

We produced a software system, using existing and new traffic data, to analyze strategies to decrease traffic congestion in the metro area. [▶ Report 2022-01](#)



DEPARTMENT OF
TRANSPORTATION
OFFICE OF RESEARCH & INNOVATION

mndot.gov/research

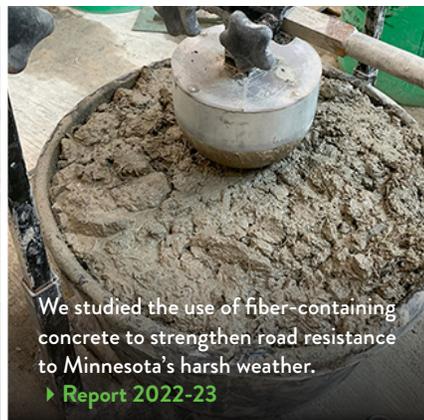
FY2022: JULY 1, 2021 – JUNE 30, 2022

RESEARCH AT-A-GLANCE

Informing, Improving and Innovating
Transportation in Minnesota



We connected with landowners and improved tools to promote the use of snow fences to keep roads clear of blowing snow. [▶ Report 2022-14](#)



We studied the use of fiber-containing concrete to strengthen road resistance to Minnesota's harsh weather. [▶ Report 2022-23](#)



We developed a new, cost-effective fence design to keep turtles and other small animals off the road. [▶ Report 2022-19](#)

DIRECTOR'S MESSAGE



This past year, our Office of Research & Innovation continued to provide research, finance, library and marketing services—accelerating national, state and local transportation research. We also welcomed six new staff members to our team.

Additionally, we accomplished a number of celebratory milestones, including the development of [MnDOT's Innovation Strategy](#), which will serve as an actionable roadmap for fostering and sustaining a culture of innovation. Moving toward implementation, we gathered participants from across the agency to discuss six topic areas: communication, recognition and reward, innovation pipeline and portfolio, professional development and training, leadership and strategic partnerships, and project selection and funding. Implementation groups generated over 200 ideas,

illuminating possibilities and challenges while also identifying a starting place for our work.

We also published the results of four COVID-19 research projects that explored the impacts of the pandemic on Minnesota's transportation system. Findings on [congestion relief](#), [public engagement](#), [speed and safety](#), and [workplace and workforce](#) reveal a unique snapshot in time and also provide valuable learnings for future disruptive events.

This next year, we look forward to continuing to ask transportation questions and finding solutions—keeping Minnesota moving.

Katie Walker, Director
MnDOT Office of Research & Innovation



MnDOT Library

Our librarians are experts at tracking down hard-to-find information and can keep you up to date in your field. Request a literature search, interlibrary loan, periodical or special publication at 651-366-3791, library.dot@state.mn.us or mndot.gov/library. Be sure to look at our new selection of [e-books](#)!

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.

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.

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 HIGHLIGHTS



SAFETY

Reducing Vehicle-Animal Collisions With Roadside Fencing



Fences were designed to redirect turtles back to the water or culvert connecting to their habitat on the other side of the road.

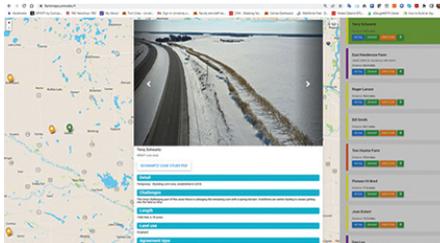
Small animals crossing the road create significant hazards for motorists, motorcyclists and bicyclists, who risk serious injury if they hit an animal. Pedestrians trying to assist the animals across the road are also at risk. At the same time, turtles are the world's most imperiled group of vertebrates, and roads are a primary threat. In collaboration with the Minnesota Zoo, researchers investigated a chain-link fence design using readily available and cost-effective materials, to keep turtles off the roads. With a **91% decrease in turtle mortality** where the fencing design was used, MnDOT will now have standard plans to use in projects to enhance both public safety and conservation. Watch a video about this project on the [MnDOT Research YouTube Channel](#).

Report 2022-19

Promoting the Adoption of Snow Fences Through Landowner Engagement

Preventing or decreasing blowing and drifting snow on the roadway saves significant resources on winter maintenance and equipment. Putting previous research into practice, MnDOT developed communication tools and methods to encourage and facilitate more landowners to use snow fences.

Report 2022-14



The Farmmaps tool allows landowners and other stakeholders to see locations, pictures and details of snow fences around the state. MnDOT district boundaries and truck stations are also included to inform winter maintenance planning.

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.



TRS2201, *The Health and Transportation Nexus: A Conceptual Framework for Collaborative and Equitable Planning*, provided a detailed overview of how transportation systems can support public health. In addition to physical and mental health, measures of social, behavioral and environmental health are considered. This framework aims to achieve equitable health and wellness—ensuring that certain populations are not disproportionately impacted by a transportation project.



ADVANCING EQUITY

Impacts of COVID on Telecommuting Practices



Work-at-home orders during the COVID-19 pandemic resulted in drastic reductions in traffic congestion. A new study investigated both employer and employee perspectives on telecommuting during and after the pandemic to better forecast future trends. Researchers found differences in telecommuting practices depending on workers' life circumstances, demographics and geographic locations. Findings will inform highway planning and telework polices. [Report 2022-05](#)

Relieving Congestion by Understanding COVID Travel Reductions

Highway congestion virtually disappeared in 2020 during the COVID-19 pandemic and gradually increased as the state reopened. By comparing 2020 traffic changes to pre-pandemic levels, researchers identified the relationship between traffic volumes and when and where congestion occurs. Investigators found that some disadvantaged groups experienced disproportionate congestion compared to others. Research results will inform investments in strategies to reduce problematic congestion areas. [Report 2022-09](#)



Knowing when traffic volume reaches the point where congestion occurs will allow traffic managers to better tailor reduction strategies.



ASSET MANAGEMENT

Strengthening Concrete to Withstand Minnesota's Harsh Weather



The box test determines how well cement holds its form once hardened.

Fiber-reinforced concrete can be stronger and more durable than regular concrete, performing better in Minnesota's harsh weather. Researchers performed a variety of tests on 57 fiber-containing concrete mixes, such as determining the workability of the concrete after vibration and measuring the air content of the wet cements, which

indicates resistance to freeze-thaw cycles. Demonstrating the characteristics concrete needs to ensure long-lasting pavements will help MnDOT reduce maintenance costs and improve road quality. [Report 2022-23](#)

Developing Strategies to Decrease Traffic Congestion in the Metro Area

MnDOT strives to provide consistent freeway travel times for Twin Cities area drivers. Managing traffic and renovation projects requires a detailed understanding of where, when and why congestion is happening. Researchers previously developed a tool that uses data from multiple sources to estimate how congested certain highway segments will be during different times of the day. A new project resulted in comprehensive refinements and expansions of the software tool, allowing the agency to use it in highway project planning. [Report 2022-01](#)



An enhanced travel-time reliability tool will allow MnDOT to understand how weather events, work zones and other factors impact freeway congestion.



CLIMATE CHANGE AND THE ENVIRONMENT

Recycling Regional Waste for Road Construction and Revegetation

When road construction projects are completed, MnDOT needs fill dirt for revegetation areas to manage stormwater runoff and provide a visual aesthetic. New research identified several local industrial byproducts that can amend soil around road construction, creating a healthy soil that supports plant growth and eliminating the need to dispose of the byproducts in a landfill. This sustainable practice addresses stormwater issues, reduces solid waste and saves financial resources for the agency and industry. In **the next phase of this study**, researchers will develop a statewide implementation design guide.

Report 2022-10



Municipal street sweepings can be combined with other materials to create suitable soil for MnDOT's road construction projects.

Managing Stormwater Ponds to Protect Water Quality



Excess phosphorus from stormwater runoff can cause harmful algae blooms that are toxic to human and ecological health.

Rainwater or snowmelt running off the streets can contain pollutants that are harmful to water quality. MnDOT and local agencies use thousands of stormwater retention ponds around the state to trap pollutants before they wash into streams and lakes, though some are aging or failing to provide this function. Researchers identified cost-effective management techniques for these ponds to prevent the release of harmful pollutants into Minnesota's waterways. **Report 2022-20**



INNOVATION AND FUTURE NEEDS

Harnessing Technology to Manage Building Maintenance and Improvements

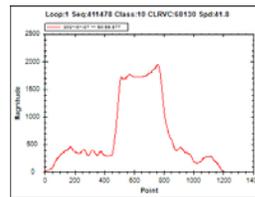


Drones can be used inside and outside of a building to collect data used for inspections, planning or design.

MnDOT manages over 900 buildings, including maintenance garages, office buildings and storage depots. Inspecting, repairing, maintaining and renovating these facilities take significant staff time, data and resources. A new project demonstrated that scanning and imaging technologies can drastically improve this process. By collecting and processing an estimated 100,000 times the data that could be collected manually, these technologies can make building asset management more comprehensive, yet efficient and cost-effective. Watch a video about this project on the **MnDOT Research YouTube Channel**. **Report 2022-26**

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Improving Vehicle Counting and Classifying for Road Planning



Electronic signatures can identify the classification of a vehicle, such as this Class 10 truck.

The number and types of vehicles that use Minnesota's roadways determine how roads should be constructed and maintained. A new project refined and tested a technical device, mounted on existing roadway infrastructure, that collects electronic footprints for each passing vehicle. This technology presents a feasible and cost-effective alternative for MnDOT's vehicle classification data needs.

Report 2021-27

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:



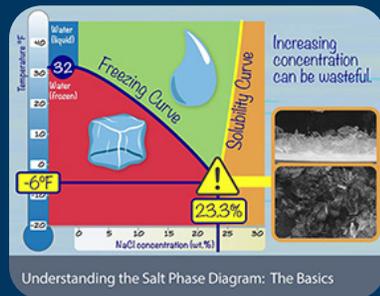
Clear Roads. The Clear Roads research program brings together transportation professionals and researchers from around the country to drive innovation in winter maintenance. By evaluating materials, equipment and methods in real-world conditions, the program identifies the most effective techniques and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



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, make them last longer, perform better, cost less to build and maintain, and have less impact on the environment. mndot.gov/mnroad/nrra

Clear Roads Project CR20-02

created training materials explaining the salt phase diagram, which can be used to determine the optimal concentrations of salt in deicers depending on outdoor temperatures. Winter maintenance managers and



operators across the state will benefit from this resource by using salt products more efficiently to keep roads clear.

In the **Mix Rejuvenator Test Sections**, researchers are evaluating the effectiveness of using asphalt rejuvenating agents to incorporate larger amounts of reclaimed asphalt pavement in hot-mix asphalt. NRRA and the Local Road Research Board will monitor the performance of test sections on Trunk Highway 6 in Emily, Minnesota, that contain seven different asphalt rejuvenating agents.



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 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).



FY2022 RESEARCH ACTIVITIES

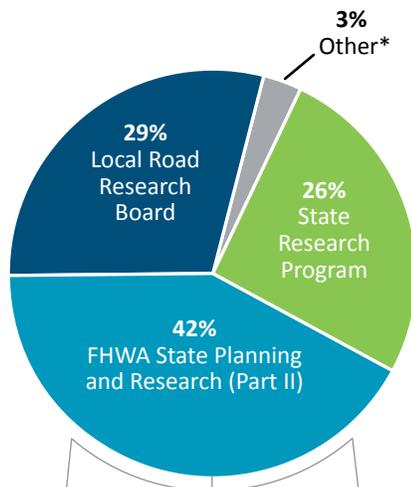
FINANCIAL OVERVIEW

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).

FY2022 Research Funds by Funding Source

State Research Program	\$ 4,231,042
FHWA State Planning and Research (Part II)	\$ 6,687,105
Local Road Research Board	\$ 4,643,030
Other*	\$ 512,018
Total	\$ 16,073,195

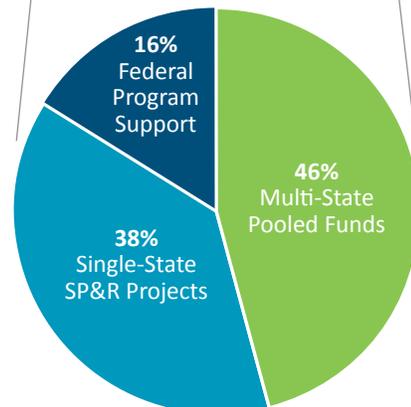
* Includes contributions from other MnDOT funds, partnerships with other agencies and other federal sources.



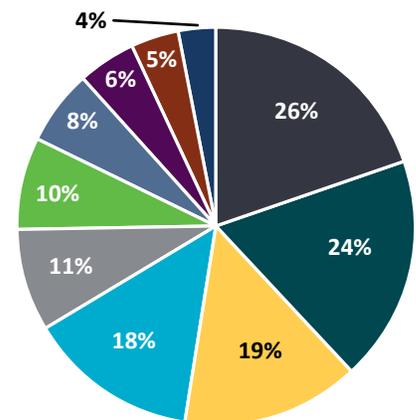
Subset: FY2022 SP&R (Part II) Funding Distribution

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	\$ 3,090,526
a: Participation in Pooled Funds Led by Other States	\$ 1,414,838
b: MnDOT-Led Pooled Funds	\$ 1,675,688
Single-State SP&R Projects	\$ 2,531,989
Federal Program Support	\$ 1,064,590
a: National Cooperative Highway Research Program	\$ 888,238
b: Transportation Research Board	\$ 161,352
c: AASHTO	\$ 15,000
Total	\$ 6,687,105



FY2022 Research Funds Allocated by Topic Area



Total: \$10,015,091*

- 26% Dedicated Programs (CTS & LTAP)
- 24% Materials & Construction
- 19% Traffic & Safety
- 18% Maintenance Operations & Security
- 11% Federal Program Support
- 10% Environmental
- 8% Multimodal
- 6% Policy & Planning
- 5% Administrative
- 4% Bridges & Structures

*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.

FY2022 RESEARCH CONTRACTS

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

- Research reports completed in fiscal year 2022 (FY2022) followed by other research contracts active during FY2022, 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
2021-23	Retightening the Large Anchor Bolts of Support Structures for Signs and Luminaires—Phase II	9/30/21	Brent Phares, Iowa State University	Jihshya Lin	\$175,000
2022-26	Building 360 Scanning and Reality Modeling	6/30/22	Barritt Lovelace, Collins Engineers, Inc.	Christopher Bjork	\$99,709
2022-28	MP-18(008): Detecting Foundation Pile Length of High-Mast Light Towers	9/30/22	Bojan Guzina, University of Minnesota	Richard Lamb	\$198,000
2022-29	Load Rating Assessment of Three Slab-Span Bridges Over Shingle Creek	8/31/22	Ben Dymond, University of Minnesota Duluth	Yihong Gao	\$181,243
2022-32	Steel Reinforcement Section Loss Guidance Tables	9/30/22	Behrouz Shafei, Iowa State University	Paul Pilarski	\$100,966
	Bridge Pile Repair Using Underwater Fiber Reinforced Polymer Sleeve and Steel Reinforced Grout	1/31/22	William Schilling, AECOM Technical Services, Inc.	Nickolas Haltvick	\$16,822
	TRS: Bridge Drainage Systems and Discharge to Waterways	12/31/22	Michael Marti, SRF Consulting Group, Inc.	Eliezer Ramirez	\$34,501
	TRS: Use of High-Pressure, Hot Water Blasting Surface Preparation and HRCSA Coatings in Bridge Maintenance	12/31/22	Xiaoning Qi, North Dakota State University	Sarah Sondag	\$31,375
	Bridge Pile Repair Using Underwater Fiber Reinforced Polymer Sleeve and Steel Reinforced Grout	2/28/23	William Schilling, AECOM Technical Services, Inc.	Nickolas Haltvick	\$99,751
	MP-18(004): Assessment of Bridge Decks With Glass Fiber Reinforced Polymer Reinforcement	3/31/23	Behrouz Shafei, Iowa State University	Paul Kettleson	\$100,104
	INV 1093: Quantifying Benefits of Bridge Maintenance	9/30/23	Basak Aldemir Bektas, Minnesota State University, Mankato	Sarah Sondag	\$166,709
	MP-21(009): Evaluation of Corrugated HDPE Pipes Manufactured With Recycled Content	1/31/24	Michael Pluimer, University of Minnesota Duluth	Erik Brenna	\$85,032

Bridges & Structures Pooled Fund Studies

Study Number	Title	Lead State or Agency	Technical Liaison	Number of Participating Agencies	2022 MnDOT Contribution	Total MN Contribution	Current MN Contribution End Date
TPF-5(372)	Building Information Modeling for Bridges and Structures	IA	Benjamin Jilk	24	\$20,000	\$80,000	2023

Bridges & Structures Pooled Fund Studies [cont.]

Study Number	Title	Lead State or Agency	Technical Liaison	Number of Participating Agencies	2022 MnDOT Contribution	Total MN Contribution	Current MN Contribution End Date
TPF-5(392)	Construction of Low-Cracking High-Performance Bridge Decks Incorporating New Technology	KS	Paul Rowekamp	2	\$0	\$255,000	2021
TPF-5(436)	Development of Criteria to Assess the Effects of Pack-Out Corrosion in Built-Up Steel Members	IN	Yihong Gao	6	\$0	\$120,000	2022
TPF-5(464)	Hydrologic and Hydraulic Software Enhancements (SMS, WMS, Hydraulic Toolbox and HY-8)	FHWA	Aislyn Ryan	5	\$10,000	\$50,000	2024
TPF-5(468)	Structural Behavior of Ultra-High Performance Concrete	FHWA	Scot Larson	6	\$10,000	\$50,000	2024
TPF-5(474)	Bridge Deck Preservation Portal	IA	Sarah Sondag	7	\$20,000	\$60,000	2022
TPF-5(486)	Center for the Aging Infrastructure: Steel Bridge Research, Inspection, Training and Education Engineering Center: SBRITE (Continuation)	IN	Kevin Western	14	\$30,000	\$150,000	2026

ENVIRONMENTAL

Report Number	Title	End Date	Investigator	Technical Liaison	Total Cost
2021-14	INV 1039: Design and Construction of Infiltration Facilities	8/31/21	John Gulliver, University of Minnesota	Dwayne Stenlund	\$238,572
2021-29	INV 1041: Assessing Culverts in Minnesota: Fish Passage and Storm Vulnerability	11/30/21	Jessica Kozarek, University of Minnesota	Nicole Bartelt	\$158,374
2022-04	MP-20(009): Effect of Warmer Minnesota Winters on Freeze-Thaw Cycles	8/31/21	Halil Ceylan, Iowa State University	Jeffrey Meek	\$59,984
2022-10	INV 1060: Reuse of Regional Waste in Sustainably Designed Soils	7/31/22	David Saftner, University of Minnesota Duluth	Dwayne Stenlund	\$197,406
2022-16	INV 1038: Regional Optimization of Roadside Turfgrass Seed Mixtures—Phase II: Regional Field Trials and Economic Analysis	8/31/22	Eric Watkins, University of Minnesota	Dwayne Stenlund	\$467,139
2022-19	Reduce Vehicle-Animal Collisions With Installation of Small Animal Exclusion Fencing	6/30/22	Seth Stapleton, Minnesota Zoo	Christopher Smith	\$110,776
2022-20	INV 1059: Wet Pond Maintenance for Phosphorus Retention	6/30/22	John Gulliver, University of Minnesota	Leslie Stovring, Patrick Sejkora	\$222,467
2022-27A	INV 1063: Evaluation of Environmental Impacts of Potassium Acetate Used as a Road Salt Alternative	7/31/22	John Gulliver, University of Minnesota	Nicklas Tiedeken	\$214,743
2022-27B	Environmental Field Evaluation of Potassium Acetate	6/30/22	Chris Rehmann, Iowa State University	Tara Carson	\$212,877
2022-30	INV 1084: Cost-Effective Roadside Vegetation Methods to Support Insect Pollinators	8/31/22	Emilie Snell-Rood, University of Minnesota	Dan MacSwain, Christopher Smith	\$281,412
TRS2202	Developing Transportation System Climate Resilience Performance Measures	6/30/22	Mark Linsenmayer, CTC & Associates, LLC	Siri Simons	\$18,025
	Assessment of Field Infiltration Performance of Swales in Comparison to Minnesota Swales Calculator Estimates	7/31/21	Rena Weis, Wenck Associates, Inc.	Nicklas Tiedeken	\$94,685
	MP-19(004): Implementation of Culvert Design Guide for Stream Connectivity and Aquatic Organism Passage	1/31/22	Matt Hernick, University of Minnesota	Nicole Bartelt	\$60,001

ENVIRONMENTAL [cont.]

Report Number	Title	End Date	Investigator	Technical Liaison	Total Cost
	Assessment of Field Infiltration Performance of Swales in Comparison to Minnesota Swales Calculator Estimates	5/31/22	Rena Weis, Stantec Consulting, Inc.	Nicklas Tiedeken	\$5,212
	TPF-5(362): Improvements to the Infrastructure Carbon Estimator (ICE)	1/31/23	Jeffrey Ang-Olson, ICF Incorporated, LLC	Timothy Sexton	\$504,989
	Turfgrass Seed Variety Evaluation Process	1/31/23	Eric Watkins, University of Minnesota	Warren Tuel	\$59,460
	Feasibility Study: State–Tribal Partnership to Support Solar Energy	3/31/23	Gabriel Chan, University of Minnesota	Siri Simons	\$25,000
	INV 1077: Stormwater Pond Maintenance and Wetland Management for Phosphorus Retention	6/30/23	John Gulliver, University of Minnesota	Ross Bintner	\$247,237
	MP-20(006): Climate Change Adaptation of Urban Stormwater Infrastructure	6/30/23	John Gulliver, University of Minnesota	Erik Brenna	\$224,997
	MP-20(009): Effect of Increased Precipitation (Heavy Rain Events) on Minnesota Pavement Foundations	11/30/23	Halil Ceylan, Iowa State University	Raul Velasquez	\$170,000
	MP-21(002): Identifying Deer-Vehicle Collision Concentrations in Minnesota	11/30/23	Raphael Stern, University of Minnesota	Christopher Smith	\$165,450
	INV 1094: Comparison of Compost and Proprietary Soil Amendments for Vegetation Establishment	3/31/24	Bora Cetin, Michigan State University	Warren Tuel	\$260,000
	INV 1115: Addressing Research Needs for the Sustainable Application of Tire-Derived Aggregate in Stormwater Infiltration/Treatment	6/30/25	John Gulliver, University of Minnesota	Mark Hansen	\$257,765

Environmental Pooled Fund Studies

Study Number	Title	Lead State or Agency	Technical Liaison	Number of Participating Agencies	2022 MnDOT Contribution	Total MN Contribution	Current MN Contribution End Date
TPF-5(358)	Wildlife Collision Reduction and Habitat Connectivity	NV	Christopher Smith	11	\$0	\$100,000	2021
TPF-5(460)	Flood-Frequency Analysis in the Midwest: Addressing Potential Nonstationary Annual Peak-Flow Records	SD	Andrea Hendrickson	8	\$55,600	\$222,400	2024

MAINTENANCE OPERATIONS

Report Number	Title	End Date	Investigator	Technical Liaison	Total Cost
2021RIC04	INV 645: Catch Basins and Manholes: Products, Installation, and Settlement and Heave Mitigation	10/31/22	Derek Tompkins, American Engineering Testing, Inc.	Steven Bot	\$59,672
2022-14	MP-20(002): Promoting the Adoption of Snow Fences Through Landowner Engagement	5/31/22	Dean Current, University of Minnesota	Daniel Gullickson	\$134,967
2022RIC01	INV 645: Minnesota Snow and Ice Field Handbook for Snowplow Operators Update	2/28/22	Mindy Carlson, University of Minnesota	Kathleen Schaefer	\$20,000
2022RIC04	INV 645: Effectiveness of Fog Seal on Chip Sealed Low-Volume Roads	4/30/22	Mike Rief, WSB & Associates, Inc.	Steven Bot	\$71,539
CR19-02, CR19-02A, CR19-02C	TPF-5(353): Recruitment and Retention of Highway Maintenance Workers (Case Studies and Recommendations)	7/31/21	Laura Fay, Western Transportation Institute	Thomas Peters	\$70,000

MAINTENANCE OPERATIONS [cont.]

Report Number	Title	End Date	Investigator	Technical Liaison	Total Cost
CR20-02	TPF-5(353): Understanding the NaCl Phase Diagram	6/30/22	Laura Fay, Western Transportation Institute	Thomas Peters	\$100,000
	TPF-5(353): Synthesis of Technical Requirements and Considerations for an Automated Snowplow Route Optimization	10/31/21	Jonathan Dowds, University of Vermont	Thomas Peters	\$73,516
	TPF-5(353): Expanding Application Rate Guidance for Salt Brine Blends for Direct Liquid Application and Anti-Icing	12/31/21	David Noyce, University of Wisconsin–Madison	Thomas Peters	\$150,000
	TPF-5(353): AWSSI Enhancements—Phase II	12/31/21	Michael Timlin, University of Illinois	Thomas Peters	\$39,809
	TPF-5(353): Measuring the Efficiencies of Tow Plows and Wing Plows	1/31/22	Ty Lasky, University of California, Davis	Thomas Peters	\$138,986
	TPF-5(353): Entry-Level Driver Training (CDL) for Maintenance Equipment Operators: Train the Trainer Webinars	3/31/22	Matthew Camden, Virginia Polytechnic Institute and State University	Thomas Peters	\$204,978
	INV 645: Best Management Practices for Drain Tile in Rights of Way	6/30/22	Susan Miller, SRF Consulting Group, Inc.	John Brunkhorst	\$52,373
	INV 645: Culvert Type Evaluation: Concrete vs. Plastic vs. Corrugated Metal	6/30/22	Michael Marti, SRF Consulting Group, Inc.	Karin Grandia	\$45,999
	INV 645: Drainage 101 County Roadways and City Streets: Best Practices and Resources Guide	7/31/22	Anita Benson, Stonebrooke Engineering, Inc.	Steven Bot	\$85,290
	TPF-5(353): Using GIS to Highlight Highway Segments Sensitive to Deicing Materials	7/31/22	Erik Minge, SRF Consulting Group, Inc.	Thomas Peters	\$142,426
	TPF-5(353): High-Performance Blade Evaluation	7/31/22	William Schneider, University of Akron	Thomas Peters	\$195,747
	INV 1065: Implementation of Lane Boundary Guidance System for Snowplow Operations	10/31/22	Max Donath, University of Minnesota	Daniel Rowe	\$733,034
	INV 645: Cost-Effectiveness of Various Pavement Markings	10/31/22	Michael Marti, SRF Consulting Group, Inc.	Jon Pratt	\$60,900
	INV 645: Ride Quality of Asphalt Pavements	10/31/22	Michael Marti, SRF Consulting Group, Inc.	Joe Triplett	\$137,135
	INV 645: Crack Treatments for Local Agencies	11/30/22	Michael Marti, SRF Consulting Group, Inc.	Daniel Knapek, Sherburne County	\$83,352
	Relative Milling Method: Relative Milling Depth Surface Model Development	11/30/22	Kyle Klasen, WSB & Associates, Inc.	Rebecca Embacher	\$99,930
	INV 645: Snowplow Optimization and GPS/AVL on Maintenance Equipment	1/31/23	Susan Miller, SRF Consulting Group, Inc.	Joe MacPherson	\$85,729
	MP-18(010): Reducing Winter Maintenance Equipment Fuel Consumption Using Advanced Vehicle Data Analytics	1/31/23	Will Northrop, University of Minnesota	Joseph Huneke	\$212,919
	TPF-5(353): Salt Shed Design Template	1/31/23	Wilfrid A. Nixon and Associates, LLC	Thomas Peters	\$124,989
	TPF-5(353): Expanded Use of AVL/GPS Technology	2/28/23	Ming Shiun Lee, AECOM Technical Services, Inc.	Thomas Peters	\$75,000
	TPF-5(353): Standard Test Procedure for Ice Melting Capacity of Deicers	2/28/23	Xianming Shi, Washington State University	Thomas Peters	\$74,087

MAINTENANCE OPERATIONS [cont.]

Report Number	Title	End Date	Investigator	Technical Liaison	Total Cost
	TPF-5(353): Evaluation of Electric Vehicle Technologies and Alternative Fuels for Winter Operations	3/31/23	Richard Brady, Matrix Consulting Group, Ltd.	Thomas Peters	\$74,995
	TPF-5(353): Continued Support for Weather Event Reconstruction and Analysis Tool	4/30/23	John Grant, The Narwhal Group	Thomas Peters	\$14,484
	TPF-5(353): Training Module Development for Evaluation of Storm Severity Index and Winter Severity Index Variables	6/30/23	Vik Aurora, Focus EduSolutions, Inc.	Thomas Peters	\$31,585
	TPF-5(353): Clear Roads Administration, Research Support and Information Services	6/30/23	Patrick Casey, CTC & Associates, LLC	Thomas Peters	\$1,238,596
	TPF-5(353): Grip Sensor Technology and Salt Applications	8/31/23	Leslie Schmidt, Montana State University	Thomas Peters	\$149,977
	TPF-5(353): Efficacy, Cost and Impacts of Non-Chloride Deicers	9/30/23	Leslie Schmidt, Montana State University	Thomas Peters	\$115,000
	TPF-5(353): Determining the Migration of Chloride-Based Deicers Through Different Soil Types	11/30/23	Dan Nordquist, Washington State University	Thomas Peters	\$99,978
	TPF-5(466): Thinlays as Preventive Maintenance Treatment	12/31/23	Andrea Blanchette, Terracon Consultants, Inc.	Joel Ullring	\$49,918
	MOR/Operations: Evaluation of Slurry Box, Underbody Scraper and Two-Way Reversible Plow	1/31/24	Brian Hirt, CTC & Associates, LLC	Thomas Peters	\$122,957
	TPF-5(353): Best Practices for Protecting DOT Equipment From the Corrosive Effect of Chemical Deicers	2/29/24	Derek Brown, Washington State University	Thomas Peters	\$99,985
	TPF-5(353): Calculating Plow Cycle Times From AVL Data	4/1/24	Ming Shiun Lee, AECOM Technical Services, Inc.	Thomas Peters	\$125,378
	Harnessing Solar Energy Through Solar Snow Fence: Implementation	6/30/24	Mijia Yang, North Dakota State University	Daniel Gullickson	\$187,201
	TPF-5(466): Flooded Pavements Assessment Application—Phase II	8/31/24	Majid Ghayoomi, University of New Hampshire	Timothy Andersen	\$200,234
	TPF-5(353): Third-Party Laboratory Testing for the Clear Roads Qualified Products Lists	9/5/24	James Hibbs, Analytical Laboratories, Inc.	Thomas Peters	\$60,000
	TPF-5(466): MnROAD Reflective Cracking Challenge	9/30/26	Eshan Dave, University of New Hampshire	Michael Vrtis	\$230,499

Maintenance Operations Pooled Fund Studies

Study Number	Title	Lead State or Agency	Technical Liaison	Number of Participating Agencies	2022 MnDOT Contribution	Total MN Contribution	Current MN Contribution End Date
TPF-5(479)	Clear Roads Winter Highway Operations—Phase III	MN	Thomas Peters	21	\$25,000	\$125,000	2026
TPF-5(347)	Development of Maintenance Decision Support System	SD	Joseph Huneke	15	\$30,000	\$195,000	2022
TPF-5(380)	Autonomous Maintenance Technology (AMT)	CO	Robert Vasek	16	\$25,000	\$100,000	2022

MATERIALS & CONSTRUCTION

Report Number	Title	End Date	Investigator	Technical Liaison	Total Cost
2021-26, 2021-26A	INV 1068: Effectiveness of Geotextiles/Geogrids in Roadway Construction: Determine a Granular Equivalent Factor	10/31/21	Vernon Schaefer, Iowa State University	Michael McCarty	\$197,339
2021-28	MP-18(006): Quantifying Benefits of Improved Compaction	12/31/21	Christopher Williams, Iowa State University	Kyle Hoegh	\$125,529
2022-02	Remaining Service Life Asset Measure—Phase II	2/28/22	Mihai Marasteanu, University of Minnesota	Glenn Engstrom	\$118,834
2022-06	INV 1086: Evaluation of SFDR Stabilizing Products	3/31/22	Michael Marti, SRF Consulting Group, Inc.	Bruce Hasbargen	\$23,543
2022-11, 2022-11S	INV 1066: Evaluation of Curing Effects on Cold In-Place Recycling	4/30/22	Eshan Dave, University of New Hampshire	Joel Ulring	\$156,052
2022-18	Development of Superpave 5 Asphalt Mix Designs for Minnesota Pavements	6/30/22	Mihai Marasteanu, University of Minnesota	Chelsea Bennett	\$144,405
2022-23	Establishing Fresh Properties of Fiber-Reinforced Concrete for Performance Engineered Mixture	6/30/22	Manik Barman, University of Minnesota Duluth	Robert Golish	\$147,070
NRRA202105	TPF-5(341): Improve Material Inputs Into Mechanistic Design Properties for Reclaimed HMA and Recycled Concrete Aggregate Roadways	8/31/21	Bora Cetin, Michigan State University	Timothy Andersen	\$30,000
NRRA202107	TPF-5(341): Drainability of Base Aggregate and Sand	8/31/21	William J. Likos, University of Wisconsin–Madison	Terrence Beaudry	\$30,000
NRRA202108	TPF-5(341): Environmental Impacts on the Performance of Pavement Foundation Layers	8/31/21	Bora Cetin, Michigan State University	Raul Velasquez	\$35,000
NRRA202109	TPF-5(341): Developing Best Practices for Rehabilitation of Concrete with Hot Mix Asphalt Overlays Related to Density and Reflective Cracking	8/31/21	Eshan Dave, University of New Hampshire	Shongtao Dai	\$169,970
NRRA202110	TPF-5(341): Mechanistic Load Restriction Decision Platform for Pavement Systems Prone to Moisture Variations	10/31/21	Majid Ghayoomi, University of New Hampshire	Timothy Andersen	\$90,231
NRRA202111	TPF-5(341): Evaluation of Long-Term Impacts of Early Opening of Concrete Pavements	8/31/21	Lev Khazanovich, University of Pittsburgh	"Bernard Izevbekhai "	\$149,999
NRRA202201	TPF-5(341): Third-Year Performance Study of Highway 4 Jointless Fiber-Reinforced Concrete Roundabout	1/31/22	Peter Taylor, Iowa State University	Maria Masten	\$49,999
NRRA202202	TPF-5(341): Novel Methods for Adding Rejuvenators in Asphalt Mixtures With High Recycled Binder Ratios	6/30/22	Fan Yin, Auburn University	Michael Vrtis	\$80,000
NRRA202203	TPF-5(341): Seismic Approach to Quality Management of HMA	7/30/22	Choon Park, Park Seismic, LLC	Jason Richter	\$299,886
NRRA202204	TPF-5(341): Enhanced Entrained Air Void System Characterization for Durable Highway Concrete	9/30/22	Anthony Torres, Texas State University	Thomas Burnham	\$100,000
	INV 1086: Evaluation of SFDR Stabilizing Products	7/31/21	Michael Marti, SRF Consulting Group, Inc.	Bruce Hasbargen	\$66,293
	TPF-5(334): Enhancement to the Intelligent Construction Data Management System (Veta) and Implementation—Phase I	2/13/22	George Chang, The Transtec Group, Inc.	Rebecca Embacher	\$1,073,813
	TPF-5(443): Continuous Asphalt Mixture Compaction Assessment Using Density Profiling System	5/31/22	Fabricio Leiva, Auburn University	Kyle Hoegh	\$228,028
	TPF-5(341): Biomaterial Maintenance Treatments	9/30/22	Christopher Williams, Iowa State University	Gerard Geib	\$50,000

MATERIALS & CONSTRUCTION [cont.]

Report Number	Title	End Date	Investigator	Technical Liaison	Total Cost
	INV 645: Contractors Overcommitting/Missing Deadlines	9/30/22	Ross Jentink, WSB & Associates, Inc.	Michael Flaagan	\$23,742
	INV 1069: Optimizing Asphalt Mixture Designs for Low-Volume Roads of Minnesota	10/31/22	Manik Barman, University of Minnesota Duluth	Joel Ullring	\$161,333
	TPF-5(341): Impact of Polymer Modification on IDEAL-CT and I-FIT for Balanced Mix Design	11/30/22	Fan Yin, Auburn University	Michael Vrtis	\$120,000
	INV 1070: Base Stabilization Additives: Effect on Granular Equivalency	1/31/23	Halil Ceylan, Iowa State University	Chad Hausman	\$197,864
	TPF-5(341): Continuous Moisture Measurement During Pavement Foundation Construction	2/17/23	Soheil Nazarian, University of Texas at El Paso	Terrence Beaudry	\$100,000
	TPF-5(341): Asphalt Real-Time Smoothness for Asphalt Paving	2/28/23	George Chang, The Transtec Group, Inc.	John Siekmeier	\$104,021
	TPF-5(341): Evaluation of Levels 3-4 Intelligent Compaction Measurement Values for Soils Subgrade and Aggregate Subbase Compaction	3/31/23	George Chang, The Transtec Group, Inc.	Rebecca Embacher	\$162,024
	TPF-5(341): Solutions to Mitigate Dowel/Tie-Bar Propagated Cracking—Phase I	3/31/23	Shreenath Rao, Applied Research Associates, Inc.	Thomas Burnham	\$101,083
	TPF-5(341): Pavement-Specific Structural Synthetic Fibers	3/31/23	Manik Barman, University of Minnesota Duluth	David Lim	\$99,972
	TPF-5(341): An Innovative Practical Approach to Assessing Bitumen Compatibility as an End Means of Material Specification	5/31/23	Eshan Dave, University of New Hampshire	Michael Vrtis	\$204,119
	INV 1103: Evaluation of Proprietary Rejuvenators	6/30/23	M. Emin Kutay, Michigan State University	JinYeene Neumann	\$199,336
	INV 1104: Cost Estimate of B vs. C Grade Asphalt Binders	6/30/23	Mihai Marasteanu, University of Minnesota	Jed Nordin	\$171,777
	TPF-5(443): Communication Coordination and Reporting for Continuous Asphalt Mixture Compaction Assessment Using Density Profiling System (DPS) Pooled Fund	6/30/23	Vaneza Callejas, CTC & Associates, LLC	Kyle Hoegh	\$69,404
	INV 1095: Benefits of Preventive Maintenance	7/31/23	Basak Aldemir Bektas, Minnesota State University, Mankato	Joel Ullring	\$157,926
	INV 1101: BMP for Issues with Asphalt Centerline Joint and Intelligent Compaction for Local Agencies	10/31/23	Syed Haider, Michigan State University	Naomi Eckerd	\$192,622
	TPF-5(341): Asphalt Pavement Milling Best Practices Through Enhanced Understanding of Milling Process	10/31/23	Eshan Dave, University of New Hampshire	John Siekmeier	\$100,000
	INV 986: Performance Monitoring of Olmsted CR 117/104 and Aggregate Base Material Update	11/30/23	Kyle Hoegh, MnDOT Office of Materials and Road Research	Kaye Bieniek	\$44,000
	TPF-5(375): National Partnership to Determine the Life-Extending Benefit Curves of Pavement Preservation (MnROAD/NCAT Joint Study)	12/31/23	Adriana Vargas-Nordbeck, Auburn University	Gerard Geib	\$2,695,545
	MP-21(001): Bridge Low Slump Concrete Overlay Mix Design for Mobile Mixers	4/30/24	Tyler Ley, Oklahoma State University	Kyle Fritz	\$271,612
	INV 1117: Mitigation of Tenting of Transverse Cracks and Joints in Asphalt Pavement	6/30/24	Manik Barman, University of Minnesota Duluth	Matthew Hemmila	\$150,900
	TPF-5(341): Long-Term Testing and Analysis on Asphalt Mix Rejuvenator Field Sections	8/31/24	Jo Sias, University of New Hampshire	Michael Vrtis	\$148,981

MATERIALS & CONSTRUCTION [cont.]

Report Number	Title	End Date	Investigator	Technical Liaison	Total Cost
	TPF-5(466): Performance Evaluation of Wicking Geotextiles for Improving Drainage and Stiffness of Road Foundation	8/31/24	Bora Cetin, Michigan State University	Raul Velasquez	\$200,000
	TPF-5(341): Analysis of Long-Term Field Performance of Spray-On Rejuvenators	10/31/24	Raquel Moraes, Auburn University	Michael Vrtis, Benjamin Worel	\$100,000
	TPF-5(466): Veta Enhancements for MDMS Standardized and Web Conversion	10/31/24	George Chang, The Transtec Group, Inc.	Rebecca Embacher	\$1,584,159
	TPF-5(466): Validation of Loose Mix Aging Procedures for Cracking Resistance Evaluation in Balanced Mix Design	12/31/24	Gene Taylor, Auburn University	Joseph Podolsky	\$100,000
	TPF-5(466): Reclamation and Recycling Techniques to Achieve Perpetual Pavements Characteristics	3/31/25	Mohammad Sabouri, Braun Intertec Corporation	Emil Bautista	\$150,002
	Cold In-Place Recycling for Bituminous Over Concrete	1/31/26	Peter Taylor, Iowa State University	Bernard Izevbekhai	\$150,000
	TPF-5(466): Use of Alternative Pozzolanic Materials Toward Reducing Cement Content in Concrete Pavements	4/30/26	Margot Yapp, Nichols Consulting Engineers, Chtd.	Maria Masten	\$175,000
	TPF-5(466): The Use of Alternative Cementitious Materials in Concrete Pavements	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	2022 MnDOT Contribution	Total MN Contribution	Current MN Contribution End Date
TPF-5(375)	National Partnership to Determine the Life-Extending Benefit Curves of Pavement Preservation (MnROAD/NCAT Joint Study)	MN	Benjamin Worel	21	\$50,000	\$300,000	2023
TPF-5(443)	Continuous Asphalt Mixture Compaction Assessment Using Density Profiling System	MN	Kyle Hoegh	11	\$25,000	\$100,000	2022
TPF-5(466)	National Road Research Alliance (NRRRA)—Phase II	MN	Glenn Engstrom	10	\$150,000	\$750,000	2025
TPF-5(368)	Performance-Engineered Concrete Paving Mixtures	IA	Maria Masten	19	\$0	\$75,000	2021
TPF-5(437)	Technology Transfer Concrete Consortium	IA	Maria Masten	26	\$12,000	\$60,000	2024
TPF-5(448)	Integrating Construction Practices and Weather Into Freeze-Thaw Specifications	OK	Maria Masten	7	\$20,000	\$60,000	2022

MULTIMODAL

Report Number	Title	End Date	Investigator	Technical Liaison	Total Cost
2022-33	Assessing the Economic Effects of Context-Sensitive Main Street Highways in Small Cities	9/30/22	Camila Fonseca-Sarmiento, University of Minnesota	Nissa Tupper	\$190,897

MULTIMODAL [cont.]

Report Number	Title	End Date	Investigator	Technical Liaison	Total Cost
	MP-20(007): Economic Benefits of Truck Weight and Safety Enforcement Improvements	3/31/22	Lubinda Walubita, Texas A&M Transportation Institute	Julie Whitcher	\$138,433
	INV 1081: Pedestrian Engineering and Enforcement at Signalized Intersections	9/30/22	Nichole Morris, University of Minnesota	Amber Dallman	\$270,520
	MP-21(010): Maximizing Transportation Assets by Building Community Connection Through Innovative Development of Rights of Way and Airspace	9/30/22	Frank Douma, University of Minnesota	Cyrus Knutson	\$70,000
	Understanding Post-COVID Safety Concerns Toward the Use of Transit, Shared Mobility, and Connected and Automated Vehicles in Greater Minnesota	10/31/22	Yingling Fan, University of Minnesota	Elliott McFadden	\$120,000
	MP-21(003): Identify Best Types of Commodity Flow Data for Freight, Railroad, Ports and Waterways Studies	12/31/22	Camila Fonseca-Sarmiento, University of Minnesota	Andrew Andrusko	\$114,914
	INV 1096: Rural Community Transit Strategies	2/28/23	Thomas Fisher, University of Minnesota	Matti Gurney	\$173,929
	INV 1082: Guidelines for Safer Pedestrian Crossings: Understanding the Factors That Positively Influence Vehicle Yielding to Pedestrians at Unsignalized Intersections	6/30/23	Raphael Stern, University of Minnesota	Hannah Pritchard	\$165,278
	INV 1090: Designing an Autonomous Service to Cover Transit Last Mile in Low-Density Areas	6/30/23	Alireza Khani, University of Minnesota	Kris Liljeblad	\$100,000
	MP-21(004): Designing and Implementing Maintainable Pedestrian Safety Countermeasures	6/30/23	David Veneziano, Iowa State University	Jacob Rueter	\$79,554
	Understanding Pedestrian Travel Behavior and Safety in Rural Settings	6/12/24	Greg Lindsey, University of Minnesota	Michael Petesch, Hannah Pritchard	\$311,434

Multimodal Pooled Fund Studies

Study Number	Title	Lead State or Agency	Technical Liaison	Number of Participating Agencies	2022 MnDOT Contribution	Total MN Contribution	Current MN Contribution End Date
TPF-5(315)	National Accessibility Evaluation	MN	Deanna Belden	14	\$1,000	\$226,000	2019
TPF-5(455)	Access Across America: National Accessibility Evaluation—Phase II	MN	Deanna Belden	11	\$36,000	\$216,000	2025
TPF-5(396)	Mid-America Freight Coalition (MAFC)—Phase III	WI	Andrew Andrusko	10	\$37,000	\$148,000	2022

POLICY & PLANNING

Report Number	Title	End Date	Investigator	Technical Liaison	Total Cost
2022-05	Telecommuting During COVID-19: How Does It Shape the Future Workplace and Workforce?	3/31/22	Xinyi Qian, University of Minnesota	Duane Hill	\$33,429
2022-07	MP-20(010): MnDOT Innovation Strategy	12/31/22	Andy Zimney, Employee Strategies, Inc.	Catherine Walker	\$117,636

POLICY & PLANNING [cont.]

Report Number	Title	End Date	Investigator	Technical Liaison	Total Cost
2022-08	INV 1073: The Impacts of Deferred Maintenance in Minnesota	4/30/22	Camila Fonseca-Sarmiento, University of Minnesota	Paul Oehme	\$144,353
2022-15	INV 645: 20 Tips to Up Your Agency's Social Media Game	11/30/22	Tom Holmes, Zan Associates	Kevin Wright	\$42,763
2022-17P	Presentation Slide: Extreme Flood Vulnerability Project	4/30/22	Chris Dorney, WSP/Parsons Brinckerhoff, Inc.	Jeffrey Meek	\$141,232
TRS2201	The Health and Transportation Nexus: A Conceptual Framework for Collaborative Health and Transportation Planning	8/31/22	Yingling Fan, University of Minnesota	Nissa Tupper	\$46,361
	Understanding How the Disparate Effects of COVID-19 are Affecting MnDOT's Efforts at Equitable Contracting	8/31/21	Moira Gaidzanwa, The Improve Group	Dawn Collins	\$49,360
	Identifying and Optimizing Electric Vehicle Corridor Charging Infrastructure for Medium- and Heavy-Duty Trucks	10/31/22	Alireza Khani, University of Minnesota	Siri Simons	\$174,832
	MP-20(008): Qualitative and Quantitative Analysis to Advance Transportation Equity	10/31/22	Zachary Elgart, Texas A&M Transportation Institute	Hally Turner	\$130,500
	MP-21(006): Improving Transportation Equity for All by Centering the Needs of Marginalized and Underserved Communities	12/31/22	Yingling Fan, University of Minnesota	Lisa Austin	\$149,648
	MP-21(007): Assessing the Effects of Highway Improvements on Adjacent Businesses	12/31/22	Yingling Fan, University of Minnesota	Kimberly Zliment	\$100,000
	MP-21(008): Advancing Equity in Accessibility and Travel Experiences: The Role of Gender and Identity	2/28/23	Ying Song, University of Minnesota	Hally Turner	\$119,799
	MP-21(005): Enhancing Managed Lane Equity Analysis	4/30/23	Adeel Lari, University of Minnesota	Bradley Larsen	\$171,788
	INV 1102: MnDOT Haul/Detour Routes: Impacts on Local Roads	6/30/23	Bora Cetin, Michigan State University	Tim Stahl	\$184,389
	Transportation Equity Training for MnDOT	7/31/23	Frank Douma, University of Minnesota	Abdullahi Abdulle	\$115,000

Policy & Planning Pooled Fund Study

Study Number	Title	Lead State or Agency	Technical Liaison	Number of Participating Agencies	2022 MnDOT Contribution	Total MN Contribution	Current MN Contribution End Date
TPF-5(453)	Automated Vehicle Pooled Fund Study	OH	Cory Johnson	8	\$50,000	\$250,000	2025

TRAFFIC & SAFETY

Report Number	Title	End Date	Investigator	Technical Liaison	Total Cost
2021-21	INV 1089: COVID-19 Impacts on Speed and Safety for Rural Roads and Work Zones	7/31/21	Shauna Hallmark, Iowa State University	Derek Leuer, Victor Lund	\$35,919
2021-25	MP-20(005): Evaluation of Road Weather Messages on DMS Based on Roadside Pavement Sensors	11/30/21	Skylar Knickerbocker, Iowa State University	Garrett Schreiner	\$75,270
2021-27	MP-20(004): Refining Inductive Loop Signature Technology for Statewide Vehicle Classification Counts	1/31/22	Chen-Fu Liao, University of Minnesota	Gene Hicks	\$67,988
2022-01, 2022-01A	Estimation of Metro Freeway System Reliability and Resilience	2/28/22	Eil Kwon, University of Minnesota Duluth	Brian Kary	\$115,000

TRAFFIC & SAFETY [cont.]

Report Number	Title	End Date	Investigator	Technical Liaison	Total Cost
2022-03	MP-19(008): Can Automated Vehicles “See” in Minnesota? Ambient Particle Effects on Lidar	8/31/22	Will Northrop, University of Minnesota	Robert Chaucierre	\$237,841
2022-09	The Tipping Point: What COVID-19 Travel Reduction Tells Us About Effective Congestion Relief	12/31/21	Paul Morris, SRF Consulting Group, Inc.	Bradley Utecht	\$12,672
2022-12	Remote Sensing in Unsheltered Encampments	4/30/22	Michael Marti, SRF Consulting Group, Inc.	Brian Duffee	\$49,296
2022-24	INV 1061: Toward Implementation of Max-Pressure Signal Timing on Minnesota Roads	1/31/23	Michael Levin, University of Minnesota	Ben Hao	\$177,000
2022-31	INV 1064: Establishing a Repeatable Method for Presenting Nontraditional Traffic Treatments to Maximize Stakeholder Support	6/30/22	Nichole Morris, University of Minnesota	Scott Thompson	\$348,994
2022-35	INV 1083: Pedestrian User Experience at Roundabouts	9/30/22	Ranjit Godavarthy, North Dakota State University	Joe Gustafson	\$120,000
2022RIC02	Autonomous Vehicles: What Should Local Agencies Expect?	3/31/22	Michael Marti, SRF Consulting Group, Inc.	Wayne Sandberg	\$72,756
2022RIC03Q, 2022RIC03	INV 645: Strategies for Effective Roundabout Speed Reduction	9/30/21	Tim Arvidson, Stonebrooke Engineering, Inc.	Joe Gustafson	\$32,853
	Automated Speed Enforcement	9/30/22	Heather Kienitz, Short Elliott Hendrickson, Inc.	Mark Wagner	\$29,811
	Setting School Zone Speed Limits	8/31/23	Heather Kienitz, Short Elliott Hendrickson, Inc.	Mark Wagner	\$29,062
	INV 1076: Driver Comprehension of Flashing Yellow Arrows	6/30/22	Gary Davis, University of Minnesota	Victor Lund	\$213,656
	Cost/Benefit Analysis of Fuel-Efficient Speed Control Using Signal Phasing and Timing Data: Evaluation for Future Connected Corridor Deployment	7/31/22	Michael Levin, University of Minnesota	Daniel Rowe	\$218,287
	TPF-5(376): North/West Passage Freight Task Force—Year 5	7/31/22	Rachel Aland, CPCS Transcom, Inc.	Cory Johnson	\$37,312
	TPF-5(376): FY22 Program Support Services for the North/West Passage Pooled Fund Research Program	7/31/22	Tina Roelofs and Dean Deeter, Athey Creek Consultants, LLC	Cory Johnson	\$198,736
	INV 1048: Criteria and Guidelines for Three-Lane Road Design and Operation	8/31/22	Gary Davis, University of Minnesota	Jack Broz	\$155,559
	Evaluation and Refinement of Minnesota Queue Warning Systems	9/30/22	John Hourdos, University of Minnesota	Garrett Schreiner	\$254,187
	INV 645: Guidelines for Determining Speed Limits on Municipal Roadways	10/31/22	Tim Arvidson, Stonebrooke Engineering, Inc.	William Manchester	\$69,484
	INV 645: Best Practice Guidelines for Intelligent (Active) Warning Devices	11/30/22	Rena Kuehl, SRF Consulting Group, Inc.	Justin Femrite	\$46,128
	INV 1075: Transverse Rumble Strips at Rural Intersections	12/31/22	Shauna Hallmark, Iowa State University	Victor Lund	\$181,686
	MP-19(005): Work Zone Intrusion Mobile Application	1/31/23	Brian Davis, University of Minnesota	Todd Haglin	\$361,653
	INV 1092: Influence of Autonomous and Partially Autonomous Vehicles on Minnesota Roads	3/31/23	Rajesh Rajamani, University of Minnesota	Victor Lund	\$88,896
	INV 1100: Tool to Estimate the Safety Impact of Vehicle Levels of Automation on Minnesota Roads	3/31/23	John Hourdos, University of Minnesota	Cory Johnson	\$109,518

TRAFFIC & SAFETY [cont.]

Report Number	Title	End Date	Investigator	Technical Liaison	Total Cost
	INV 1079: Development of a Smartphone App to Warn the Driver of Unintentional Lane Departure Using GPS Technology	6/30/23	Imran Hayee, University of Minnesota Duluth	Victor Lund	\$147,145
	INV 1080: Assessing Pavement Markings for Automated Vehicle Readiness	6/30/23	Adam Pike, Texas A&M Transportation Institute	Ethan Peterson	\$228,183
	INV 1085: Impact of Speed Limit Changes on Urban Streets	6/30/23	Gary Davis, University of Minnesota	Victor Lund	\$156,561
	INV 1091: User-Centered Smart Traffic Sign Development Study	6/30/23	Nichole Morris, University of Minnesota	Wayne Sandberg	\$240,793
	INV 1098: Pavement Marking/Colored Pavement Friction Differential and Product Durability	6/30/23	Mihai Marasteanu, University of Minnesota	Ethan Peterson	\$136,861
	INV 1105: Multi-Method Investigation of Pedestrian Safety Impacts of Right-Turn Lanes	6/30/23	Curtis Craig, University of Minnesota	Bradley Estochen	\$156,540
	Pavement Marking Patterns and Widths: Human Factors Study	6/30/23	Adam Pike, Texas A&M Transportation Institute	Ethan Peterson	\$208,890
	TPF-5(376): North/West Passage—Phase IV	6/30/23	Erika Witzke, CPCS Transcom, Inc.	Cory Johnson	\$93,362
	INV1099: Performance Evaluation of Different Detection Technologies for Signalized Intersections in Minnesota	11/30/23	John Hourdos, University of Minnesota	Steven Misgen	\$179,950
	Assessment of Pedestrian Safety and Driver Behavior Near an Automated Vehicle	1/31/24	Nichole Morris, University of Minnesota	Cory Johnson	\$241,816
	Vehicle Mount Debris Removal Tool	1/31/24	Dean Deeter, Athey Creek Consultants, LLC	John McClellan	\$24,960
	TPF-5(376): North/West Passage Website Maintenance	2/29/24	Patrick Nichols, North Dakota State University	Cory Johnson	\$20,844
	INV 1074: Taconite as a Lower Cost Alternative High Friction Surface Treatment to Calcined Bauxite for Low-Volume Roads in Minnesota	8/31/24	Lawrence Zanko, University of Minnesota Duluth	Tracey Von Barga	\$322,225

Traffic & Safety Pooled Fund Studies

Study Number	Title	Lead State or Agency	Technical Liaison	Number of Participating Agencies	2022 MnDOT Contribution	Total MN Contribution	Current MN Contribution End Date
TPF-5(376)	North/West Passage—Phase IV	MN	Cory Johnson	7	\$25,000	\$129,601	2022
TPF-5(317)	Evaluation of Low-Cost Safety Improvements	FHWA	Derek Leuer	42	\$25,000	\$50,000	2022
TPF-5(343)	Roadside Safety Research for MASH Implementation	WA	Khamsai Yang	28	\$50,000	\$350,000	2022
TPF-5(359)	Evaluating New Technologies for Roads Program Initiatives in Safety and Efficiency (ENTERPRISE)—Phase II	MI	Cory Johnson	8	\$0	\$150,000	2021
TPF-5(430)	Midwest States Pooled Fund Crash Test Program	NE	Khamsai Yang	19	\$66,000	\$263,000	2023
TPF-5(435)	Aurora Program (FY2020-2024)	IA	Joseph Huneke	17	\$25,000	\$125,000	2024
TPF-5(444)	Traffic Safety Culture—Phase II	MT	Kristine Hernandez	17	\$10,000	\$50,000	2024

Traffic & Safety Pooled Fund Studies [cont.]

Study Number	Title	Lead State or Agency	Technical Liaison	Number of Participating Agencies	2022 MnDOT Contribution	Total MN Contribution	Current MN Contribution End Date
TPF-5(487)	Transportation Management Centers Pooled Fund Study—Phase II	FHWA	John McClellan	20	\$25,000	\$150,000	2026
TPF-5(489)	Safety Service Patrol Standardization and Management Practices	FHWA	John McClellan	14	\$25,000	\$125,000	2025
TPF-5(490)	Evaluating New Technologies for Roads Program Initiatives in Safety and Efficiency (ENTERPRISE)—Phase III	MI	Cory Johnson	7	\$30,000	\$150,000	2026

ADMINISTRATIVE

Report Number	Title	End Date	Investigator	Technical Liaison	Total Cost
2021RIC05	INV 645: Training Roadmap for Civil Engineering Technicians User Guide	8/31/21	Stephanie Malinoff, University of Minnesota—CTS	Chris Byrd	\$99,983
	INV 645B: LRRB Outreach and Marketing Support (2020-2021)	7/31/21	Rena Kuehl, SRF Consulting Group, Inc.	Shannon Fiecke	\$99,985
	INV 916: LRRB Technology Summaries (FY2021)	7/31/21	Patrick Casey, CTC & Associates, LLC	Shannon Fiecke	\$40,344
	INV 927: LRRB Website Development and Hosting	7/31/21	Patrick Casey, CTC & Associates, LLC	Shannon Fiecke	\$29,926
	MP-18(013): Facilitation and Reporting for MnDOT State Planning & Research Peer Exchange	4/30/22	Patrick Casey, CTC & Associates, LLC	Catherine Walker	\$32,256
	INV 936: Developing LRRB Need Statements (FY2022)	6/30/22	Michael Marti, SRF Consulting Group, Inc.	Brent Rusco	\$39,256
	MnDOT Research Librarian Services (2021-2022)	6/30/22	Arlene Mathison, University of Minnesota—CTS	Sheila Hatchell	\$80,604
	INV 645B: LRRB Outreach and Marketing Support (2021-2022)	9/30/22	Michael Marti, SRF Consulting Group, Inc.	Kristine Elwood	\$99,536
	MnDOT Office of Research & Innovation Organizational Assessment	12/31/22	Karen Gaides, Minnesota Management and Budget	Catherine Walker	\$56,140
	Development of MnDOT Research Roadmaps	1/31/23	Patrick Casey, CTC & Associates, LLC	Catherine Walker	\$57,270
	INV 916: LRRB Technical Summaries (FY2022)	1/31/23	Patrick Casey, CTC & Associates, LLC	Shannon Fiecke	\$98,357
	INV999: MnDOT Office of Research & Innovation Report Publication Services (FY2022-2023)	6/30/23	Arlene Mathison, University of Minnesota—CTS	Micaela Resh	\$115,049
	INV 927: LRRB Website Hosting and Maintenance (FY2022-2023)	7/31/23	Mark Linsenmayer, CTC & Associates, LLC	Julie Swiler	\$14,997
	MP-19(007): MnDOT Technical Summaries (FY2022)	7/31/23	Patrick Casey, CTC & Associates, LLC	Micaela Resh	\$99,485
	INV 645: Research Implementation Committee (RIC) Implementation of Research Findings (FY2022-2026)	6/30/24	Michael Marti, SRF Consulting Group, Inc.	Michael Flaagan	\$600,000
	MnDOT Technology Transfer (T2) Material Development: R&I At-A-Glance, Other T2 Materials (FY2022-2024)	7/31/24	Patrick Casey, CTC & Associates, LLC	Micaela Resh	\$99,996
	INV 916: LRRB Technology Transfer (T2) Material Development: LRRB At-A-Glance, Videos, Other T2 Materials (FY2022-2024)	7/31/24	Mark Linsenmayer, CTC & Associates, LLC	Julie Swiler	\$99,975

Federal Program Support

Study Number	Title	2022 MnDOT Contribution	Total MN Contribution
TPF-5(421)	National Cooperative Highway Research Program (FY2022)	\$888,238	\$759,316
TPF-5(473)	TRB Core Program Services for a Highway RD&T Program (FY2021-2022)	\$0	\$140,603
TPF-5(496)	TRB Core Program Services for a Highway RD&T Program (FY2023)	\$161,352	\$161,352
	AASHTO Technical Services Program: Transportation Performance Management (TPM) (FY2022)	\$15,000	

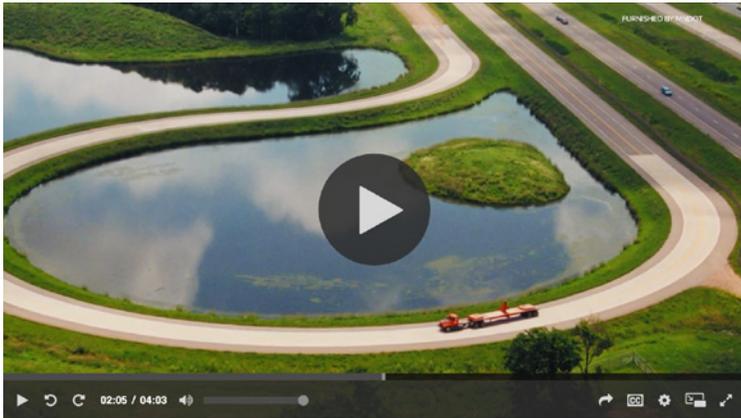
DEDICATED PROGRAMS

Title	End Date	Investigator	Technical Liaison	Total Cost
INV 668: Local Technical Assistance Program (LTAP) (FY 2021)	9/30/21	Stephanie Malinoff, University of Minnesota–CTS	Kristine Elwood	\$300,000
INV 998: Operational Research Program for Local Transportation Groups (OPERA) (FY2021-2023)	8/31/22	Mindy Carlson, University of Minnesota–CTS	Kristine Elwood	\$160,000
INV 1087: LRRB Marketing Assessment and Plan	10/31/21	Arlene Mathison, University of Minnesota–CTS	Shannon Fiecke	\$32,508
INV 686: LTAP Expanded Activities (FY2021-2022)	6/30/22	Stephanie Malinoff, University of Minnesota–CTS	Kristine Elwood	\$438,000
INV 668: Local Technical Assistance Program (LTAP) Base Operations (FFY2022)	9/30/22	Stephanie Malinoff, University of Minnesota–CTS	Kristine Elwood	\$300,000
Center for Transportation Studies (CTS) Operations (FY2022-2023)	6/30/23	Kyle Shelton, University of Minnesota–CTS	Catherine Walker	\$4,000,000



We explored innovative technologies to collect information necessary to maintain and improve our buildings. [Report 2022-26](#)

RESEARCH ACROSS MnDOT



Since MnROAD began in 1994, research at the testing facility has led to several breakthroughs and innovations in road-building technology. KARE11 covered MnROAD's efforts in [a news story from August 2022](#).

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.

KEEP UP WITH MnDOT RESEARCH



Email Updates: Subscribe at mndot.gov/research/subscribe.html.



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

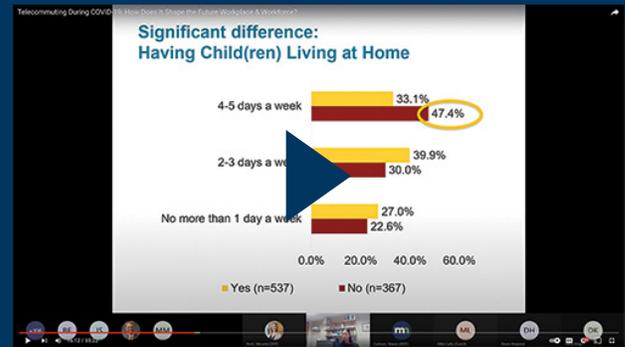


Presentations: Schedule a visit to learn how the research program or library can help your office or district.



Social Media: Connect with us at @MnDOTResearch using your favorite social media channels.

Videos: We highlight research projects and educational resources for the public. See the [MnDOT Research YouTube Channel](#).

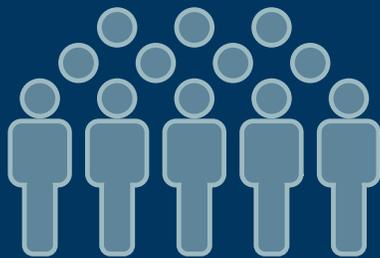


Telecommuting During COVID-19: How Does It Shape the Future Workplace & Workforce?

BY THE NUMBERS

17 qualified universities participated in our academic RFP

144 research ideas submitted



10,500 e-newsletter subscribers

4,168 library information transactions

3,550 MnDOT Research Twitter followers



1,794 digital and print materials circulated



215 active and completed research projects during FY2022



Produced by CTC & Associates LLC for:
 Minnesota Department of Transportation
 Office of Research and Innovation
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651-366-3780
 Website: mndot.gov/research
 Minnesota Department of Transportation: mndot.gov
 MnDOT Library: mndot.gov/library
 Minnesota Local Road Research Board: lrrb.org