\$520,410) of the 2011 budget. These cooperative efforts allow MnDOT to leverage its research dollars to facilitate more in-depth studies. Minnesota is the lead state in 11 of these efforts, described with current status updates in the “MnDOT-Led Multi-State Pooled Fund Projects” section on page 25. Other pooled funds with 2011 commitments or with past MnDOT commitments that are still accruing value for Minnesota are listed in the “Other Active Multi-State Pooled Fund Projects” section on page 30. Technical Summaries for many of these can be found in the *2010 Annual Report*.

SP&R funds enable MnDOT to invest in and pursue long-range strategies and research into



MnDOT leads 11 pooled fund projects, including TPF-5(190): North/West Passage Corridor, which integrates traveler information systems between states to improve the safety and efficiency of Minnesota travelers. For its leadership of this pooled fund study, MnDOT Research Services received the CTS 2010 Research Partnership Award and the 2010 Best of ITS Rural Award at the National Rural ITS Conference in the category Best New Practice. A Technical Summary of this study can be found on page 66.

innovative new technologies that might not otherwise be feasible. SP&R funds are often used to fund implementation and technology transfer efforts to ensure that developed innovations are understood and used by MnDOT districts and offices. MnDOT allocated \$1,127,764 of its 2011 commitments toward implementation efforts.

MnDOT-Led Multi-State Pooled Fund Projects

This section provides basic information on MnDOT-led SP&R Projects funded by multiple states that were active in 2011. In some cases, state financial commitments ended prior to 2011, but these funds are still being spent.

TPF-5(129): Recycled Unbound Pavement Materials (MnROAD Study)

Number of Participating States: 6

URL: www.pooledfund.org/projectdetails.asp?id=361&status=4

Funded by: SP&R/SRP **Total Cost:** \$882,352

MN Paid in 2009: \$15,000

Performed by: UW–Madison **PI:** Tuncer Edil

TL: Andrew Eller **AL:** Nelson Cruz

Description: This study will monitor the performance of several test cells constructed with recycled materials in the granular base layers, including blended with virgin materials and 100 percent recycled asphalt and concrete pavement materials. Material properties will be used to verify mechanistic-empirical design inputs, especially variations with changing seasons and moisture regimes. **Status:** A pooled fund teleconference was held April 3, 2009, while PIs met in person at MnDOT. Representatives from participating states provided pavement samples (including four samples related to the MnROAD test facility) that are being tested for various index and structural properties. Testing to determine compaction characteristics, grain size distribution and resilient modulus is under way.

Start Date: 2007

Projected End Date: 2011

Work Complete: 20%

TPF-5(129): Recycled Unbound Pavement Materials (MnROAD Study)

Number of Participating States: 6

URL: <http://www.pooledfund.org/Details/Study/361>

Funded by: SP&R/SRP **Total Cost:** \$718,120

Total MN Commitments: \$120,000

MN 2011 Commitment: \$15,000

Performed by: UW–Madison

PI: Tuncer Edil

TL: Andrew Eller **AL:** Nelson Cruz

MN 2011 Commitment: \$0

Description: This study monitors the performance of several test cells constructed with recycled materials in the granular base layers, including blended with virgin materials and 100 percent recycled asphalt and concrete

pavement materials. Material properties are used to verify mechanistic-empirical design inputs, especially variations with changing seasons and moisture regimes.

Status: Researchers evaluated the effect of RAP content on the stiffness of Class 5 aggregate used as conventional unbound road base/subbase layer. They performed resilient modulus tests on two RAP samples—one typical and one medium gradation. Researchers also investigated the effect of compaction moisture content on the resilient modulus of unbound road base/subbase layers using two RAPs and two RCAs (representing typical, coarser and finer gradation). They completed a report on the relationship between resilient modulus and composition of RCA and RAP samples. The PIs developed standard protocols for monitoring and evaluating the leaching behavior of pavements constructed with unconventional materials, and are collecting and analyzing field lysimeter samples for metals.

MN Commitment End Date: 2011

TPF-5(132): Investigation of Low Temperature Cracking in Asphalt Pavements, Phase II

Number of Participating States: 7

URL: <http://www.pooledfund.org/Details/Study/395>

Funded by: SP&R/SRP **Total Cost:** \$475,000

Total MN Commitments: \$100,000

MN 2011 Commitment: \$20,000

Performed by: University of Minnesota

PI: Mihai Marasteanu

TL: Timothy Clyne **AL:** Bruce Holdhusen

Description: Phase I of this study looked at developing a fracture mechanics-based specification for a better selection of asphalt binders and mixtures with resistance to crack formation and propagation. In Phase II, researchers validate the laboratory test procedures, models and pavement design procedures from Phase I by monitoring two new test sections at MnROAD.

Status: Researchers have developed methods to obtain creep from DCT or SCB test samples, and are finalizing a specification for fracture and stiffness. They began the final compilation of the combined TC Model code; climatic files for three locations (cold, average and warm) within

each participating state are being generated for a range of pavement structures. Researchers investigated the effect of thermal cycling on the stress buildup and thermo-volumetric properties of MnROAD mixtures using the Asphalt Thermal Cracking Analyzer. They determined the effect of physical hardening, relaxation and glass transition behavior on the thermal stress buildup of asphalt mixtures using analytical modeling; after validation testing, they will select the best test device and method of conditioning mixes for long-term aging. The University of Illinois team conducted ruggedness and round-robin testing to establish precision and bias statistics for the D7313-07 specification for the DC(T) test. Initial work on developing draft AASHTO standards has also begun.

MN Commitment End Date: 2011



TPF-5(134): PCC Surface Characteristics—Rehabilitation (MnROAD Study)

Number of Participating States: 3

URL: <http://www.pooledfund.org/Details/Study/363>

Funded by: SP&R/SRP **Total Cost:** \$275,000

Total MN Commitments: \$75,000

MN 2011 Commitment: \$0

Performed by: Mankato State University

PI: W. James Wilde

TL: Bernard Izevbekhai **AL:** Bruce Holdhusen

Description: To create smooth pavements, researchers need to quantify the effects of pavement performance parameters. This project provides data that will optimize pavement quietness, friction, texture and ride. Researchers determine to what degree total noise is generated by tire-pavement interactions, and they develop a prediction of noise level based on grinding techniques.

Status: Researchers monitored several HMA pavements with various surfaces for noise, texture, friction, permeability, ride quality and durability testing, and observed trends with the data over time and various seasons. The PI attended presentations and meetings related to HMA surface characteristics at the Transportation Research Board Annual Meeting. Jurek Ejsmont from Poland discussed bringing his rolling resistance test equipment to MnROAD in fall 2011 to quantify fuel efficiency of vehicles traveling over various pavement surfaces. Researchers posted an RFP and selected Purdue University to analyze HMA surface characteristics data and develop a model for noise that includes viscoelasticity, texture and porosity. The final statistical pass-by report was submitted for publication.

MN Commitment End Date: 2010

TPF-5(148): The Effects of Implements of Husbandry “Farm Equipment” on Pavement Performance (MnROAD Study)

Number of Participating States: 6

URL: <http://www.pooledfund.org/Details/Study/375>

Funded by: SP&R/SRP **Total Cost:** \$433,000

Total MN Commitments: \$105,000

MN 2011 Commitment: \$0

Performed by: University of Minnesota

PI: W. Lev Khazanovich

TL: Shongtao Dai **AL:** Bruce Holdhusen

Description: This study compares pavement response under various types of agricultural equipment (including the impacts of different tires and additional axles) to the response under a typical five-axle tractor-trailer, allowing policy and design decisions to be driven by direct experimental results rather than by models.

Status: In spring 2011 researchers completed tire footprint measurements using Tekscan. They also prepared task reports summarizing the data collection and data analysis efforts. A report detailing the damage modeling is nearly complete as is the final report. The PI made presentations at the county engineers meeting and the Midwest Forage Association conference.

MN Commitment End Date: 2008

TPF-5(149): Design and Construction Guidelines for Thermally Insulated Concrete Pavements (MnROAD Study)

Number of Participating States: 5

URL: <http://www.pooledfund.org/Details/Study/376>

Funded by: SP&R/SRP **Total Cost:** \$455,000

Total MN Commitments: \$100,000

MN 2011 Commitment: \$20,000

Performed by: University of Minnesota

PI: Lev Khazanovich

TL: Timothy Clyne **AL:** Nelson Cruz

Description: A life-cycle cost evaluation of thermally insulated concrete pavements is needed along with effective design and construction guidelines for applications where these pavements have economic advantages. A better understanding of the effects of design, materials and construction parameters on TICP performance is needed to develop these guidelines. This study performs the life-cycle cost comparison with alternative strategies and develops the required guidelines for mechanistic design and construction.

Status: Researchers completed the life-cycle analysis and task report describing cases where composite pavements were competitive with conventional concrete pavements in terms of cost and performance. They evaluated several pavement response models: Asphalt was modeled under a dual-modulus approach to account for traffic and environmental loadings; a finite element model analyzed a composite pavement that incorporates elastic and viscoelastic layers; and a stress computation procedure was developed to calculate stresses in the composite pavement subjected to traffic loads and temperature curling using two load duration-dependent AC moduli. This procedure demonstrated that the MEPDG may significantly underestimate the stress in composite pavements subjected to traffic loading and temperature curling. Finally, researchers developed a framework for implementing the proposed stress procedure into the MEPDG that requires minimum modifications to the existing framework. Design and construction guidelines are also under way.

MN Commitment End Date: 2011



TPF-5(153): Optimal Timing of Preventive Maintenance for Addressing Environmental Aging in HMA Pavements

Number of Participating States: 5

URL: <http://www.pooledfund.org/Details/Study/380>

Funded by: SP&R/SRP **Total Cost:** \$405,000

Total MN Commitments: \$131,205

MN 2011 Commitment: \$15,000

Performed by: Asphalt Institute

PI: Mike Anderson

TL: Thomas Wood **AL:** Bruce Holdhusen

Description: This study determines the proper timing of preventive maintenance treatments to optimize life-cycle costs and pavement performance. Researchers seek to better understand the aging mechanism and how it can be reduced through pavement preservation. Work is performed on newly built test sections at MnROAD.

Status: MnDOT cored and shipped samples of recovered asphalt binder to the Asphalt Institute where the following testing is under way: dynamic shear rheometer frequency sweep, DSR test at 44.7 degrees Celsius using the Texas A&M method, bending beam rheometer, double-edged notched tension and DSR amplitude sweep. Additional core tests include mixture BBR and disk-shaped compact tension test at three temperatures.

MN Commitment End Date: 2011

TPF-5(165): Development of Design Guide for Thin and Ultrathin Concrete Overlays of Existing Asphalt Pavements**Number of Participating States:** 6**URL:** <http://www.pooledfund.org/Details/Study/389>**Funded by:** SP&R/SRP **Total Cost:** \$406,000**Total MN Commitments:** \$69,200**MN 2011 Commitment:** \$9,200**Performed by:** University of Pittsburgh**PI:** Julie Vandenbossche**TL:** Tom Burnham **AL:** Nelson Cruz

Description: This project creates a unified national design guide for thin and ultrathin concrete overlays of existing asphalt pavements. In these guidelines, researchers use existing validated performance models as well as new analytical models that address design aspects not considered in existing methods.

Status: Researchers examined climatic effects on various layers of thin and ultrathin concrete overlays. The fifth of six participating states committed the extra funds requested for additional work to characterize interlayer bonding, determine the effect of structural fibers on performance and provide improved project assessment guidelines. Researchers also developed a laboratory testing platform to evaluate the time-dependent contribution of interlayer bonding and structural fibers in concrete overlays. A Technical Advisory Panel meeting was held in March 2011.

MN Commitment End Date: 2011**TPF-5(190): North/West Passage—Phase III****Number of Participating States:** 8**URL:** <http://www.pooledfund.org/Details/Study/412>**Funded by:** SP&R/SRP **Total Cost:** \$750,000**Total MN Commitments:** \$200,000**MN 2011 Commitment:** \$25,000**Performed by:** Athey Creek Consultants**PI:** Dean Deeter**TL:** Matthew Gjersvik **AL:** Debra Fick

Description: This series of projects continues to integrate traveler information systems and coordinates maintenance operations across state borders along the I-90/I-94 corridor from Wisconsin to Washington.

Status: Investigators in the citizen-assisted reporting feasibility study shared the details of Wyoming's ECAR

program with other NWP states, exploring ways to improve Wyoming's program and to expand the citizen reporting system to other NWP states. Researchers from the Consistent and Coordinate DMS Use project conducted a workshop and developed guidelines to help TMC/TOC operations staff coordinate with other states during a major event. Members of the NWP Regional Permitting, Phase 2 project worked toward reducing the confusion about regulations and requirements for oversize/overweight trips and provided a single mechanism for obtaining permits for oversize/overweight loads. The Facilitating the Use of Open Source Software Throughout the Corridor project team began planning a 2012 workshop to help NWP states reduce the costs of developing and maintaining software systems. The NWP Steering Committee has developed a general brochure, a 511 brochure and an annual progress report (available at nwpassage.info), and the NWP states have developed a corridorwide traveler information website (i90i94travelinfo.com).

MN Commitment End Date: 2011**TPF-5(192): Loop and Length Based Classification Pooled Fund****Number of Participating States:** 14**URL:** <http://www.pooledfund.org/Details/Study/416>**Funded by:** SP&R/SRP **Total Cost:** \$485,000**Total MN Commitments:** \$40,000**MN 2011 Commitment:** \$15,000**Performed by:** SRF Consulting Group, Inc. **PI:** Erik Minge**TL:** Gene Hicks **AL:** Debra Fick

Description: Many states are collecting length-based classification data but few are collecting it using the same criteria. Agencies need to know the variability in their collection programs. In this study, researchers develop field-test installation methods for loops to determine the most cost-effective and best-performing procedures and materials. The number of bins and the length spacing for each bin are determined. Calibration standards for vehicle length-based measurements are also established.

Status: Twelve loops and four Sensys detectors were installed at the MnROAD test site. A review of the loop inductance value revealed unacceptable inductance changes from unexpected reinforcement in the pavement, greatly reducing their utility for research purposes. Researchers

documented inductance readings and shared different options for moving the project forward with the Technical Advisory Committee. Delays in contracting and starting the project pushed the initial schedule back two months.

MN Commitment End Date: 2011

TPF-5(215): Transportation Engineering and Road Research Alliance

Number of Participating States: 5

URL: <http://www.pooledfund.org/Details/Study/443>

Funded by: SP&R/SRP **Total Cost:** \$157,500

Total MN Commitments: \$37,500

MN 2011 Commitment: \$7,500

Performed by: N/A. TERRA supervises and funds a number of different research projects.

TL: Maureen Jensen **AL:** Debra Fick

Description: The Transportation Engineering and Road Research Alliance was formed in 2004 by a task force of government, industry and academic representatives. TERRA's mission is to develop, sustain and communicate a comprehensive research program on pavement, materials and related transportation engineering challenges, including issues related to cold climates.

Status: Researchers hosted the 2011 Pavement Conference and began planning for the Innovation Series. The state government shutdown forced a full-day conference on TERRA research at MnROAD to reschedule. The Research Committee held a webinar on pavement rehabilitation, and Michigan Tech conducted a webinar on warm-mix asphalt. Researchers conducted a call for Research and Implementation ideas, and finalized pooled fund proposals for nondestructive testing and unbonded concrete overlays. MnROAD held an open house, and the board and all subcommittees met. The annual highlights, three research synthesis reports, quarterly e-newsletters, a concrete overlays fact sheet and updates to the program one-pager were completed.

MN Commitment End Date: 2014

TPF-5(218): Clear Roads Winter Highway Operations Pooled Fund (continued from TPF-5(092))

Number of Participating States: 22

URL: <http://www.pooledfund.org/Details/Study/446>

Funded by: SP&R/SRP **Total Cost:** \$1,220,000

Total MN Commitments: \$70,000

MN 2011 Commitment: \$25,000

Performed by: CTC & Associates LLC

PI: Patrick Casey

TL: Tom Peters **AL:** Debra Fick

Description: This project emphasizes state agency needs along with technology transfer and implementation in advancing national winter highway operations. Member states evaluate new tools and practices in both lab and field settings, develop industry standards and performance measures, provide technology transfer and cost/benefit analysis, and support winter highway safety.

Status: The Technical Advisory Committee met in February 2011, and planning for the October 2011 TAC meeting began. Investigators helped to develop the scopes of work for eight new research projects and worked with AASHTO, Aurora and PNS members on the 2011 Winter Maintenance Peer Exchange. The TAC evaluated responses to RFIs and RFPs for the Improving Snowplow Design, True Costs of Snow and Ice Control, and Weather Mapping projects. Results of the 2010-2011 product experience survey were finalized and posted on the Clear Roads website. Work began on a training video for deicer testing; the project subcommittee and PI provided feedback on the editing and direction of the deliverables. The subcommittee for the Plug and Play Initiative refined the GPS/AVL and material spreader specifications.

MN Commitment End Date: 2013



Other Active Multi-State Pooled Fund Projects

Study Number	Title	Technical Liaison	Administrative Liaison	Lead State or Agency	Number of Participating States	Current MN Commitment End Date	Total Cost	Total MN Commitment	MN 2011 Commitment
SPR-2(207)	Transportation Management Center Pooled Fund Study	Brian Kary	Debra Fick	FHWA	28	2012	\$5,407,267	\$400,000	\$50,010
SPR-3(042)	Aurora Program	Curtis Pape	Debra Fick	IA	18	2011	\$3,122,500	\$375,000	\$0
SPR-3(074)	Pavement Research and Technology	Roger Olson	Debra Fick	WA	4	2010	\$625,000	\$280,000	\$0
TPF-5(029)	High Occupancy Vehicle (HOV)/Managed Use Lane (MUL)	Janelle Anderson	Debra Fick	FHWA	11	2013	\$1,940,000	\$225,000	\$25,000
TPF-5(054)	Development of Maintenance Decision Support System (MDSS)	Curtis Pape	Debra Fick	SD	18	2012	\$3,120,884	\$200,000	\$0
TPF-5(109)	Core Program Services for a Highway Research, Development and Technology Program (TRB)	Linda Taylor	Debra Fick	FHWA	21	2011	\$7,108,855	\$510,820	\$127,705
TPF-5(156)	Mid America Freight Coalition Pooled Fund	John Tompkins	Debra Fick	WI	10	2011	\$1,175,000	\$125,000	\$25,000
TPF-5(159)	Technology Transfer Concrete Consortium	Maria Masten	Debra Fick	IA	20	2012	\$537,500	\$30,000	\$5,000
TPF-5(174)	Construction of Crack-Free Bridge Decks, Phase II	Paul Kivisto	Debra Fick	KS	14	2011	\$995,000	\$75,000	\$15,000
TPF-5(177)	Improving Resilient Modulus (MR) Test Procedures for Unbound Materials	Shongtao Dai	Debra Fick	FHWA	10	2010	\$300,000	\$40,000	\$0
TPF-5(179)	Evaluation of Test Methods for Permeability (Transport) and Development of Performance Guidelines for Durability	Bernard Izevbekhai	Debra Fick	IN	11	2011	\$883,000	\$87,000	\$12,000
TPF-5(187)	Updating U.S. Precipitation Frequency Estimates for the Midwestern Region	Andrea Hendrickson	Debra Fick	FHWA	8	2010	\$1,315,572	\$300,001	\$0
TPF-5(193)	Midwest States Pooled Fund Crash Test Program	Michael Elle	Debra Fick	NE	16	2011	\$2,009,155	\$1,320,863	\$66,700
TPF-5(197)	The Impact of Wide-Base Tires on Pavement Damage: A National Study	Shongtao Dai	Debra Fick	FHWA	7	2012	\$675,000	\$100,000	\$25,000
TPF-5(198)	Urban Mobility Study, 2009 Continuation	Paul Czech	Debra Fick	TX	9	2012	\$295,000	\$165,000	\$60,000
TPF-5(202)	HY-8 Culvert Analysis Program—Phase Three of Development Efforts	Petronella DeWall	Debra Fick	FHWA	8	2011	\$155,000	\$30,000	\$0



Active NCHRP Projects with MnDOT Panel Membership

Project Number	Project Title	MnDOT Panel Member	Division	Role	Start Date	End Date
D0146	Handbook for Pavement Design, Construction, and Management	Curt M. Turgeon	Policy, Safety & Strategic Initiatives	Member	2009	2011
D0148	Incorporating Pavement Preservation Into the MEPDG	Roger C. Olson	Policy, Safety & Strategic Initiatives	Member	2010	2012
D0362	Guidelines for Accessible Pedestrian Signals	Beverly Farraher	Operations	Member	2001	2012
D0836	Research for AASHTO Standing Committee on Planning: Support for Improved Transportation Planning and Project Development	Timothy A. Henkel	Modal Planning & Program Management	Member	1998	Ongoing
D0855	Developing a Logical Model for a Geo-Spatial Right-Of-Way Land Management System	Kevin F. Leonard	Engineering Services	Member	2007	2011
D0871	Optimum Life-Cycle Analysis of Maintainable Assets	Mark B. Nelson	Modal Planning & Program Management	Chair	2009	2011
D0875	Performance Measurement and Evaluation of Tolling and Congestion Pricing Project Benefits and System Impacts	Kenneth R. Buckeye	Policy, Safety & Strategic Initiatives	Chair	2009	2011
D0879	Producing Transportation Data Products from the American Community Survey that Comply with Disclosure Rules	Jonette Kreideweis	Modal Planning & Program Management	Member	2010	2011
D0885	The Comprehensive Economic Effects of Highway-Rail At-Grade Crossing Crashes	Susan H. Aylesworth	Modal Planning & Program Management	Member	2011	2012
D0930A	Rutting Performance Models for HMA Mix and Structural Design	Shongtao Dai	Policy, Safety & Strategic Initiatives	Member	2005	2011
D0940	Optimization of Tack Coat for HMA Pavements	Roger C. Olson	Policy, Safety & Strategic Initiatives	Member	2005	2011
D0943	Mix Design Practices for Warm Mix Asphalt Technologies	Timothy R. Clyne	Policy, Safety & Strategic Initiatives	Member	2007	2011
D0950	Performance-Related Specifications for Asphaltic Binders Used in Preservation Surface Treatments	Shongtao Dai	Policy, Safety & Strategic Initiatives	Member	2011	2014
D0952	Short-Term Laboratory Conditioning of WMA Mixtures for Mix Design and Performance Testing	Timothy R. Clyne	Policy, Safety & Strategic Initiatives	Member	2011	2012
D1071	Evaluation of CIP Reinforced Joints for Full-Depth Precast Concrete Bridge Decks	Daniel L. Dorgan	Engineering Services	Chair	2006	2011
D1077	Developing Guidelines for GPS (Geographical Positioning System) Controlled Construction Machine Guidance and Required CADD Software	Louise K. Barrett	Engineering Services	Member	2009	2011
D1084	Modulus-Based Construction Specifications and Issues for Highway Earthwork and Unbound Base Materials	John A. Siekmeier	Policy, Safety & Strategic Initiatives	Chair	2010	2013
D1085	A Guidebook for Construction Manager-At-Risk Contracting for Highway Projects	Jay J. Hietpas	Engineering Services	Member	2011	2013
D1089	Determination of Best Practices for Optimal Construction Inspection	Terry Ward	Engineering Services	Member	Pending	Pending
D1283	Calibration of LRFD Concrete Bridge Design Specifications for Serviceability	David Dahlberg	Engineering Services	Member	2009	2012
D1284	Guidelines for the Load and Resistance Factor Design and Rating of Riveted, Bolted, and Welded Gusset-Plate Connections for Steel Bridges	Kevin Western	Engineering Services	Member	2008	Not Specified
D1426	Culvert and Storm Drain Inspection Manual	Bonnie Peterson	Engineering Services	Member	2011	2012
D1533	The AASHTO Guide for Transportation Landscape and Environmental Design	Scott D. Bradley	Engineering Services	AASHTO Monitor	2006	2011
D1539	Superelevation Criteria for Horizontal Curves on Steep Grades	James Rosenow	Engineering Services	Member	2010	2012
D1546	A Guidebook for Design Contract Administration for Transportation Projects Delivered Using Integrated Project Delivery	Jon Chiglo	Engineering Services	Member	2011	2012
D1749	Guide for Effective Tribal Crash Reporting	Linda Aitken	Government Affairs	Member	2011	2013

cont. ➡

Active NCHRP Projects with MnDOT Panel Membership, Cont.

Project Number	Project Title	MnDOT Panel Member	Division	Role	Start Date	End Date
D1751	Input to the Development of a National Highway Safety Strategy	Bernard J. Arseneau	Deputy Commissioner/Chief Engineer	Member	2011	2012
D2036	Highway Research and Technology—International Information Sharing	Mukhtar Thakur	Modal Planning & Program Management	Member	1993	2012
D2082	Next Generation of the FHWA Transportation Pooled Fund (TPF) Website	Susan J. Lodahl	Operations	Chair	2009	2012
D208307	Sustainable Transportation Systems and Sustainability as an Organizing Principle for Transportation Agencies	Robert Edstrom	Engineering Services	Member	2010	2013
D2085	Wind, Solar and Ground-Source Energy for Maintenance Area Facilities	Robert Miller	Operations	Member	2010	2012
D2432	Scour at Wide Piers and Long Skewed Piers	Andrea Hendrickson	Engineering Services	Member	2007	2011
D2433	Development of Design Methods for In-Stream Flow Control Structures	Petronella L. DeWall	Engineering Services	Member	2008	2012
D2436	Scour at the Base of Retaining Walls and Other Longitudinal Structures	Petronella L. DeWall	Engineering Services	Member	Pending	Pending
D2539	Developing Environmental Performance Measures and a Methodology for Incorporation into Performance Management Programs	Jennie Ross	Engineering Services	Member	Pending	Pending

Active ACRP Projects with MnDOT Panel Membership

Project Number	Project Title	MnDOT Panel Member	Division	Role	Start Date	End Date
DA0327	Evaluating Methods for Counting Aircraft Operations at Non-Towered Airports	Peter Buchen	Modal Planning & Program Management	Member	Pending	Pending

Active NCFRP Projects with MnDOT Panel Membership

Project Number	Project Title	MnDOT Panel Member	Division	Role	Start Date	End Date
DF022	Applying Benefit-Cost Analysis to Freight Project Selection: Lessons from the Corps of Engineers	William D. Gardner	Modal Planning & Program Management	Member	2011	2011
DF024	Preserving and Protecting Freight Infrastructure and Routes	William D. Gardner	Modal Planning & Program Management	Member	2009	2011
DF035	The Great Lakes Region Impacts on the Intermodal Freight Systems	William D. Gardner	Modal Planning & Program Management	Chair	2010	2012

Active TCRP Projects with MnDOT Panel Membership

Project Number	Project Title	MnDOT Panel Member	Division	Role	Start Date	End Date
TB34	Guidebook for Commingling ADA-Eligible and Other Passengers on ADA-Complementary Paratransit Services	Sarah B. Lenz	Employee & Corporate Services	Member	2006	2011
TD13	A Guide for Implementing Bus-On-Shoulder (BOS) Systems	Jennifer Conover	Operations	Member	2006	2011

Active SHRP 2 Technical Expert Task Groups with MnDOT Membership

Project Number	Project Title	MnDOT Technical Expert Task Group Member	Division	Role	Start Date	End Date
FB026	Guide for the Process of Managing Risk on Rapid Renewal Contracts	Jay J. Hietpas	Engineering Services	Member	2007	2011
FB034	Using Infrared and High Speed GPR for Uniformity Measurements on New HMA Layers and Nondestructive Testing to Identify Delaminations between HMA Layers	Shongtao Dai	Policy, Safety & Strategic Initiatives	Member	2009	2012
FB038	Real-Time Smoothness Measurements on Portland Cement Concrete Pavements During Construction	Bernard Izevbekhai	Policy, Safety & Strategic Initiatives	Member	2009	2011
FB039	Development of Continuous Sensors	Erland Lukanen	Policy, Safety & Strategic Initiatives	Member	2009	2011
FB049	The Project on Communicating Railroad-DOT Mitigation Strategies	Susan Aylesworth	1	Member	Not Specified	Not Specified
FC020	Incorporating Reliability Performance Measures into the Transportation Planning and Programming Processes	Peggy A. Reichert	Modal Planning & Program Management	Member	2010	2012



Single-State SP&R Projects

This section provides basic information on single-state SP&R Projects with active contracts in 2011, or in some cases, funds were committed in 2011 but have not yet resulted in a contract.

Studies with FY2011 Commitments

MPR-0(003): Reporting Capabilities for Continuous Vehicle Class and WIM Data

Funded by: SP&R/SRP

Total Cost: \$35,268 **Paid to Date:** \$8,298

MN 2011 Commitment: \$28,214

Performed by: University of Minnesota, Duluth

PI: Taek Kwon

TL: Benjamin Timerson **AL:** Nelson Cruz

Description: In the previous project, data warehouse and reporting utilities for weigh-in-motion and vehicle classification binary data were successfully developed. The goal of this project is to develop new reporting functions and also modify existing functions to add more capabilities and improve utility. Additional objectives include upgrading error code translation and nearest 0.01-second time stamp for each vehicle record in Bullconverter; implementing eight new reporting functions and several modifications to existing functions in Bull report; adding new functions to Bullpiezo to recognize FHWA.cla formats and produce reports directly from FHWA-formatted data; and conducting extensive tests on the new software.

Status: IRD error codes were successfully decoded and fully implemented in the new versions of Bullconverter. Researchers modified existing reporting functions; the completed works include average, median and 85th percentile speeds in the Speed reports and optional parameters for ESAL computations. Researchers will include lane-by-lane data option in all reports.

Start Date: 11/18/2010 **Projected End Date:** 6/30/2012

MPR-1(001): AASHTO Technical Service Programs

Funded by: SP&R

Total Cost: \$18,750 **Paid to Date:** \$18,750

MN 2011 Commitment: \$18,750

Description: This is a one-time assessment contribution to support American Association of State Highway and Transportation Officials operations.

Status: This is a one-time contribution to support

enhancement of the Anti-Icing/Road Weather Information System computer-based training program and other tools related to winter maintenance.

Start Date: 3/15/2011 **Projected End Date:** 8/9/2011

MPR-1(002): Development of a Spatial Time Domain Acoustic Device for Rapid Concrete Evaluation

Funded by: SP&R/SRP

Total Cost: \$98,000 **Paid to Date:** \$0

MN 2011 Commitment: \$78,400

Performed by: MnDOT Office of Materials

PI: Bernard Izevbekhai

TL: Maureen Jensen **AL:** Daniel Warzala

Description: The goals of the project are to design and create a system that measures the reflected impulses from concrete pavement measured at driving speed. The system consists of an acoustic intensity and frequency analyzer that replaces what the human ear would do for a chain drag and removes the subjectivity. The uniform impact device transmits impulses to which concrete at varying degrees of degradation or poor mixing will respond differently. The responses are isolated from the transmitted waves and are displayed in a time domain-spatial domain plot. This device is useful for bridge deck condition monitoring as well.

Status: This project is in its initial stages of development.

Start Date: 4/5/2011 **Projected End Date:** 3/30/2014



MPR-1(003): Implementation of Pavement Evaluation Tools**Funded by:** SP&R/SRP**Total Cost:** TBD **Paid to Date:** \$0**MN 2011 Commitment:** \$62,400**Performed by:** University of Minnesota**PI:** Joseph Labuz**TL:** Shongtao Dai **AL:** Daniel Warzala

Description: Despite their effectiveness as tools for noninvasive pavement diagnosis, falling weight deflectometer and ground penetrating radar devices are not widely used because of the complexity of data interpretation. This study provides a graphical user interface with a common interface for interpreting both FWD and GPR data, eliminating the complexities of respective backanalyses and yielding backcalculation results in a user-friendly, graphical environment. The study also resolves FWD testing by incorporating GopherCalc and improving the state-of-the-art developments in FWD backcalculation. Results of a completed GPR study are used to mitigate the impediments to GPR by increasing the accuracy of layer thickness estimates and relating the backcalculated electromagnetic wave properties. The study also highlights the effectiveness of the proposed multimodal (FWD-GPR) pavement assessment through a limited field study. Researchers provide a hands-on demonstration to county engineers promoting the use of the assessment.

Status: This project is in its initial stages of development.**Start Date:** TBD **Projected End Date:** TBD**MPR-1(004): Matrix Riprap Implementation****Funded by:** SP&R/SRP**Total Cost:** TBD **Paid to Date:** \$0**MN 2011 Commitment:** \$28,000**Performed by:** Ayers Associates **PI:** TBD**TL:** Nicole Danielson-Bartelt **AL:** Shirlee Sherkow

Description: Bridge scour causes material loss around bridge abutments and can result in the loss of the approach panel and bridge failure. Matrix riprap (also known as partially grouted riprap) is a relatively new scour countermeasure technique in the United States. Although construction specifications have been developed for use in Minnesota, implementation has been challenging because of the lack of expertise. In this project, the consultant trains MnDOT

personnel about the basic design and installation of matrix riprap on bridge abutments, and supervises its installation at a preselected bridge site in District 3. The consultant also provides technical guidance, a white paper/manual and comments that are used to revise the matrix riprap special provision and design details.

Status: This project is in its initial stages of development.**Start Date:** TBD **Projected End Date:** TBD**MPR-1(006): Guardrail, Cable Median and Concrete Barrier Inventory****Funded by:** SP&R/SPR**Total Cost:** TBD **Paid to Date:** \$0**MN 2011 Commitment:** \$140,000**Performed by:** TBD **PI:** TBD**TL:** Bruce Holdhusen **AL:** Bruce Holdhusen

Description: The objective of this project is to employ geographic information system-based asset data harvesting (feature extraction) software that will efficiently and accurately locate and process asset data from LiDAR (Light Detection and Ranging) and georeferenced photo images to obtain attributes for guardrail, high-tension cable median barrier and concrete barrier.

Status: This project is in its initial stages of development.**Start Date:** TBD **Projected End Date:** 12/31/2012**MPR-1(007): Commercial Freight Weight Enforcement Innovation****Funded by:** SP&R/SPR**Total Cost:** TBD **Paid to Date:** \$0**MN 2011 Commitment:** \$80,000**Performed by:** SFR Consulting Group**PI:** Brian Scott**TL:** Ben Timerson **AL:** Debra Fick

Description: This project demonstrates how technology enhancements can improve overweight vehicle enforcement at weigh-in-motion sites. The project also refines the state's existing classification algorithm to improve the accuracy of WIM data, thereby better measuring the tonnage of freight being shipped in Minnesota.

Status: This project is in its initial stages of development.**Start Date:** 9/22/2011 **Projected End Date:** 11/30/2012



MPR-1(008): Developing Performance Measures Using GPS Arterial Travel Time Data

Funded by: SP&R/SPR

Total Cost: TBD **Paid to Date:** \$0

MN 2011 Commitment: \$100,000

Performed by: Texas Transportation Institute (tentative)

PI: Shawn Turner (tentative)

TL: Paul Czech **AL:** Debra Fick

Description: The goals of this project are to develop and implement mobility-related performance measures for arterial roadways using private sector GPS speed data, similar to practices currently under way on the instrumented freeway system.

Status: This project is in its initial stages of development.

Start Date: TBD **Projected End Date:** TBD

MPR-1(009): High-Friction Epoxy/Aggregate Surface Treatment for Bridge Decks

Funded by: SP&R/SPR

Total Cost: TBD **Paid to Date:** \$0

MN 2011 Commitment: \$160,000

Performed by: TBD **PI:** TBD

TL: Clark Moe **AL:** Farideh Amiri

Description: In this investigation, researchers identify high-friction surface products that will provide good performance on Minnesota bridges and recommend a method for qualifying future products. This project implements earlier research on high-friction surface treatments conducted by the University of Minnesota, Duluth, which evaluated SafeLane product on Mitchell bridges in Duluth over a three-year period. The current evaluation includes three additional products on eight

more bridges statewide. Information is gathered through data collection and a survey of other DOTs and local agencies as well as feedback from MnDOT Bridge and Traffic Safety staff to identify any new and innovative materials and installation vehicles. Additional objectives of this project include using the results of the evaluation to select and apply epoxy and high-friction aggregate on bridges and ramps recommended by the Traffic and Bridge staff.

Status: This project is in its initial stages of development.

Start Date: TBD

Projected End Date: TBD

MPR-1(010): Vehicle-Mounted Robotic Roadway Message and Symbol Painter

Funded by: SP&R/SPR

Total Cost: TBD **Paid to Date:** \$0

MN 2011 Commitment: \$96,000

Performed by: University of Minnesota, Duluth

PI: Ryan Rosandich

TL: Randy Reznicek **AL:** Daniel Warzala

Description: Researchers have developed a computer-controlled, truck-mounted robotic message painter system that automates painting of pavement markings which currently require a stencil. The project enhances productivity and safety by replacing a two-person painting crew with a one-person operation, completing pavement markings more quickly and allowing the operator to remain inside the truck when markings are painted.

Status: This project is in its initial stages of development.

Start Date: TBD

Projected End Date: TBD



MPR-1(011): Annual Accessibility Measure for the Twin Cities Metro Region**Funded by:** SP&R/SRP**Total Cost:** TBD **Paid to Date:** \$0**MN 2011 Commitment:** \$48,000**Performed by:** University of Minnesota**PI:** David Levinson**TL:** Mark Nelson **AL:** Debra Fick

Description: This project develops an annual accessibility measure or series of measures for the Minneapolis-St. Paul metropolitan region based on the methods developed through research and implementation of data and models maintained by MnDOT and the Metropolitan Council. The measure tracks accessibility trends at both the regional and subregional level. Measures of accessibility are reported annually to MnDOT senior management, the legislature and the general public, providing decision makers with a more complete understanding of the impact of transportation investments and land use decisions.

Status: This project is in its initial stages of development.**Start Date:** 9/27/2011 **Projected End Date:** 11/30/2012**MPR-1(012): Statewide Cycloplan: Bicycle Planning Tool and Participatory GIS****Funded by:** SP&R/SRP**Total Cost:** \$130,000 **Paid to Date:** \$0**MN 2011 Commitment:** \$104,000**Performed by:** TBD **PI:** TBD**TL:** Greta Alquist **AL:** Shirlee Sherkow

Description: This project promotes the statewide implementation of Cycloplan, an innovative way to assist planners in creating a regional bikeways system map through coordination and input from various agencies and the public. Cycloplan lets planners keep a regional bikeways system map current and determine where additions and improvements to the system are most needed. Key features of Cycloplan include maintenance of a bikeways registry; communication of route closures, additions and upcoming projects that require input; and feedback from personalized geographic regions.

Status: This project is in its initial stages of development.**Start Date:** TBD **Projected End Date:** TBD**MPR-1(013): Use of Non-Woven Fabric Interlayer for Unbonded Concrete Overlays****Funded by:** SP&R/SRP**Total Cost:** TBD **Paid to Date:** \$0**MN 2011 Commitment:** \$60,000**Performed by:** University of Minnesota**PI:** Lev Khazanovich**TL:** Maureen Jensen **AL:** Daniel Warzala

Description: Use of unwoven fabrics as an interlayer for unbonded overlays has the potential to reduce the cost of this long-term fix. However, no long-term performance data are available. (The first construction was in 2008 in Missouri.) In this project, investigators conduct laboratory tests of UBOL to validate the performance and design parameters.

Status: This project is in its initial stages of development.**Start Date:** 9/1/2011 **Projected End Date:** 8/31/2012**MPR-1(014): Hand-held Thermographic Bridge Inspection Technology****Funded by:** SP&R/SPR**Total Cost:** TBD **Paid to Date:** \$0**MN 2011 Commitment:** \$44,000**Performed by:** TBD **PI:** TBD**TL:** Tom Styrbicki **AL:** Debra Fick

Description: The goal of this project is to implement the results of a pooled fund study (Field Testing Hand-held Thermographic Inspection Technologies, Phase II) as a component of the bridge safety inspection program. Objectives include obtaining thermal inspection equipment for advanced inspect techniques of the wear surface and underside of bridge decks; reducing the time, money and effort necessary to inspect a bridge deck for loose concrete; giving bridge maintenance personnel a tool to identify and prioritize delamination removals quickly and efficiently; and developing a technical manual and training seminar for bridge inspection and maintenance personnel.

Status: This project is in its initial stages of development.

Three thermal cameras have been purchased and were received at the end of June.

Start Date: TBD **Projected End Date:** TBD

MPR-1(015): LED Roadway Lighting**Funded by:** SP&R/SPR, Other State Funds**Total Cost:** TBD **Paid to Date:** \$0**MN 2011 Commitment:** \$20,000**Performed by:** TBD **PI:** TBD**TL:** Sue Zarling **AL:** Debra Fick

Description: Researchers evaluate the use of LED lighting luminaires in MnDOT roadway lighting. New LED roadway lighting luminaires replace existing high pressure sodium luminaires along a segment of highway. New HPS luminaires also replace adjacent existing HPS luminaires for a fair comparison. Researchers measure electrical power usage on circuits and light levels of the LED and HPS sections. Researchers create a cost comparison of the LED and HPS luminaires and document maintenance issues.

Status: This project is in its initial stages of development.**Start Date:** TBD **Projected End Date:** TBD**MPR-1(017): ARTS Technical Support and Maintenance Services****Funded by:** SP&R/SPR**Total Cost:** TBD **Paid to Date:** \$0**MN 2011 Commitment:** \$120,000**Performed by:** None listed**PI:** None listed**TL:** None listed **AL:** Ann McLellan

Description: This project covers expenses associated with managing and monitoring the Automated Research Tracking System. The primary goal is to provide technical support and maintenance of ARTS and provide training and knowledge transfer to Research Services staff.

Status: This project is in its initial stages of development.**Start Date:** TBD **Projected End Date:** TBD**MPR-1(018): SPR Program Administration Research and Contract Accounts****Funded by:** SP&R/SPR**Total Cost:** TBD **Paid to Date:** \$0**MN 2011 Commitment:** \$152,000**Performed by:** NA **PI:** NA**TL:** Linda Taylor **AL:** Ann McLellan

Description: This project covers expenses associated with managing, monitoring and implementing the State Planning and Research Program. It funds the salaries

for two positions and continues MPR-6(006). The overall goals are to support MnROAD, develop an annual implementation program and continue to ensure that all federal projects are administered in accordance with the federal authorization.

Status: N/A**Start Date:** 7/1/11**Projected End Date:** 6/30/12**Studies with No FY2011 Commitments****MPR-0(004): Scour Monitoring Technology Implementation****Funded by:** SP&R/SPR**Total Cost:** \$38,233 **Paid to Date:** \$2,045**Performed by:** University of Minnesota**PI:** Jeff Marr**TL:** Andrea Hendrickson **AL:** Shirlee Sherkow

Description: Bridge scour causes the loss of material around bridge foundations and can result in the bridge failure. Scour-critical bridges are monitored to identify when unacceptable scour is occurring. Two types of monitoring are available: portable and fixed. MnDOT currently uses only portable monitoring devices. In this project, researchers install fixed monitoring equipment at two bridge sites and analyze several device options for installation and performance.

Status: In 2011, researchers selected two bridges—TH14 over the Minnesota River and TH43 over the Mississippi River—for monitoring, and identified products and installation methods.

Start Date: 4/18/2011 **Projected End Date:** 5/31/2014**MPR-0(005): Bridge Deck Cracking TRS****Funded by:** SP&R/SPR**Total Cost:** \$5,000 **Paid to Date:** \$0**Performed by:** American Engineering Testing, Inc.**PI:** Dave Rettner**TL:** Ronald Mulvaney **AL:** Shirlee Sherkow

Description: In this implementation project, researchers conduct a statistical analysis of data collected from many bridge deck construction projects to identify the most important variable for controlling bridge deck cracking. Project activities include completion of a Transportation Research Synthesis summarizing the analysis.

Status: In 2011, the contractor completed a draft TRS.**Start Date:** 3/22/2011 **Projected End Date:** 11/30/2011



MPR-0(005): Analysis of Bridge Deck Cracking Data

Funded by: SP&R/SRP

Total Cost: \$45,599 **Paid to Date:** \$0

Performed by: American Engineering Testing, Inc.

PI: Dave Rettner

TL: Ronald Mulvaney **AL:** Shirlee Sherkow

Description: This study conducts a statistical analysis of data collected from more than 60 recent bridge deck construction projects to identify which construction controls, material properties or environmental characteristics most affect the cracking susceptibility of typical MnDOT concrete bridge deck mix designs. Conclusions of the data analysis and a set of recommendations are provided.

Status: All raw data were supplied to the contractor for review and analysis. The kickoff meeting was scheduled for September 2011.

Start Date: 5/25/2011 **Projected End Date:** 7/31/2012

MPR-6(003): Business Assessment of RSS Processes and Tools

Funded by: SP&R/SRP/Other State Funds

Total Cost: \$109,920 **Paid to Date:** \$74,970

Performed by: Trissential **PI:** Steve Beise

TL: Ann McLellen **AL:** Benjamin Worel

Description: Research Services has been redesigning the way it provides services. The primary goal of this project is to analyze and document the remaining business processes and detail all business flows.

Status: This task is ongoing, with contract work proceeding according to plan.

Start Date: 11/4/2009 **Projected End Date:** 12/31/2011

MPR-6(003): Strategic Program Development

Funded by: SP&R/SRP

Total Cost: \$50,000 **Paid to Date:** \$42,165

Performed by: David Johnson

PI: David Johnson

TL: Linda Taylor **AL:** Nelson Cruz

Description: This project involves working with Research Services to determine and document the workflows and handoff points for managing research contracts involving numerous roles and project phases to optimize the new Automated Research Tracking System database supporting Research Services activities.

Status: This work has been completed.

Start Date: 12/22/2009 **Projected End Date:** 3/31/2012

MPR-6(005): Next Generation of ARTS Tech Support and Maintenance Services

Funded by: SP&R/SRP/Other State Funds

Total Cost: \$122,540 **Paid to Date:** \$98,050

Performed by: ArchWing Innovations, LLC

PI: Ryan Anderson

TL: Nelson Cruz **AL:** Benjamin Worel

Description: The primary goals of this project are to provide technical support and maintenance services for three Web-based applications of the current Next Generation of ARTS. Project activities include training and knowledge transfer to MnDOT staff.

Status: This project is ongoing. The consultant will continue to troubleshoot any maintenance issues and make minor changes along with enhancements to the new ARTS program.

Start Date: 5/13/2009 **Projected End Date:** 4/30/2011

MPR-6(011): Intelligent Compaction

Funded by: SP&R/SRP/Other State Funds

Total Cost: \$225,000 **Paid to Date:** \$0

Performed by: The Trantec Group

PI: George Chang

TL: Glenn Engstrom **AL:** Clark Moe

Description: The purpose of this project is to implement intelligent compaction performance-based specifications in Minnesota.

Status: This project is ongoing.

Start Date: 9/13/2010 **Projected End Date:** 12/21/2011

MPR-6(012): Development of New Test Roller Equipment and Construction Specs for Subgrade Compaction Acceptance**Funded by:** SP&R/SRP**Total Cost:** \$253,300 **Paid to Date:** \$253,300**Performed by:** Minnesota State University, Mankato**PI:** Aaron Budge**TL:** Tim Anderson, Terrance Beaudry**AL:** Daniel Warzala

Description: This study's objective is to develop a more effective test roller system, including new specifications that improve the existing test roller specs and account for project variations (such as the type of subgrade or the thickness of the base material).

Status: A final Technical Advisory Panel meeting was held March 30 to review and provide comments on the following completed tasks: relating the test roller deflections to pavement deflections, validating the prototype and deflection formula, developing test roller construction specifications, and conducting field tests and shadow specifications. A report has been completed (2011-15: 92107 MPR-6(012): Development of New Test Roller Equipment and Construction Specifications for Subgrade Compaction Acceptance).

Start Date: 1/24/2008 **Projected End Date:** 6/30/2011**MPR-6(016): Construction Report for MnROAD Thin Unbonded Concrete Overlay Test Cell 5 (Sub-Cells 105-405)****Funded by:** SP&R, Other State Funds, Partnership Funds**Total Cost:** \$126,100 **Paid to Date:** \$0**Performed by:** MnDOT Office of Materials**PI:** Mark Watson**TL:** Bernard Izevbekhai **AL:** Bruce Holdhusen

Description: The primary objective of this research study is to develop better distress and life prediction models for thin unbonded concrete overlays over older concrete pavements. Secondary objectives include understanding the behavior of these overlays with regard to maturity, slab warp and curl thermal expansion; developing repair techniques; and resurfacing mainline test cell 5 of MnROAD Phase I with a 1-inch drainable stress relief layer and concrete overlays of 4 to 5 inches.

Status: No tasks were completed from January through June 2011.

Start Date: 12/29/2008 **Projected End Date:** 2/28/2014**MPR-6(019): Technology Transfer Material Development****Funded by:** SP&R/SRP**Total Cost:** \$99,825 **Paid to Date:** \$99,791**Performed by:** CTC & Associates LLC **PI:** Patrick Casey**TL:** Linda Taylor**AL:** Sandra McCully

Description: The goals of this project are to develop outreach materials that market Research Services and Local Road Research Board products and services, and to distribute these materials to current and potential customers.

Status: In 2011, the contractor delivered Technical Summaries to complete all work on this project.

Start Date: 9/17/2010 **Projected End Date:** 9/30/2011**MPR-6(019): Technology Transfer Material Development—2011 Annual Reporting****Funded by:** SP&R/SRP**Total Cost:** \$35,102 **Paid to Date:** \$3,392**Performed by:** CTC & Associates LLC **PI:** Patrick Casey**TL:** Linda Taylor**AL:** Sandra McCully

Description: The goals of this project are to develop outreach materials that market Research Services and Local Road Research Board products and services, and to distribute these materials to current and potential customers.

Status: Planning meetings were held during the first half of 2011 for this half-year report.

Start Date: 4/28/2011 **Projected End Date:** 3/31/2012**MPR-6(019): Technology Transfer Material Development****Funded by:** SP&R/SRP**Total Cost:** \$99,973 **Paid to Date:** \$26,499**Performed by:** CTC & Associates LLC **PI:** Patrick Casey**TL:** Linda Taylor**AL:** Sandra McCully

Description: The goals of this project are to develop outreach materials that market Research Services and Local Road Research Board products and services, and to distribute these materials to current and potential customers.

Status: Technical Summaries were developed for this half-year report.

Start Date: 4/29/2011 **Projected End Date:** 3/31/2012

MPR-6(021): Evaluation of Skid Resistance of Turf Drag Textured Concrete Pavements**Funded by:** SP&R**Total Cost:** \$100,882 **Paid to Date:** \$0**Performed by:** MnDOT Office of Materials**PI:** Bernard Izevbekhai**TL:** Benjamin Worel **AL:** Bruce Holdhusen

Description: This study focuses on fundamental pavement surface characteristics, including ride quality, friction, hydroplaning potential, splash and spray, texture and noise. Various texturing configurations in the MnROAD Low Volume Road and the mainline are used, but comparative analysis may introduce data from cells or test sections outside of MnROAD. The study observes the progression of these variables with time and the function of their interdependency within a five-year period.

Status: The contractor completed a draft interim report for Robotex and EFR data collection and measurements.

Start Date: 12/19/2008 **Projected End Date:** 1/1/2013**MPR-6(022): INV 864: Recycled Asphalt Pavements****Funded by:** SP&R/LRRB/Other State Funds**Total Cost:** \$275,000 **Paid to Date:** \$25,000**Performed by:** MnDOT Office of Materials**PI:** Eddie Johnson**TL:** Greg Johnson **AL:** Bruce Holdhusen

Description: In this project, researchers study the performance of recycled asphalt pavement under controlled testing conditions. The asphalt concrete test sections have similar structural designs and contain 30 percent RAP but vary by binder grade and fractionated RAP content. In 2009 three new mix designs were added: warm mix with RAP, Superpave with no RAP and Superpave with 20 percent RAP.

Status: During a Technical Advisory Panel meeting January 5, the TAP approved the following study tasks: construction of test sections and a combined year one and year two annual report.

Start Date: 1/4/2008 **Projected End Date:** 12/31/2012**MPR-6(029): INV 868: HMA Surface Characteristics****Funded by:** LRRB/SP&R/Other State Funds**Total Cost:** \$326,632 **Paid to Date:** \$84,625**Performed by:** MnDOT Office of Materials**PI:** Timothy Clyne**TL:** Greg Johnson **AL:** Bruce Holdhusen

Description: This study focuses on key pavement surface characteristics like noise and friction while also studying their relationship to ride quality, texture and mixture durability. Researchers conduct statistical pass-by noise monitoring and data analysis to make relative comparisons of pavement surfaces on the Interstate test sections at the MnROAD.

Status: Researchers performed seasonal monitoring of several HMA pavements with various surfaces. Testing included noise (OBSI and sound absorption), texture (circular texture meter), friction (skid truck and dynamic friction tester), permeability, ride quality (LISA and Pathways) and durability (distress surveys and ALPS rutting). Trends are starting to emerge with the data over various seasons and over time. In January, the PI attended several presentations and meetings related to HMA surface characteristics at the Transportation Research Board Annual Meeting in Washington, D.C.

Start Date: 9/18/2007 **Projected End Date:** 6/30/2013**MPR-6(031): Concrete Pavement Optimization: Determining the Lower Threshold of Slab Thickness for High Volume Roadways****Funded by:** SP&R/Other State Funds**Total Cost:** \$126,100 **Paid to Date:** \$0**Performed by:** MnDOT Office of Materials**PI:** Thomas Burnham**TL:** Bernard Izevbekhai **AL:** Bruce Holdhusen

Description: The goal of this project is to develop better distress and life prediction models for more optimized (thinner) concrete pavements. Secondary objectives include understanding the behavior of these pavements with regard to maturity, slab warp and curl, thermal expansion and repair techniques. Researchers conduct seasonal load response testing and monitor the field performance of an instrumented variable thickness concrete pavement test cell.

Status: This project is ongoing; reporting will begin when a pavement fails. Seasonal monitoring and performance reporting will take place each year.

Start Date: 1/3/2008 **Projected End Date:** 7/31/2014

MPR-6(033): TRACS Research and Implementation Project**Funded by:** SP&R/SRP/Other State Funds**Total Cost:** \$350,000 **Paid to Date:** \$336,235**Performed by:** Project Information Services **PI:** L. Tim Malagon**TL:** Thomas Wiener **AL:** Clark Moe

Description: In this project, researchers evaluate available construction project management software with a focus on the Transportation Automated Control System software. Stakeholder interviews identify barriers to the software's implementation and use. Secondary objectives include conducting a detailed review of the software and its capabilities, and developing and delivering training and presentations to MnDOT and state industry groups.

Status: Researchers completed all tasks; the project has been closed.

Start Date: 3/12/2008 **Projected End Date:** 6/30/2011**MPR-6(033): Construction Project Management Software Evaluations****Funded by:** SP&R/SRP/Other State Funds**Total Cost:** \$190,932 **Paid to Date:** \$53,432**Performed by:** Minnesota State University, Mankato**PI:** Brian Wasserman**TL:** Thomas Wiener **AL:** Farideh Amiri

Description: The objectives of this work are to evaluate and improve the Transportation Automated Control System, which will streamline field inspectors' documentation and payment processes on large, complex transportation construction projects. Training on proper use of TRACS is also included.

Status: No tasks were completed from January through June 2011.

Start Date: 9/24/2008 **Projected End Date:** 4/30/2012**MPR-8(002): Vehicle Telematics for Novice Teenage Driver Support System—Smartphone Based Novice Teenage Driver Support****Funded by:** SP&R/SRP**Total Cost:** \$500,000 **Paid to Date:** \$500,000**Performed by:** University of Minnesota**PI:** Max Donath**TL:** Susan Sheehan **AL:** Daniel Warzala

Description: This project provides a Teenage Driver Support System demonstration based on smartphone technology

that prevents vehicle operation when alcohol is detected or seat belts are unfastened. Various on-board technologies communicate with in-vehicle subsystems to provide real-time feedback to teen drivers about unsafe or illegal activities such as speeding and stop sign noncompliance. **Status:** Researchers developed a conceptual model of the revised GDL program in which the TDSS can be integrated to provide motivation and utility for teens, parents and licensing agencies. The final report was also completed (2011-13: 89261 WO115 MPR-8(002): Usability Evaluation of a Smartphone-Based Novice Teen Driver Support System (TDSS), available at <http://www.dot.state.mn.us/research/TS/2011/201113.pdf>). A Technical Summary of this report is available at <http://www.dot.state.mn.us/research/TS/2011/201113TS.pdf>.

Start Date: 12/9/2008 **Projected End Date:** 5/31/2011**MPR-8(004): Development of a Concrete Maturity Test Protocol****Funded by:** SP&R/SRP**Total Cost:** \$113,952 **Paid to Date:** \$61,944**Performed by:** Minnesota State University, Mankato**PI:** W. James Wilde**TL:** Alexandra Akkari **AL:** Sandy McCully

Description: The objective of this project is to develop strength-maturity relationships in concrete that allow contractors, field personnel and materials engineers to estimate the strength of high-pozzolan/SCM and low-w/c concrete pavement mixes in the field, with reduced sampling and testing of concrete. Specific goals are to test strength-maturity relationships in the laboratory, develop a standard test method for maturity testing and reduced physical testing in the field, and establish field strength-maturity relationships.

Status: Researchers conducted field validation for year one goals and developed a procedure for the sensor placement and specimen preparation for field sites. They also developed a lab testing plan and matrix for establishing strength-maturity curves.

Start Date: 4/2/2009 **Projected End Date:** 9/30/2012

MPR-9(001): Stabilized Full Depth Reclamation (SFDR) Implementation

Funded by: SP&R/SRP

Total Cost: \$50,111 **Paid to Date:** \$50,111

Performed by: American Engineering Testing, Inc.

PI: Dave Rettner

TL: Steven Adamsky, Gerard Geib **AL:** Clark Moe

Description: In this study, two mix designs are generated for full depth reclamation projects constructed in 2010. These designs use three asphalt emulsions and, if successful, aid in the standardization of MnDOT's FDR procedures.

Status: This project is complete. Researchers developed three FDR mix designs, meeting the requirement of 2331-FDRE for TH65 in District 3. Researchers also performed quality assurance testing on the FDRE project to be constructed on TH55 in District 4.

Start Date: 9/18/2009 **Projected End Date:** 2/28/2011

MPR-9(002): Concrete Bridge Deck Crack Sealant Evaluation and Implementation

Funded by: SP&R/SRP

Total Cost: \$80,918 **Paid to Date:** \$16,672

Performed by: Braun Intertec Corporation

PI: Mathew Oman

TL: Edward Lutgen **AL:** Daniel Warzala

Description: This study examines the performance of the best candidate crack-repair materials in MnDOT bridges. The scope of work includes field testing, evaluation of crack sealant products, depth of penetration, product effectiveness and performance validation. Objectives include creating a best practices manual for MnDOT practitioners.

Status: During a Technical Advisory Panel meeting in April, the group discussed issues such as additional coring and evaluation, product comparisons of materials currently installed on other bridge decks and product testing record keeping. Eleven crack repair products were field-applied to test sections on a bridge in September 2011.

Start Date: 9/30/2009 **Projected End Date:** 3/31/2013

MPR-9(004): Load and Resistance Factor Design (LRFD) Pile Driving Static Load Test Data Collection (LRFD Implementation)

Funded by: SP&R/SRP

Total Cost: \$99,750 **Paid to Date:** \$50,710

Performed by: American Engineering Testing, Inc.

PI: Gregory Reuter

TL: Derrick Dasenbrock **AL:** Bruce Holdhusen

Description: Several states, including Minnesota, have recently completed research to develop new pile design formulas using the LRFD mandated by AASHTO. The objective of this project is to collect Minnesota static load test data and PDA/CAPWAP data for calibrating the LRFD model.

Status: This contract was finalized in January. Work began on the 500-ton load frame and associated designs for the frame, frame fabrication and standard plan development as well as the eventual SLT testing and PDA/CAPWAP work on the inaugural use of the 500-ton frame.

Start Date: 1/21/2011 **Projected End Date:** 1/31/2012

MPR-9(005): Changeable Message Signs (CMS)/Digital Message Signs (DMS) Manual of Practice Development, Implementation and Training

Funded by: SP&R/SRP

Total Cost: \$96,302 **Paid to Date:** \$38,553

Performed by: Iteris, Inc.

PI: Robb Luckow

TL: Jesse Larson **AL:** Alan Rindels

Description: This project focuses on developing a document similar to other states (such as Texas and California) that contains experience and guidance for RTMC, Construction and Maintenance staff about proper messaging for changeable message signs (permanent and temporary). The goal of this messaging is to provide traveler information without negatively impacting freeway traffic or work zone and driver safety (causing people to slow down to read the message).

Status: A Technical Advisory Panel meeting was held in February. Researchers conducted a literature search for CMS guidelines and interviewed MnDOT staff and other state and regional stakeholders about CMS practices.

Start Date: 11/3/2010 **Projected End Date:** 11/30/2012

MPR-9(006): Research Implementation of the SMART Signal System on TH13

Funded by: SP&R/SRP

Total Cost: \$239,000 **Paid to Date:** \$55,000

Performed by: University of Minnesota

PI: Henry Liu

TL: Steven Misgen **AL:** Alan Rindels

Description: The SMART-Signal (Systematic Monitoring of Arterial Road Traffic and Signals) system generates both intersection and arterial performance measures in real time. At single intersection level, SMART-Signal can monitor the maximum queue length, intersection delay and level of service. At arterial level, it can report travel time, speed and average number of stops. The objectives of this project are to design hardware for the TS-2 controller cabinet using Bus Interface Unit connection and user-friendly graphical interface for system installation and day-to-day traffic management, and to test the redesigned system hardware and software on TH13 at 14 intersections between Yankee Doodle Road and TH101.

Status: From January through June 2011, researchers redesigned the field data collection units for the TS-2 controller cabinet. Eighteen data collection units were tested in the lab; field testing is also under way. A Technical Advisory Panel meeting was held February 3. This project is roughly six to 12 months behind schedule because the redesign of the field device took significantly longer than expected.

Start Date: 12/17/2009 **Projected End Date:** 2/2/2012

LAB 878: Porous Asphalt Pavement Performance in Cold Regions

Funded by: SP&R/LRRB/Other State Funds

Total Cost: \$71,000 **Paid to Date:** \$22,400

Performed by: MnDOT Office of Materials

PI: Mathew Lebens

TL: Larry Matsumoto **AL:** Bruce Holdhusen

Description: The objectives of this research are to evaluate the durability, hydrologic characteristics and environmental effects of porous asphalt pavement when used on a low-volume roadway in a cold climate. Additional activities include documenting appropriate construction and maintenance procedures.

Status: A Technical Advisory Panel meeting was held February 1 during which preliminary water sample results

were presented. Deliverables for Task 5, Pavement and Environmental Monitoring and Maintenance, will not be finalized until data collection is completed next summer. The midpoint hydrological and environmental report was finalized in June.

Start Date: 7/26/2007 **Projected End Date:** 4/30/2012

INV 879 MPR-6(027): Drainable Pavements at MnROAD Pervious Concrete and Porous Concrete Overlay Cells 39, 85, and 89

Funded by: SP&R/LRRB/Other State Funds

Total Cost: \$46,000 **Paid to Date:** \$39,000

Performed by: MnDOT Office of Materials

PI: Bernard Izevbekhai

TL: Mark Maloney **AL:** Bruce Holdhusen

Description: The reduction of pervious surfaces is a concern for the construction of bound pavement surfacing. Some cities in the Minneapolis-St. Paul metropolitan area have been forced to improvise methods of minimizing stormwater intrusion from developments that are in proximity to wetlands. Runoff from these surfaces has been known to distort the thermal balance of streams when extreme temperatures precede heavy rain. Various groups have worked at solving this problem. While the understanding of this problem and solutions is rudimentary, MnDOT is collaborating with the Aggregate and Ready Mix Association of Minnesota, a group that provides leadership in technology.

Status: The final report for this project has been submitted.

Start Date: 7/30/2007 **Projected End Date:** 9/30/2011



January through June 2011 Technical Summaries

Introduction

These project summaries, organized by topic area, were produced by Research Services with the help of participants on the projects described. They have been created for technology transfer purposes. You can access and download any of these Technical Summaries at <http://www.dot.state.mn.us/research/2011-technical-summaries.html>. Additional 2011 summaries covering research performed in 2011 will be posted at this site on an ongoing basis. Summaries completed in early 2011 on 2010 reports can be found at <http://www.dot.state.mn.us/research/2010-technical-summaries.html>.

You can use these summaries as handouts at conferences, mailings to staff in areas that should be made aware of this research, information sheets for legislators or simply as quick-reference sheets.

For more information about any of these projects, contact the Administrative or Technical Liaison indicated on the summary. For more information about Technical Summaries, please contact Sandy McCully at Sandra.Mccully@state.mn.us.





RESEARCH SERVICES

OFFICE OF POLICY ANALYSIS,
RESEARCH & INNOVATION

TECHNICAL SUMMARY

Technical Liaison:

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Administrative Liaison:

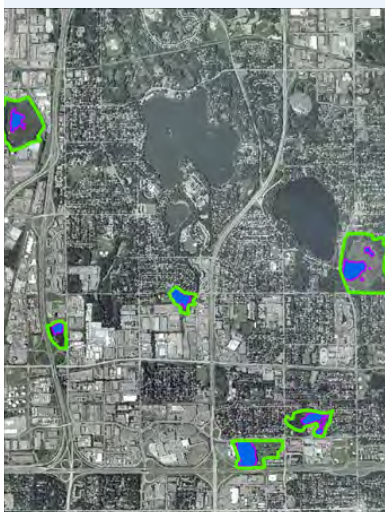
Shirlee Sherkow, Mn/DOT
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Principal Investigator:

John Nieber, University of Minnesota

PROJECT COST:

\$158,872



Researchers used geographic information systems software to map Twin Cities metro area wetlands and buffers.

Protecting Urban Wetlands with Buffer Zones

What Was the Need?

Mn/DOT has long recognized the importance of preserving and protecting the state's many wetlands. These marshes, swamps and bogs provide habitat to a wide diversity of plants and animals that could not otherwise thrive. Sustaining this ecosystem requires a minimum water quality, which is influenced by the runoff from upland areas. Runoff that contains sediments and chemicals from human activities such as farming, forestry and land development can negatively affect wetland ecosystems and reduce biodiversity.

Minnesota's [Wetland Conservation Act](#) requires that replacement wetlands of less than two acres be surrounded by a buffer zone at least 25 feet wide with no road, structures or other human activity. For all other replacement wetlands, the buffer has an average width of 50 feet with a minimum of 25 feet. These buffers help protect wetlands by filtering sediments and toxins out of the water running toward them, promoting the retention of nutrients in the soil, sheltering plants and animals from direct contact with adjacent human activities, and providing connectivity between the wetland and migratory destinations such as breeding grounds.

Research was needed to validate this minimum buffer width and to confirm whether width was an appropriate criterion for assessing how well buffers protect wetlands. Other potentially important criteria include vegetation, soil composition, land slope and surrounding land use.

What Was Our Goal?

The goal of this project was to evaluate the effect of buffer size and other characteristics on the ecological diversity and water quality of wetlands.

What Did We Do?

Researchers began by compiling a database with information about 64 wetlands in the Twin Cities metro area. Data included information on each wetland's size and type, levels of human disturbance and adjacent land use, water quality and chemistry, and Index of Biological Integrity scores for both plants and animals. These IBI scores represent the health of biological communities and the degree to which they have been impaired by human activities; IBI measures the abundance and variety of those plants and animals most sensitive to pollution.

Researchers then updated this database with topographical information to determine the characteristics of buffer zones adjacent to the wetlands, including the area of the contributing watershed, soil composition and hydrology, land slope, land use and buffer width in each direction from the wetland. This information was acquired using both aerial photographs and geographic information systems.

Researchers conducted a statistical analysis of the compiled data to ascertain any relationships between buffer characteristics, IBI scores and water quality. Statistical methods included linear regression, multidimensional scaling, recursive partitioning and clustering.

Using the assessment tool developed in this project, researchers can design buffers to meet the needs of a specific wetland, helping to save costs by avoiding efforts and land use that would not be effective in the given circumstances.

continued

"This project gave us a good sense of what data we'll need to collect going forward to conduct a more comprehensive analysis of wetland buffers."

—Kenneth Graeve,
Botanist/Plant Ecologist,
Mn/DOT Office of
Environmental Services

"We developed a tool that should be very useful to agencies wishing to assess the impact of an existing or planned buffer on water quality and wildlife."

—John Nieber,
Professor, University of
Minnesota Bioproducts
and Biosystems
Engineering

Produced by CTC & Associates for:

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Buffers are limited in their ability to provide undisturbed connectivity to adjacent habitats in urban areas because of roads, houses and other developments, and do little to address the mortality of certain wildlife species at road crossings.

Finally, the Minnesota wetland buffer assessment tool was developed for evaluating the potential benefits of wetland buffers to water quality and wildlife when planning future Mn/DOT projects. This tool was applied to a subset of the wetlands studied through this project to show how it might work.

What Did We Learn?

Researchers did not find a statistically significant relationship between buffer characteristics and wetland water quality or ecological health. They concluded that establishing this relationship will require a larger data set with more detailed information on water level, water quality and ecological factors.

Researchers developed the Minnesota wetland buffer assessment tool, which uses a number of criteria (developed through a literature search) for rating how well buffers protect wetlands, including:

- Buffer width and area.
- The ability of the buffer to reduce stormwater volume and remove sediments, nitrogen and phosphorus from water flowing through it.
- Connectivity to adjacent habitats, measured by the amount of human disturbance within 500 meters of the wetland and the percentage of the wetland connected to upland areas.
- Vegetative characteristics, including diversity and the ability to provide cover to wildlife with benefits for such life functions as reproduction, feeding and migration.

This tool may be useful in designing buffers to meet a particular wetland's specific wildlife and water needs. Its analyses in this study showed that while many metropolitan area wetland buffers are effective for increasing water quality, they probably have few benefits to wildlife. For the protection of wildlife, connectivity to adjacent habitats is a far more important factor than buffer width.

What's Next?

The assessment tool still needs to be field-tested to evaluate its ability to predict the effects of any given buffer on habitat and water quality. Researchers recommend that Mn/DOT and other state and local agencies develop programs to more consistently and intensively monitor wetlands for water levels, water quality and biological diversity. Doing so will allow future studies to more definitively establish the effect of buffer width and other characteristics on wetlands.

This Technical Summary pertains to Report 2011-06, "Evaluation of Buffer Width on Hydrologic Function, Water Quality, and Ecological Integrity of Wetlands," published February 2011. The full report can be accessed at <http://www.lrrb.org/PDF/201106.pdf>.



TECHNICAL SUMMARY

Technical Liaison:

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Principal Investigator:

Diwakar Gupta, University of Minnesota

LRRB COST:
\$45,000



The Workforce Deployment Tool is designed to limit “dead time” on the road by optimizing operators’ routes and schedules given particular conditions.



RESEARCH SERVICES

OFFICE OF POLICY ANALYSIS,
RESEARCH & INNOVATION

Optimal Workforce Planning and Shift Scheduling for Snow and Ice Removal

What Was the Need?

Cities and counties fighting winter storms must contend with shrinking budgets, smaller workforces, and high equipment and fuel costs while keeping Minnesota’s roads safe for winter travelers. In the face of these challenges, agencies are eager to find ways to increase the efficiency of winter operations.

Winter maintenance managers juggle multiple, and sometimes competing, factors when deploying snowplow operators to fight a winter storm. Limited resources, work rules, overtime costs and the uncertainty of storm conditions may all affect how and where operators are deployed.

Decision support tools that aid in the flexible deployment of a snowplow fleet and its operators can lead to a more uniform approach to snow and ice removal, improve services and lower costs. Tracking and measuring the effects of how snowplow operators are deployed also provide data for state and county administrators to support recommendations for cost-effective crew hiring and retention plans.

What Was Our Goal?

The objective of this research was to develop a decision support tool to determine the optimal-size snow removal crew to employ given information about weather conditions, service level objectives, regular and overtime wages, and other agency characteristics. The system would recommend plowing routes and priorities among road segments.

What Did We Do?

St. Louis County in northeastern Minnesota served as the test case for data analysis, model development and creation of the decision support tool.

Researchers began by gathering data to populate a software-based model that generates recommended plow routes and deployments. They developed five typical storm scenarios to test this model by combining weather data and snowplow operator logs. The most frequently occurring storm type based on weather data produces about 2.5 inches of snow, lasts six hours and occurs when the pavement temperature is just below freezing.

Other data inputs for the model include average annual daily traffic (AADT) counts, sand and salt application rates, available crew size, hourly wage rates, earliest start time, maximum work time without a break, average snowplow speeds and road surface type.

Researchers also built a snowplow route network that groups road segments based on road type, AADT counts or road length. Each group within the network represents a single pass of the plow that can be plowed and sanded with a single payload of material.

What Did We Learn?

Using the algorithms and models developed in this project, researchers created the Workforce Deployment Tool and tested it using data from St. Louis County’s snow and ice removal program. Within six months, cost savings were achieved with reduced use of deicing chemicals.

The Workforce Deployment Tool, which uses historical storm patterns and data about an agency’s snow removal operations to determine crew size and plowing routes, enabled immediate savings in St. Louis County by helping to reduce overtime costs and the amount of deicing chemicals used.

continued

“As budgets tighten and operating costs rise, it becomes more difficult to provide the same level of service the public expects. By recommending more effective use of limited resources, the Workforce Deployment Tool will help us meet that challenge.”

—Ronald Garden,
Deputy Public Works
Director, St. Louis County

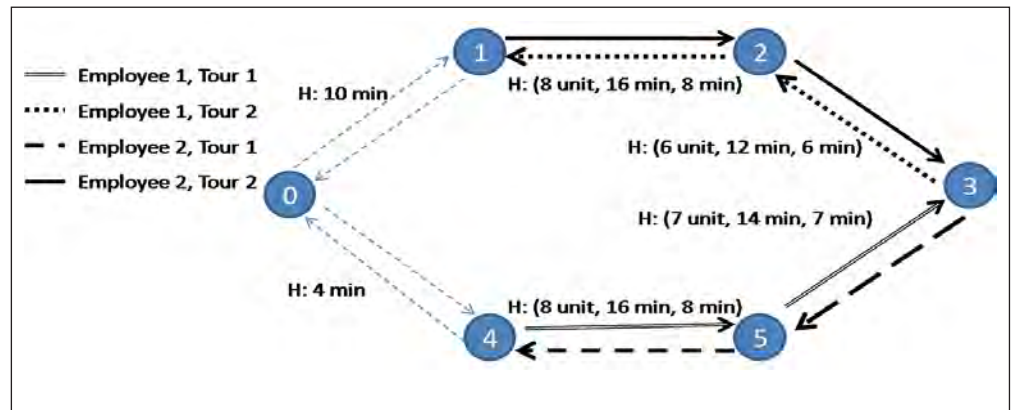
“Using historical storm patterns and data about an agency’s snow removal operations, the Workforce Deployment Tool determines the optimal crew size based on estimates of the plowing time needed to meet an agency’s level of service goals.”

—Diwakar Gupta,
Professor, University of
Minnesota Department
of Mechanical
Engineering

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This graphic shows a road network with eight road segments that need to be plowed during a high-intensity storm. Circled numbers are the end points of the road segments, with 0 denoting the depot. Data in parentheses are the sand/salt requirements, active travel time and inactive travel time, respectively. The values next to the dashed road segments correspond to travel times to and from the depot.

The interactive software program assumes a goal of clearing roads by St. Louis County within 24 hours after snowfall ends. Data on weather conditions and an agency’s staff, equipment, work rules and levels of service are used to generate recommendations for:

- The number of operators needed at each depot three to four hours in advance of actual deployment. Plow route assignments can be reorganized to balance workload at each depot.
- Start and end times for plowing. The software program balances the cost of overtime and delaying plow start times to recommend how much plowing should be done in overtime mode and how much should be delayed to the start of the next day’s regular shift.
- Fixed routes that should be plowed first.
-

An optimal number of employees and the range of possible extra plowing costs over 10 years of storms.

The tool also compares three strategies for deploying the available workforce: contract employees, split shifts and staggered shifts. The program calculates the optimal number of employees for each strategy and identifies the most flexible and cost-effective solution.

What’s Next?

St. Louis County will begin using the Workforce Deployment Tool during the 2011-2012 winter season and expects to recoup the cost of this study within that season by making more efficient use of operators, equipment and materials. The decision support tool is also expected to result in a more uniform response to storms by the county’s four maintenance districts that manage road networks with significant variations in traffic volume. Over time, the county may provide training and make the Workforce Deployment Tool available to all 17 maintenance reporting sites in the county.

This Technical Summary pertains to LRRB-produced Report 2011-03, “Optimal Workforce Planning and Shift Scheduling for Snow and Ice Removal,” published December 2010. The full report can be accessed at <http://www.lrrb.org/PDF/201103.pdf>.



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Lev Khazanovich, University of Minnesota

LRRB PROJECT COST:

\$126,042



The TONN program processes falling weight deflectometer results, which can be used to evaluate pavement stiffness.



RESEARCH SERVICES

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Allowable Axle Loads on Pavements

What Was the Need?

One measure of the durability of a road is the degree to which its pavement sections bend under a given load. These deflections can be an indication of both the strength and stiffness of the layers composing the pavement. A falling weight deflectometer, or FWD, is often used to measure these deflections by dropping a large weight onto a pavement and recording its consequent deformation.

Minnesota currently interprets FWD measurements of asphalt pavements on low-volume roads using a computer program called TONN (referring to the tonnage pressing down on a pavement). This software processes deflection measurements to determine whether a pavement section—given its thickness and expected traffic—is stiff enough to carry vehicles up to a certain weight per axle, or axle load, without incurring undue amounts of damage.

However, the TONN program uses a simple and outdated method to correlate FWD displacements and stiffness, accounting only for the properties of the top pavement layer. Since FWD deflections are greatly affected by the stiffness of the subgrade layers of soil and rock that support the top asphalt layer, TONN may underestimate the allowable axle load for soft clay subgrades but overestimate it for stiff sand or granular subgrades. These errors can lead either to the overdesign of pavements and unnecessary construction costs, or to underdesign and subsequent rehabilitation costs. Research was needed to update the TONN program in light of more current and accurate methods for interpreting FWD measurements.

What Was Our Goal?

The goal of this project was to improve the accuracy of Mn/DOT's existing program for estimating axle load capacities on Minnesota low-volume roads by taking into account the stresses on pavement subgrade layers and incorporating mechanistic-empirical design to predict the resulting damage.

What Did We Do?

Researchers developed an update to TONN called TONN2010. Where TONN relies on a less rigorous empirical system using performance data collected by AASHTO-sponsored road tests in the 1950s to correlate deflections and stiffness, TONN2010 incorporates mechanistic-empirical design, which uses a pavement's materials, structure, expected traffic and surrounding environment to predict pavement performance.

Researchers then calibrated TONN2010 by comparing its analyses of FWD measurements performed on two sections of MnROAD's low-volume road to the observed performance of these sections over three years. They further evaluated TONN2010 by applying it to 8,400 deflection measurements taken in nine Minnesota counties and comparing its results to those of TONN.

What Did We Learn?

Calibration and evaluation of TONN2010 showed it to be more conservative and accurate than TONN for the majority of analyzed FWD data. TONN2010, delivered as a FORTRAN-based program that can be run in an MS-DOS environment, is simple and easy

Investigators developed a more accurate software program for estimating pavement axle load capacities on Minnesota low-volume roads. It is expected to be widely used and will save money by avoiding the over- and underdesign of Minnesota roads.

continued

“This is one of the most important research projects with which I’ve been involved, and a big step forward in giving us a more accurate assessment of pavement load capacities.”

—Jerry Geib,
Research Project
Engineer, Mn/DOT
Office of Materials & Road
Research

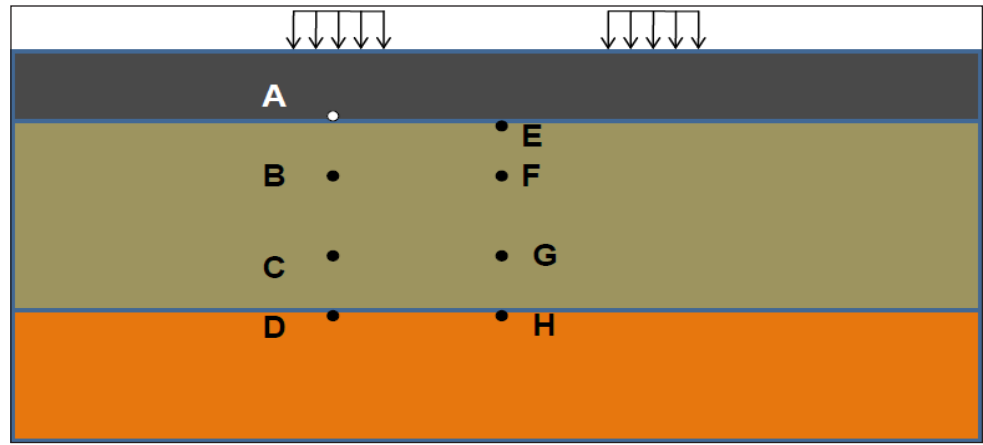
“TONN2010 will save costs by helping to avoid unnecessary construction and rehabilitation costs associated with over- or underdesigning pavements.”

—Lev Khazanovich,
Associate Professor,
University of Minnesota
Department of Civil
Engineering

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This diagram shows the eight points across three layers of a pavement whose structural responses to loads are used by TONN2010 to calculate pavement stiffness. The previous program only took into account deflections in the asphalt layer.

to use; it is expected to be widely used by local agencies, Mn/DOT staff and consulting engineers. Its calculations are based on a wider range of inputs than TONN, including pavement layer thickness, FWD deflections, air temperature, pavement surface temperature, pavement location and anticipated traffic. Using these inputs, TONN2010:

- Back-calculates resilient modulus (a measure of stiffness) from FWD deflection measurements. This is accomplished by iteratively determining which resilient modulus value is calculated to yield the measured FWD deflections in an identical pavement receiving the same load.
- Adjusts resilient modulus calculations based on season and temperature at the time of testing using factors developed within MnPAVE, the version of the mechanistic-empirical design procedure calibrated for Minnesota low-volume roads.
- Derives from adjusted resilient modulus values the stresses and strains at various points in the pavement base layer using MnLAYER, a layered elastic theory analysis tool developed at the University of Minnesota that simulates flexible pavement responses to loading.
- Derives from MnLAYER results the anticipated pavement damage caused by a vehicle axle of a given weight, including asphalt layer cracking, subgrade rutting, base shear failure and base deformation. If this anticipated damage is greater than the damage expected at the end of the pavement’s design life, then either rehabilitation should be required before this point or vehicle axle weights should be restricted, especially during seasons when the damage would be greatest.

What’s Next?

Researchers will soon be developing a graphical user interface for TONN2010. Additional testing is needed to verify TONN2010 predictions for a wide range of pavement structures and site conditions by comparing TONN2010 ratings with actual pavement performance. The program can be recalibrated as necessary based on these results to improve its predictions.

This Technical Summary pertains to the LRRB-produced Report 2011-02, “Allowable Axle Loads on Pavements,” published December 2010. The full report can be accessed at <http://www.lrrb.org/PDF/201102.pdf>.



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TASK COST:

\$5,000



The ultimate grind was developed to improve the friction of the innovative grind by using wider, corrugated fins.

Creating Quieter Pavements Without Compromising Friction

What Was the Need?

To ensure that concrete pavements exhibit sufficient friction and skid resistance, these pavements are textured during construction; this commonly involves dragging an inverted turf or stiff-bristled broom across the surface, creating tines (grooves) in the concrete using a mechanical rake, or brushing away some of the mortar before it hardens to expose the texture of the aggregate. These textures wear away over time, requiring pavement rehabilitation.

To create a long-lasting texture, some agencies require grinding a pavement's surface immediately after paving and curing. The grinding texture is selected based on the resulting pavement's skid resistance, ride quality and level of tire-pavement noise. A common texture is the diamond grind, which uses closely spaced, diamond-coated saw blades to cut longitudinal grooves that yield less noise than lateral grooves.

Purdue University's Institute for Safe, Quiet, and Durable Highways conducted research to optimize diamond grinding and found that pavements could be made quieter by widening grooves and creating a smoother profile for fins, which are the peaks along-side grooves. Because this innovative grind results in less friction than the conventional diamond grind, Purdue also developed an alternative called the ultimate grind, which enhances the friction of the innovative grind by adding corrugations to even wider fins. Further research was needed to verify the friction and noise characteristics of these textures on full-scale tests in the field.

What Was Our Goal?

This study aimed to verify the constructability of Purdue's quiet configuration and to further optimize it with regard to noise, friction, ride quality and texture depth.

What Did We Do?

Field tests were performed at Minnesota's [MnROAD pavement research facility](#). Researchers prepared 500-foot-long test cells with the following textures:

- The conventional grind, using 0.125-inch wide blades spaced 0.12 inches apart.
- The innovative grind, in which fins are made wider by spacing saw blades farther apart and made flush by shaving a thin layer off the top of the pavement.
- The ultimate grind, which modifies the innovative grind by making fins even wider and corrugating them with an additional pass by grinding machinery.

Researchers began by grinding and evaluating proof-of-concept test strips on cell 37 of MnROAD's low-volume road, a 2.5-mile loop with traffic restricted to MnROAD-operated vehicles. Researchers then conducted full-width grinding of each texture on cells 7, 8 and 9 of MnROAD's main line, which consists of a two-lane, 3.5-mile Interstate roadway that carries live traffic from I-94 for three weeks per month.

Before and after grinding, researchers measured all of these cells for:

- Noise levels, using onboard sound intensity testing (AASHTO TP 76-09), which takes

Investigators studied an innovative concrete pavement grind texture that helps both to restore pavement friction and reduce tire-pavement noise. Quieter pavements can save the expense of sound barriers on highways, which can cost up to \$3 million per mile.

continued

“The innovative grind is the quietest diamond ground pavement in the United States. This can save Minnesota millions of dollars in noise wall construction.”

—W. James Wilde,
Professor, Minnesota
State University Mankato
Department of Civil
Engineering

“This project was a model of industry and government collaboration, with the International Grooving and Grinding Association providing free grinding that otherwise would have been very costly.”

—Bernard Izevbekhai,
Concrete Research
Operations Engineer,
Mn/DOT Office of
Materials

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The innovative and ultimate grinds were developed and evaluated in the laboratory using Purdue's Tire Pavement Test Apparatus, a 12-foot-diameter rotating drum to which pavements can be attached and moved relative to a tire or grinding head at 30 miles per hour.

measurements with microphones mounted near vehicle tires.

- Friction and skid resistance, using locked-wheel skid testing (ASTM E-274), in which a vehicle drags an immobilized tire across a wet pavement.
- Ride quality, with the lightweight profiler (ASTM E-950), a small utility vehicle with laser sensors for measuring pavement smoothness.
- Mean profile depth, using the circular track meter (ASTM E-2157).

What Did We Learn?

The innovative grind was found to be much quieter for both high- and low-volume traffic than the conventional grind and the un-ground tine: The noise difference of 6 dB(A) typically observed is tantamount to an 80 percent reduction in tire-pavement noise. On the main line, the ultimate grind was also quieter than the conventional grind and un-ground tine, although somewhat louder than the innovative grind.

The friction of the ultimate grind on the main line—though less than that of the conventional grind—was an improvement over that of the innovative grind. The ultimate grind also had greater mean texture depth, suggesting that it will maintain its friction longer. All diamond grind textures on the main line exhibited better ride quality than the existing transverse tine, with the innovative and ultimate grinds exhibiting equal or greater smoothness than the conventional grind.

What's Next?

Minnesota has been evaluating diamond grinding at MnROAD since 2007, and this project is part of pooled fund study [TPF-5\(134\), PCC Surface Characteristics—Rehabilitation](#), which is exploring grinding techniques that [reduce tire-pavement noise](#) and increase ride quality without compromising friction. Researchers plan to monitor test cells over the next five years to evaluate the long-term performance of the different grinding methods. They will also take measurements correlating air temperature and tire-pavement noise, and conduct rolling resistance testing of innovative grind cells in comparison to various other MnROAD surfaces.

This Technical Summary pertains to the Interim Report 2011-05, “Innovative Diamond Grinding on MnROAD Cells 7, 8, 9, and 37,” published December 2010. The full report can be accessed at <http://www.lrrb.org/PDF/201105.pdf>. More information about the ongoing pooled fund study TPF-5(134) can be found at <http://pooledfund.org/projectdetails.asp?id=363&status=4>.



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Lee Munnich, University of Minnesota

PROJECT COST:

\$19,000



Heathrow Airport will initially have three stations and 18 podcars connecting parking and one terminal over 2.4 miles of elevated and at-grade tracks.

The Potential Viability of Automated Rapid Transit at the MSP Airport

What Was the Need?

One of MnDOT's key strategic directions for research is to provide a sound multimodal infrastructure. In December 2009 MnDOT began investigating innovative multimodal options including [automated rapid transit](#). Like a rail system, ART involves a dedicated network of tracks. However, the infrastructure associated with ART is typically much smaller than rail infrastructure. ART vehicles are also much smaller than traditional rail vehicles, typically holding no more than six passengers. This smaller scale infrastructure may make ART easier for cities and states to implement due to shorter track lengths required for stopping vehicles and less overall energy use. Additionally, like taxis, ART vehicles function on demand, taking passengers directly to their destinations. Any car can be deployed to any point on the network at any time.

In August 2010, MnDOT hosted an [ART workshop](#) that focused on potential uses of ART in Minnesota. The workshop included an initial review of the ART pilot system in London's Heathrow Airport. This review led MnDOT to explore the viability of an ART system at the Minneapolis-St. Paul International Airport. MnDOT was particularly interested in potential interactions between a future ART system and the highway system, specifically in regards to MnDOT right of way. If a future ART system were to leave airport property to serve nearby parking facilities and hotels, it would likely run within or cross a state or Interstate highway and impact MnDOT right of way.

What Was Our Goal?

The original goal for this project was to determine the feasibility of an ART system at the MSP Airport. However, initial research determined that existing ART implementations such as the one at Heathrow Airport were too preliminary for investigators to determine how reliable and cost-effective a system at the MSP Airport would be. The objective was changed to include a survey of the current state of ART applications in airport environments. By reviewing literature in this area and contacting those involved with current projects, investigators could characterize ART system options and identify points of potential application to the MSP Airport.

What Did We Do?

Investigators performed a literature review on current ART applications, focusing especially on two systems: Heathrow Airport, which was in the piloting stage, and [Mineta International Airport in San Jose, California](#), which was in the planning/discussion stage. Following the review, investigators conducted face-to-face and telephone interviews with staff working on these two systems to gather details about their design, rationale, level-of-service, potential risks, cost and revenue estimates, funding arrangements and sources, and integration with the existing environment.

In addition, investigators described existing MSP Airport automated people mover systems (the MSP C-Concourse Tram and Hub Tram) to provide a basis for evaluating a potential ART implementation.

A study of existing automated rapid transit systems informed MnDOT about the viability of ART for the Minneapolis-St. Paul International Airport and on potential right of way issues that may arise during a future implementation.

continued

“If an airport ART system touches the highway system, then from a right of way perspective, we would need to know the impact on MnDOT.”

—Mukhtar Thakur,
Director, MnDOT Office of
Multimodal Innovation

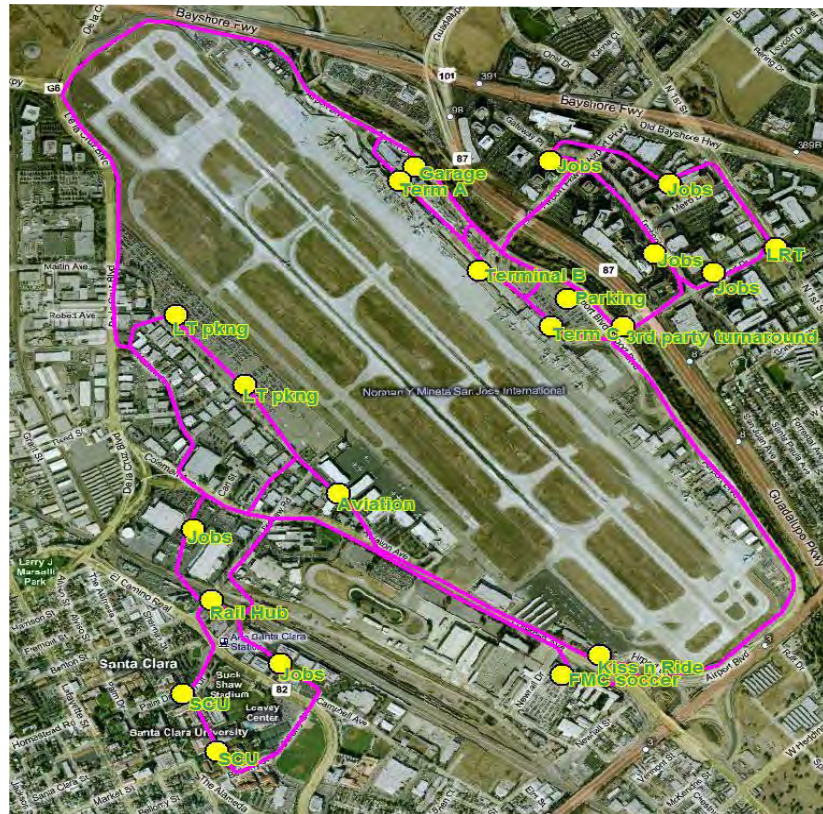
“ART systems tend to serve niche applications in areas not well-served by traditional transit modes, addressing the types of congestion and transit challenges faced by busy airports and activity centers. ART could provide highly available systems with low energy use.”

—Ferrol Robinson,
Research Fellow, State
and Local Policy Program,
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of Minnesota

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The planned system for the San Jose airport (shown above) would exceed the Heathrow system in both scope and level of services, providing connections to transit facilities, parking, hotels and employers within two miles of the airport.

What Did We Learn?

The report provides a thorough introduction to the ART concept, describing its intended purposes and major design options. Typically, ART use in airport environments includes travel between parking facilities and terminals; inter-concourse travel; and connections to nearby transit stations, hotels and/or activities. A set of standards for ART system specifications does not yet exist. To MnDOT's point of interest—how to handle potential right of way issues resulting from ART implementation—the report described the legal issues involved.

The existing MSP automated people mover systems examined were found to be very reliable. Also, plans are already in place that consider another automated system for Concourse G. However, passenger volumes are expected to grow from the current 32.5 million per year to 56 million by 2030. This will require significant improvements in the airport's internal and external transportation systems. While an ART system is a potential solution, issues including security, capital and operating costs, emergency requirements and passenger loading would have to be resolved. Additionally, performance criteria for evaluating future technology options like ART would need to be developed.

What's Next?

Future analysis may focus on the viability of a specific selected ART site. Analysis may include needs identification, positive and negative impacts, technology issues, business plan development, outreach and education, and permitting and approvals.

MnDOT has also evaluated ART for other purposes through a recent report (2011-17), which includes the potential benefits and challenges for implementing ART as a transit option in the Twin Cities.

This Technical Summary pertains to Report 2011-14, "Potential Viability of Automated Rapid Transit at the Minneapolis-St. Paul Airport," published May 2011. The full report can be accessed at <http://www.lrrb.org/PDF/201114.pdf>.



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PROJECT COST:

\$21,858



Mn/DOT District 3 recently implemented Mn/STEP, where workers perform regular stretching exercises to increase flexibility and prevent injury.

Reducing Injuries with a Workplace Wellness Program

What Was the Need?

For Mn/DOT workers who perform laborious tasks, the most common on-the-job injuries are strains, sprains and other musculoskeletal disorders caused by overexertion or awkward postures. While Mn/DOT is committed to reducing such injuries, work conditions differ significantly among field workers, making it difficult to establish standard procedures that minimize overexertion.

However, it is possible to reduce the frequency of such injuries by improving the overall fitness of field workers. To do so, agencies typically use workplace health promotion and wellness programs, which educate employees about beneficial lifestyle changes. While some Mn/DOT districts have informal workplace wellness programs focused on stretching and nutritional education, Mn/DOT does not currently have a formal, departmentwide program in place.

To assess the possibility of implementing a formal workplace wellness program, Mn/DOT [conducted research in 2010 to gauge employee receptiveness](#). To continue this assessment, further research was needed to review wellness programs currently in place at other state departments of transportation.

What Was Our Goal?

The goal of this project was to establish best practices for developing an Mn/DOT health and wellness program based on successful programs at other state DOTs.

What Did We Do?

Researchers began by conducting a literature review of textbooks, journal publications and websites, and identified basic terms and definitions related to workplace health and wellness promotion. Next, they conducted phone interviews with nine safety officers at other DOTs to identify factors leading to the success or failure of past and current workplace health and wellness promotion initiatives, and to gather data about the costs of these programs. Finally, researchers conducted a phone interview with a Minnesota expert in health and wellness promotion to ask about current options available to the Mn/DOT workforce and past experiences with groups similar to Mn/DOT field workers.

What Did We Learn?

Of the nine agencies contacted, four smaller agencies (less than 1,000 field workers) had programs that were primarily educational, with incentives for health screening. Three medium-size agencies (1,000 to 2,000 field workers) had more formal programs that included stretching, exercise, walking and education. Two larger agencies (more than 5,000 field workers) had formal programs as well as committees; worker input; management commitment; and performance measures such as participation, lost workdays and workers' compensation costs.

A majority of agencies indicated that overexertion or back injury was their primary concern when developing initiatives, followed by slips, trips and falls. To reduce overexertion and back injuries, agencies used measures ranging from education about lifting safely and preshift stretching or exercises, to "fit-for-work" policies or specific hiring of fit workers, to "no-lift policies," which involved hiring outside help for work that was

Experts claim that implementing a health and wellness program can produce 300 percent to 600 percent return on investment by reducing worker injuries and workers' compensation payments.

continued

“A workplace wellness program can help Mn/DOT develop a work environment that will enable employees to be healthier and reduce their risk of getting injured, both at work and at home.”

—Todd Haglin,
Safety Director, Mn/DOT
Office of Administration

“A health and wellness program should be comprehensive; prework stretching and tips on proper nutrition are just the beginning. It should focus on developing healthier relationships between workers, supervisors and top management.”

—Todd Loushine,
Assistant Professor,
University of Minnesota
Duluth Department of
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Investigators used interviews to determine steps for effective implementation of a health and wellness program. The first phase involves obtaining a mandate from upper management, whose level of support can dictate the success of the program. (Image republished with permission from the American Journal of Health Promotion.)

considered riskier. To address slips, trips and falls, agencies used education that encouraged the proper selection and use of footwear.

Overall, results showed that successful health and wellness programs:

- Focus not just on establishing nutrition education and exercise components, but on fostering the value of wellness as part of the organizational culture. This includes promoting positive relationships between supervisors and staff, which are critical to avoiding employee dissatisfaction and its negative effect on well-being.
- Require the leadership and commitment of managers as much as the involvement and participation of employees.
- Empower workers to take control of their own health and provide incentives to increase participation in programs.
- Require a significant amount of planning using a team or committee approach.

What's Next?

Mn/DOT is currently reviewing its options for a workplace wellness program and may create a pilot program in a district or subdistrict office that can be evaluated, refined and expanded in the future. Meanwhile, Mn/DOT District 3 has initiated its own pilot program, Mn/STEP, which is focused on stretching. In developing a health and wellness program, researchers recommended that Mn/DOT take the following approach:

- Establish management commitment and leadership, and involve key stakeholders such as health care providers and workers' compensation officials.
- Form a committee consisting of workers, management and a health promotion and wellness expert to assess the needs of workers and define how health promotion and wellness can be aligned with organizational goals, policies and measures.

Researchers recommend that before implementation, Mn/DOT establish baseline measures of health conditions, worker perceptions, injury and illness, and workers' compensation data so that during implementation, the performance of the program can be periodically assessed. According to experts interviewed for this study, a properly developed and administered health promotion and wellness program could provide a return on investment of 300 percent to 600 percent.

This Technical Summary pertains to Report 2011-07, "Review of Workplace Wellness Program Options to Reduce Musculoskeletal Disorders in Laborious Work," published January 2011. The full report can be accessed at <http://www.lrrb.org/PDF/201107.pdf>. For information about Mn/STEP, see <http://www.admin.state.mn.us/risk/publications/MN%20Step%20Flexibility%20Program.pdf>.



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\$74,929



The P3 enabling Virginia's Capital Beltway (I-495) high occupancy toll lanes helped fund infrastructure improvements such as the reconstruction of bridges over the wider highway.

Clarifying Public-Private Partnership Options in Transportation Projects

What Was the Need?

There are many arrangements by which private firms can aid in funding or assume risk for delivering transportation projects. Some of these arrangements are already standard Mn/DOT practice such as design-build contracting in which a contractor assumes responsibility for much of the design phase of a project as well as for the construction phase. This shifts risk from Mn/DOT and reduces delivery time by overlapping the design and construction phases.

The term "public-private partnership" is often associated with controversial arrangements like the leasing of the Chicago Skyway, where a private firm assumed operations and maintenance responsibilities for an existing toll highway in exchange for being able to keep the toll revenue for a 99-year term. However, several other types of P3s are being used to help government entities finance and deliver transportation facilities effectively and efficiently.

Mn/DOT needed to better define P3s and clarify what factors need to be taken into account to determine whether any given arrangement is truly in the public interest.

What Was Our Goal?

By reviewing literature and contacting involved public agency staff about existing P3s involving state highway development, investigators aimed to explain the range of P3s to address Mn/DOT's concerns about when a P3 produces desirable outcomes for the public and what approaches can mitigate the risks of P3s to public sector interests. This document would then help to educate Minnesota stakeholders about when and how to choose a P3 arrangement.

What Did We Do?

Investigators drew on academic research, news articles, agency publications and other sources of information about cross-sector collaboration and contract management to identify a number of P3 examples in the United States and abroad. Investigators then categorized and annotated the examples to highlight the type of project, manner of private involvement, and the key benefits and issues involved. Particular cases were reviewed further to gather lessons learned and best practices on selecting and implementing P3s. Additional literature reviews looked into public concerns surrounding P3s and state and federal laws that affect P3 arrangements. Results of these investigations were organized into a comprehensive report.

What Did We Learn?

The report discusses economic reasons for pursuing P3s along with their history, global pervasiveness, and the political and legal climate surrounding them. Appropriate P3 legislation needs to be in place before private sector involvement to achieve the best project outcomes.

Investigators clearly defined P3 alternatives, detailing how risks are transferred with each option and the costs and benefits involved, which included additional capital and budget revenue, competition in delivery among alternative options, the infusion of private expertise and new technologies, and life-cycle considerations. In many cases,

A report explaining public-private partnership options will help Minnesota transportation stakeholders to leverage private funding while protecting the public interest, producing substantial benefits for the state.

continued

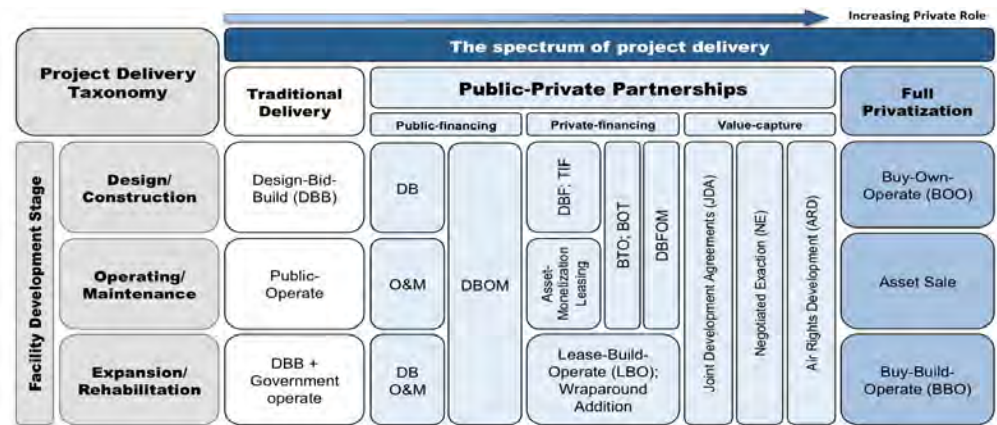
“There was a lot of confusion and misunderstanding on P3 options and costs. This report helped to clarify what P3s could be and hopefully dispelled a lot of myths and the fear that goes with them.”

—Ken Buckeye,
Value Pricing Program
Manager, Mn/DOT Office
of Policy Analysis,
Research & Innovation

“For certain long-term, large-scale projects, new procurement strategies for private financing can produce substantial benefits, as with the HOT-lane design/build/finance/operate/maintain arrangements in Virginia and Florida.”

—Brad Larsen,
Traditional & Innovative
Finance Director, Mn/DOT
Office of Financial
Management

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Investigators provided a framework to categorize P3 options by the level and type of involvement (the horizontal axis to the chart above) and what stages the private firm is involved in (the vertical axis). The abbreviations stand for different arrangements; for example, “DB” is design-build, described at the beginning of this summary.

the key benefit of a P3 is expediting a project: Private financing doesn’t entail raising additional public revenue.

Often illustrating with specific P3 experiences, the report details factors key to a successful P3 implementation, including:

- Selecting suitable candidate P3 projects and evaluating whether a P3 will provide more benefit than traditional project delivery.
- Specifying procurement methods: who can initiate proposals, when to process procurements, whether they should be negotiated or bid, and decision rules to choose contractors.
- Developing P3 contracts, including specification of payment options, contract length, tolling rate policies, expected rate of return, noncompete clauses and hand-back provisions.
- Managing projects, including contract oversight, contract change management, transparency and public participation, and the use of P3 revenue.

What’s Next?

An outreach effort began in spring 2011 with several presentations of these findings at academic and transportation conferences. Funding has been sought for a \$120,000 follow-up study to develop an evaluation methodology and tool to provide decision support for determining whether a P3 approach should be pursued for a given project using a value-for-money or public-sector comparator analysis. The project would also apply this methodology to one or two specific projects.

Also as a response to this report, Mn/DOT has tasked the University of Minnesota’s Humphrey Institute to lead a P3 task force made up of legislators; Mn/DOT, metro and local government representatives; industry groups; and other stakeholders to build an understanding of P3s and eventually evaluate specific prospective P3 projects. To pursue P3s requires specific legislation, and this task force is there to represent and allay public concerns that approved arrangements will not result in increased costs or agency loss of control over public infrastructure.

This Technical Summary pertains to Report 2011-09, “Advancing Public Interest in Public-Private Partnership of State Highway Development,” published February 2011. The full report can be accessed at <http://www.lrrb.org/PDF/201109.pdf>. For more information about the P3 task force, please contact Brad.Larsen@state.mn.us.



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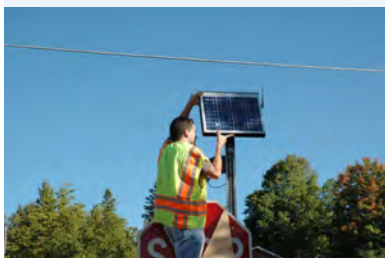
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Principal Investigator:

Taek Kwon, University of
Minnesota Duluth

LRRB PROJECT COST:

\$125,476



At the test site, solar panels powered the radar detectors mounted at the top of STOP signs located on the secondary road.



RESEARCH SERVICES

OFFICE OF POLICY ANALYSIS,
RESEARCH & INNOVATION

Advanced LED Warning Signs for Rural Intersections Powered by Renewable Energy

What Was the Need?

Like other Midwestern states, Minnesota has many unsignalized rural intersections where high-speed major highways are crossed by lower-speed secondary roads. Recent crash data indicates that a majority of Minnesota's intersection-related fatal crashes occur at these rural through/stop intersections.

Vertical and horizontal curves can make it difficult for drivers crossing or turning into the high-speed lane to identify a safe gap in the oncoming traffic, and communicating intersection conditions to drivers approaching this type of intersection can be challenging. Static advance warning signs do not appear to be effective. Realignment intersection approaches can improve safety, but this countermeasure is expensive and difficult to justify at low-volume rural intersections, particularly given the limited budgets of local agencies managing rural roadways.

What Was Our Goal?

The objective of this research is to improve the safety of rural blind intersections by developing a low-cost, easy-to-install advance warning sign system that can be implemented as modifications of existing static signs.

What Did We Do?

Researchers developed the Advanced Light-Emitting Diode Warning System, or ALWS, using three Intelligent Transportation Systems technologies: a low-power light-emitting diode signaling scheme; wireless technology for vehicle detection; and solar panels to power the system. In October 2009, after building and testing components in the lab, researchers installed the ALWS at a rural Duluth, Minnesota, intersection with a severe vertical curve on the approach of the main highway.

The field installation included three signs with LEDs on the perimeter of the sign panels:

- One CROSS TRAFFIC WHEN FLASHING sign, installed 525 feet from the intersection in the westbound lane of traffic on the main highway.
- Two signs with the message VEHICLE APPROACHING WHEN FLASHING, installed on the secondary road opposite the STOP signs.

Researchers modified wiring on commercial signs that continuously blink so that the signs only blink when a vehicle is detected on the opposing approach. Blinking time for the sign on the main highway varies based on the time a vehicle is detected at the STOP signs on the secondary road. The signs on the secondary road blink for 10 seconds when a vehicle is detected on the main highway. If the wireless signal to the signs ceases for more than 10 minutes (that is, if the system is offline), then the LEDs blink continuously.

Four non-intrusive vehicle detectors mounted on STOP signs and posts transmit wireless signals to the signs to initiate blinking. Communication between the vehicle detectors

Researchers developed the Advanced Light-Emitting Diode Warning System as a low-cost, non-intrusive, mobile warning system to improve safety at rural through/stop intersections. The system, which uses solar energy to power wireless technology for vehicle detection, shows promise in changing driver behavior by increasing wait times and reducing speeds.

continued

“Overall, the ALWS was effective at reducing vehicle speeds on the main highway, increasing the wait time and altogether stopping roll-throughs for vehicles on the secondary road when a conflict exists at the intersection.”

—Taek Kwon,
Professor, University
of Minnesota Duluth
Department of Electrical
and Computer
Engineering

*“I believe low-cost
Intelligent Transportation
Systems like those used
in the ALWS will play a
larger role in the future
as a strategy to reduce
unsignalized intersection
crashes and to contribute
to Minnesota’s Toward
Zero Deaths effort.”*

—Victor Lund,
Traffic Engineer, St. Louis
County Public Works
Department

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This blinker sign on the main highway is the largest of the three signs installed at the test site. When radar detectors mounted at the top of STOP signs on the secondary road detected vehicles stopped at the STOP signs, a wireless signal transmitted to this sign initiated blinking.

and blinker signs is transmitted wirelessly, which eliminates the need to bury wires in the pavement and makes it possible to use the system on gravel roads.

A solar-integrated power pole at the intersection powers the blinker signs’ LEDs and the vehicle detectors. Researchers estimated solar radiation at the test location and the expected daily power consumption of each component to select the solar panels.

What Did We Learn?

Researchers gathered video data during the three months before and nine months after installation of the ALWS. Video cameras recorded vehicles traveling toward the intersection through the vertical curve and vehicle movements through the intersection.

Video data analysis indicates the ALWS was effective at reducing vehicle speeds on the main highway an average of 4.5 mph when a vehicle was present on the secondary road. Results also indicate an increase in the wait time on the secondary road (the time it takes for a vehicle to enter the intersection after coming to a complete stop) of an average of 5.4 seconds.

The ALWS also stopped drivers from rolling through the intersection when vehicles were present on the main highway, but researchers noted an increase in roll-throughs on the secondary road when no vehicle conflict was present. This may mean that drivers treated the warning signs like a traffic signal, pausing only briefly before proceeding when the warning signs were not flashing. This driver response is a concern if electronics in the warning system fail.

Mail-in and on-site surveys augmented the video data analysis, with respondents indicating that the warning system was easy to understand and had improved the safety of the intersection.

What’s Next?

The ALWS shows promise in changing driver behavior to improve safety at rural through/stop intersections. The Local Road Research Board has identified this effort as a priority for further research: It provides an effective solution for a safety concern at a low cost. Continued research might include additional field tests at intersections with differing traffic volumes and alignments, and an evaluation of alternatives for sign placement and potential solutions to discourage roll-throughs when no conflict exists at the intersection. While these projects are considered, signage at the rural Duluth, Minnesota, test site remains in place with the blinking system deactivated.

This Technical Summary pertains to LRRB-produced Report 2011-04, “Advanced LED Warning Signs for Rural Intersections Powered by Renewable Energy,” published December 2010. The full report can be accessed at <http://www.lrrb.org/PDF/201104.pdf>.



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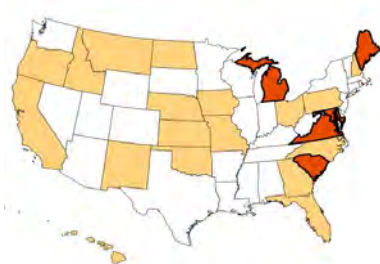
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Principal Investigator:

Reginald Souleyrette,
Iowa State University

PROJECT COST:

\$28,403



Twenty-two states (shaded yellow and red) responded to an email survey about current crash analysis systems, and five (in red) were studied in-depth.

Developing a State-of-the-Art Crash Analysis System

What Was the Need?

To reduce fatal and serious injury crashes and overall crash frequency on Minnesota roads, Mn/DOT collects data on automobile crashes such as their location and how they occurred. To store and analyze this data, engineers use a crash analysis system—software that can help them determine where crashes are most common and how roads can be improved to reduce crash frequency. Mn/DOT's current crash analysis system, called the Transportation Information System, or TIS, is a mainframe database that has been in use for more than 30 years.

Since the TIS was created, crash analysis systems have become more complex and capable, and the [FHWA has developed multiple crash tools](#) in collaboration with other states. Improved data management, an increase in the depth of data sources and the use of roadway geometric data allow these tools to provide more accurate information on crash trends and countermeasures. Mn/DOT is planning to replace its TIS with a platform that integrates with these tools and takes advantage of the latest developments in crash analysis. Mn/DOT needed to better understand the available technologies.

An up-to-date crash analysis system will be easier to use, more responsive to the needs of decision makers and will help Mn/DOT increase the safety of its transportation system by determining with greater precision where and how roadways need to be improved.

What Was Our Goal?

The objective of this research was to identify and assess existing crash analysis software tools being used in other states to determine the safety analysis capabilities that should be considered when replacing Mn/DOT's TIS.

What Did We Do?

Researchers began by conducting Web research to identify the crash analysis software systems used by other state agencies as well as the vendors that supply them. Then they reviewed agency Web resources detailing the use of such software, and searched the Internet for examples of Request for Proposal and Request for Information documents related to highway safety analysis software.

Researchers also presented an interactive poster at the 2010 Association of Transportation Safety Information Professionals Traffic Records Forum to discuss the completeness of their Web review with participants and learn about systems unknown to them. Feedback from crash analysis experts in both the public and private sector at this poster session formed the basis of a follow-up email survey of state safety engineers regarding the features of crash analysis systems currently being used or developed by their agencies.

What Did We Learn?

Researchers identified 39 states with a crash analysis system, and identified and summarized the capabilities of 13 available commercial, federal and pooled fund crash analysis software products (collectively abbreviated CFPF). They used this information to develop a list of features and capabilities that best matched Mn/DOT's goals for its new system.

The study found that a system should support new, robust approaches to highway safety like systemic procedures, which help to determine how to distribute low-cost treat-

continued

“This preliminary investigation allowed us to validate our hypothesis that no one turnkey crash analysis system will meet all of our needs. Now we can focus on finding a combination of systems and customizations.”

—Bradley Estoche,
ITS Project Manager,
Mn/DOT Office of Traffic,
Safety and Technology

“A new crash analysis system will both reduce the time it takes Mn/DOT to analyze crash data and improve the safety of Minnesota’s transportation system through mitigation or proactive projects, saving lives and millions of dollars.”

—Reginald Souleyrette,
Associate Director, Iowa
State University Center for
Transportation Research
and Education

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Systemic treatments such as rumble strips are important to reducing fatalities on rural roads prevalent in Minnesota. Mn/DOT’s new crash analysis system will be designed with the processing power to determine where such treatments are needed.

ments such as rumble strips and high visibility signage over the entire roadway system. They are important for rural roads, which while accounting for the majority of automobile fatalities in Minnesota, cannot be analyzed in the traditional way for high-crash locations, or “black spots,” because of their low volume of traffic.

A state-of-the-art system should also be able to:

- Calculate crash metrics based on both severity and type.
- Identify locations with potential safety issues using both black spot and systemic analysis.
- Conduct statistical analyses with comparisons between individual locations, networks and subsets of the network.
- Diagnose crash issues, generate collision diagrams and identify the distribution of crash types—such as rear-end, head-on and left-turn—and other crash attributes.
- Conduct an economic analysis estimating the cost-effectiveness of countermeasures, benefit-cost ratios and other metrics.
- Establish a priority ranking of countermeasures based on location crash metrics and economic metrics.

Researchers also drafted a Request for Information document that can be used to solicit additional information from crash analysis software developers and vendors to help Mn/DOT further refine the desired features of a new crash analysis system and prepare a Request for Proposal to procure services for developing this system.

What’s Next?

Using this report and the results of the Request for Information, Mn/DOT will create a proposal for a new crash analysis system that meets as many of its needs as possible. To reduce costs, researchers recommend basing the system’s functionality on a CFPF system and then customizing as needed. CFPF systems offer the advantage of being supported outside of Mn/DOT along with the availability of lessons learned from other states using the same system. Researchers hope to have Mn/DOT’s new system in place in the next three to five years.

This Technical Summary pertains to Report 2011-10, “Minnesota Department of Transportation Traffic Safety Analysis Software State of the Art,” published February 2011. The full report can be accessed at <http://www.lrrb.org/PDF/201110.pdf>.



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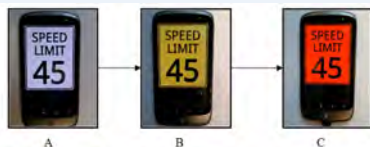
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Principal Investigators:

Max Donath, Janet Creaser,
Alec Gorjestani and Michael Manser,
University of Minnesota

PROJECT COST:

\$500,000



The system displays speed limits using white signs when the vehicle is traveling within the speed limit, and yellow or red signs when it exceeds the speed limit by less or more than 5 mph.

Improving the Safety of Teen Drivers with Monitoring Technologies

What Was the Need?

Motor vehicle crashes are the leading cause of teen deaths in the United States. One promising method for reducing these crashes is the use of graduated driver licensing programs, which restrict teen drivers from behaviors such as night driving or unsupervised driving until they have gained more experience. These licensing programs can be difficult to enforce, so researchers have developed monitoring technologies that can be used to increase compliance and improve teens' driving by alerting them to risky behaviors in real time. One such technology is the Teen Driver Support System, or TDSS, designed by the Intelligent Transportation Systems Institute at the University of Minnesota. TDSS software can run on a teen's smartphone while it is mounted on the car dashboard. This technology uses the phone's built-in accelerometer and GPS to monitor compliance with speed limits and STOP signs, hard braking and cornering, driving location and time of day, number of passengers and seat belt use. During use, the TDSS also restricts the phone's text messaging and calling features.

If the system detects risky or illegal driving behaviors, it alerts teens with visual and auditory messages, and if these warnings are ignored, it alerts parents via text message. Parents also have ongoing access to a Web-based report of the teen's recent and historical driving behaviors, allowing them to track improvements and engage their teens in conversations about their driving.

The TDSS is currently in prototype form, and research was needed to evaluate the usability of its functions and interface so that they could be optimized before further field testing.

What Was Our Goal?

The purpose of this study was to evaluate how teens and parents perceived the usability of the TDSS.

What Did We Do?

Researchers began by recruiting 30 teen-parent pairs to participate in the usability study. Teens (16 to 17 years old) had possessed driver's licenses for less than two years, and since beginning driving had been involved collectively in 13 at-fault crashes and several traffic violations.

Researchers introduced parents and teens to the TDSS via a short presentation and took them on a 10-minute demonstration drive in which one researcher drove a vehicle along a predetermined route while another explained its reminders and warnings.

After the demonstration, parents returned to a conference room to review a parental summary website, while teens accompanied by a researcher drove a 30-minute route involving town and rural roads with an active TDSS to experience how the system worked during regular driving. Parents and teens then completed demographic, driving behavior and usability questionnaires that included questions about the system's various functions and interfaces as well as the system as a whole.

The Teen Driver Support System is designed to reduce teen car crash fatalities by providing real-time, in-vehicle feedback to teens about risky driving behaviors and immediately communicating with parents if these behaviors continue.

continued

“This system has the potential to significantly improve the driving safety of teens by reducing crashes and fatalities.”

—Susan Sheehan,
ITS Program Manager,
Mn/DOT Office of Traffic,
Security and Operations

“This is the only technology of its kind to provide such in-vehicle coaching to teens on a wide variety of driving behaviors as well as the ability for parents to monitor their teens’ driving in real time.”

—Janet Creaser,
Research Fellow,
HumanFIRST Program,
University of Minnesota

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The system’s visual feedback interface is designed around simple, easy-to-understand graphical elements. Teens preferred these visual messages to auditory alerts, which could be distracting.

What Did We Learn?

Most teens said the TDSS could help them learn to drive more safely. They rated all but one of the functions favorably, reporting that recommended curve speeds were too low and least likely to be obeyed. Some teens also thought that STOP sign and speeding thresholds were too low, and found some auditory messages distracting, preferring visual messages.

Teens’ biggest concern about the system was privacy. They liked that they could prevent parental notifications by modifying their behavior in time, but they also indicated that these notifications were critical to motivating them to change their behavior. While most teens thought the system would have a positive effect on their discussions with parents about driving, some worried it could become a source of conflict.

Parents were very positive about the TDSS and its potential to improve the driving habits of their teens. While they had favorable opinions of most functions, they considered the passenger reminder feature less reliable because it could not distinguish authorized from unauthorized passengers. Parents did not consider most system functions to be an invasion of their teen’s privacy and said they would pay a nominal monthly fee for it.

What’s Next?

Researchers plan to conduct a large-scale field test of the TDSS during which teens will be evaluated while using the system in daily driving for several months. Before this test, researchers recommend redesigning the current system based on parent and teen feedback from this study. Specifically, some messages should be shortened or eliminated to reduce distraction, and thresholds for speeding and other factors should be modified for the best balance of usability and safety. Researchers also recommend updating the parental website to include more access to informational tools they can use to better discuss driving risks with their teens.

This Technical Summary pertains to Report 2011-13, “Usability Evaluation of a Smartphone-Based Novice Teen Driver Support System (TDSS),” published June 2011. The full report can be accessed at <http://www.lrrb.org/PDF/201113.pdf>.



TRANSPORTATION POOLED FUND
PROGRAM

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TOTAL STATE CONTRIBUTIONS TO DATE:

\$750,000

Mn/DOT CONTRIBUTIONS TO DATE:

\$200,000

PARTICIPATING STATES:

ID, MN, MT, ND, SD, WA, WI, WY



i90i94travelinfo.com includes a clickable map allowing users to view camera images of road conditions for key locations along the corridor as well as information about truck stops, rest areas and commercial vehicle restrictions.



RESEARCH SERVICES

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Pooling Our Research: Improving Road Condition Information for Interstate Travelers

Why a Pooled Fund Study?

Interstates 90 and 94 between Wisconsin and Washington form a main corridor for commercial and recreational travel. Extreme winter weather conditions pose significant challenges for travelers within this corridor, so states typically provide real-time road and weather information via dynamic message signs, or DMSs; 511 phone systems; and the Web. Traveler information is supported in turn by Intelligent Transportation Systems, or ITS, which include a variety of technologies for collecting, processing and integrating travel-related data. ITS technologies are also important to roadway maintenance operations, traffic management and commercial vehicle operations.

Because states independently maintain their own ITS, it can be difficult to accomplish ITS-related goals that require sharing information between states. Recognizing this need, Minnesota initiated a meeting in 2002 with representatives from seven states along the I-90 and I-94 corridor to begin discussions on ITS collaboration. These states face similar travel-related issues because of their predominantly rural makeup. This group then established itself as the North/West Passage Corridor Pooled Fund Study TPF-5(093) in 2003, continuing in 2009 as TPF-5(190).

What is the Pooled Fund Study's Goal?

The goal of the North/West Passage Corridor pooled fund study is to develop effective methods for sharing, coordinating and integrating traveler information and operational activities between states along the I-90/I-94 corridor from Wisconsin to Washington.

What Have We Learned?

Since its inception, the North/West Passage Corridor pooled fund study has completed 18 projects, including the development of i90i94travelinfo.com. This website provides travel information for the entire corridor, including camera images, truck stop and rest area information, and weather conditions. Other accomplishments include helping North Dakota and South Dakota 511 callers receive information about Minnesota's highways, standardizing the terminology used to describe road events along the I-90/I-94 corridor, providing a forum for state patrol and DOT staff to discuss integration of systems, and identifying action items for increased cross-border maintenance and operations collaboration.

Recently completed projects include:

- [Call Forwarding and Evaluation of Cross Border Information](#), which created recommendations to further enhance the ability of travelers using 511 systems to access traveler information from adjacent states.
- [NWP Traveler Information Website Phase 2 and Center-to-Center Communications Concept of Operations](#), which enhanced i90i94travelinfo.com by adding the ability to acquire active event reports posted by member agencies and to display active corridor events.

TPF-5(190): North/West Passage Corridor.

Minnesota benefits both from pooled fund projects that improve the safety and efficiency of Minnesota travelers by integrating traveler information systems between states as well as the opportunity to develop contacts and exchange information with other member states.

continued

“This study’s DMS project is a great example of the importance of sharing solutions across boundaries. Making dynamic message signs consistent between states is critical to drivers using them to make better travel decisions.”

—Cory Johnson,
IntelliDrive Program
Engineer, Mn/DOT
Office of Traffic, Safety
and Technology

“Just as valuable as this study’s projects are the relationships it helps build between member states, leading to better cooperation on critical issues.”

—Deb Fick,
Research SP&R
Administrator, Mn/DOT
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DMSs such as this one on I-94 in St. Paul are used to warn travelers about accidents, congestion, severe weather and other incidents. This study’s ongoing DMS project aims to coordinate their use between member states. A possible future project would integrate them with other ITS technologies.

- [Traveler Information Dissemination to Commercial Vehicle Operators](#), which created recommendations to enhance existing corridorwide trucker and traveler information dissemination systems.

For its leadership of this pooled fund study, Mn/DOT Research Services received the CTS 2010 Research Partnership Award and the [2010 Best of ITS Rural Award](#) at the National Rural ITS Conference in the category *Best New Practice*.

What’s Going On Now?

Member states continue to benefit from this study by developing contacts, sharing lessons learned and promoting the exchange of traveler information. The group is also currently working on six projects, including:

- [Consistent and Coordinated DMS Use](#), initiated by Minnesota to establish coordinated use of dynamic message signs and other traveler information dissemination tools along the corridor.
- [NWP Regional Permitting—Phase 2](#), initiated by Minnesota to identify options and next steps to move member states toward regional permitting.
- [Citizen-Assist Reporting Feasibility Study](#), to share the results of Wyoming’s current program for using road condition data reported by travelers, and to explore the possibility of its expansion to other member states.

What’s Next?

The projects under consideration for this study’s next work plan would continue to integrate ITS technologies and coordinate them between states, with possibilities including:

- NWP Regional Permitting—Phase 3, proposed by Minnesota to continue exploring regional permitting recommendations from Phases 1 and 2.
- Corridorwide Traveler Information Coordination—Operational Test, which would build on two current projects to conduct an operational test of traveler information coordination between DMSs, 511 phone, Web and other existing systems.

This Technical Summary pertains to the ongoing Pooled Fund TPF-5(190), North/West Passage Corridor Pooled Fund, continuing the project initiated under TPF-5(093). Details of this effort can be found at <http://pooledfund.org/projectdetails.asp?id=412&status=4>, <http://pooledfund.org/projectdetails.asp?id=316&status=23> and <http://www.nwpassage.info/>.

For more than 25 years, FHWA’s Transportation Pooled Fund Program has been providing state DOTs and other organizations the opportunity to collaborate in solving transportation-related problems. The TPF Program is focused on leveraging limited funds, avoiding duplication of effort, undertaking large-scale projects and achieving broader dissemination of results on issues of regional and national interest.



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