



FY2023: JULY 1, 2022 – JUNE 30, 2023

RESEARCH AT-A-GLANCE

Informing, Improving and Innovating
Transportation in Minnesota



DEPARTMENT OF
TRANSPORTATION
OFFICE OF RESEARCH & INNOVATION

mndot.gov/research



▶ [Report 2023-13](#)



We assessed stormwater control methods such as rain gardens for flood prevention. ▶ [Report 2023-21](#)



We refined a system to help snowplow drivers navigate within traffic lanes during low-visibility conditions. ▶ [Report 2023-27](#)

DIRECTOR'S MESSAGE



I am pleased to present MnDOT's Research & Innovation Annual Report, highlighting our ongoing commitment to pushing the boundaries in transportation to better serve the people of Minnesota.

As we look ahead to the future, we're preparing to unveil our new [Research Strategic Plan](#) in 2024. This plan will serve as our roadmap to address the evolving transportation challenges in Minnesota, guiding research investments and outcome evaluations. This past year, we conducted surveys and hosted focus groups and a peer exchange to gather valuable insights from our program and industry partners.

[Evaluating and communicating the value of research](#) are top priorities, but no small feat. In a collaborative effort with the Local Road Research Board, we've identified a new benefit-monitoring framework. This next year we will

be piloting new methods for benefit quantification, which will enable us to better communicate the tangible impacts of research to the transportation community and beyond.

Remaining responsive to the emerging trends in transportation is crucial. Our team is actively engaged in addressing topics such as [culture building and behavior change strategies for vehicle miles traveled reduction](#) and the [effects of legalization of marijuana on traffic safety](#). Trending issues like these have significant implications on the safety and sustainability of our transportation system. It's our goal to stay on the forefront of transportation research and policy.

Our commitment to fostering a culture of innovation within MnDOT continues to grow. As part of implementing MnDOT's Innovation Strategy, we recently launched the Innovation Hub, providing a platform for our staff members to submit and share their innovative ideas and access valuable resources to support their projects. We believe MnDOT is filled with determined innovators, and this portal will enable us to harness and recognize the collective creativity of MnDOT.

As we reflect on the past year and look ahead to the challenges and opportunities that await us, I want to express my sincere gratitude to all MnDOT employees and our partners who have contributed to our ongoing success. Your hard work, dedication and innovative thinking are what drive the continued improvement of Minnesota's transportation system.

Katie Walker, Director
MnDOT Office of Research & Innovation



OUR MISSION

MnDOT's Office of Research & Innovation supports Minnesota's transportation community by meeting the innovation and information needs of practitioners.

In addition to running the state transportation library, our office manages research funded by the MnDOT State Research Program (SRP) and Federal Highway Administration (FHWA) State Planning and Research (SP&R) Program (Part II). We also administer the Local Road Research Board (LRRB) program, which facilitates transportation research and information-sharing among city and county engineers.

OUR STRATEGIC PRIORITIES

Nearly 200 MnDOT professionals and leaders participated in the Research Strategic Direction Visioning workshops. Their input provided the framework for *MnDOT's Research Strategic Priorities: safety, advancing equity, asset management, climate change and the environment, and innovation and future needs*. These Research Strategic Priorities do not explicitly direct the topics of research; instead, they show ways that research at MnDOT garner progress toward MnDOT's strategic operating goals and mission.



Advancing equity projects aim to recognize the role research plays in the assurance of equitable access to safe and efficient transportation systems. While research may not necessarily focus only on equity, MnDOT prioritizes research projects that advance equitable access to safe and efficient transportation systems.



Asset management research may include projects that focus on asset-related data collection processes and data management, measurement of asset life cycle and life cycle costs. Such projects inform preservation of assets and are critical measurements of return on investment.



Climate change and the environment research may manifest as projects specific to endangered and threatened species, wetland protections, salt use and incursion, congestion impacts on air quality, and the impacts of MnDOT work on the environment.

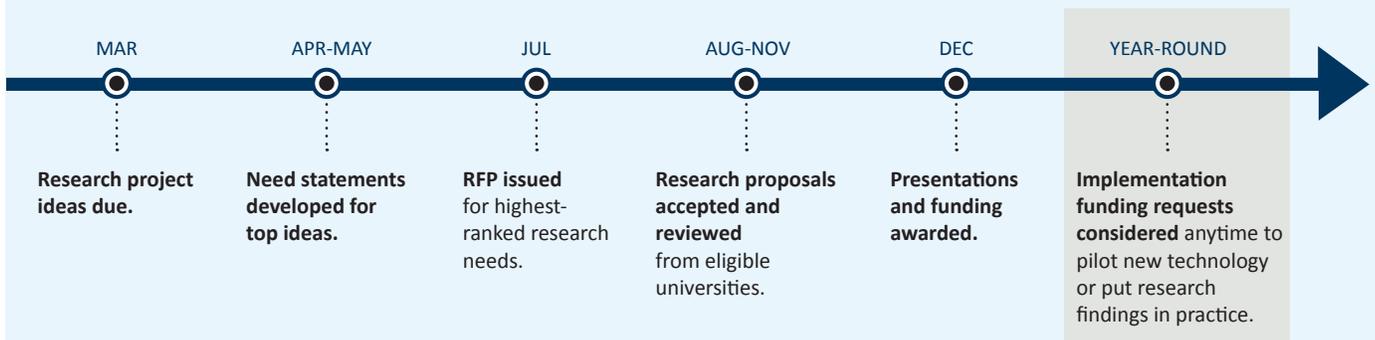


Innovation and future needs projects help MnDOT to better understand and meet the transportation needs of the future by continuing to invest in forward-looking research.



Safety research aims to ensure that all road users have access to a safe roadway system, work zones are safe for the public and workers, and MnDOT employees have the tools and skills to work in the safest way possible.

RESEARCH FUNDING CYCLE



NOTES: Dates subject to change. Check mndot.gov/research for current schedule. Out-of-cycle funding requests are accepted in some circumstances.

RESEARCH HIGHLIGHTS



SAFETY

Decreasing Congestion with Max-Pressure Traffic Signals



Advanced traffic signal control technology can reduce traffic congestion and travel times.

Traffic signal timing can be a primary cause of traffic congestion. While local transportation agencies are introducing adaptive signal timing that responds to the vehicles present, existing technology may not consider other variables to optimize the number of cars and trucks moving through an intersection. Simulations of max-pressure signal controllers—which use advanced algorithms to dynamically adjust signals based on vehicle queue lengths—showed significantly reduced delays. Local agencies will continue to explore and potentially pilot-test the technology. [Report 2022-24](#)

Supporting Snowplow Operators with Lane Guidance System

Snowplow operators work in difficult, often low-visibility conditions. Working with plow drivers over two winter seasons, researchers refined a system that provides visible feedback on the truck’s position in a lane and alerts drivers to upcoming obstacles. Operators responded positively to the product, reporting decreased stress and driving incidents. MnDOT is moving forward to enhance the system, explore production options and implement the system statewide. [Report 2023-27](#)



A dashboard guidance system displays visual indicators and auditory warnings to significantly enhance safety in whiteout conditions.



ADVANCING EQUITY

How Gender and Other Identities Impact Travel Needs and Experiences

Ensuring the transportation network is accessible and welcoming to all demographics requires understanding the needs and experiences of different genders and other social identities such as race, family type and employment status. Two-week travel diaries of participants across gender and social identities revealed specific needs and barriers among different demographics and impacts on their subjective well-being. Findings will support equitable and inclusive transportation policy and planning. [Report 2023-10](#)



Understanding the needs, challenges and overall experiences of all communities and demographics is critical to advancing an equitable transportation system.

Revitalizing Communities Through Innovative Right of Way Projects

Urban highways built decades ago improved movement through cities but created substantial hardship for communities that were physically divided and uprooted. Today, nontransportation uses of right of way spaces above, below or adjacent to highways hold potential for supporting and advancing these communities and benefiting the traveling public. Researchers explored creative right of way projects from around the country, identifying lessons learned and useful practices for developing community areas with multiple social benefits, including robust community engagement, to facilitate equitable outcomes in infrastructure projects. [Report 2023-28](#)

Projects such as highway caps can reconnect and revitalize once-divided communities.



ASSET MANAGEMENT

Using Data to Bolster Minnesota's Freight Infrastructure



Commodity-specific data informs freight transportation infrastructure needs.

Efficient freight transportation, whether by road, rail, air, water or pipelines, is critical to a strong state economy. Ensuring transportation infrastructure supports freight needs requires understanding supply chain patterns and other commodity trends. Researchers consulted with practitioners, stakeholders and other states to discover best practices, data sets and other tools for freight transportation management. These findings will help MnDOT advance plans to develop a tool that will optimize freight transport. [Report 2023-02](#)

Evaluating New Materials to Strengthen Bridge Decks

A nonmetallic alternative to steel rebars that typically reinforce concrete bridge decks has the potential to better withstand Minnesota's harsh climate conditions. Because glass fiber-reinforced polymer (GFRP) doesn't rust like steel, it resists corrosion and the concrete cracking that often follows. After monitoring two side-by-side bridges—one built with traditional rebar and the other with GFRP—for nearly four years, researchers discovered the two bridge decks behaved very similarly. Although GFRP decks may have a longer service life and be more cost-effective, several more years of evaluation will provide more information about bridge deck performance. [Report 2023-13](#)



Live-load testing revealed glass fiber-reinforced polymer rebars in concrete is as strong as steel rebars.



CLIMATE CHANGE AND THE ENVIRONMENT

Identifying Sustainable Turfgrass Varieties to Line Minnesota's Roads

Turfgrass, in addition to making roadsides visually appealing, controls erosion, provides stability for the road base, minimizes stormwater runoff and improves water quality. To ensure grass varieties can withstand drought, road salts and other harsh conditions, MnDOT maintains an approved turfgrass seed list. New research evaluated the performance of seed on the existing list given a changing climate and incorporated new, innovative seed varieties. Researchers also suggested a revised and transparent seed approval process to support MnDOT in keeping the list current into the future. [Report 2023-20](#)



Adapting Stormwater Infrastructure for More Severe Storms



More frequent severe storms and an increasing population necessitated an evaluation of MnDOT's stormwater infrastructure capacity. The agency currently uses drainage pipes, ponds, ditches and other strategies to control flooding around streets and highways. After reviewing future storm scenarios and needed stormwater management capacity, researchers estimated the cost-effectiveness of various adaptation strategies. Stormwater ponds and diverting stormwater to infiltrate vegetated areas were among the most promising practices. MnDOT will continue to evaluate additional stormwater management strategies to ensure capacity that will accommodate future storm predictions and ongoing development throughout the state. [Report 2023-21](#)



INNOVATION AND FUTURE NEEDS

Preparing Road Maintenance Operations for Autonomous Vehicles

Road maintenance and traffic operations may need to evolve with autonomous vehicle technology. Automated lane-keeping features, for example, depend on visible road markings to function properly. But crews may move lanes temporarily in work zones during construction, and snow may cover markings in winter conditions. Additionally, adaptive cruise control may change the flow of heavier traffic. The exploration of these and other issues informs the ongoing inquiry of road maintenance and operations needs as automated vehicle technology progresses. [Report 2023-23](#)



Partnering with a Tribal Nation to Advance Mutual Energy Goals



MnDOT strives to strengthen government-to-government relationships with tribes located within the state and to meet renewable energy goals. A potential project may accomplish both and provide an opportunity for the Red Lake Nation to exercise its sovereignty, meet its own renewable energy goals and serve as a model for tribal energy development. Under a virtual power purchase agreement, the tribe could develop a solar plant and MnDOT could buy renewable energy credits. The agency continues to explore this innovative, mutually beneficial opportunity with the Red Lake Nation. [Report 2023-12](#)

LEVERAGING OUR RESEARCH DOLLARS

For every \$1  invested in a pooled fund study with other states, MnDOT leverages \$10  worth of research.

The Transportation Pooled Fund (TPF) Program allows federal, state and local agencies and other organizations to combine resources to support research into shared transportation priorities.

Minnesota leads nine pooled funds and participates in another 36. Find a summary of all pooled fund activity at mndot.gov/research/pooled.html. Some of our notable studies:



Clear Roads. The Clear Roads research program brings together transportation professionals and researchers from around the country to drive innovation in winter maintenance. By evaluating materials, equipment and methods in real-world conditions, the program identifies the most effective techniques and technologies to save agencies money, improve safety and mobility, and increase efficiency. clearroads.org

Clear Roads Project CR21-05

evaluated the benefits and challenges of alternative fuel and electric vehicles suitable for use in winter maintenance operations. Transportation agency decision-makers can use this information to prepare for



converting an existing winter maintenance fleet powered by diesel fuel to one that uses electric and alternative technologies.



National Road Research Alliance. The National Road Research Alliance (NRRA) was created by MnDOT to help fund and direct research at the MnROAD cold-weather pavement test track. NRRA finds ways to build roads faster and make them last longer, perform better, cost less to build and maintain, and have less impact on the environment. mndot.gov/mnroad/nrra

In Real-Time Smoothness for Asphalt Paving, field demonstrations have shown how pavers can accurately measure the smoothness of roads as they are constructed using sensors on the paving screed (the bar that smooths the pavement).



North/West Passage. Minnesota initiated this pooled fund to investigate intelligent transportation systems solutions to traffic management, traveler information and commercial vehicle operations on Interstates 90 and 94 between Washington and Minnesota. nwpassage.info

How to Participate in National Research Projects

Pooled Funds — If your research idea addresses an issue that affects multiple states, we can help establish a TPF project to leverage resources and collaborate with other state departments of transportation (DOTs) to solve a problem. Find guidance at mndot.gov/research/pooled.html.

NCHRP Research — If you are trying to solve a problem of regional or national significance, we can help you develop a problem statement through the National Cooperative Highway Research Program (NCHRP). Contact us at research.dot@state.mn.us.

Track National Trends

Get the latest research news in your subject area from across the country by searching the national database (trid.trb.org), watching webinars (webinar.mytrb.org) and signing up for the e-newsletter (trb.org).



FY2023 RESEARCH ACTIVITIES

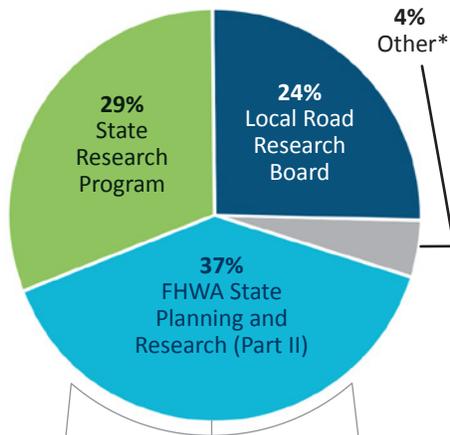
FINANCIAL OVERVIEW

MnDOT research is funded through the MnDOT State Research Program (SRP) and Federal Highway Administration (FHWA) State Planning and Research (SP&R) Program (Part II). MnDOT's Office of Research & Innovation also manages research for the Minnesota Local Road Research Board (LRRB).

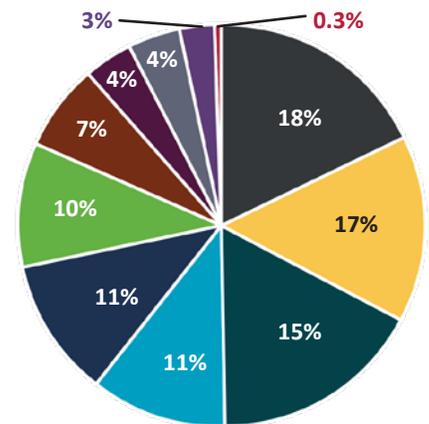
FY2023 Research Funds by Funding Source

FHWA State Planning and Research (Part II)	\$ 5,363,624
State Research Program	\$ 4,638,189
Local Road Research Board	\$ 3,930,343
Other*	\$ 709,429
Total	\$ 14,641,585

* Includes contributions from other MnDOT funds, partnerships with other agencies and other federal sources.



FY2023 Research Funds Allocated by Topic Area



Total: \$11,944,952*

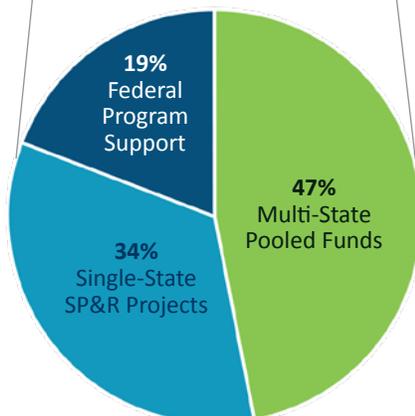
- 18% Dedicated Programs (CTS & LTAP)
- 17% Traffic & Safety
- 15% Materials & Construction
- 11% Maintenance Operations & Security
- 11% Multimodal
- 10% Environmental
- 7% Administrative
- 4% Policy & Planning
- 4% Bridges & Structures
- 3% Equity
- 0.3% Other

* This total is less than the total in Figure 1 because it includes only contracts and leaves out purchase orders, travel and most staff salaries.

Subset: FY2023 SP&R (Part II) Funding Distribution

FHWA SP&R (Part II) funds are allocated to MnDOT for eligible state-specific needs and to participate in multi-state initiatives as shown below:

Multi-State Pooled Funds	\$ 2,785,921
a: Participation in Pooled Funds Led by Other States	\$ 757,100
b: MnDOT-Led Pooled Funds	\$ 2,028,821
Single-State SP&R Projects	\$ 2,046,895
Federal Program Support	\$ 1,108,208
a: National Cooperative Highway Research Program	\$ 906,213
b: Transportation Research Board	\$ 164,435
c: AASHTO	\$ 37,560
Total	\$ 5,941,024



FY2023 RESEARCH CONTRACTS

Each research topic area on the following pages includes two tables:

- Research reports completed in fiscal year 2023 (FY2023) followed by other research contracts active during FY2023, sorted by contract end date.
- Multi-state pooled funds and American Association of State Highway and Transportation Officials (AASHTO) projects, with MnDOT-led pooled funds listed first.

Prefixes in project titles indicate funding for projects not supported entirely by the MnDOT SRP:

- **INV** – Partial or full LRRB funded
- **MPR/MP** – 80% federally funded/20% state funded
- **TPF** – MnDOT-administered pooled fund (100% federal funds)

For more information about projects, including two-page technical summaries for completed reports, search by the title on the “Search Projects” tab at mndot.gov/research. For more information about pooled funds, search at pooledfund.org.

BRIDGES & STRUCTURES					
Report Number	Title	End Date	Investigator	Technical Liaison	Total Cost
2022-28	<u>MP-18(008): Detecting Foundation Pile Length of High-Mast Light Towers</u>	9/30/22	Bojan Guzina, University of Minnesota	Richard Lamb	\$198,000
2022-29	<u>Load Rating Assessment of Three Slab-Span Bridges Over Shingle Creek</u>	8/31/22	Ben Dymond, University of Minnesota Duluth	Yihong Gao	\$181,243
2022-32	<u>Steel Reinforcement Section Loss Guidance Tables</u>	9/30/22	Behrouz Shafei, Iowa State University	Paul Pilarski	\$100,966
2023-13	<u>MP-18(004): Assessment of Bridge Decks with Glass Fiber-Reinforced Polymer Reinforcement</u>	3/31/23	Behrouz Shafei, Iowa State University	Paul Kettleison	\$100,104
TRS2302	<u>Use of High-Pressure, Hot Water Blasting Surface Preparation and HRCSA Coatings in Bridge Maintenance</u>	12/31/22	Xiaoning Qi, North Dakota State University	Sarah Sondag	\$31,375
TRS2304	<u>Bridge Drainage Systems and Discharge to Waterways</u>	6/30/23	Michael Marti, SRF Consulting Group, Inc.	Eliezer Ramirez	\$37,520
	<u>Bridge Pile Repair Using Underwater Fiber Reinforced Polymer Sleeve and Steel Reinforced Grout</u>	10/31/23	William Schilling, AECOM Technical Services, Inc.	Nickolas Haltvick	\$99,751
	<u>MP-21(009): Evaluation of Corrugated HDPE Pipes Manufactured with Recycled Content</u>	1/31/24	Michael Pluimer, University of Minnesota Duluth	Erik Brenna	\$85,032
	<u>MP-22(001): Develop Element-Level Bridge Performance Measures and Targets</u>	6/30/24	Basak Aldemir Bektas, Minnesota State University, Mankato	David Hedeem	\$215,704
	<u>INV 1093: Quantifying Benefits of Bridge Maintenance</u>	9/30/24	Basak Aldemir Bektas, Minnesota State University, Mankato	Sarah Sondag	\$166,709
	<u>Performance Evaluation of Reinforced Concrete Box Culverts</u>	8/31/25	Lauren Linderman, University of Minnesota	Yihong Gao	\$270,078

Bridges & Structures Pooled Fund Studies

Study Number	Title	Lead State or Agency	Technical Liaison	Number of Participating Agencies	2023 MnDOT Contribution	Total MN Contribution
TPF-5(372)	<u>Building Information Modeling (BIM) for Bridges and Structures</u>	IA	Benjamin Jilk	24	\$20,000	\$80,000
TPF-5(464)	<u>Hydrologic and Hydraulic Software Enhancements (SMS, WMS, Hydraulic Toolbox and HY-8)</u>	FHWA	Aislyn Ryan	15	\$10,000	\$50,000
TPF-5(468)	<u>Structural Behavior of Ultra-High Performance Concrete</u>	FHWA	Scot Larson	9	\$10,000	\$50,000
TPF-5(474)	<u>Bridge Deck Preservation Portal</u>	IA	Sarah Sondag	7	\$20,000	\$60,000
TPF-5(480)	<u>Building Information Modeling (BIM) for Infrastructure</u>	IA	Benjamin Jilk	20	\$37,500	\$150,000
TPF-5(486)	<u>Center for the Aging Infrastructure: Steel Bridge Research, Inspection, Training and Education Engineering Center (SBRITE) (Continuation)</u>	IN	Kevin Western	15	\$30,000	\$150,000
TPF-5(503)	<u>Standardizing Rigid Inclusions for Transportation Projects—Phase I</u>	KS	Richard Lamb	7	\$30,000	\$60,000
TPF-5(508)	<u>Concrete Bridge Engineering Institute (CBEI)</u>	TX	Karl Johnson	9	\$50,000	\$200,000

ENVIRONMENTAL

Report Number	Title	End Date	Investigator	Technical Liaison	Total Cost
2022-10	<u>INV 1060: Reuse of Regional Waste in Sustainably Designed Soils</u>	7/31/22	David Saftner, University of Minnesota Duluth	Dwayne Stenlund	\$197,406
2022-16S, 2022-16	<u>INV 1038: Regional Optimization of Roadside Turfgrass Seed Mixtures—Phase II: Regional Field Trials and Economic Analysis</u>	8/31/22	Eric Watkins, University of Minnesota	Dwayne Stenlund	\$467,139
2022-27A	<u>INV 1063: Evaluation of Environmental Impacts of Potassium Acetate Used as a Road Salt Alternative</u>	7/31/22	John Gulliver, University of Minnesota	Nicklas Tiedeken	\$214,743
2022-30	<u>INV 1084: Cost-Effective Roadside Revegetation Methods to Support Insect Pollinators</u>	8/31/22	Emilie Snell-Rood, University of Minnesota	Dan MacSwain, Christopher Smith	\$281,412
2023-12	<u>Assessing a Solar Project and a Virtual Power Purchase Agreement Between the Red Lake Nation and the Minnesota Department of Transportation</u>	3/31/23	Gabriel Chan, University of Minnesota	Siri Simons	\$25,000
2023-20	<u>Turfgrass Seed Variety Evaluation Process</u>	5/31/23	Eric Watkins, University of Minnesota	Warren Tuel	\$59,460
2023-21	<u>MP-20(006): Climate Change Adaptation of Urban Stormwater Infrastructure</u>	6/30/23	John Gulliver, University of Minnesota	Erik Brenna	\$224,997
2023-25	<u>INV 1077: Stormwater Pond Maintenance and Wetland Management for Phosphorus Retention</u>	6/30/23	John Gulliver, University of Minnesota	Ross Bintner	\$247,237

ENVIRONMENTAL [cont.]

Report Number	Title	End Date	Investigator	Technical Liaison	Total Cost
TRS2305	<u>Transportation Options and VMT Reduction Field Scan</u>	7/31/23	Chris McCahill, University of Wisconsin–Madison	Nissa Tupper	\$58,380
	<u>TPF-5(362): Improvements to the Infrastructure Carbon Estimator (ICE)</u>	5/7/23	Jeffrey Ang-Olson, ICF Incorporated, LLC	Timothy Sexton	\$504,989
	<u>INV 645: Best Practices for Dust Control/Issues with CaCl</u>	11/30/23	Michael Marti, SRF Consulting Group, Inc.	Bruce Hasbargen	\$64,718
	<u>MP-20(009): Effect of Increased Precipitation (Heavy Rain Events) on Minnesota Pavement Foundations</u>	11/30/23	Halil Ceylan, Iowa State University	Raul Velasquez	\$170,000
	<u>MP-21(002): Identifying Deer-Vehicle Collision Concentrations in Minnesota</u>	11/30/23	Raphael Stern, University of Minnesota	Christopher Smith	\$165,450
	<u>Culture Building and Behavior Change Strategies for Vehicle Miles Traveled (VMT) Reduction</u>	2/28/24	Stefanie Brodie, Toole Design Group	Nissa Tupper	\$39,696
	<u>INV 645: Boulevard Tree Selection—Best Practice</u>	5/31/24	Susan Miller, SRF Consulting Group, Inc.	Jen Desrude	\$54,741
	<u>INV 1108: Update of Stormwater Management—Best Practices Manual (from 2009)</u>	6/30/24	Andrew Erickson, University of Minnesota	Brian Giese	\$126,895
	<u>MP-22(007): Assessing a New Tool for Early Detection of Endangered Turtles on Proposed Transportation Projects</u>	6/30/24	Mark Davis, University of Illinois	Christopher Smith	\$251,676
	<u>INV 1120: Reuse of Minnesota Waste Material in Sustainably Design Soils—Part II</u>	9/30/24	David Saftner, University of Minnesota Duluth	Dwayne Stenlund	\$186,280
	<u>MP-22(006): Statistical and Process-Based Models of Stormwater Treatment Basin Aging to Quantify Infiltration Rate Sustainability and Maintenance Intervals</u>	11/30/24	Anthony Parolari, Marquette University	Dwayne Stenlund, Steven Gebauer	\$199,128
	<u>INV 1094: Comparison of Compost and Proprietary Soil Amendments for Vegetation Establishment</u>	3/31/25	Bora Cetin, Michigan State University	Warren Tuel	\$380,500
	<u>INV 1115: Addressing the Research Needs for the Sustainable Application of TDA in Stormwater Infiltration/Treatment</u>	6/30/25	John Gulliver, University of Minnesota	Mark Hansen	\$257,765
	<u>TPF-5(466): Use of Carbon Dioxide for Sustainable and Resilient Concrete Pavements</u>	1/31/26	Peter Taylor, Iowa State University	Bernard Izevbehai	\$150,000
	<u>Development of Erosion Control Product Longevity Test Methodology</u>	6/30/26	John Chapman, University of Minnesota	Dwayne Stenlund	\$300,665
	<u>MP-22(008): Regional Optimization of Roadside Turfgrass Seed Mixtures—Phase III</u>	7/31/26	Eric Watkins, University of Minnesota	Dwayne Stenlund	\$275,928

Environmental Pooled Fund Study

Study Number	Title	Lead State or Agency	Technical Liaison	Number of Participating Agencies	2023 MnDOT Contribution	Total MN Contribution
TPF-5(460)	<u>Flood-Frequency Analysis in the Midwest: Addressing Potential Nonstationary Annual Peak-Flow Records</u>	SD	Andrea Hendrickson	8	\$55,600	\$222,400

MAINTENANCE OPERATIONS

Report Number	Title	End Date	Investigator	Technical Liaison	Total Cost
2023-03, 2023-03A	<u>MP-18(010): Reducing Winter Maintenance Equipment Fuel Consumption Using Advanced Vehicle Data Analytics: Appendices</u>	1/31/23	Will Northrop, University of Minnesota	Joseph Huneke	\$202,273
2023-27	<u>INV 1065: Implementation of Lane Boundary Guidance System for Snowplow Operations</u>	6/30/23	Max Donath, University of Minnesota	Daniel Rowe	\$733,034
2023-31	<u>MOR/Operations: Evaluation of Slurry Box, Underbody Scraper and Two-Way Reversible Plow</u>	8/31/23	Brian Hirt, CTC & Associates, LLC	Thomas Peters	\$83,317
2023RIC01	<u>INV 645: Best Practices for Improving Subgrade Drainage</u>	10/31/22	Susan Miller, SRF Consulting Group, Inc.	John Brunkhorst	\$49,014
2023RIC04	<u>INV 645: Cost-Effectiveness of Various Pavement Markings</u>	4/30/23	Michael Marti, SRF Consulting Group, Inc.	Jon Pratt	\$59,077
2023RIC05	<u>INV 645: Crack Treatments for Local Agencies</u>	4/30/23	Michael Marti, SRF Consulting Group, Inc.	Daniel Knappek	\$79,549
2023RIC06	<u>INV 645: Culvert Type Evaluation: Concrete vs. Plastic vs. Corrugated Metal</u>	6/30/23	Michael Marti, SRF Consulting Group, Inc.	Karin Grandia	\$52,756
2023RIC08	<u>INV 645: Drainage 101—County Roadways, City Streets and Drainage Ways: Best Practices and Resources Guide</u>	7/31/22	Tim Arvidson, Stonebrooke Engineering, Inc.	Steven Bot	\$85,329
	<u>Relative Milling Method: Relative Milling Depth Surface Model Development</u>	11/30/22	Kyle Klasen, WSB & Associates, Inc.	Rebecca Embacher	\$99,930
	<u>TPF-5(353): High-Performance Blade Evaluation</u>	1/31/23	William Schneider, University of Akron	Thomas Peters	\$195,747
	<u>TPF-5(353): Expanded Use of AVL/GPS Technology</u>	2/28/23	Ming Shiun Lee, AECOM Technical Services, Inc.	Thomas Peters	\$73,124
	<u>TPF-5(353): Evaluation of Electric Vehicle Technologies and Alternative Fuels for Winter Operations</u>	3/31/23	Kate Vigneau, Matrix Consulting Group, Ltd.	Thomas Peters	\$74,995
	<u>INV 645: Snowplow Optimization and GPS/AVL on Maintenance Equipment</u>	5/31/23	Susan Miller, SRF Consulting Group, Inc.	Joe MacPherson	\$94,440
	<u>TPF-5(353): Clear Roads Administration, Research Support and Information Services</u>	6/30/23	Brian Hirt, CTC & Associates, LLC	Thomas Peters	\$1,238,596
	<u>TPF-5(353): Salt Shed Design Template</u>	7/31/23	Wilfrid A. Nixon and Associates, LLC	Thomas Peters	\$125,000
	<u>INV 645: Ride Quality of Asphalt Pavements</u>	9/30/23	Michael Marti, SRF Consulting Group, Inc.	Joe Triplett	\$99,577
	<u>TPF-5(353): Clear Roads II Standard Test Procedure for Ice Melting Capacity of Deicers</u>	9/30/23	Xianming Shi, Washington State University	Thomas Peters	\$75,000
	<u>TPF-5(353): Efficacy, Cost and Impacts of Non-Chloride Deicers: An Educational Primer and Product Information Sheets</u>	9/30/23	Laura Fay, Western Transportation Institute	Thomas Peters	\$114,946
	<u>TPF-5(353): Using GIS to Highlight Highway Segments Sensitive to Deicing Materials</u>	9/30/23	Erik Minge, SRF Consulting Group, Inc.	Thomas Peters	\$142,430
	<u>INV 645: Cutting Edges—Performance User’s Guide</u>	11/30/23	Susan Miller, SRF Consulting Group, Inc.	Joe Wiita	\$52,169
	<u>INV 645B: Roadway Pavement Maintenance 101</u>	11/30/23	Rick West, Stonebrooke Engineering, Inc.	Christopher Cheney	\$59,988
	<u>TPF-5(466): Thinlays as Preventive Maintenance Treatment</u>	12/31/23	Andrea Blanchette, Terracon Consultants, Inc.	Joel Ulring	\$49,918

MAINTENANCE OPERATIONS [cont.]

Report Number	Title	End Date	Investigator	Technical Liaison	Total Cost
	<u>TPF-5(353): Training Module Development for Evaluation of Storm Severity Index (SSI) and Winter Severity Index (WSI) Variables</u>	1/31/24	Randeep Kaur Sethi, Focus EduSolutions, Inc.	Thomas Peters	\$31,585
	<u>TPF-5(353): Calculating Plow Cycle Times from AVL Data</u>	4/1/24	Ming Shiun Lee, AECOM Technical Services, Inc.	Thomas Peters	\$125,378
	<u>TPF-5(353): Determining the Migration of Chloride-Based Deicers Through Different Soil Types</u>	5/31/24	Xianming Shi, Washington State University	Thomas Peters	\$99,978
	<u>Harnessing Solar Energy Through Solar Snow Fence: Implementation</u>	6/30/24	Mijia Yang, North Dakota State University	Daniel Gullickson	\$187,201
	<u>TPF-5(479): 22-05 Use of Dashboards for Winter Operations</u>	6/30/24	Ming Shiun Lee, AECOM Technical Services, Inc.	Thomas Peters	\$74,477
	<u>TPF-5(353): Grip Sensor Technology and Salt Applications</u>	8/31/24	Laura Fay, Western Transportation Institute	Thomas Peters	\$149,977
	<u>TPF-5(353): Update to CR 13-04: Best Practices for Protecting DOT Equipment from the Corrosive Effect of Chemical Deicers</u>	8/31/24	Xianming Shi, Washington State University	Thomas Peters	\$99,985
	<u>MP-22(004): Effective Strategies to Extend Remaining Life of ASR-Affected Pavements</u>	12/31/24	Fatih Bektas, Minnesota State University, Mankato	Greg Ous	\$135,544

Maintenance Operations Pooled Fund Studies

Study Number	Title	Lead State or Agency	Technical Liaison	Number of Participating Agencies	2023 MnDOT Contribution	Total MN Contribution
TPF-5(347)	<u>Development of Maintenance Decision Support System</u>	SD	Joseph Huneke	15	\$30,000	\$364,200
TPF-5(380)	<u>Autonomous Maintenance Technology (AMT)</u>	CO	Robert Vasek	16	\$0	\$100,000
TPF-5(479)	<u>Clear Roads Winter Highway Operations—Phase III</u>	MN	Thomas Peters	39	\$25,000	\$125,000

MATERIALS & CONSTRUCTION

Report Number	Title	End Date	Investigator	Technical Liaison	Total Cost
2023-19	<u>INV 1104: Cost Estimate of B vs. C Grade Asphalt Binders</u>	6/30/23	Mihai Marasteanu, University of Minnesota	Jed Nordin	\$171,777
2023-34	<u>INV 1069: Optimizing Asphalt Mixture Designs for Low-Volume Roads of Minnesota</u>	8/31/23	Manik Barman, University of Minnesota Duluth	Joel Ulring	\$161,333
2023-35	<u>INV 1101: Best Management Practices for Issues with Asphalt Centerline Joint and Intelligent Compaction for Local Agencies</u>	10/31/23	Syed Haider, Michigan State University	Naomi Eckerd	\$192,622
2023RIC03	<u>INV 645: Mitigating Projects Missing Deadlines</u>	3/31/23	Justin Bossert, WSB & Associates, Inc.	Michael Flaagan	\$42,620
NRRA202204	<u>TPF-5(341): NRRA: Enhanced Entrained Air Void System Characterization for Durable Highway Concrete</u>	9/30/22	Anthony Torres, Texas State University	Thomas Burnham	\$100,000

MATERIALS & CONSTRUCTION [cont.]

Report Number	Title	End Date	Investigator	Technical Liaison	Total Cost
NRRA202302	<u>TPF-5(341): Asphalt Real-Time Smoothness for Asphalt Paving</u>	2/28/23	George Chang, The Transtec Group, Inc.	John Siekmeier	\$104,021
NRRA202303	<u>TPF-5(341): NRRA: Impact of Polymer Modification on IDEAL-CT and I-FIT for Cracking Resistance Evaluation of Asphalt Mixtures</u>	11/30/22	Fan Yin, Auburn University	Michael Vrtis	\$100,000
NRRA202304	<u>TPF-5(341): Evaluation of Levels 3-4 Intelligent Compaction Measurement Values (ICMV) for Soils Subgrade and Aggregate Subbase Compaction</u>	3/31/23	George Chang, The Transtec Group, Inc.	John Siekmeier	\$162,024
NRRA202306	<u>TPF-5(341): Biomaterial Maintenance Treatments</u>	9/30/23	Christopher Williams, Iowa State University	Gerard Geib	\$50,000
NRRA202307	<u>TPF-5(341): Continuous Moisture Measurement During Pavement Foundation Construction</u>	8/31/23	Soheil Nazarian, University of Texas—El Paso	Terrence Beaudry	\$100,000
	<u>MP-22(005): A Synthesis of Usage and Performance of Daylighted Bases in Comparison to Edge Drains</u>	9/30/23	Bora Cetin, Michigan State University	Bernard Izevbekhai	\$84,997
	<u>TPF-5(341): R1.40 Asphalt Pavement Milling Best Practices Through Enhanced Understanding of Milling Process</u>	10/31/23	Eshan Dave, University of New Hampshire	John Siekmeier	\$100,000
	<u>INV 645: Pavement Design Around Utilities—Best Practice</u>	12/31/23	Jeff Stempihar, Nichols Engineering Consultants	Tom Trowbridge	\$51,194
	<u>TPF-5(375): MnROAD/NCAT Joint Study: National Partnership to Determine the Life-Extending Benefit Curves of Pavement Preservation</u>	12/31/23	Adriana Vargas-Nordbeck, Auburn University	Gerard Geib	\$2,695,545
	<u>TPF-5(443): Density Profiling System (DPS) Pooled Fund Study Data Statistical Analysis and Protocol Recommendations</u>	12/31/23	Jo Sias, University of New Hampshire	Kyle Hoegh	\$163,234
	<u>INV 1070: Base Stabilization Additives: Effect on Granular Equivalency</u>	5/31/24	Halil Ceylan, Iowa State University	Chad Hausman	\$197,864
	<u>INV 1107: Evaluation of Gravel Stabilizer Used on Gravel Roads and Gravel Shoulders</u>	6/30/24	Bora Cetin, Michigan State University	Terrence Beaudry	\$193,687
	<u>INV 1117: Mitigation of Tenting of Transverse Cracks and Joints in Asphalt Pavement</u>	6/30/24	Manik Barman, University of Minnesota Duluth	Matthew Hemmila	\$150,900
	<u>INV 1095: Benefits of Preventive Maintenance</u>	7/31/24	Basak Aldemir Bektas, Minnesota State University, Mankato	Joel Ulring	\$157,926
	<u>TPF-5(341): R1.21 Long-Term Testing and Analysis on Asphalt Mix Rejuvenator Field Sections</u>	8/31/24	Jo Sias, University of New Hampshire	Michael Vrtis	\$148,981
	<u>MP-22(003): Development of Process to Lower Global Warming Potential of Construction Materials</u>	10/31/24	Amlan Mukherjee, Michigan Technological University	Curt Turgeon	\$260,278
	<u>TPF-5(341): R1.22 Analysis of Long-Term Field Performance of Spray-On Rejuvenators</u>	10/31/24	Raquel Moraes, Auburn University	Michael Vrtis	\$133,912

MATERIALS & CONSTRUCTION [cont.]

Report Number	Title	End Date	Investigator	Technical Liaison	Total Cost
	<u>INV 1110: Improving and Developing Pavement Design Inputs and Performance Functions for Cold Recycled Pavement Layers in Minnesota</u>	11/30/24	Eshan Dave, University of New Hampshire	Timothy Andersen	\$163,943
	<u>INV 1103: Evaluation of Proprietary Rejuvenators</u>	12/31/24	Muhammed Kutay, Michigan State University	JinYeene Neumann	\$199,336
	<u>TPF-5(466): Validation of Loose Mix Aging Procedures for Cracking Resistance Evaluation in Balanced Mix Design</u>	12/31/24	Fan Yin, Auburn University	Joseph Podolsky	\$100,000
	<u>INV 1112: Asphalt Pavement Cracking Performance Data Analysis</u>	3/31/25	Eshan Dave, University of New Hampshire	Shongtao Dai, Joseph Voels	\$130,993
	<u>TPF-5(466): Reclamation and Recycling Techniques to Achieve Perpetual Pavement Characteristics</u>	3/31/25	Mohammad Sabouri, Braun Intertec Corporation	Emil Bautista	\$150,002
	<u>MP-21(001): Bridge Low Slump Concrete Overlay Mix Design for Mobile Mixers</u>	6/30/25	Tyler Ley, Oklahoma State University	Kyle Fritz, Jacob Gave	\$354,612
	<u>TPF-5(466): Veta Enhancements for MDMS Standardized and Web Conversion</u>	6/30/25	George Chang, The Transtec Group, Inc.	Rebecca Embacher	\$1,895,830
	<u>TPF-5(466): Use of Alternative Pozzolanic Materials Toward Reducing Cement Content in Concrete Pavements</u>	4/30/26	Margot Yapp, Nichols Consulting Engineers	Maria Masten	\$175,000
	<u>TPF-5(466): The Use of Alternative Cementitious Materials in Concrete Pavements</u>	3/31/27	Prashant Ram, Applied Pavement Technology, Inc.	Thomas Burnham	\$150,000

Materials & Construction Pooled Fund Studies

Study Number	Title	Lead State or Agency	Technical Liaison	Number of Participating Agencies	2023 MnDOT Contribution	Total MN Contribution
TPF-5(375)	<u>National Partnership to Determine the Life-Extending Benefit Curves of Pavement Preservation (MnROAD/ NCAT Joint Study)</u>	MN	Benjamin Worel	22	\$50,000	\$300,000
TPF-5(437)	<u>Technology Transfer Concrete Consortium</u>	IA	Maria Masten	35	\$12,000	\$60,000
TPF-5(443)	<u>Continuous Asphalt Mixture Compaction Assessment Using Density Profiling System (DPS)</u>	MN	Kyle Hoegh	14	\$0	\$100,000
TPF-5(448)	<u>Integrating Construction Practices and Weather Into Freeze-Thaw Specifications</u>	OK	Maria Masten	14	\$0	\$60,000
TPF-5(466)	<u>National Road Research Alliance (NRR)—Phase II</u>	MN	Glenn Engstrom	12	\$150,000	\$750,000
TPF-5(504)	<u>Continuous Bituminous Pavement Stripping Assessment Through Non-Destructive Testing</u>	MN	Eyoab Zegeye	7	\$25,000	\$125,000
TPF-5(522)	<u>Improving the Quality of Preventive Maintenance Treatment Construction and Data Collection Practices</u>	MN	Joel Ulring	9	\$50,000	\$250,000

MULTIMODAL

Report Number	Title	End Date	Investigator	Technical Liaison	Total Cost
2022-33	<u>Assessing the Economic Effects of Context-Sensitive Main Street Highways in Small Cities</u>	9/30/22	Camila Fonseca-Sarmiento, University of Minnesota	Nissa Tupper	\$190,897
2023-02	<u>MP-21(003): Identify Best Types of Commodity Flow Data for Freight, Railroad, Ports and Waterways Studies</u>	12/31/22	Camila Fonseca-Sarmiento, University of Minnesota	Andrew Andrusko	\$114,914
2023-08	<u>INV 1096: Rural Community Transit Strategies: Building Upon, Expanding and Enhancing Existing Assets and Programs</u>	2/28/23	Thomas Fisher, University of Minnesota	Matti Gurney	\$173,929
2023-11	<u>INV 1081: Pedestrian Engineering and Enforcement at Signalized Intersection</u>	3/31/23	Nichole Morris, University of Minnesota	Amber Dallman	\$270,520
2023-16	<u>Understanding Post-COVID Safety Concerns Toward the Use of Transit and Shared Mobility in Greater Minnesota</u>	4/30/23	Yingling Fan, University of Minnesota	Elliott McFadden	\$120,000
2023-18	<u>MP-21(004): Designing and Implementing Maintainable Pedestrian Safety Countermeasures</u>	6/30/23	David Veneziano, Iowa State University	Jacob Rueter, Timothy Mitchell	\$79,554
2023-24	<u>INV 1082: Guidelines for Safer Pedestrian Crossings: Understanding the Factors That Positively Influence Vehicle Yielding to Pedestrians at Unsignalized Intersections</u>	6/30/23	Raphael Stern, University of Minnesota	Hannah Pritchard	\$165,278
2023-28, 2023-28A	<u>MP-21(010): Maximizing Transportation Assets by Building Community Connection Through Innovative Deployment of Rights of Way and Airspace: Appendices</u>	6/30/23	Frank Douma, University of Minnesota	Lisa Austin	\$70,000
	<u>TPF-5(455): National Accessibility Evaluation—Phase II</u>	12/31/25	Eric Lind, University of Minnesota	Deanna Belden	\$2,106,000

Multimodal Pooled Fund Studies

Study Number	Title	Lead State or Agency	Technical Liaison	Number of Participating Agencies	2023 MnDOT Contribution	Total MN Contribution
TPF-5(315)	<u>National Accessibility Evaluation</u>	MN	Deanna Belden	14	\$0	\$226,000
TPF-5(396)	<u>Mid-America Freight Coalition (MAFC)—Phase III</u>	WI	Andrew Andrusko	10	\$0	\$148,000
TPF-5(455)	<u>Access Across America: National Accessibility Evaluation—Phase II</u>	MN	Deanna Belden	12	\$36,000	\$216,000
TPF-5(509)	<u>Mid-America Freight Coalition (MAFC)—Phase IV</u>	WI	Andrew Andrusko	10	\$52,000	\$156,000

POLICY & PLANNING

Report Number	Title	End Date	Investigator	Technical Liaison	Total Cost
2022-07	<u>MP-20(010): MnDOT Innovation Strategy</u>	6/30/23	Andy Zimney, Employee Strategies, Inc.	Catherine Walker	\$117,636
2023-10	<u>MP-21(008): Advancing Equity in Accessibility and Travel Experiences: The Role of Gender and Identity</u>	5/31/23	Ying Song, University of Minnesota	Hally Turner	\$119,799
2023-14	<u>MP-20(008): Qualitative and Quantitative Analysis to Advance Transportation</u>	4/30/23	Zachary Elgart, Texas A&M Transportation Institute	Hally Turner	\$130,500
2023-15	<u>MP-21(005): Enhancing Managed Lanes Equity Analysis</u>	4/30/23	Adeel Lari, University of Minnesota	Bradley Larsen	\$171,788
2023-29	<u>Identifying and Optimizing Electric Vehicle Corridor Charging Infrastructure for Medium- and Heavy-Duty Trucks</u>	6/30/23	Alireza Khani, University of Minnesota	Siri Simons, Anna Pierce	\$174,832
2023-30	<u>MP-21(007): The Effects of Highway Improvement Projects on Nearby Business Activity</u>	8/31/23	Yingling Fan, University of Minnesota	Kimberly Zlimen	\$100,000
2023-32	<u>MP-21(006): Centering the Margins: The Transportation Experience of Underserved Communities</u>	9/30/23	Yingling Fan, University of Minnesota	Lisa Austin	\$149,648
2023-33	<u>Transportation Equity Video</u>	7/31/23	Frank Douma, University of Minnesota	Abdullahi Abdulle	\$115,000
TRS2201	<u>TRS: The Health and Transportation Nexus: A Conceptual Framework for Collaborative Health and Transportation Planning</u>	8/31/22	Yingling Fan, University of Minnesota	Nissa Tupper	\$46,361
	<u>Human-Centered Design Webinar</u>	5/1/23	Andy Zimney, Employee Strategies, Inc.	Catherine Walker	\$2,750
	<u>MP-22(010): Research Program Strategic Plan</u>	12/31/23	Donald Ludlow, CPCS Transcom, Inc.	Catherine Walker	\$150,000
	<u>INV 645: Using Apps to Notify the Public of Local Road and Bridge Closures</u>	3/31/24	Dean Deeter, Athey Creek Consultants, LLC	Perry Clark	\$51,535
	<u>INV 645: Right of Way Acquisition Issues</u>	5/31/24	Michael Marti, SRF Consulting Group, Inc.	Ryan Thilges	\$76,889
	<u>INV 1102: MnDOT Haul/Detour Routes: Impacts on Local Roads</u>	6/30/24	Bora Cetin, Michigan State University	Tim Stahl	\$184,389
	<u>Utilizing Arts and Culture to Mitigate the Negative Impacts of Transportation Infrastructure on Communities</u>	6/30/24	Julie Cidell, University of Illinois	Jessica Oh	\$235,702
	<u>Grand Rapids Autonomous Vehicle Project (goMARTI): Data and Research Support</u>	7/31/24	Gina Baas, University of Minnesota-CTS	Thomas Johnson-Kaiser	\$109,105
	<u>INV 645: Asset Management Tools for Local Governments</u>	7/31/24	Michael Marti, SRF Consulting Group, Inc.	Lyndon Robjent	\$102,411
	<u>INV 1118: Haul Road and Detour Maintenance</u>	8/31/24	Mihai Marasteanu, University of Minnesota	Timothy Andersen	\$153,003

Policy & Planning Pooled Fund Study

Study Number	Title	Lead State or Agency	Technical Liaison	Number of Participating Agencies	2023 MnDOT Contribution	Total MN Contribution
TPF-5(453)	<u>Automated Vehicle Pooled Fund Study</u>	OH	Cory Johnson	9	\$50,000	\$250,000

TRAFFIC & SAFETY

Report Number	Title	End Date	Investigator	Technical Liaison	Total Cost
2022-03	<u>MP-19(008): Can Automated Vehicles “See” in Minnesota? Ambient Particle Effects on LiDAR</u>	8/31/22	Will Northrop, University of Minnesota	Robert Chaucierre	\$235,840
2022-24	<u>INV 1061: Toward Implementation of Max-Pressure Signal Timing on Minnesota Roads</u>	1/31/23	Michael Levin, University of Minnesota	Ben Hao	\$177,000
2023-04	<u>MP-19(005): Work Zone Intrusion Mobile Application</u>	2/29/24	Brian Davis, University of Minnesota	Steven Blaufuss	\$386,653
2023-05	<u>Evaluation and Refinement of Minnesota Queue Warning Systems</u>	3/31/23	John Hourdos, University of Minnesota	Garrett Schreiner	\$254,187
2023-06	<u>Cost/Benefit Analysis of Fuel-Efficient Speed Control Using Signal Phasing and Timing (SPaT) Data: Evaluation for Future Connected Corridor Deployment</u>	3/31/23	Michael Levin, University of Minnesota	Daniel Rowe	\$218,287
2023-09	<u>INV 1048: Criteria and Guidelines for Three-Lane Road Design and Operation</u>	2/28/23	Gary Davis, University of Minnesota	KC Atkins	\$155,559
2023-17	<u>INV 1075: Transverse Rumble Strips at Rural Intersections</u>	4/30/23	Shauna Hallmark, Iowa State University	Victor Lund	\$181,686
2023-22	<u>INV 1085: Impact of Speed Limit Changes on Urban Streets</u>	6/30/23	Gary Davis, University of Minnesota	Victor Lund	\$156,561
2023-23	<u>INV 1092: Influence of Autonomous and Partially Autonomous Vehicles on Minnesota Roads</u>	5/31/23	Rajesh Rajamani, University of Minnesota	Victor Lund	\$88,896
2023-26	<u>INV 1091: User-Centered Smart Traffic Sign Development Study</u>	6/30/25	Nichole Morris, University of Minnesota	Wayne Sandberg	\$435,851
2023RIC02	<u>INV 645: Guidelines for Using Intelligent Warning Devices</u>	11/30/22	Rena Kuehl, SRF Consulting Group, Inc.	Justin Femrite	\$46,128
2023RIC07	<u>INV 645: Guidelines for Determining Speed Limits on Municipal Roadways</u>	9/30/23	Tim Arvidson, Stonebrooke Engineering, Inc.	William Manchester	\$76,963
TRS2301	<u>School Zone Speed Limits (SZSLs): Effectiveness of SZSLs in Reducing Vehicle Speeds, Crash Severity and Crash Frequency</u>	1/31/23	Heather Kienitz, Short Elliott Hendrickson, Inc.	Mark Wagner	\$28,627
TRS2303	<u>Speed Safety Cameras</u>	1/31/23	Heather Kienitz, Short Elliott Hendrickson, Inc.	Mark Wagner	\$29,711
	<u>TPF-5(376): North/West Passage Freight Task Force—Year 6</u>	6/30/23	Erika Witzke, CPCS Transcom, Inc.	Cory Johnson	\$93,362
	<u>TPF-5(376): FY22 Program Support Services for the North/West Passage Pooled Fund Research Program</u>	7/31/22	Dean Deeter, Athey Creek Consultants, LLC	Cory Johnson	\$100,417
	<u>TPF-5(376): FY23 Program Support Services for the North/West Passage Phase IV Pooled Fund</u>	7/31/23	Athey Creek Consultants, LLC	Cory Johnson	\$99,681
	<u>Pavement Marking Patterns and Widths: Human Factors Study</u>	10/31/23	Adam Pike, Texas A&M Transportation Institute	Ethan Peterson	\$208,890
	<u>INV 645: Mini-Roundabout FAQs</u>	11/30/23	Michael Marti, SRF Consulting Group, Inc.	Jon Pratt	\$64,453
	<u>INV 1076: Driver Comprehension of Flashing Yellow Arrows</u>	12/31/23	Gary Davis, University of Minnesota	Victor Lund	\$213,656
	<u>INV 1080: Assessing Pavement Markings for Automated Vehicle Readiness</u>	12/31/23	Adam Pike, Texas A&M Transportation Institute	Ethan Peterson	\$228,183
	<u>INV 1119: Evaluation of Static and Dynamic No Right Turn on Red Signs at Traffic Signals</u>	12/31/23	Christopher Day, Iowa State University	Susan Zarling	\$81,782
	<u>Assessment of Pedestrian Safety and Driver Behavior Near an Automated Vehicle</u>	1/31/24	Nichole Morris, University of Minnesota	Cory Johnson	\$241,816

TRAFFIC & SAFETY [cont.]

Report Number	Title	End Date	Investigator	Technical Liaison	Total Cost
	<u>Vehicle-Mounted Debris Removal Tool</u>	1/31/24	Dean Deeter, Athey Creek Consultants, LLC	John McClellan	\$24,960
	<u>INV 1098: Pavement Marking/Colored Pavement Friction Differential and Product Durability</u>	2/28/24	Mihai Marasteanu, University of Minnesota	Ethan Peterson	\$152,473
	<u>TPF-5(376): North/West Passage Website Maintenance</u>	2/29/24	Patrick Nichols, North Dakota State University	Cory Johnson	\$20,844
	<u>INV 1113: Toward Implementation of Max-Pressure Control on Minnesota Roads—Phase II</u>	4/30/24	Raphael Stern, University of Minnesota	Ben Hao	\$145,034
	<u>Implementing Inductive Loop Signature Technology for Vehicle Classification Counts</u>	5/31/24	Erik Minge, SRF Consulting Group, Inc.	Gene Hicks	\$77,728
	<u>INV 1099: Performance Evaluation of Different Detection Technologies for Signalized Intersections in Minnesota</u>	5/31/24	Yao-Yi Chiang, University of Minnesota	Michael Fairbanks	\$179,950
	<u>Assessment of Travel-Time Reliability and Operational Resilience of Metro Freeway Corridors</u>	6/30/24	Eil Kwon, University of Minnesota Duluth	Michael Iacono	\$113,500
	<u>INV 1109: Complete Streets Speed Impacts</u>	6/30/24	Peter Savolainen, Michigan State University	Duane Hill	\$155,939
	<u>INV 1111: Identification and Assessment of Preventive Methods to Mitigate Cognitive and Physical Declines Which Influence Driving Performance of Older Drivers</u>	6/30/24	Nichole Morris, University of Minnesota	Derek Leuer	\$359,847
	<u>TPF-5(376): Program Support Services and Technical Writing for the North/West Passage Pooled Fund Research Program</u>	6/30/24	Tina Roelofs and Dean Deeter, Athey Creek Consultants, LLC	Cory Johnson	\$44,868
	<u>INV 1074: Taconite as a Lower Cost Alternative High-Friction Surface Treatment to Calcined Bauxite for Low-Volume Roads in Minnesota</u>	8/31/24	Mihai Marasteanu, University of Minnesota Duluth	Victor Lund	\$322,250
	<u>INV 1114: Development of a System to Report School Bus Stop-Arm Violations</u>	11/30/24	Brian Davis, University of Minnesota	Scot Edgeworth, Mike Krukowski	\$196,194
	<u>Understanding Risks and Opportunities for Ramp Metering Control in a Mixed-Autonomy Future</u>	11/30/24	Raphael Stern, University of Minnesota	Garrett Schreiner	\$148,495
	<u>INV 1121: Development and Demonstration of a Novel Red Light Running Warning System Using Connected V2I Technology</u>	12/31/24	Michael Levin, University of Minnesota	Victor Lund	\$258,010
	<u>INV 1105: Multi-Method Investigation of Pedestrian Safety Impacts of Right-Turn Lanes</u>	6/30/25	Curtis Craig, University of Minnesota	Bradley Estochen	\$200,696

Traffic & Safety Pooled Fund Studies

Study Number	Title	Lead State or Agency	Technical Liaison	Number of Participating Agencies	2023 MnDOT Contribution	Total MN Contribution
TPF-5(317)	<u>Evaluation of Low-Cost Safety Improvements</u>	FHWA	Derek Leuer	42	\$0	\$50,000
TPF-5(343)	<u>Roadside Safety Research for MASH Implementation</u>	WA	Khamsai Yang	28	\$0	\$350,000
TPF-5(376)	<u>North/West Passage—Phase IV</u>	MN	Cory Johnson	6	\$0	\$129,601
TPF-5(385)	<u>Pavement Structural Evaluation with Traffic Speed Deflection Devices (TSDDs)</u>	VA	Eyoab Zegeye	27	\$55,000	\$55,000

Traffic & Safety Pooled Fund Studies [cont.]

Study Number	Title	Lead State or Agency	Technical Liaison	Number of Participating Agencies	2023 MnDOT Contribution	Total MN Contribution
TPF-5(430)	<u>Midwest Roadside Safety Pooled Fund Program</u>	NE	Khamsai Yang	22	\$65,000	\$263,000
TPF-5(435)	<u>Aurora Program (FY2020-2024)</u>	IA	Joseph Huneke	19	\$25,000	\$125,000
TPF-5(438)	<u>Smart Work Zone Deployment Initiative (FY2020-2024)</u>	IA	Michelle Moser	9	\$25,000	\$50,000
TPF-5(444)	<u>Traffic Safety Culture—Phase II</u>	MT	Kristine Hernandez	20	\$10,000	\$50,000
TPF-5(451)	<u>Road User Charge (RUC) America</u>	OR	Christopher Berrens	23	\$25,000	\$25,000
TPF-5(487)	<u>Transportation Management Centers Pooled Fund Study—Phase II</u>	FHWA	John McClellan	23	\$25,000	\$150,000
TPF-5(489)	<u>Safety Service Patrol Standardization and Management Practices</u>	FHWA	John McClellan	17	\$25,000	\$125,000
TPF-5(490)	<u>Evaluating New Technologies for Roads Program Initiatives in Safety and Efficiency (ENTERPRISE)—Phase III</u>	MI	Cory Johnson	7	\$30,000	\$150,000
TPF-5(501)	<u>Roadside Safety Pooled Fund—Phase III</u>	WA	Khamsai Yang	27	\$65,000	\$195,000
TPF-5(506)	<u>North/West Passage Transportation Pooled Fund Study—Phase V</u>	MN	Cory Johnson	6	\$30,000	\$150,000
TPF-5(519)	<u>Enhanced Traffic Signal Performance Measures</u>	IN	Steven Misgen	9	\$40,000	\$120,000
TPF-5(520)	<u>Improving Traffic Detection Through New Innovative i-LST Technology Demonstration Pilot</u>	FHWA	Gene Hicks	18	\$15,000	\$30,000

ADMINISTRATIVE

Report Number	Title	End Date	Investigator	Technical Liaison	Total Cost
	INV 999: MnDOT Office of Research & Innovation Report Publication Services (FY2022-FY2023)	6/30/23	Arlene Mathison, University of Minnesota—CTS	Micaela Kranz	\$115,049
	INV 916: LRRB Technical Summaries (FY2022)	7/31/23	Brian Hirt, CTC & Associates, LLC	Micaela Kranz	\$29,679
	INV 936: LRRB Idea Solicitation and Need Statement Development	7/31/23	Michael Marti, SRF Consulting Group, Inc.	Kristine Elwood	\$99,979
	MP-19(007): MnDOT Technical Summaries (FY2022)	7/31/23	Brian Hirt, CTC & Associates, LLC	Micaela Kranz	\$63,450
	INV 1106: MnDOT/LRRB Joint Improvement Initiative: Evaluating and Communicating the Value of Research	9/30/23	Rahil Saeedi, CPCS Transcom, Inc.	Catherine Walker	\$99,966

ADMINISTRATIVE [cont.]

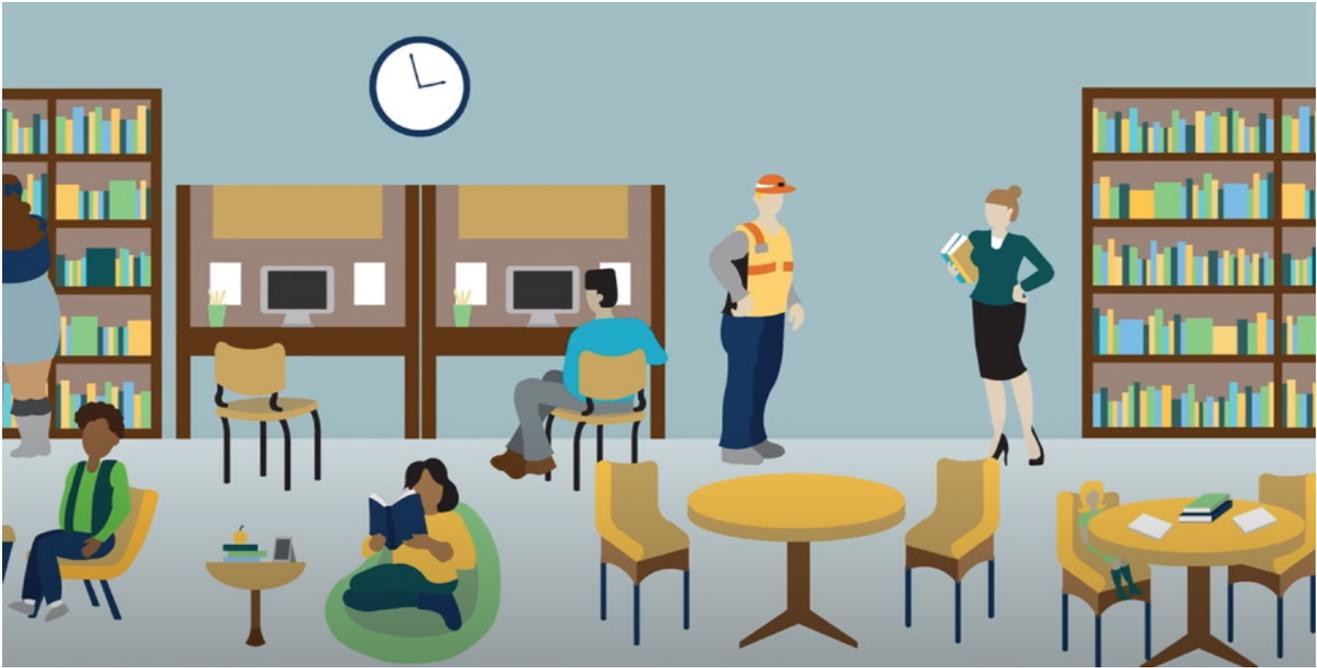
Report Number	Title	End Date	Investigator	Technical Liaison	Total Cost
	Research and Innovation Office Organizational Assessment	12/31/23	Karen Gaides, Minnesota Management and Budget	Catherine Walker	\$56,140
	<u>TPF-5(443): Communication Coordination and Reporting for Continuous Asphalt Mixture Compaction Assessment Using Density Profiling System (DPS) Pooled Fund</u>	12/31/23	Katie Johnson, CTC & Associates, LLC	Kyle Hoegh	\$98,858
	MP-22(009): MnDOT Technical Summaries (FY2023)	4/30/24	Mark Linsenmayer, CTC & Associates, LLC	Micaela Kranz	\$99,973
	Technology Transfer (T2) Material Development: R&I At-A-Glance, Other T2 Materials (FY2022-2024)	7/31/24	Brian Hirt, CTC & Associates, LLC	Micaela Kranz	\$99,996
	INV 916: LRRB Technology Summaries (FY2021)	7/31/24	Mark Linsenmayer, CTC & Associates, LLC	Julie Swiler	\$99,975

Federal Program Support

Study Number	Title	2023 MnDOT Contribution
TPF-5(422)	National Cooperative Highway Research Program Annual Contribution	\$906,213
TPF-5(496)	TRB Core Program Services for Highway RD&T Program (FFY2022)/TRB (State DOTs) (FY2023)	\$164,435
	AASHTO Technical Services Program: Transportation Performance Management (TPM) (FY2023)	\$37,560

DEDICATED PROGRAMS

Title	End Date	Investigator	Technical Liaison	Total Cost
<u>Center for Transportation Studies (CTS) Operations (FY2023-2024)</u>	6/30/23	Kyle Shelton, University of Minnesota-CTS	Catherine Walker	\$4,000,000
<u>INV 668: Local Technical Assistance Program (FFY2022)</u>	9/30/22	Stephanie Malinoff, University of Minnesota	Kristine Elwood	\$300,000
<u>INV 998: Operational Research Program for Local Transportation Groups (OPERA) (FY2021-2023)</u>	8/31/22	Mindy Carlson, University of Minnesota-CTS	Kristine Elwood	\$160,000
<u>INV 645B: LRRB Outreach and Marketing Support (2021-2022)</u>	9/30/22	Michael Marti, SRF Consulting Group, Inc.	Kristine Elwood	\$99,536
<u>INV 668: Local Technical Assistance Program (LTAP) (FY2023-2024)</u>	9/30/23	Stephanie Malinoff, University of Minnesota-CTS	Kristine Elwood	\$300,000
<u>INV 668: Local Technical Assistance Program (LTAP) Expanded Activities (FY2023-2024)</u>	6/30/24	Stephanie Malinoff, University of Minnesota-CTS	Kristine Elwood	\$660,000
<u>INV 645B: LRRB Outreach (FY2023)</u>	6/30/24	Michael Marti, SRF Consulting Group, Inc.	Kristine Elwood	\$172,973
MnDOT Research Librarian Services (2023-2024)	6/30/24	Arlene Mathison, University of Minnesota-CTS	Sheila Hatchell	\$87,458



MnDOT LIBRARY

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TRANSPORTATION RESEARCH SYNTHESIS

A Transportation Research Synthesis (TRS) helps answer your research questions without the time or expense of a full research project. These reports may summarize existing research or assess the state of practice through a practitioner survey. For more information, visit mndot.gov/research/TRS.html.

Effects of Legalization of Marijuana on Traffic Safety, a TRS currently in progress, will explore the potential impacts of legalizing recreational marijuana use on traffic safety. Researchers will target selected transportation agencies in states where recreational use is legal to examine any changes in traffic safety and impacts to law enforcement agencies. A review of the latest research on traffic safety will supplement these findings.



RESEARCH ACROSS MnDOT



MnDOT is preparing for a future with connected and automated vehicles. A 2022 video explains technology currently being evaluated, such as the auto-driving shuttles shown here.

In addition to the more than 170 local, state and federal transportation research projects administered annually through the MnDOT Office of Research & Innovation, the following MnDOT programs have in-house teams that conduct or sponsor specialized research:

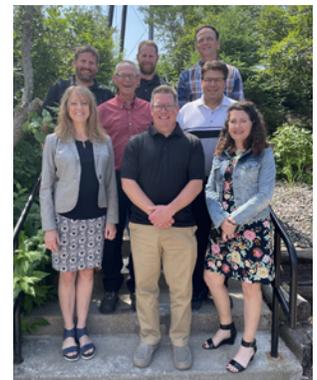
- Maintenance Operations Research
- MnROAD (Office of Materials & Road Research)
- Connected and Automated Vehicles
- Traffic Engineering

Learn more at mndot.gov/research.html.

LOCAL ROAD RESEARCH BOARD



Administered by the MnDOT Office of Research & Innovation, the LRRB has been bringing innovations to local Minnesota engineers since 1959. LRRB research ideas come from local Minnesota transportation professionals, either through the IdeaScale button at lrrb.org or at LRRB sessions during October State Aid prescreening meetings held around the state. MnDOT Office of Research & Innovation helps to identify existing solutions and formulate need statements to elicit project proposals. In December, the LRRB evaluates all proposals and makes funding selections.



JOIN A TECHNICAL ADVISORY PANEL

You can help shape research and innovation projects in your subject area by serving on a Technical Advisory Panel (TAP). Involvement may include a few meetings and assistance developing work plans and reviewing final deliverables.

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Crossroads Blog: Check out our recent stories on Minnesota transportation research at mntransportationresearch.org.



Presentations: Schedule a visit to learn how the research program or library can help your office or district.



Transportation Equity: How Can We Make Transportation Accessible to Everyone?

BY THE NUMBERS

 **35**
research ideas submitted

16 
qualified universities participated in our academic RFP


617
active Technical Advisory Panel members

14,456
e-newsletter subscribers



7,129 
library alert subscribers (email updates with new materials based on topic)



179
active and completed research projects during FY2023

27,222
transportation research blog visitors

 **8,030**
library information transactions


1,324
digital and print materials circulated



DEPARTMENT OF TRANSPORTATION
OFFICE OF RESEARCH & INNOVATION

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Minnesota Department of Transportation: mndot.gov

MnDOT Library: mndot.gov/library

Minnesota Local Road Research Board: lrrb.org