



Michigan Department of Transportation

RESEARCH Administration

STATE PLANNING & RESEARCH PART II PROGRAM

FISCAL YEAR 2023

ANNUAL REPORT

OCTOBER 1, 2022 — SEPTEMBER 30, 2023



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STATE PLANNING AND RESEARCH, PART II, PROGRAM 2023 ANNUAL REPORT

Introduction

The Michigan Department of Transportation (MDOT) State Planning and Research (SPR), Part II Program is authorized and funded through the Code of Federal Regulations, Title 23, Part 420, Subpart B. This program is administered through the Research Administration Section in the Bureau of Field Services and funds projects that have been initiated to address specific research needs at MDOT. SPR, Part II funding can be used to research and evaluate new technologies that relate to design, construction, maintenance, and operation of all surface transportation modes. Other eligible uses include technology transfer and certain training activities.

Each year, MDOT develops a program consisting of 80 percent federally funded projects and 100 percent federally funded projects. The program also includes funding for various national research initiatives, such as the American Association of State Highway and Transportation Officials (AASHTO) Technical Service Programs (TSPs), Transportation Research Board (TRB), and National Cooperative Highway Research Program (NCHRP). The program must be reviewed and approved by the Federal Highway Administration (FHWA) Michigan Division Office prior to implementation. MDOT received FHWA approval on Aug. 22, 2022. This annual report covers the MDOT SPR Part II Program from Oct. 1, 2022, through Sept. 30, 2023.

Summary

Fiscal Year (FY) 2023 research was conducted in the following focus areas, representing several modes of transportation and MDOT's diverse business functions:

Highways Development

- Environment and Water Sources
- Real Estate, Utilities and Permits
- Project Development
- Surveys and Automated Design

Highways Bridges and Structures

- Bridge and Structure Design and Construction
- Bridge and Structure Preservation and Inspection
- Geotechnical and Foundation Design

Planning and Organizational Development

- Non-Motorized Planning and Development
- Travel Demand Forecasting

Multimodal Transportation and Finance

- Aviation
- Passenger and Freight Rail
- Local Transit
- Contract Administration
- Finance

Highways Delivery and Operations

- Construction
- Intelligent Transportation Systems and Signals
- Fleet/Facility Management & Operations
- Roadway and Roadside Maintenance
- Mobility and Traffic Incidents
- Pavements and Materials
- Transportation Safety

The FY 2023 SPR, Part II, Program consisted of 91 projects; 50 were 80 percent federally funded and 41 were 100 percent federally funded. The FY 2023 approved budget was \$9,152,603.77 and expenditures totaled \$6,227,495.35. Table 1 summarizes 80 percent federally funded projects that were funded in FY 2023 while the associated progress reports contain project summaries with projects listed sequentially by job number. Table 2 summarizes

100 percent federally funded projects. For additional information regarding a specific project, please contact Research Administration.

Program and Administrative Milestones

Research Administration (RAd) staff continued remote work transitioning from a two-day remote work week hybrid schedule to a primarily remote work schedule. The research program was delivered successfully and included the following FY 2023 milestones:

- A new position was developed in the research section to manage the implementation and innovation efforts of the office. Heidi Spangler was hired as the Innovation Engineer to fulfill this role for the first time.
- Dean Kanitz was hired into the RAd team as the Research Project Program Manager to manage the administrative side of the research project program.
- Carol Aldrich retired after a lifetime achievement managing a successful research program. Michael Townley was hired as the Engineer of Research providing leadership to the RAd Section.
- MDOT received an American Association of State Highway and Transportation Officials (AASHTO) Research Advisory Committee (RAC) High Value Research (HVR) award given to the top 16 research projects in the nation for *Evaluating Safety and Traffic Improvements Along Michigan's First Flex Route*.
- Staff attended the TRB Annual Meeting in January 2023 and coordinated the attendance of other MDOT employees. Research staff presented information at a poster session on the 2022 Supplemental Safety Recognition HVR award winning research project, *Effectiveness of Crash Fact/Safety Message Signs on Dynamic Message Signs*.
- Completed 19 projects that were 80 percent federally funded.
- Initiated contracts for 17 new 80 percent federally funded projects in FY 2023, with total budgets of approximately \$4.4 million.
- Research staff participated the No Boundaries Peer Exchange in Kansas City, Missouri and a Research Peer Exchange in Helena, Montana. These events contributed to RAd's knowledge and sharing of best practices for developing great research projects and implementing them. Fourteen state DOTs were represented along with universities and FHWA.
- Published an MDOT video highlighting successful research project managers and the critical role they plan in successful projects.

- Published documents to transfer the results of research and innovation to practitioners, including the following Research Spotlights, highlighting the value of individual research projects:
 - [SPR-1719](#) *Developing a Consistent Data Driven Methodology to Multimodal, Performance Based and Context Sensitive Design*
 - [SPR-1721](#) *Safety Enhancements at Short-Storage-Space Railroad Crossings*
 - [SPR-1716](#) *Assessing System Performance of the Michigan Trunkline: Measures and Analytical Procedures for Planning and Operations*
 - [SPR-1720](#) *Quantifying the Impact of Wide Base Tires on Pavement Performance in Michigan*
 - [SPR-1698](#) *Effects of Concrete Cure Time on Epoxy Overlay and Sealant Performance*
 - [SPR-1725](#) *Evaluating the Performance and Safety Effectiveness of Roundabouts - An Update*
 - [SPR-1722](#) *Evaluation of MDOT's Long-Life Pilot Projects*
 - [SPR-1727](#) *Determining State and Federal Transportation Responsibilities to Residents on Islands*
 - [SPR-1703](#) *Concrete Deterioration of Prestressed Bridge Beams*

- MDOT's [High Value Research StoryMap](#): The StoryMap highlights several MDOT projects that were selected through AASHTO over the last five years as sweet 16 or special category.
 - AASHTO RAC High Value Research Sweet 16
 - 2023: *Evaluation of an Active Traffic Management System with Part-Time Use of the Inside Shoulder (US-23 Flex Route)*
 - 2021: *Develop and Implement a Freeze-Thaw Model-Based Seasonal Load Restriction Decision Support Tool*
 - 2020: *Evaluating Long-Term Capacity and Ductility of Carbon Reinforced Polymer Prestressing and Post-Tensioning Strands Subject to Long-Term Losses, Creep, and Environmental Factors, and Development of Carbon Fiber-Reinforced Polymer (CFRP) Prestressing Specifications for the Design of Highway Bridges*
 - AASHTO RAC High Value Research Special Category Recognition
 - 2022: *Benefits of Dynamic Message Signs on Driver Behavior (Category - Safety)*
 - 2021: *Effectiveness of Green Strobes on Winter Maintenance Vehicles and Equipment (Category - Maintenance)*

- A [Technical Readiness](#) document was created to explain the steps a technology takes from innovative concept to implementation.

- Initiated a research project implementation tracking and planning process for the second time in FY 2023:
 - Held a workshop in February 2023 to guide project managers (PMs) of recently completed projects through the process.
 - PMs reviewed research implementation recommendations and determined if findings should be executed.

- Preliminary implementation plans were drafted that include objectives and tasks, scope, schedule, pilot locations (if applicable), estimated cost, and possible funding sources.
 - PMs recommended an implementation manager (IM).
 - Hosted RAC meetings in March 2023 where the PMs presented their implementation plans. The RAC determined if implementation was recommended, assigned an IM, and identified specific funding sources for implementation.
 - Held a Research Executive Committee (REC) meeting in May 2023, where the PMs and recommended IMs presented their study implementation recommendation(s) in an informative presentation. The REC provided further guidance.
 - RAd will be in communication with IMs, periodically requesting an implementation status report.
- RAd identified 10 research projects that could be contracted with the two University Transportation Centers (UTCs) recently awarded to Michigan universities. The University of Michigan and its partners were awarded a \$3 million UTC grant for connected and automated transportation research. Prairie View A&M University was awarded a \$4 million grant for a UTC lead by Prairie View A&M University. Michigan State University is a subcontractor in this award for research on durability and extending the life of transportation infrastructure. MDOT plans to provide matching state funds, project selection, and project management support.
- RAd met with the newly assigned FHWA region officer, Jenny Staroska, to provide introductions and offer an overview of the MDOT Research Program.
- Began the FY 2025, 2026, and 2027 research program planning process:
 - During summer 2023, MDOT developed new research priorities with input from focus area managers (FAMs) and administrators throughout the department. The priorities were shared with internal and external stakeholders.
 - In fall 2023, RAd requested the submittal for technology transfer and research ideas addressing MDOT's priorities and all stakeholders were contacted. The new research ideas were due in early November 2023.
- RAd prepared the FY 2024 SPR II program and received FHWA approval on Aug. 11, 2023.
- MDOT's [State Innovation Alignment Team \(SIAT\)](#), along with several subject matter experts, continued populating the external [Innovation website](#) to have a central location to showcase MDOT innovations.
- The public facing RAd website went through updates including the release of a new resource called the [Research Repository](#), making accessing past research reports and project resources easier than ever with advanced search capabilities. Additionally, the Partners in Research webpage initially launched in September 2022 was updated. The page is intended to be a resource for public and private transportation stakeholders interested in our research partners and their specific areas of expertise.

- The MDOT Library was remodeled to rejuvenate the collection, provide more racks of information, and include desks for users to have hoteling space while visiting the Downtown Lansing facility.
- MDOT continues to partner with the FHWA along with industry, local and state government agencies working together toward innovating our transportation system through the [State Transportation Innovation Council \(STIC\)](#), [Every Day Counts Initiative \(EDC\)](#), and the [Accelerated Innovation Deployment \(AID\) Demonstration](#) program. The following achievements can be noted this year:
 - Awarded a STIC incentives grant to install wrong way driving devices in Grand Rapids on US131 exit ramps.
 - Coordinated the EDC-7 initiative assisting FHWA with its administrative role.
 - Held two STIC Highlights meetings featuring more than 15 Michigan transportation industry innovations, with a combined attendance of more than 100 people.
- During the winter and spring of 2023, MDOT received the NCHRP ballot. The ballot was sent to focus area managers throughout MDOT for review and comment. RAd met with executive staff to score each problem statement included in the ballot. The summary ballot was submitted online to TRB's Cooperative Research Programs and final vote submitted by the MDOT director.
- Several MDOT staff members have attended AASHTO Research Advisory Committee meetings throughout the year to understand the national research agenda and processes. These meetings have included periodic AASHTO RAC chats, Region 3 Collaboration and Business meetings, and the national meeting in Chattanooga, Tennessee.

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TABLE 1 - 80% FEDERALLY FUNDED

Job No.	FY 2023 Expenditures	Expenditures to Date	Total Budget	Project Manager	Agency	Principal Investigator	Title	Start Date	End Date	Page No.
128602	\$98,659.75	\$721,635.55	\$1,168,711.17	Kahl, Steve	LTU	Grace	Statewide Overall Carbon Fiber Composite Cable Bridge Monitoring	12/17/2013	9/30/2025	15
132231	\$23,321.42	\$466,383.74	\$528,322.24	Qu, Yige	MSU	Cregg	Slope Restoration on Urban Freeways	4/1/2017	12/31/2025	17
201393	\$54,040.71	\$531,379.04	\$534,646.44	Belcher, John	WMU	Attanayake	Effects of Concrete Cure Time on Epoxy Overlay and Sealant Performance	7/1/2018	12/31/2022	19
204646	\$5,868.75	\$137,415.20	\$206,280.18	Renner Lindsey	MSU	El-Gafy	Training Tools for Effective Advancement of Digital Technologies for Construction Field Operations	2/1/2020	4/30/2023	21
208773	\$52,081.32	\$292,946.57	\$359,310.57	Grabarkiewicz, Jeff	MSU	Roloff	Eastern Massasauga (<i>Sistrurus catenatus</i>) Road Ecology and Population Dynamics in Michigan	11/25/2019	5/31/2023	23
208774	\$37,770.86	\$106,642.11	\$106,642.26	Johnson, Nikkie	Texas A&M	Das	Safety Enhancements at Short-Storage-Space Railroad Crossings	1/1/2020	12/31/2022	25
208776	\$20,478.75	\$410,425.02	\$410,425.02	Eacker, Michael	MSU	Kutay	Evaluation of MDOT's Long-Life Pilot Projects	10/25/2019	12/31/2022	27
208777	\$87,691.78	\$569,745.33	\$566,803.88	Schenkel, Justin	MSU	Haider	Testing Protocol, Data Storage and Recalibration for Pavement-ME Design	1/21/2020	6/30/2023	29
209437	\$46,679.25	\$247,866.25	\$492,314.72	Hoffmeyer, Mary	CTC & Associates	Casey	Research Administration Section Planning and Communications	10/1/2020	9/30/2025	32
210791	\$43,523.18	\$180,202.33	\$180,204.74	Maffeo, Robert	MSU	Zockaie	Assessing System Performance of the Michigan Trunkline Measures and Analytical Procedures for Planning and Operations	8/1/2020	12/31/2022	34
211053	\$258,011.19	\$442,505.15	\$442,505.15	Zwolinski, Andrew	U of M	Kerkez	Electronic Water Level Sensors for Monitoring Scour Critical Structures	4/1/2021	12/31/2023	37
211056	\$88,082.17	\$233,123.67	\$559,375.31	Mueller, Michele	Kimley-Horne	Good	Utilizing Video Analytics w/Connected Vehicles for Improved Safety	2/15/2021	1/31/2024	39
211058	\$275,060.99	\$302,570.52	\$355,167.11	Smith, Dave	MSU	Gates	Effective Bridge Deck Weather Warning Technologies	2/15/2021	7/31/2023	40
211059	\$22,171.45	\$160,573.35	\$160,573.35	Shultz, Valerie	MSU	Zockaie	Determining State and Federal Transportation Responsibilities to Residents on Islands	1/15/2021	6/30/2023	41
211061	\$202,076.72	\$511,962.32	\$572,828.13	Eacker, Michael	MSU	Kutay	Evaluation of MDOT's Methodologies for both Quantifying Pavement Distress & Modeling Pavement Performance for LCC and RSL Estimation Purposes	2/2/2021	5/31/2023	43
211062	\$57,814.31	\$260,361.94	\$260,557.28	Schenkel, Justin	MTU	You	Quantifying the Impact of Super Single (Wide Base) Tires on Pavement Damage in Michigan	3/15/2021	12/31/2022	45
211063	\$90,843.90	\$234,791.94	\$269,745.08	Miller, Nathan	WSP	Wendling	Corridor and Systemwide Application of Performance Based Practical Design	2/1/2021	1/31/2024	47
211064	\$153,817.95	\$344,074.70	\$386,327.00	Fitch, Matt	MSU	Bunting	Right of Way Mapping Conversion to GIS	2/1/2021	4/30/2023	48
211065	\$113,189.67	\$249,996.49	\$249,999.99	Ealy, Jason	MSU	Savolainen	Evaluating the Performance & Safety Effectiveness of Roundabouts - An Update	3/1/2021	4/30/2023	50
213122	\$70,829.12	\$136,195.90	\$484,499.23	Kahl, Steve	LTU	Grace	Influence of Revising CFCC Guaranteed Strength on Performance of CFCC Prestressed Highway Bridge Beams Subjected to Various Environmental Conditions	10/1/2021	9/30/2024	51
213309	\$128,432.83	\$241,812.24	\$241,812.24	Beatty, Matt	WSU	Menkulasi	Repair of Bridge Deck Fascias	10/1/2021	9/30/2023	53
213313	\$115,852.34	\$161,566.24	\$164,918.18	Eacker, Michael	LTU	Bandara	Establish Policies and Procedures for Use of Subgrade Stabilization in Michigan	10/1/2021	3/31/2023	55
213314	\$110,332.70	\$195,439.56	\$209,770.69	Bott, Mark	WMU	Van Houten	Effective Pedestrian/Non-Motorized Crossing Enhancements along Higher Speed Corridors	10/1/2021	9/30/2023	57
213316	\$183,846.08	\$317,504.32	\$584,935.71	Carlson, Erik	MTU	Watkins	Michigan Hydrologic Calculation Procedures	11/1/2021	12/31/2024	58
213318	\$81,440.75	\$139,259.75	\$508,568.57	Snook, Ryan	U of M	Hryciw	Michigan Cone Penetrometer Test Calibration	1/1/2022	11/30/2024	61

Job No.	FY 2023 Expenditures	Expenditures to Date	Total Budget	Project Manager	Agency	Principal Investigator	Title	Start Date	End Date	Page No.	
213321	\$117,321.26	\$168,897.97	\$258,887.71	Pakala, Parush	WMU	Attanayake	Operational Baseline for the 2nd Avenue Network Arch Bridge	1/1/2022	5/31/2024	63	
216349	\$0.00	\$150,000.00	\$257,424.97	Smith, Linn	Airspace Link	Free	Analysis and Deployment of an Unmanned Traffic Management System in Michigan – Phase 1 Feasibility Analysis	2/1/2022	1/31/2023	65	
217331	\$4,983.98	\$4,983.98	\$170,882.34	DeBruyn, Josh	UC Denver	Misra	Leveraging Crowd-sourced Data in Planning, Design, Analysis, and Evaluation of Pedestrian and Bicycle Traffic	6/21/2023	5/31/2024	67	
217419	\$79,228.21	\$79,228.21	\$380,430.69	Tempinson, Don	WMU	Attanayake	Capacity Prediction of Repaired and Unrepaired Bridge Beams with Deteriorated Ends	10/1/2022	9/30/2024	68	
217421	\$146,181.33	\$146,181.33	\$210,637.52	Bowerman, Glenda	CRAFT	Ketterl	Construction Digital Delivery Technology Scan	12/9/2022	6/30/2024	69	
217455	\$158,865.66	\$158,865.66	\$192,465.00	Davis, Kelly	WSU	Eamon	Enhanced Bridge Cost Estimating	10/26/2022	9/30/2023	71	
217934	\$11,601.95	\$11,601.95	\$255,632.95	Uzcategui, Alonso	MSU	Gates	Efficacy of Speed Warning Technologies	1/23/2023	2/15/2025	73	
217937	\$43,536.34	\$43,536.34	\$226,250.61	Roath, James	MSU	Zockaie	Winter Severity Index with Winter Maintenance Expenses and Material Usage	2/6/2023	2/6/2025	74	
218359	\$0.00	\$0.00	\$222,451.62	Ahlschwede, Carla	MTU	Dobson	Identify Mapping Techniques of Invasive Plant Species within the MDOT Right-of-Way (ROW)	10/11/2023	9/30/2025	75	
218361	\$53,715.77	\$53,715.77	\$241,889.86	Sevigny, Diane	Hatch	Bodarya	MDOT Fleet Electrification Strategies	6/21/2023	2/28/2025	76	
218362	\$40,730.86	\$40,730.86	\$183,438.15	Smerdon, Tim	WMU	Van Houten	Examination of Lighting Practices at Crosswalks	4/24/2023	1/31/2025	77	
218364	\$72,392.00	\$72,392.00	\$497,947.58	Hoffman, Sarah Krom, Ben	WMU	Oh	Evaluation of MDOT's Methodology for Estimating Work Zone User Delay Times	5/3/2023	2/28/2026	78	
218367	\$46,947.00	\$46,947.00	\$359,434.06	Halloran, Mike	HDR	Longfield	Improving MDOT's Movable Bridge Reliability and Operations	3/17/2023	5/31/2024	79	
218391	\$0.00	\$0.00	\$358,967.92	Martin, John	MSU	Savolainen	Socio Economic Impacts of Technology Based Stakeholder Engagement Platforms	8/21/2023	8/21/2026	80	
218392	\$85,822.91	\$85,822.91	\$221,837.88	Smith, Linn	C&S	Trendowski	Multimodal Aircraft Charging Station Deployment	4/3/2023	8/31/2024	81	
*218394	\$0.00	\$0.00	\$385,875.00	Kahl, Steve	LTU	TBD	Design Guidance Development for Continuous Prestressed CFCC Strand Beams	10/1/2024	9/30/2027	83	
218396	\$5,193.80	\$5,193.80	\$325,050.01	Firman, Jason	MSU	Savolainen	Identify Best Locations for New Flex-Route Projects Throughout the State of Michigan	6/14/2023	6/14/2025	84	
*218397	\$0.00	\$0.00	\$460,000.00	Gorman, Joseph	KPMG	Ganesh	Revenue Opportunities from MDOT Fiber Infrastructure and Other Utility Types	To Be Determined	To Be Determined	85	
218398	\$41,188.50	\$41,188.50	\$474,600.82	Schenkel, Justin	MSU	Haider	Pavement ME Rehabilitation Design Protocols for MDOT Implementation	7/13/2023	7/13/2025	86	
218401	\$50,946.23	\$50,946.23	\$116,284.36	Kirkpatrick, Kristi	WMU	Liu	Improving Cost Estimation and Budget Planning with New Michigan Highway Construction Cost Index	5/30/2023	12/31/2024	88	
*218402	\$0.00	\$0.00	\$160,069.82	Feldpausch, Adam	TX A&M	Glover	Bonding vs. Pay-Go	10/30/2023	2/28/2025	89	
*218403	\$0.00	\$0.00	\$307,618.22	Hohf, Kevin Kent, Ellen	CRAFT	Ketterl	Marketing and Education Budget for Implementation of New Transit Technology	To Be Determined	To Be Determined	90	
218404	\$8,123.61	\$8,123.61	\$219,727.94	Brink, Steve Miller, Dawn	MSU	Gates	Optimizing work Zone Conditions to Maximize Safety and Mobility	6/27/2023	6/27/2025	91	
*219527	\$0.00	\$0.00	\$619,053.00	Smith, Linn	WSP	Wheeler	Unmanned Aircraft System Communications Mesh Test Deployment	To Be Determined	To Be Determined	92	
219532	\$25,000.00	\$25,000.00	\$25,000.00	Clover, Andre	TRB	TRB	TRB Forum on Preparing for Automated Vehicles and Shared Mobility (AV/SM Forum)	10/1/2022	9/30/2023	93	
**None	\$0.00	\$0.00	\$142,000.00	Douglas, Scott	To Be Determined	To Be Determined	Business Architecting for Digital Delivery	10/1/2022	7/31/2023	**None	
**None	\$0.00	\$0.00	\$175,000.00	Engle, John	To Be Determined	To Be Determined	Predicting Urban Street Speed and its Relationship to Reliability and Level of Service	To Be Determined	To Be Determined	**None	
	\$3,413,697.35	\$8,789,735.35	\$17,454,102.27	TOTAL 80% FEDERALLY FUNDED PROJECTS							

*Project was included in the FY 2023 program assuming a start date that was delayed.

**Project was canceled and is not included in this report.

TABLE 2 - 100% FEDERALLY FUNDED PROJECTS

Project No.	FY 2023 Expenditures	Expenditures to Date	Total Budget	Agency	Project Manager	Title	Start Date	End Date	Page No.
*Sol. 1513	\$0.00	\$0.00	\$175,000.00	Ohio DOT	Budds, Bryan	Infrastructure to Support Advance Autonomous Aircraft Technologies	To Be Determined	To Be Determined	*None
Sol. 1562	\$0.00	\$0.00	\$90,000.00	South Dakota DOT	Croze, Tim	Development of a Winter Maintenance Decision Support System (Phase 3)	1/2/2022	9/30/2025	97
Sol. 1598	\$0.00	\$0.00	\$150,000.00	MDOT	Feldpausch, Elise Annelin, Niles	Mid-America Association of State Transportation Officials Connected Automated Vehicle - Steering Committee	10/1/2023	9/30/2028	99
SPR1801(179)	\$195,000.00	\$195,000.00	\$195,000.00	AASHTO/ FHWA	Clover, Andre	AASHTO Engineering Technical Service Programs	10/1/2022	9/30/2023	100
TPF-5(255)	\$0.00	\$100,000.00	\$100,000.00	FHWA	Bott, Mark	Highway Safety Manual Implementation	11/9/2015	12/31/2025	101
TPF-5(317)	\$50,000.00	\$90,000.00	\$90,000.00	Nevada DOT	Bott, Mark	Evaluation of Low-Cost Safety Improvements	10/1/2019	9/30/2023	104
TPF-5(343)	\$0.00	\$270,000.00	\$270,000.00	Washington DOT	Torres, Carlos	Roadside Safety and Research for MASH Implementation	10/1/2016	6/30/2024	106
TPF-5(347)	\$0.00	\$170,000.00	\$170,000.00	South Dakota DOT	Roath, James	Development of Maintenance Decision Support System	10/1/2016	9/30/2023	111
TPF-5(353)	\$0.00	\$125,000.00	\$125,000.00	Minnesota DOT	Droste, Justin	Clear Roads Winter Highway Operations Pooled Fund (Phase II)	10/1/2016	6/30/2023	114
TPF-5(372)	\$25,000.00	\$125,000.00	\$125,000.00	Iowa DOT	Wagner, Brad	Building Information Modeling (BIM) for Bridges and Structures	10/1/2017	1/31/2024	119
TPF-5(375)	\$50,000.00	\$250,000.00	\$250,000.00	Minnesota DOT	Kennedy, Kevin	National Partnership to Determine the Life Extending Benefit Curves of Pavement Techniques (MnROAD/NCAT Joint Study-Phase II)	1/1/2019	12/31/2023	121
TPF-5(385)	\$45,000.00	\$260,000.00	\$260,000.00	Virginia DOT	Shapter, Paul	Pavement Structural Evaluation with Traffic Speed Deflection Devices (TSDD's)	3/1/2019	10/31/2023	123
TPF-5(396)	\$0.00	\$148,000.00	\$148,000.00	Wisconsin DOT	Wulff, Elisha	Mid-America Freight Coalition (MAFC) Phase 3	2/1/2019	3/31/2023	125

Project No.	FY 2023 Expenditures	Expenditures to Date	Total Budget	Agency	Project Manager	Title	Start Date	End Date	Page No.
TPF-5(423)	\$1,463,324.00	\$1,463,324.00	\$1,500,000.00	FHWA	Clover, Andre	National Cooperative Highway Research Program (NCHRP) for FY 2023	10/1/2022	9/30/2023	127
TPF-5(433)	\$0.00	\$30,000.00	\$30,000.00	Utah DOT	Tichenor, Joel	Behavior of Reinforced and Unreinforced Lightweight Cellular Concrete for Retaining Walls	10/1/2019	3/31/2024	128
TPF-5(435)	\$25,000.00	\$100,000.00	\$125,000.00	Iowa DOT	Roath, James	Aurora Program (FY20-FY24)	10/1/2019	12/31/2024	130
TPF-5(436)	\$0.00	\$120,000.00	\$120,000.00	Indiana DOT	Nadjarian, Allie	Development of Criteria to Assess the Effects of Pack-out Corrosion in Built-up Steel Members	10/1/2019	9/30/2024	133
TPF-5(437)	\$12,000.00	\$48,000.00	\$60,000.00	Iowa DOT	Kennedy, Kevin	Technology Transfer Concrete Consortium (FY20-FY24)	10/1/2019	12/31/2025	136
TPF-5(438)	\$25,000.00	\$100,000.00	\$125,000.00	Iowa DOT	Brookes, Chris	Smart Work Zone Deployment Initiative	10/1/2019	12/31/2024	138
TPF-5(441)	\$10,000.00	\$40,000.00	\$50,000.00	Colorado DOT	Rowley, Todd	No Boundaries Transportation Maintenance Innovations	10/1/2019	9/30/2024	141
TPF-5(444)	\$10,000.00	\$40,000.00	\$50,000.00	Montana DOT	Bott, Mark	Traffic Safety Culture - Phase 2	10/1/2019	9/30/2024	143
TPF-5(446)	\$80,000.00	\$80,000.00	\$80,000.00	FHWA	Carlson, Erik	High Performance Computational Fluid Dynamics (CFD) Modeling Services for Highway Hydraulics	10/1/2022	9/30/2025	145
TPF-5(447)	\$20,000.00	\$60,000.00	\$100,000.00	FHWA	Bott, Mark	Traffic Control Device (TCD) Consortium (3)	1/1/2021	2/15/2025	146
TPF-5(453)	\$50,000.00	\$150,000.00	\$250,000.00	Ohio DOT	Feldpausch, Elise	Automated Vehicle Pooled Fund Study	10/1/2020	9/30/2025	148
TPF-5(460)	\$55,600.00	\$111,200.00	\$166,800.00	South Dakota DOT	Carlson, Erik	Flood-Frequency Analysis in the Midwest: Addressing Potential Nonstationary Annual Peak-Flow Records	10/1/2021	9/30/2024	149
TPF-5(465)	\$10,000.00	\$10,000.00	\$30,000.00	Alabama DOT	Kennedy, Kevin	Consortium for Asphalt Pavement Research and Implementation (CAPRI)	10/1/2022	9/30/2025	150
TPF-5(466)	\$150,000.00	\$450,000.00	\$750,000.00	Minnesota DOT	Kennedy, Kevin	National Road Research Alliance - NRRRA (Phase-II)	10/1/2020	1/31/2026	152
TPF-5(468)	\$10,000.00	\$40,000.00	\$50,000.00	FHWA	Wagner, Brad	Structural Behavior of Ultra- High- Performance Concrete	2/1/2021	12/31/2025	154

Project No.	FY 2023 Expenditures	Expenditures to Date	Total Budget	Agency	Project Manager	Title	Start Date	End Date	Page No.
TPF-5(479)	\$25,000.00	\$50,000.00	\$125,000.00	Minnesota DOT	Droste, Justin	Clear Roads Winter Highway Operations Pooled Fund (Phase III)	5/1/2022	9/30/2024	156
TPF-5(480)	\$30,000.00	\$90,000.00	\$150,000.00	Iowa DOT	Arnold, Luke	Building Information Modeling (BIM) for Infrastructure	7/1/2021	9/30/2025	160
TPF-5(486)	\$30,000.00	\$60,000.00	\$210,000.00	Indiana DOT	Curtis, Beckie	Center for the Aging Infrastructure: Steel Bridge Research, Inspection, Training and Education Engineering Center - SBRITE (Continuation)	10/1/2021	9/30/2026	162
TPF-5(487)	\$25,000.00	\$25,000.00	\$125,000.00	FHWA	Peplinski, Suzette	Transportation Management Centers Pooled Fund Study Phase II	4/17/2022	4/16/2027	164
TPF-5(489)	\$25,000.00	\$50,000.00	\$100,000.00	FHWA	Gill, Sarah	Safety Service Patrol Standardization and Management Practices	10/1/2021	9/30/2025	166
TPF-5(490)	\$35,000.00	\$70,000.00	\$175,000.00	MDOT	Feldpausch, Elise	ITS Pooled Fund Program (ENTERPRISE) Phase III	10/15/2022	9/30/2027	168
TPF-5(495)	\$0.00	\$12,000.00	\$12,000.00	Iowa DOT	Leix, Tracie	2023 Technology Exchange on Low Volume Road Design, Construction and Maintenance	9/1/2021	9/30/2023	170
TPF-5(501)	\$65,000.00	\$65,000.00	\$195,000.00	Washington DOT	Torres, Carlos	Roadside Safety Pooled Fund – Phase 3	1/1/2023	9/30/2025	172
TPF-5(508)	\$50,000.00	\$50,000.00	\$200,000.00	Texas DOT	Liptak, Rick	Concrete Bridge Engineering Institute (CBEI)	10/1/2022	9/30/2026	174
TPF-5(511)	\$226,874.00	\$226,874.00	\$226,874.00	AASHTO/ FHWA	Clover, Andre	TRB Core Program Activities FFY 2023 (TRB FY 2024)	10/1/2022	9/30/2023	176
TPF-5(516)	\$16,000.00	\$16,000.00	\$80,000.00	FHWA	Bott, Mark	Highway Safety Manual Implementation 2nd Edition	10/1/2022	9/30/2027	177
TPF-5(517)	\$0.00	\$0.00	\$100,000.00	Iowa DOT	Bahmer, Ethan	Sustainable Performance Engineered Concrete	10/1/2022	9/30/2027	178
	\$2,813,798.00	\$5,290,398.00	\$7,333,674.00	TOTAL 100% FEDERALLY FUNDED PROJECTS					

*Solicitation 1513 had no expenditures this year and the lead state is still seeking participants. A full project report form can be found in the FY 2022 annual report.

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80% FEDERALLY FUNDED PROJECTS

Sequentially Listed by Job Number

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**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2023**

PROJECT TITLE: Statewide Overall Carbon Fiber Composite Cable Bridge Monitoring

FUNDING SOURCE: SPR, Part II OTHER (PLEASE EXPLAIN)

PROJECT MANAGER: Steve Kahl

CONTRACT/AUTHORIZATION NO.	2014-0043	PROJECT START DATE	12/17/2013
PROJECT NO.	128602	COMPLETION DATE (Original)	9/30/2020
OR NO.	OR14-039	COMPLETION DATE (Revised)	9/30/2025
RESEARCH AGENCY	Lawrence Technological University (LTU)		
PRINCIPAL INVESTIGATOR	Nabil Grace		

BUDGET STATUS

FY 2023 Budget		Total Budget	
Vendor Budget FY 2023	\$122,692.12	Total Vendor Budget	\$1,166,711.17
MDOT Budget FY 2023	\$1,000.00	Total MDOT Budget	\$2,000.00
Vendor FY 2023 Expenditures	\$98,659.75	Total Budget	\$1,168,711.17
MDOT FY 2023 Expenditures	\$0.00	Total Expenditures	\$721,635.55
		Total Amount Available	\$447,075.62

PURPOSE AND SCOPE

Carbon Fiber Composite Cable (CFCC), and other Carbon Fiber Reinforced Polymer (CFRP) materials are being used for prestressing applications in Michigan bridge rehabilitation and replacement projects. As this is still considered an innovative material, understanding and quantification of the long-term behavior based on stress/strain gage readings of previous field deployments is essential for future design and construction considerations. Continued monitoring of the CFCC elements in already constructed bridges will provide information on the long-term behavior and allow for recommendations to be made for future designs, considering the behavior of current field deployments.

FISCAL YEAR 2014 ACCOMPLISHMENTS

Completed the setup of the monitoring website and data are now available for review and download. The research team at Lawrence Technological University (LTU) was successful at downloading data from the website and recordings from Bridge Street bridge, M-50 bridge, and M-39 bridge have been checked. Readings from M-50 and M-39 bridges had minor issues that were corrected later. The system was then working properly in both bridges and the readings conformed to the theoretical calculations. At the close of the Fiscal Year (FY), work was continuing connecting M-102 bridge to the website and making the data available. As part of the nearly completed construction project, a power system is to be installed on-site. Scheduled maintenance visits to Bridge Street bridge and M-50 bridge were postponed until the necessary power system for M-102 is available.

FISCAL YEAR 2015 ACCOMPLISHMENTS

Data from each bridge has been used for a separate research project, 2013-0065 - Evaluating Long Term Capacity and Ductility of Carbon Fiber Reinforced Polymer prestressing and post tensioning strands. There have been pieces of data collection equipment and sensors that have been noted as not functioning properly, and a meeting with the supplier will take place in early 2016. In the meantime, data received is being used to corroborate analytical calculations and responses.

FISCAL YEAR 2016 ACCOMPLISHMENTS

Monitoring of bridges containing CFRP elements continued throughout FY 2016. Several locations had equipment upgrades, along with assessments of the adequacy of the data collection equipment. Reports were provided of the trends in strains, loads, and deflections at different locations, and the data has been continued to be used in conjunction of research project 2013-0065 - Evaluating Long Term Capacity and Ductility of Carbon Fiber Reinforced Polymer prestressing and post tensioning strands. The data analysis and trends from this monitoring continue to validate numerical simulation of bridge behavior being done as part of that research.

FISCAL YEAR 2017 ACCOMPLISHMENTS

Monitoring of the current inventory of bridges will continue. The I-75 SB over Sexton Kilfoil Drain construction is complete and load test was performed. This bridge was added to the overall monitoring contract, and monitoring activities will continue until project completion in 2020.

FISCAL YEAR 2018 ACCOMPLISHMENTS

Continued monitoring, and regular data reporting on all six (6) wired bridges will keep correlating actual experimental data with theoretical calculated values.

Reporting of data to the Research Advisory Panel (RAP) was done with meetings for the OR14-024 project, and this data was used to calibrate several equations and constants used in the proposed guide specifications.

The subcontractor visited the M-50 and Bridge Street bridges for annual maintenance. Defective equipment was noted, which resulted in abnormal readings. The subcontractor was able to replace the defective hardware and bring the system back to functioning properly. The Bridge Street bridge is also suffering from possible defective hardware but the troubleshooting and repair of the system is beyond the scope of annual maintenance.

In addition, the wireless carrier has issued a firmware upgrade to their phones as a fix from universal hacking and introducing malware into these systems. This fix can be done remotely on newer phones. Older phones such as those supplied in the bridge monitoring systems need to be upgraded manually. While the subcontractor was able to upgrade the firmware manually on the phones, the wireless carrier will stop supporting 3G networks in the next year and all phones will require the ability to utilize a 4G network. Therefore, an estimate for the repair of the hardware at Bridge Street and an upgrade for the phones in all bridge locations has been submitted to MDOT for review and approval of this amendment.

FISCAL YEAR 2019 ACCOMPLISHMENTS

Monitoring continues for the M-39, M-50, M-102, Bridge Street and I-75 bridges. The research team at LTU was successful at downloading data from all bridges with some concerns in the Bridge Street Bridge. The subcontractor visited all bridge sites, checked hardware as well as the accuracy of the collected data, and provided a report on the conditions of all bridge monitoring systems. The systems on M-50, M-102, and I-75 bridges were all in good working condition and provided accurate readings. There were some sensors on M-39 bridge that were not giving accurate readings (even when collected manually) and they were assumed defective. In Bridge Street Bridge, it appears that a recent power surge caused some hardware issues and caused some sensors to stop reading properly. Defective sensors were removed from the site and a plan to address the conditions of the monitoring system of Bridge Street Bridge is currently underway and being discussed with MDOT Engineers.

FISCAL YEAR 2020 ACCOMPLISHMENTS

Continued monitoring of the bridges in the contract, and analysis of long-term material behavior is expected. This analysis is being used to adjust material resistance factors and long-term durability considerations in the current design guidelines that MDOT has implemented as part of a separate research project. There were several data collection and communication components that were replaced and/or upgraded.

FISCAL YEAR 2021 ACCOMPLISHMENTS

Continued monitoring of the instrumented bridges on M-39, M-50, M-102, Bridge Street and I-75, along with generation of data points for long-term material performance and refinement of the creep-rupture factors for the 0.6" diameter CFRP strands. The MDOT Project Manager (PM) held quarterly meetings throughout the year.

FISCAL YEAR 2022 ACCOMPLISHMENTS

Monitoring continued for the M-39, M-50, M-102, Bridge Street and I-75 bridges. Overall, there seem to be no new issues with the monitoring system or the readings from the sensors. Monitoring on M-39 was interrupted due to software issues, which were resolved by the subcontractor. The research team analyzed the recorded data, shared the results with MDOT Engineers, and continues to download and analyze data while watching for any faulty readings. The team is working closely with the subcontractor to assess the readings from the sensors and address any maintenance issues. They team also performed in-depth calculations and finite element simulation to assess the effect of temperature change on the readings from different sensors.

FISCAL YEAR 2023 ACCOMPLISHMENTS

The monitoring continued for M-39, M50, M-102, Bridge Street and I-75 Bridges. Overall, there seems to be no new issues with the monitoring system or the readings from the sensors.

The research team is currently analyzing the recorded data and has shared the results with MDOT engineers. The team continues to download data and perform the necessary analysis and watch for any faulty readings. They're working closely with the subcontractor to assess the readings from the sensors and address any maintenance issues.

FISCAL YEAR 2024 PROPOSED ACTIVITIES

The research team will continue monitoring instrumented bridges on M-39, M-50, M-102, Bridge Street and I-75, along with generation of data points for long-term material performance and refinement of the creep-rupture factors for the 0.6" diameter CFRP strands. The MDOT Project Manager will plan and schedule progress meetings throughout FY 2024 and anticipates data generation for the duration of the research project through FY 2025.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

Project cost was increased in FY 2017 to include the addition of the I-75 SB over Sexton-Kilfoil Drain, which is the longest CFCC prestressed bridge built to date. The contract was also modified early 2019 to add five years of data collection and increase the budget to cover unexpected repairs that caused failures in bridge monitoring. There was also a change in MDOT project manager in FY 2022.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project expected completion FY 2025.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2023**

PROJECT TITLE: Slope Restoration on Urban Freeways

FUNDING SOURCE: SPR, Part II OTHER (PLEASE EXPLAIN)

PROJECT MANAGER: Yige Qu

CONTRACT/AUTHORIZATION NO.	2013-0066 Z10	PROJECT START DATE	4/1/2017
PROJECT NO.	132231	COMPLETION DATE (Original)	7/31/2019
OR NO.	OR16-008	COMPLETION DATE (Revised)	12/31/2025
RESEARCH AGENCY	Michigan State University (MSU)		
PRINCIPAL INVESTIGATOR	Bert Cregg		

BUDGET STATUS

FY 2023 Budget		Total Budget	
Vendor Budget FY 2023	\$0.00	Total Vendor Budget	\$476,941.06
MDOT Budget FY 2023	\$8,590.00	Total MDOT Budget	\$51,381.18
Vendor FY 2023 Expenditures	\$23,321.42	Total Budget	\$528,322.24
MDOT FY 2023 Expenditures	\$0.00	Total Expenditures	\$466,383.74
		Total Amount Available	\$61,938.50

PURPOSE AND SCOPE

The purpose of this project is to research and subsequently develop best practices and viable alternatives to turf as a solution for slope stabilization, especially steep slopes. Current methods and practices necessary to specify correct soils, plant species, cultural practices, planting standards, maintenance plans, benefits, and costs will be analyzed. The result will be best practice recommendations for slope restoration and continued maintenance. The scope of work includes the following tasks:

- Analyze existing research regarding erosion control, restoration, and maintenance on steep slopes adjacent to freeways.
- Identify field research plot location(s) in the I-696 corridor.
- Provide MDOT with research work plan.
- Partner with MDOT and vendor installation contractor to provide oversight on installation.
- Perform subsequent maintenance of research plots.
- Collect data.
- Review and analyze data collected to determine best practices and cost-benefit ratios.
- Identify best practices for site preparation.
- Identify native and non-native trees, shrubs, herbaceous perennials, and grasses suitable for Michigan roadside plantings. Compile research from the current project as well as a review of literature of similar studies and relevant guides from other DOTs to develop a new MDOT Plant Selection Guide
- Present research results with final recommendations.

FISCAL YEAR 2017 ACCOMPLISHMENTS

Hired Research Technician for the project (Deborah Trelstad), finalized plot site selection, and marked research plot boundaries. Collected mulch, compost, and soil samples from study area. Also identified comparative areas along I-696 (outside of study blocks) and initiated sampling and assessment, of areas where establishment was successful. Hired a designer to complete plot design drawings for bid specs and a graduate student (Liza Christopher) initiated literature review of related roadside planting protocols from DOTs in other states. MDOT did not complete the planting in fiscal year 2017 as originally planned.

FISCAL YEAR 2018 ACCOMPLISHMENTS

Plot designs and plant lists were completed by MSU. MSU reviewed literature of related roadside planting protocols from DOTs in other states as well as roadside salts. The contractor for plot installation was selected (WH Canon) and installation started June 15, 2018. Plot installation and planting completed for blocks 4-6 and 4a-6a. Over 50 percent of plant installations were completed in 2018 in coordination with major construct of I-696 and despite operators strike. MDOT facilitated watering operations between local municipalities, MDOT, researchers and contractors. MDOT region provided additional funding for plant replacement due to mortality from I-696 construction damage and 2018 summer drought. MSU measured leaf chlorophyll index on Cornus, Physocarpus, Forsythia and Dierivilla plants in blocks 4-6. Collected leaf tissue for nitrogen (N) analysis. They also installed rain gauges data loggers/ temperature sensors on the plots and collected data. Periodic growth measurements taken for blocks 4-6 and 4a-6a.

FISCAL YEAR 2019 ACCOMPLISHMENTS

Contractor completed installation of study treatments and plants in Blocks 1-3 in October 2018 on North side of I-696 West and East of the Nieman St. overpass. Sites for Blocks 1-3 were moved from their original planned locations to avoid additional lane closures during I-696 construction in Summer-Fall 2018. MSU researchers installed soil moisture sensors, soil temperature sensors and automatic data loggers in each plot. Data collection continued the site throughout the 2019 growing season and included plant growth, plant moisture stress, plant nutrient status, and photosynthetic rate. MSU Personnel conducted periodic

maintenance on the plots including hand- weeding and application of pre- and post-emergent herbicides. Project was amended to allow for longer-term (5 years) evaluation of the test plantings. In conjunction with project amendment, MSU Researchers developed a proposal for additional funding through MSU project GREEN, which was funded at \$35,000 per year for two years (\$70,000 total). The grant funding will provide continuing support for an M.S. graduate student at MSU. Preliminary results of the project indicate the addition of compost greatly improved plant establishment and growth. The response of plants to compost appears to be primarily related to improve plant nutrient availability. To date, tillage appears to provide relatively little benefit for plant establishment and growth.

FISCAL YEAR 2020 ACCOMPLISHMENTS

MSU graduate student Maddy Dubelko, Drs, Cregg and Schutzki provided research results to date on the project at the Michigan Nursery and Landscape Association Great Lakes Trade Expo in January 2020. Covid-19 shutdown protocols affected early season site visits. When the MSU Research Team was cleared for travel, data collection and maintenance operations resumed, and the researchers were able to track plant growth, plant physiology, and soil testing throughout the remainder of the growing season. MSU researchers continued progress on the plant selection guide, which includes species from plant research and species based on an exhaustive literature search. Researchers installed two automated weather stations, one on the south side of I-696 and one on the north side of I-696. These stations will provide detailed micro-climate information that highlight conditions which affect plants by their respective locations. MSU used equipment currently on hand for one weather station and secured funding from the Michigan Department of Agriculture and Rural Development Horticulture fund to purchase equipment for the second weather station. It is expected that field operations will conclude late fall season 2020 and resume when weather and Covid-19 restrictions permit.

FISCAL YEAR 2021 ACCOMPLISHMENTS

MSU personnel completed intensive plant-based measurements on I-696 field plots in fall 2020. Data analysis and summary of data were completed in spring 2021. MSU Graduate student (Maddy Dubelko) completed an MS thesis documenting field study finding, which were also summarized in a project report submitted to MDOT. Key findings of the initial phase of the field research include Initial plant establishment was improved by addition of compost but was not affected by tillage. This indicates that top-dressing with compost is adequate, saving the cost of tilling sites before planting. The improvement of plant establishment with compost was related to improved soil and plant nutrition. Plant establishment varied with plant type as shrubs, particularly Diervilla, Physocarpus, and Cephalanthus selections had greater survival, growth, and plant cover than most of the herbaceous and grass selections. MSU personnel (Dubelko and Schutzki) completed and submitted a plant selection guide for roadside plantings for Michigan including plant selection for various regions of the state and planting specifications. MSU personnel presented key findings and recommendations from the project to MDOT Metro region personnel via virtual meeting on May 25, 2021. MSU personnel developed a request and plan of work for an extension of the project through 2025. The project extension will allow continued monitoring of the site to determine longer-term impacts of site preparation on soil properties and plant performance as well as evaluation of freeway microclimates. MSU personnel continued site visits in 2021 to maintain the field plots, including pre- and post-emergent herbicide applications, maintain the weather stations, and collect data on plant coverage.

FISCAL YEAR 2022 Accomplishments

MSU personnel re-assessed plant coverage on all plots in September 2022. They maintained automated on-site weather stations and conducted periodic data downloads, conducted on-site plot maintenance, and applied pre- and post-emergent herbicides to control competing vegetation. MSU published a peer-reviewed article (Dubelko, M., Schutzki, R., Andresen, J., & Cregg, B. (2022). Compost addition, but not tillage, affects establishment of urban highway plantings. *Urban Forestry & Urban Greening*, 75, 127688) based on plant growth and soils data collected through the first three years of the project.

FISCAL YEAR 2023 Accomplishments

MSU personnel applied pre-emergent and post-emergent herbicides for weed control, gathered and summarized data from survival and plant cover assessments, including data from automated weather stations. They presented research findings to the Meridian Garden Club. Soil sampling on study blocks for soil pH and bulk density determination, along with the plant sampling for rooting depth determination, has been finalized. The MDOT Plant Manual for Slope Planting has been added to the [Michigan Open Data Portal](#).

FISCAL YEAR 2024 PROPOSED ACTIVITIES

The team will analyze and summarize data from soil sampling for pH and bulk density determination and plant sampling for rooting depth determination. An article on plant selection will be drafted for peer-reviewed journal.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

A Project Manager (PM) change was approved on 3/13/2018 due to staff changes at MDOT. Another contract revision was approved 7/15/2019 that added scope and budget as well as extending the end date to 4/30/2021. The scope addition was a deliverable for documenting plant recommendations to replace outdated MDOT guidance. One additional year was needed because of delays associated with the planting phase. Another extension was granted to 12/31/2025 to support long-term evaluation of roadside plantings and refine plant selection and long-term maintenance recommendations. There was another PM change done during FY 2023 due to staff changes at MDOT.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project expected completion in FY 2026.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2023**

PROJECT TITLE: Effects of Concrete Cure Time on Epoxy Overlay and Sealant Performance

FUNDING SOURCE: SPR, Part II OTHER (PLEASE EXPLAIN)

PROJECT MANAGER: John Belcher

CONTRACT/AUTHORIZATION NO.	2016-0069 Z6	PROJECT START DATE	7/1/2018
PROJECT NO.	201393	COMPLETION DATE (Original)	12/31/2019
OR NO.	OR17-201	COMPLETION DATE (Revised)	12/31/2022
RESEARCH AGENCY	Western Michigan University (WMU)		
PRINCIPAL INVESTIGATOR	Upul Attanayake		

BUDGET STATUS

FY 2023 Budget		Total Budget	
Vendor Budget FY 2023	\$57,308.11	Total Vendor Budget	\$534,646.44
MDOT Budget FY 2023	\$8,200.00	Total MDOT Budget	\$0.00
Vendor FY 2023 Expenditures	\$54,040.71	Total Budget	\$534,646.44
MDOT FY 2023 Expenditures	\$0.00	Total Expenditures	\$531,379.04
		Total Amount Available	\$3,267.40

PURPOSE AND SCOPE

MDOT currently waits 28 days after the placement of all concrete decks, rigid overlays, and patches on bridge decks before placing epoxy overlays and sealants. Often this extended period conflicts with traffic and weather limitations. With more information on the crack development and moisture release characteristics of MDOT standard concrete materials (Grade D, DM, SFMC, LMC, etc.) and special/patching mixtures, MDOT could potentially reduce the time required between placements.

The objectives of this project include the following:

1. Research criteria and benefits of epoxy overlay and sealant placement timing with regards to standard materials and special/patching material.
2. Develop a testing plan that encompasses the material used by MDOT.
3. Prepare specimens and conduct QAQC testing.
4. Evaluate overlay/sealant performance vs crack development and curing.
5. Analyze results and quantify the cost savings.
6. Recommend a procedure for determining overlay/sealant placement timing based on material/mix design.

The scope of work for this project includes the following tasks:

- Task 1. Review state-of-the-art and state-of-the-practice.
- Task 2. Develop a testing plan that encompasses the material used by MDOT.
- Task 3. Prepare specimens and conduct QAQC testing.
- Task 4. Evaluate overlay/sealant performance vs crack development and curing.
- Task 5. Evaluate long-term bond strength and concrete durability properties of epoxy overlay.
- Task 6. Analyze results and quantify the cost savings.
- Task 7. Produce final research report.

FISCAL YEAR 2018 ACCOMPLISHMENTS

The team was able to establish which testing protocols and mix designs will be included in the research.

FISCAL YEAR 2019 ACCOMPLISHMENTS

Tasks 1 through the initial intent of 4 are complete. Work was added to task 4 for FY 2020.

FISCAL YEAR 2020 ACCOMPLISHMENTS

Completion of tasks 4-6. A final report was submitted for review but will need to be updated when extended testing is complete.

FISCAL YEAR 2021 ACCOMPLISHMENTS

Extended testing was completed, and the draft final report was updated accordingly.

FISCAL YEAR 2022 ACCOMPLISHMENTS

Epoxy overlay bond strength was evaluated in August 2022 using more than 50 large concrete slab specimens exposed to Michigan outdoor conditions since summer 2019. The evaluation parameters included two concrete mix designs, two overlay types, three concrete ages at the time of overlay application, impact of silane pretreatment, exposure conditions (summer and winter) and duration, and concrete temperature at the time of bond strength evaluation.

The North and southbound bridges on the US-131 business route over Ravine Road were selected to evaluate thin epoxy overlay performance over patches and repairs. Grade DM concrete, latex modified concrete, and MasterEmaco T 1060 were the three patching/repair materials selected for this study. Our team documented all the patched areas and the material used in each patch. Also, two slab specimens were fabricated using each mix. E-bond 526 Lo-Mod thin epoxy overlay was applied over the bridge decks and the slab specimens. Bond strength was evaluated over the patches and the parent concrete.

The Sixth Street bridge over I -94 in the Southwest Region was selected. Initially, the deck was repaired by injecting epoxy into delaminated areas. Following healer sealer application, 8 cores were removed to evaluate the depth of penetration and the bond performance. These cores were photographed and prepared to pond with a mix of water and a blue dye to evaluate the water tightness of the sealed cracks.

FISCAL YEAR 2023 ACCOMPLISHMENTS

All bond strength data collected in 2022 from over 50 slab specimens was analyzed and presented with the data collected since 2019 to compare overlay performance variation with respect to evaluation parameters. Bond strength was evaluated over the patches and the parent concrete in two bridge decks; results will be summarized and compared to identify the performance differences. The water tightness of the sealed cracks was evaluated using the cores taken out from the Sixth Street bridge deck following the healer sealer application and results were summarized and presented. A summary of activities was also developed and presented with implementation recommendations for thin epoxy overlays and healer sealers.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

On 6/6/2019, funds were shifted within the existing budget to cover the purchase of new equipment to manage the work schedule and case a set of new slabs to collect additional data for clarifying observation results. A contract revision was also approved on 9/30/2019 to add scope and costs for additional studies to evaluate material outside of the laboratory for a longer period, which also extended the project end date. Additional testing was added to the scope with additional costs to evaluate the performance of full-scale bridge application and to study longer term performance of materials. FY 2022 saw the project extended to include work on a summer project and a shift in the budget to include the purchase of a pendulum skid tester kit.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Research results are being utilized to address expedited construction projects and being considered for specification updates.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2023**

PROJECT TITLE: Training Tools for Effective Advancement of Digital Technologies for Construction Field Operations

FUNDING SOURCE: SPR, Part II OTHER (PLEASE EXPLAIN)

PROJECT MANAGER: Lindsey Renner

CONTRACT/AUTHORIZATION NO.	2020-0159	PROJECT START DATE	2/1/2020
PROJECT NO.	204646	COMPLETION DATE (Original)	4/30/2022
OR NO.	OR19-133	COMPLETION DATE (Revised)	4/30/2023
RESEARCH AGENCY	Michigan State University (MSU)		
PRINCIPAL INVESTIGATOR	Mohamed El-Gafy, Ph.D., P.E.		

BUDGET STATUS

FY 2023 Budget		Total Budget	
Vendor Budget FY 2023	\$74,733.73	Total Vendor Budget	\$205,881.39
MDOT Budget FY 2023	\$3,160.00	Total MDOT Budget	\$398.79
Vendor FY 2023 Expenditures	\$5,868.75	Total Budget	\$206,280.18
MDOT FY 2023 Expenditures	\$0.00	Total Expenditures	\$137,415.20
		Total Amount Available	\$68,864.98

PURPOSE AND SCOPE

Simple and effective training tools are needed to increase the knowledge base of construction field staff to support sustainable construction field operation practices. Core competency development with software and hardware technologies is necessary to realize the benefits of digital technology. Engineer and technical field staff skillsets vary widely in preparation for use of these technologies and practices. Training opportunities are often restricted to on-the-job learning and growth potential through exposure and learning with consultant staff field support, thus bridging knowledge gaps. Construction field staff training typically lags in comparison to the contracting and consultant industries. Training in the field or on-the-job has not been sustainable as opportunities to use knowledge gained year to year creates a population of construction field staff with varying levels of proficiency which in turn yields limited project management consistency and alignment within the Michigan Department of Transportation. Staff should have exposure to digital technologies as the standard for construction field operations through education and training.

FISCAL YEAR 2019 ACCOMPLISHMENTS

Contract authorization was delayed until Fiscal Year 2020. This Fiscal Year, proposals received were scored and the selected research organization was announced.

FISCAL YEAR 2020 ACCOMPLISHMENTS

The first year of the project has focused on data collection and analysis. COVID-19 interfered with this first phase task as MSU was not able to perform this work for several months between March and July. Work resumed in August of 2020. Each Transportation Service Center (TSC) and Region office was contacted and those that responded (~95%) were interviewed on the state of the practice using digital technology in construction including the areas of 3D modeling, project PDFs and digital survey equipment used for payment. Assets management was not included as there are other ongoing efforts in the department regarding this topic. Subject matter experts within central office were also interviewed in the later part of 2020 for their perspective in support and policy roles.

FISCAL YEAR 2021 ACCOMPLISHMENTS

A brief overview presentation of the project was provided by the Principal Investigator (PI) at the Statewide Construction Alignment Conference. COVID-19 continued to hinder progress regarding student assistance for the project until the August/September timeframe when traditional college schedules resumed including student availability.

Task 1: Performed an assessment of knowledge and experience in 3D technology, project PDF's, and asset management of construction field operation staff in all seven regions. (Progress 85%)

- As noted in the 2020 annual report asset management was not pursued to assist in focusing project efforts.
- Task 1 was expanded to include assessments of other leading states in training for digital technologies.
- All assessments within the state of Michigan have been complete. Other state assessments are ongoing. FHWA resource expert for digital as-builts, David Unkefer, is anticipated to provide more direct focus to the assessment effort as David also has been following states progression in this area.
- A document report is anticipated before calendar year end 2021.

Task 2: Developing a performance measurement tool for advancing the training solution and to test the solution effectiveness to ensure training is effective and sustainable. (Progress 75%)

- Work has begun on a simplified version of the Kirkpatrick business partnership model to evaluate the training program. This task was delayed for the reasons noted above and is anticipated to complete in November of 2021.

- Additional meeting with MDOT training personnel is needed to identify the MDOT specifications and requirements for implementing performance measurement tools. These meeting should begin early FY 2022.

Task 3: Working with subject matter experts at MDOT to further develop BIM for transportation processes by improving the integration of e-reference guides and developed training curriculum for use through MDOT. (Progress 10%)

- Only two subject matter experts (SME) have been identified with content that could be incorporated in the training: Glenda Bowerman (Central Office – Design Survey Support) and Dale Johnson (Metro Region). Additional SME (internal to MDOT or out of state SMEs) will need to be identified and their work artifacts need to be collected and analyzed.
- The PI started working with Glenda Bowerman and collected her training materials. The vendor’s research team is currently working on analyzing the materials and provide some recommendations.
- Work on this task began earlier than originally planned. Work began in September of 2021 and is expected to be completed in March of 2022.

FISCAL YEAR 2022 ACCOMPLISHMENTS

Task 1 is complete. Virtual Interviews were conducted to review and assess the knowledge and experience in 3D technology and project PDFs of construction field operation staff in all seven regions. The team could not find any substantial work on asset management due to the loss of personal championing this area to the industry. Per agreement with the formal project manager, this area excluded from the project scope.

Task 2 is 75% complete. The original target completion date was June 30, 2022, and the revised target completion date is November 30, 2022. The research team has developed a proposed performance measurement protocol based on the Kirkpatrick Business Model and the application of Kern's 6-Step approach in curriculum development. The proposed protocol will be implemented during development of the MDOT Subject Matter Expert (SME) training.

Task 3 is 50% complete. The original target completion date was June 30, 2022, and the revised target completion date is December 29, 2022. The current e-reference guides and available training curricula have been collected and evaluated against the current best practices of curriculum development. Few isolated training materials were found, and the team is currently working on identifying additional resources. The research team worked closely with the project manager to identify current pilot projects and means for other material/artifact collection.

FISCAL YEAR 2023 ACCOMPLISHMENTS

This contract is being terminated due to the failure of the PI to provide documents required by the Contract after multiple attempts to communicate expectations and provide flexibility in good faith to achieve an acceptable final product. It is of note that the University failed to provide any final products as expected including a Final Report, Final Presentation, and a Training Module aimed at assisting with Digital Technologies, and completely disengaged in correspondence with MDOT at the time that deliverables were expected. An additional project time extension did not yield results.

The contract includes the following uncompleted tasks:

- Working with SMEs at MDOT to further develop Building Information Modeling (BIM) for transportation processes by improving the integration of e-reference guides and developed training curriculum for use throughout MDOT.
- Developing multiple educational schemes/mechanism for training.
- Revising and submitting a final report.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

The budget was shifted in FY 2021 to shift budgeted funds from a subcontractor back to MSU. A project extension was granted in 2022 to accommodate impacts to MSU staffing on the research project due to the COVID pandemic. There was a change in the MDOT project manager due to staff changes at MDOT. A final extension was granted as a renew and amend to extend research to the final completion date of April 30, 2023. (No charges were allowed between November 1, 2022, and the final amendment approval date.)

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project was terminated for cause.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2023**

PROJECT TITLE: Eastern Massasauga (<i>Sistrurus Catenatus</i>) Road Ecology and Population Dynamics in Michigan			
FUNDING SOURCE: <input checked="" type="checkbox"/> SPR, Part II <input type="checkbox"/> OTHER (<i>PLEASE EXPLAIN</i>)			
PROJECT MANAGER: Jeff Grabarkiewicz			
CONTRACT/AUTHORIZATION NO.	2019-1007	PROJECT START DATE	11/25/2019
PROJECT NO.	208773	COMPLETION DATE (Original)	5/31/2023
OR NO.	OR19-137	COMPLETION DATE (Revised)	02/29/2024
RESEARCH AGENCY	Michigan State University (MSU)		
PRINCIPAL INVESTIGATOR	Gary Roloff		

BUDGET STATUS			
FY 2023 Budget		Total Budget	
Vendor Budget FY 2023	\$118,445.32	Total Vendor Budget	\$358,958.81
MDOT Budget FY 2023	\$7,558.00	Total MDOT Budget	\$351.76
Vendor FY 2023 Expenditures	\$52,081.32	Total Budget	\$359,310.57
MDOT FY 2023 Expenditures	\$0.00	Total Expenditures	\$292,946.57
		Total Amount Available	\$66,364.00

PURPOSE AND SCOPE

Eastern massasauga rattlesnakes (EMR) are listed as threatened under the Endangered Species Act. In 2017, the Federal Highway Administration (FHWA), Michigan Department of Transportation (MDOT), and the U.S. Fish & Wildlife Service (FWS) developed a statewide Programmatic Agreement (Programmatic) on the conservation and management of EMR in relation to road construction and maintenance projects. Presently, MDOT and County Road Commissions maintain roads through approximately 9,300 miles of EMR habitat (modeled as Tier I and Tier II; <https://ecos.fws.gov/ipac/>). These roadways and associated Right-of-Way (ROW) are subjected to a variety of development and maintenance activities that have the potential to affect EMRs. Due to many factors, including the secretive nature of the species and a lack of research, the potential effects of construction and maintenance activities are not understood. Yet, federal regulators require many best management practices (BMPs) to protect EMR during both construction and maintenance activities. These BMPs include silt fence installation, inspections, alternative erosion control measures, species surveys, and seasonal restrictions for mowing, clearing, culvert replacement, and ditching. Research and monitoring that addresses EMR use of ROW areas is needed to calibrate these BMPs, maintain compliance with the Endangered Species Act, and ensure the wise use of transportation funds.

The scope of work includes:

1. Year 1, Survey potential study sites, complete pilot telemetry study.
2. Year 2, Finalize study sites, initiate telemetry study, and monitor habitat use.
3. Year 3, Continue telemetry study and habitat use monitoring, begin exposing EMR to maintenance activities, begin data analysis.
4. Year 4, Analysis of data, draft final report to understand patterns of EMR habitat use around MDOT roads and behaviors in response to maintenance activities; evaluate efficacy of required BMPs.

FISCAL YEAR 2020 ACCOMPLISHMENTS

The first year of this project was important to build a strong foundation for the remaining three years of research. The research team responded with several key accomplishments despite a year complicated by COVID-19. Below are some of the more notable items:

- Hired a graduate student to spearhead research activities as well as two assistant field technicians.
- Acquired three state and federal permits for the research, in addition to an internal MSU animal care approval.
- Identified candidate research sites and coordinated sites with MDOT and regulators.
- Acquired written permission from 16 landowners to access their properties for research.
- Performed numerous surveys at candidate sites, with field work adding up to 200+ person-hours.
- Found and applied transmitters to four adult Massasauga rattlesnakes at two different sites.
- Tracked telemetered snakes for two months to document movements near MDOT right-of-way.
- Hosted a field event with MDOT staff to demonstrate field techniques and talk about research progress.

PROPOSED FISCAL YEAR 2021 ACCOMPLISHMENTS

Proposed activities for FY 2021 include:

- The project investigators have established two research sites: I-75 in Holly and US-12 at Onsted. The research team pursued additional sites in 2021 but were not able to get access or find EMR at the sites.
- Completed 37.5 hours of formal survey effort consistent with the published survey protocol.
- Spent over 300 informal hours searching for EMR to radio tag in 2021. A total of ten individuals were captured – six at the US-223 Onsted site and four at the I-75 Holly site.
- Obtained an average of 4.3 visual and 7.7 triangulated EMR positions in 2021 per individual EMR. Confirmed EMR litters near US-12 shoulder.
- The research team had some success coordinating with MDOT Oakland County mowing contractors to conduct before and after surveys.
- Hosted an advisory committee meeting at the Onsted field site to discuss project with MDOT and DNR staff.

FISCAL YEAR 2022 ACCOMPLISHMENTS

- Project researchers continued monitoring the I-75 Holly location and US-12 site at Onsted, where six snakes were captured at Holly and eight snakes at Onsted this year.
- More than 40 hours of formal detection surveys and 6 vegetation surveys were conducted in Iosco County trying to find a “northern” EMR site, but those surveys were not successful in finding EMR.
- Field staff performed a total of 166 hours of informal detection surveys.
- Across the project lifespan, a total of 173 EMR locations have now been recorded at Holly and Onsted, with 11-14 average locations per individual (11 Holly, 14 Onsted).
- Ongoing data cleaning and analysis is being performed in preparation for the final report.

FISCAL YEAR 2023 ACCOMPLISHMENTS

- Field data collection and data analysis was completed.
- A research presentation was made at the Midwest Chapter of the Wildlife Society’s meeting.
- MSU worked with the U.S. Fish and Wildlife Service on best management recommendations based on the results of this project.
- Part of the final report (chapter 1) was submitted to the research advisory committee for review on September 2, 2023. The thesis/report consists of two chapters – roughly 50% of the report work was submitted in FY 2023.
- The remainder of chapter 2 is 99% complete and awaiting one final edit to a graph.

FISCAL YEAR 2024 PROPOSED ACTIVITIES

- A draft of the full report/thesis will be provided to the research committee for review and comment.
- A meeting will be held between MSU and the committee to discuss the comments on both chapters and any necessary revisions will be completed.
- A final draft, with management recommendations, will be provided to MDOT in the winter of 2024

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

Two time extensions were granted in FY 2023 and one recently in FY 2024. The first, in May 2023, was to accommodate MDOT review of thesis manuscripts prior to submission to peer-referred journals. Additional time was granted in August to complete the modeling and edits associated with the draft report while allowing sufficient time for internal MDOT review. The final contract revision was authorized in November to allow time for committee review, discussion, and any final revisions to the final report.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project completion expected FY 2024.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2023**

PROJECT TITLE: Safety Enhancements at Short-Storage-Space Railroad Crossings

FUNDING SOURCE: SPR, Part II OTHER (PLEASE EXPLAIN)

PROJECT MANAGER: Nikkie Johnson

CONTRACT/AUTHORIZATION NO.	2019-1033	PROJECT START DATE	1/1/2020
PROJECT NO.	208774	COMPLETION DATE (Original)	12/31/2022
OR NO.	OR19-032	COMPLETION DATE (Revised)	
RESEARCH AGENCY	Texas A&M University Transportation Institute		
PRINCIPAL INVESTIGATOR	Subasish Das		

BUDGET STATUS

FY 2023 Budget		Total Budget	
Vendor Budget FY 2023	\$37,771.01	Total Vendor Budget	\$106,642.26
MDOT Budget FY 2023	\$0.00	Total MDOT Budget	\$0.00
Vendor FY 2023 Expenditures	\$37,770.86	Total Budget	\$106,642.26
MDOT FY 2023 Expenditures	\$0.00	Total Expenditures	\$106,642.11
		Total Amount Available	\$0.15

PURPOSE AND SCOPE

MDOT regulates safety devices at public railroad crossings. MDOT also invests state and federal dollars on a prioritized basis to enhance safety at public railroad crossings. Other than pre-signals, there is not currently prescribed enhancements to address crossings that do not have sufficient space for traffic to queue at nearby roadway intersections without backing over the crossing. Although the points of conflict are less frequent, because of the severity of car-train crashes, MDOT would like to establish additional potential solutions for crossings that are near roadway intersections that don't warrant traffic signals (and, therefore, a pre-signal is not an option). Any potential safety enhancements for these crossings, at a minimum, should not negatively impact the road intersection. Typically, storage space is limited when a primary road runs parallel to the track with a secondary road intersecting the track and primary road within 200' of each other. MDOT estimates there are at least 300 crossings that have these conditions throughout the state, including but not limited to, crossings along the CSX Transportation (a Class I freight railroad company) corridor that parallels Chicago Drive from Hudsonville to Zeeland.

1. Identify additional approaches currently utilized by other State DOTs to enhance safety at crossings w/ short storage space.
2. Identify novel or emerging solutions, such as in-vehicle auditory alerts.
3. Utilize the Strategic Highway Research Program 2 (SHRP2) Naturalistic Driving Study data to analyze driver behavior at crossings w/ short storage space and at the nearby roadway intersection.
4. Utilize simulation to test impacts of potential safety enhancements on driver behavior at the crossing, as well as the intersection.
5. Evaluate the potential transfer of risk from the crossing to the roadway intersection, including the expected type of crashes and the severity of those crashes. Quantify, when possible.
6. Plan & facilitate a meeting between Traffic & Safety and Office of Rail to present findings & facilitate discussion regarding next steps for inclusion in MDOT guidance documents.
7. Summarize findings in a final report.

FISCAL YEAR 2020 ACCOMPLISHMENTS

Fiscal year 2020 accomplishments by the Principal Investigator and research team included work on the following research tasks:

Task 1 – Project Management: Progress meetings between the Research Advisory Panel (RAP) and research team were held, February 4, 2020, June 2, 2020, and October 1, 2020. Quarterly reports noting research activities and progress were submitted 2nd, 3rd, and 4th quarter. Invoices have been submitted monthly.

Task 2 – Literature Review/Current Knowledge: A review of key literature, federal guidelines, other state practices and state-of-the-art practices for treatments for short storage crossings has been conducted. Findings from this task have been compiled into a draft interim report which was submitted to the RAP for review October 2020.

Task 3 – Site Selection & Data Integration: A status report on rail crossing related geometric data and crash data in Michigan was provided to the RAP. MDOT provided the research team a list of short-storage crossings in Michigan. Site selection, data integration and analysis are on-going.

Task 4 – Strategic Highway Research Program 2 (SHRP 2) Naturalistic Driving Study (NDS) and Simulation: Begin collecting information from the data query tool available from the SHRP-2 Insight website.

FISCAL YEAR 2021 ACCOMPLISHMENTS

Task 1 – Project Management: Progress meetings between the RAP and research team were held, January 19, April 20, and September 14, 2021. Quarterly reports noting research activities and progress were submitted 2nd, 3rd, and 4th quarters with invoices submitted monthly.

Task 2 – Literature Review/Current Knowledge: Complete. A draft interim report was submitted to the RAP for review October 2020. An updated report was submitted in December 2020 and a final draft interim report was provided February 2021.

Task 3 – Site Selection & Data Integration: Complete. Research team provided an overview of the database in September 2021.

Task 4 – SHRP-2 NDS & Simulation Study: 41 short-storage locations in North Carolina and Washington were identified in the SHRP 2 data. Simulation study is on-going.

Task 5 – Guideline Development & In-person Meeting/Workshop: Begin developing recommended MDOT guidelines which will cover enhancing railroad crossings, driver behavior, selection of effective countermeasures, limitations, and future research. Begin preparing for workshop and discussion with Traffic & Safety and Office of Rail.

FISCAL YEAR 2022 ACCOMPLISHMENTS

Task 1 – Project Management: Completed. Progress meetings between the RAP and research team were held January 26, April 26, and September 19, 2022. Quarterly reports noting research activities and progress were submitted 2nd, 3rd, and 4th quarters with invoices submitted monthly.

Task 4 – SHRP-2 NDS & Simulation Study: Completed. This provided an opportunity for the research team to compare driver behavior at different crossing types using SHRP-2 NDS data and simulation data. The study considered five major factors 1) Acceleration, 2) Speed before, 3) Speed after, 4) Head rotation, and 5) Sign and marking following. The statistical importance of SHRP-2 NDS data and simulation data study showed that driver behaviors differed significantly at each of the selected treatments. Results indicated that drivers face difficulties in following signs and markings near the short storage locations with dynamic envelop markings and crossbuck with stops being more effective.

Task 5 – Guideline Development & hybrid (virtual/in-person) Workshop: Completed. The research team and MDOT RAP coordinated a Peer Exchange that took place on September 15, 2022. The workshop provided an opportunity to build communication between key areas within the department to refine guidelines. Learning objectives of the workshop were to 1) Directly engage a mix of planning and engineering staff from MDOT Traffic and Safety and the Office of Rail, on existing, practices for short-space railroad crossings 2) Understand safety effectiveness of different countermeasures, 3) Understand alternative data sources such as driving simulator and naturalistic driving study, 4) Understanding insights of crash narratives using tools such as text mining and perceptual cycle model (PCM), and 5) Focus dialogue around effective countermeasures and driver comfort.

FISCAL YEAR 2023 ACCOMPLISHMENTS

Task 6 – Final Report: Completed. All findings from tasks 1-5 were compiled in the final report. The findings of literature review show that little research has been conducted to empirically evaluate the effectiveness of different treatments for grade crossings with short storage, outside of traffic signal preemption strategies. The findings also show that short storage locations are mostly on local undivided roadways. Both SHRP 2 naturalistic driving study (NDS) and simulation study results indicate that drivers face difficulties in following signs and markings near the short storage locations. A workshop held for MDOT Traffic & Safety, and the Office of Rail (facilitated by Dr. Steven Lavrenz from Wayne State University) discussed specific ideas for language changes and modifications to existing MDOT publications based on the preliminary findings of the project. The findings of this study can help authorities in identifying the issues of driver-related distraction and sign following patterns to aid in improving short storage crossing safety.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Recommendations made included but are not limited to potential development of additional educational and warning materials for drivers either as part of a driver education curriculum or alongside the Michigan Operation Lifesaver program, which focus on several risks and recommended driving behaviors associated with active and passive highway-rail grade crossing (HRGCs) around the state. In addition, this project provided recommendations for modifications to the language in six relevant MDOT publications that are currently in the process of being revised by the Office of Rail.

1. Michigan MUTCD, Part 8: Traffic Controls for Railroad and Light Rail Transit Grade Crossings
 2. MDOT Road Design Manual
 3. MDOT Guidelines for Highway-Railroad Grade Crossings
 4. MDOT Standard Plan 965-D: Railroad Grade Crossing Pavement Markings
 5. MDOT Standard Plan 966: Exclusion zone Pavement Markings
 6. MDOT Form 1425: Notification of Proposed Project Involving a Public Railroad Crossing
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**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2023**

PROJECT TITLE: Evaluation of MDOT's Long-Life Pilot Projects

FUNDING SOURCE: SPR, Part II OTHER (PLEASE EXPLAIN)

PROJECT MANAGER: Michael Eacker

CONTRACT/AUTHORIZATION NO.	2019-0997	PROJECT START DATE	10/25/2019
PROJECT NO.	208776	COMPLETION DATE (Original)	9/30/2021
	OR19-081	COMPLETION DATE (Revised)	12/31/2022
RESEARCH AGENCY	Michigan State University (MSU)		
PRINCIPAL INVESTIGATOR	Kutay		

BUDGET STATUS

FY 2023 Budget		Total Budget)	
Vendor Budget FY 2023	\$19,511.27	Total Vendor Budget	\$396,892.19
MDOT Budget FY 2023	\$9,455.44	Total MDOT Budget	\$13,532.83
Vendor FY 2023 Expenditures	\$19,511.27	Total Budget	\$410,425.02
MDOT FY 2023 Expenditures	\$967.48	Total Expenditures	\$410,425.02
		Total Amount Available	\$0.00

PURPOSE AND SCOPE

As a result of Public Act 175 of 2015 and the Roads Innovation Task Force (RITF) Report, the Michigan Department of Transportation (MDOT) committed to designing and constructing four long-life pavements using hot mix asphalt (HMA) and concrete. The four different long-life pavements are as follows: 30-year HMA on US-131 in the Grand Region, 30-year concrete on I-69 in the Bay Region, 50-year HMA on I-475 in the Bay Region, and a 50-year concrete on US-131 in the Grand Region. In 2017, the first of these pilot projects was constructed (30-year HMA on US-131). In 2018, three more will be let with two being built in 2018 and one in 2019. Several changes were made to standard designs and materials to increase the design life. These include increased structural support (increased layer thicknesses, etc.), improved material selection (HMA binder selection, etc.), improved construction specifications (lower initial ride requirements, etc.), and improved design aspects (increased drainage freeboard, etc.). Before further long-life projects can be planned, an assessment of the potential of the four pilot projects for meeting their intended design and services lives (50 and 75 years) should be performed. An evaluation of the effectiveness of all improvements will help transportation investments on future designs result in longer pavement life. The scope of work includes the following:

- Review the Roads Innovation Task Force report, project plans and available materials information.
- Interview Region MDOT personnel for construction related details.
- Laboratory testing of HMA, concrete, base, subbase, and subgrade samples from test sections within each of the four projects.
- Update DynaMOD and other MDOT materials databases.
- Use the mechanistic-empirical pavement design method (and other pavement design methods as warranted) to predict pavement performance using all information collected in previous tasks.
- Use the MDOT life cycle cost analysis (LCCA) process or other appropriate method to estimate service life.
- Suggest other improvements/changes that could be made to future long-life projects that have potential to help achieve the desired service life.
- Final report documenting all work in the project, test results of laboratory testing, and suggested improvements/changes.

FISCAL YEAR 2020 ACCOMPLISHMENTS

- The project kick-off meeting and quarterly meetings for Q1, Q2, and Q3 have been held with reports prepared by the research team in advance of each project meeting.
- Task 1 - Completed. Reviewed the Roads and Innovation Task Force (RITF) Report and all project plan and construction information was gathered. A summary of the RITF recommendations was prepared and verification of the recommendations regarding structure, material, construction, and QA/QC measures for each of the long-life projects was completed.
- Task 2 - Completed. Organized and reviewed project construction, materials, and testing data provided by MDOT. Had meetings with MDOT construction personnel for all projects where MSU prepared a list of questions and clarifications on the projects. Began review and summarization of post construction data.

- Task 3 – Ongoing. Material Testing and Characterizations. Project material samples were received from MDOT, organized, and cataloged. Began various flexible and rigid material testing. Began to characterize materials following completed tests. So far, no concerning data was observed.
- Covid-19 restrictions closed testing labs and material testing was delayed. Labs reopened in July 2020 and material testing resumed. As of September 30, 2020, work is approximately 33 percent complete with approximately 42 percent of project duration complete.
- Task 5 – Ongoing: The pproject team began comparing the predicted (using Pavement-ME) performance of the designed and as-built sections by using laboratory-measured inputs and measured material properties.

FISCAL YEAR 2021 ACCOMPLISHMENTS

The research team completed a significant amount of laboratory testing on materials from the long-life pilot projects:

- HMA Materials
 - Dynamic modulus testing
 - Indirect tensile strength testing (IDT)
 - 3-point bending testing
- Cement Stabilized Materials
 - Compression testing
- Concrete Materials
 - Compression testing
 - Flexural strength testing
- Aggregate Materials
 - Sieve analysis
 - Classification
 - Atterberg limits
 - Optimum moisture and maximum density
 - Resilient modulus

In addition, analysis of Falling Weight Deflectometer (FWD), Light Weight Deflectometer (LWD), and Dynamic Cone Penetrometer (DCP) data from construction testing were analyzed for stiffness properties of unbound materials.

The results of all testing were used to choose inputs that best represent the as-built properties for use in pavement design software. These input values were used in the PerRoad and Pavement ME design programs. The performance predictions from Pavement ME are being compared to those from MDOT’s initial designs using expected project material properties.

FISCAL YEAR 2022 ACCOMPLISHMENTS

Work completed in fiscal year 2022 is as follows:

- Remainder of lab testing to characterize materials provided by MDOT was completed.
- Data from lab testing was added to MDOT’s DynaMOD database.
- A database was created to house all the construction and material information for the 4 long-life projects.
- Performance prediction of the 4 long-life projects using the ME design software and the research team’s MEAPA software, was completed.
- The life-cycle cost analysis task was started and completed.
- The draft final report was delivered on October 2, 2022.

Quarterly RAP update meetings and meetings with MDOT staff to discuss the life-cycle analysis task were held.

FISCAL YEAR 2023 ACCOMPLISHMENTS

Final report was finalized.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

In FY 2021, the project end date was extended because of delays due to COVID-19 along with a change in Project Manager due to staffing changes at MDOT. Another extension was granted to allow more time to complete all objectives and required deliverables.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

As Region’s determines to include long-life pavements in their regular program of projects, the suggested specification changes recommended by this report can be utilized. Pavement design input recommendations can be immediately adopted. It is understood that the initial fix life estimates calculated by the research team are very early in the life of these pavements. As such, they may need to be revisited and revised. MDOT will continue to monitor these long-life pavements to assess fix lives every 3 to 5 years.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2023**

PROJECT TITLE: Testing Protocol, Data Storage and Recalibration for Pavement-ME Design

FUNDING SOURCE: SPR, Part II OTHER (PLEASE EXPLAIN)

PROJECT MANAGER: Justin Schenkel

CONTRACT/AUTHORIZATION NO.	2020-0235	PROJECT START DATE	1/21/2020
PROJECT NO.	208777	COMPLETION DATE (Original)	12/31/2022
OR NO.	OR19-092	COMPLETION DATE (Revised)	9/30/2023
RESEARCH AGENCY	Michigan State University (MSU)		
PRINCIPAL INVESTIGATOR	Haider		

BUDGET STATUS

FY 2023 Budget		Total Budget	
Vendor Budget FY 2023	\$86,405.00	Total Vendor Budget	\$462,403.88
MDOT Budget FY 2023	\$0.00	Total MDOT Budget	\$104,400.00
Vendor FY 2023 Expenditures	\$86,405.00	Total Budget	\$566,803.88
MDOT FY 2023 Expenditures	\$1,286.78	Total Expenditures	\$569,745.33
		Total Amount Available	-\$2,941.45

PURPOSE AND SCOPE

Pavement-ME (mechanistic-empirical) analysis and design procedure are in the implementation stages for designing new and rehabilitated pavements in Michigan. Several studies were performed in the recent past to characterize traffic, material properties, and local calibration of the performance models to address the local materials and construction practices in the Pavement-ME procedure. While all the local materials and calibration of performance models were addressed to improve the local applicability and the accuracy of the approach, there are still some data gaps, especially for material characterization and pavement construction. For example, typical Resilient Modulus (MR) values were used for base, subbase, and subgrade moduli and initial International Roughness Index (IRI) values were back casted for the pavement sections used in MDOT's local ME calibration. Since these values are estimated, they may not be accurate for the location, so having the actual values for new projects improves ME calibration accuracy. In addition, a limited number of Michigan rigid pavement sections were available for ME calibration, so adding more data from new sections would improve ME calibration. Furthermore, MDOT currently does not have criteria for selecting future projects for calibration and material sampling and testing for ME inputs. Thus, there is a need to have a consistent procedure to include new pavement sections in the performance model calibration and to obtain actual as-constructed material properties for ME inputs. Such procedures will be essential to enhance the accuracy and adequacy of the performance models for future pavement designs. Additionally, with updated Michigan ME data, MDOT would benefit from a recalibration of AASHTOWare Pavement ME Design to improve design prediction accuracy. The scope of work includes the following, (which can be reordered as needed per the Principal Investigator (PI)):

- Review of Literature
- Develop a Prioritized Inputs List and Relevant Testing Protocols
- Develop a Test Matrix and/or Set of Criteria for ME based Testing
- Conduct Laboratory Testing and Collect/Analyze Falling Weight Deflectometer (FWD) Data
- Evaluate Databases
- Review of Project Data for Calibration
- Evaluate the Local Calibration of Performance Models
- Re-Calibrate Performance Models
- Evaluate the Impact of Re-calibration on Pavement Design
- Final Report and Technology Transfer

FISCAL YEAR 2020 ACCOMPLISHMENTS

The project team has conducted a review of original work related to calibration. The objective of the evaluation is to identify any gaps in construction, materials, and performance data in Task 1. More recent literature from other states has been reviewed to determine and confirm important input variables related to traffic, design features, material properties, and climate.

In Task 2, the team developed a prioritized input list and testing protocols. Based on testing protocols, they identified four pavement sections (I-75, I-196, I-94 BL, and US-41) for testing and sampling for the year 2020. Two of these projects are Jointed Plain Concrete Pavement (JPCP) reconstruct (I-75 SB and I-196 EB), while the other two (I-94 BL and US-41) are Hot Mix Asphalt (HMA) overlay projects. Also, research team selected projects for the next year (2021). These projects include I-75 (JPCP unbonded concrete overlay and HMA rubblized reconstruct), US-41 (HMA reconstruct and aggregate lift, and HMA overlay), I-69 (JPCP and HMA reconstruct), M-3 (HMA reconstruct), and US-24 (Demo HMA reconstruct).

Per Task 4, the research team and MDOT has conducted Dynamic Cone Penetrometer (DCP) and Light Weight Deflectometer (LWD) testing on the I-196 and I-75 projects. MDOT performed FWD testing on I-94 BL existing pavement for the overlay project. Material samples for subgrade, subbase, and base are being collected for the 2020 projects. In addition, the HMA samples from some pre-selected projects by MDOT were tested in the laboratory. The test results were documented.

Due to COVID-19 safety protocols, Task 6 began earlier than originally planned since the type of work activities under this task limited human exposure/contact. The team accomplished the following work under Task 6:

- The Pavement Management System (PMS) data were used to extract pavement distresses for the selected projects. While exploring the data source and converting the measured distress units to the Pavement-ME compatible units, a project length issue was discussed with MDOT. MDOT PMS sections provided the updated PMS data with additional PDs to address the discrepancy in project lengths.
- The research team has been working on automating the distress data extraction from the PMS data by utilizing MATLAB codes. This automation will improve the efficiency of data extraction significantly.
- The team has already summarized the average IRI, faulting and rutting data for all the selected sections. In addition, spatial variability of the distresses was quantified in terms of the standard deviation, using the automated analysis algorithms written in MATLAB. With the standard deviation data, Pavement ME standard deviation equations will be evaluated.
- The MATLAB coding for cracking data is in progress.

MDOT provided a comprehensive database of all the projects constructed in Michigan. Initially, all the existing projects (108 flexible and 20 Jointed Plain Concrete Pavement (JPCP) used in the previous calibration effort were reviewed. Based on distress data in terms of distress index (DI), the team identified and selected 206 potential new candidate pavement projects. The potential projects include 27 HMA reconstruct, 24 JPCP reconstruct, and 155 rehabilitated (i.e., HMA overlay, rubblized overlay, unbonded concrete overlay) pavement projects. The project is slightly behind schedule as of September 30, 2020. Approximately 19 percent of the planned work is complete with approximately 28 percent of the project duration complete.

FISCAL YEAR 2021 ACCOMPLISHMENTS

The research project team (with MDOT assistance) has continued to work on Task 4, conducting DCP and LWD testing and collecting material samples for subgrade, subbase, base, and pavement on the selected 2021 construction projects. MDOT (and their consultant support staff) performed FWD testing on projects, except for I-69 as this project is still early in its construction progress. In addition, lab testing continues for those available sample materials not yet tested.

In addition, the research team continued work on Tasks 6, through 8 of the study, accomplishing the following items of work:

- The research team completed Pavement Management System data extraction for all required distress types in a compatible format with the Pavement-ME.
- The MDOT PMS data was further analyzed to identify damage at the PCC joints, which correspond to medium and high severity spalling levels, to evaluate the spalling model in the Pavement-ME. As part of this effort, assumed PCC joint spacing was also evaluated/verified.
- The Pavement-ME input files for pavement sections and their distress data were prepared for use in the calibration assistance tool.
- Compared MERRA and MDOT climatic data and used MERRA data in Pavement-ME.
- Updated traffic data for the existing and newly selected JPCP projects, prepared the Pavement-ME (.dgp) files and performed the preliminary calibration of distress models for all the rigid pavement sections.
- Evaluated the representation of the selected JPCP sections used to calibrate the overall JPCP performance within the entire state.

The project has approximately 69 percent of the planned work complete and 66 percent of the project duration complete. However, it is anticipated a time extension will be needed to accommodate lab testing and unexpected subtasks that are expected to further improve the research outcomes.

FISCAL YEAR 2022 ACCOMPLISHMENTS

The research team continued work on Tasks 4 through 8 of the study, accomplishing the following items of work:

- Conducted laboratory testing of the materials (unbound layers, loose asphalt mixtures, cores, etc.).
- Obtained/determined Pavement-ME inputs from the construction records for the selected pavement projects for the local calibration of performance models.
- Performed model calibrations for rigid Pavement-ME performance models, which included:
 - Use of Modulus of Resilience (MOR) versus the 28-day compressive strength for the PCC layer
 - Using a cap on the average faulting and the number of faulted joints to eliminate the possibility of including false counts for faulted joints.
 - Using input for widened lanes as 12.5 ft (versus 14 ft).
- Started model calibrations for flexible Pavement-ME performance models.
- Continue to analyze a storage/organization system for material and testing data (Task 5) for the Pavement-ME use for designs and model calibrations.
- Per the rigid model calibration, the research team is evaluating of their impacts to the MDOT Pavement Design.

FISCAL YEAR 2023 ACCOMPLISHMENTS

Project is going through the final closeout process. The research team accomplished the following items of work:

- Final Reporting with deliverables were be provided. This included the following:
 - Completed model calibrations for flexible and rigid Pavement-ME performance models.
 - Provided MDOT performance data conversion estimations and equations used for the calibration.
 - Final recommendations for future MDOT pavement project sampling and testing needed for Pavement-ME. Accordingly, provided non-destructive field-testing equations to correlate/estimate lab testing results in order to potentially reduce sampling needs.
 - Provided an updated version of DynaMOD for storage/organization of material and testing data used for Pavement-ME designs. Accordingly, the lab testing results from this research and past available data were added to this system. Excel spreadsheets provided to identify and store the section data (characteristics and performance data) used for Pavement ME calibration.
- Also, with additional project funding, Appendix C was added to potentially improve the calibration results for the following Pavement ME models using the associated denoted methods:
 - The fatigue cracking model (bottom-up) can be calibrated by using specific material coefficients in the damage calculations. The original calibration used default coefficients.
 - The rutting model of (HMA type fixes) can be calibrated using specific HMA coefficients in Michigan. The original calibration used default material coefficients.
 - The thermal cracking model can be calibrated using specific k-value for different binder types, HMA mixes, IDT, and/or regions. The original calibration used a single k-value for all sections.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

The completion date was extended due to new subtasks, which included multiple rigid local calibration iterations to improve the calibration, data correction for MDOT's performance data, and the refinement of inputs for flexible design local calibration. An additional extension was granted to accommodate additional subtasks to improve the Pavement-ME model calibrations.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

The following outlines the steps for MDOT implementation:

- Present research and calibration results to MDOT at-large and industry partners.
 - Update the MDOT Pavement ME User Guide to show new local calibration coefficients and any other related changes.
 - Implement the new local calibration coefficients in Pavement ME v2.6.
 - Continue to obtain material related data as outlined in the report.
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**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2023**

PROJECT TITLE: Research Administration Section Planning and Communications

FUNDING SOURCE: SPR, Part II OTHER (PLEASE EXPLAIN)

PROJECT MANAGER: Mary Hoffmeyer

CONTRACT/AUTHORIZATION NO.	2020-0776	PROJECT START DATE	10/1/2020
PROJECT NO.	209437NI	COMPLETION DATE (Original)	9/30/2025
OR NO.	OR21-001	COMPLETION DATE (Revised)	
RESEARCH AGENCY	CTC & Associates, LLC.		
PRINCIPAL INVESTIGATOR	Patrick Casey		

BUDGET STATUS			
FY 2023 Budget		Total Budget	
Vendor Budget FY 2023	\$98,462.94	Total Vendor Budget	\$492,314.72
MDOT Budget FY 2023	\$0.00	Total MDOT Budget	\$0.00
Vendor FY 2023 Expenditures	\$46,679.25	Total Budget	\$492,314.72
MDOT FY 2023 Expenditures	\$0.00	Total Expenditures	\$247,866.25
		Total Amount Available	\$244,448.47

Contract includes additional state funding from MDOT's Innovative Contracting Unit:

	Budget	Expenditures by Fiscal Year		
		FY 2021	FY 2022	FY 2023
SPR-II	\$492,314.72	\$129,481.84	\$ 71,705.16	\$ 46,679.25
Additional State Funds	\$ 9,298.30	\$ 0.00	\$ 2,200.76	\$ 779.93
Total	\$501,613.02	\$129,481.84	\$ 73,905.92	\$ 47,459.18

PURPOSE AND SCOPE

MDOT works diligently to deliver innovative research projects that improve operations and services. Research Administration (RA) works to effectively communicate these research findings clearly and in platforms for wider public reach. This project works with RA to continue to improve operations and provides the means to communicate department research efforts in a multitude of platforms (i.e., publications, social media, and visual media) that will share the outcomes of innovative research. These high impact tools are essential to enhance the visibility and presence of the department's work to a diverse set of end-users to further educate and implement the outcomes for the improvement of applicable operations and services. Effective communication and subsequent implementation of research will aid MDOT to work more efficiently, more safely, and increase economic benefit to the traveling public. The improvement of services and operations because of implementation will assist the department to aligning further with its core vision and values

FISCAL YEAR 2021 ACCOMPLISHMENTS

Completed the At-A-Glance report summary of funding statistics and project progress for FY 2020. Completed spotlight newsletters including, but not limited to, Bridge Structural Analysis for Staged Construction, Construction Price Index, Evaluation of Camber and Deflections for Bridge Girders, and Developing Michigan Pedestrian and Bike Safety Models. Completed production of video spotlights on Carbon Fiber Reinforced Concrete and Effectiveness of Green Strobes on Winter Maintenance. Developed needed communication distribution strategies for spotlights. Began providing technical editing for final research project reports on Innovative Contracting. Developed RA's first ArcGIS StoryMap to highlight MDOT's collaboration with other states on research projects through the Transportation Pooled Fund program. This interactive StoryMap highlights MDOT's success stories with research topics ranging from bridge design to intelligent transportation systems to highway maintenance.

FISCAL YEAR 2022 ACCOMPLISHMENTS

Completed the At-A-Glance report summary of funding statistics and project progress for FY 2021. Completed spotlight newsletters including, but not limited to, Integration of Unmanned Aerial Systems Data Collection into Day-to-Day Usage for Transportation Infrastructure - A Phase III Project, Connected/Automated Vehicle and Infrastructure Research [Michigan Mobility Transformation Facility (MTF)], Infrastructure Protection and Rehabilitation Response to High Lake Levels, Quantifying Effectiveness and Impacts of Digital Message Signs on Traffic Flow, Evaluation of an Active Traffic Management System with Part-Time Use of the Inside Shoulder, and Synthesis of National Best Practices on Pedestrian and Bicycle Design, Guidance, and Technology Innovations. Completed spotlight videos on Slope Restoration on Urban Freeways and High-Tech Workforce Preparation for Emerging Transportation Technologies. Developed needed communication distribution strategies for spotlight newsletters and videos. Continued providing technical editing for final research project reports on Innovative Contracting.

FISCAL YEAR 2023 ACCOMPLISHMENTS

Completed the At-A-Glance report summary of funding statistics and project progress for FY 2022. Completed spotlight newsletters including, but not limited to, *SPR-1719 Developing a Consistent Data Driven Methodology to Multimodal*,

Performance Based and Context Sensitive Design, SPR-1721 Safety Enhancements at Short-Storage-Space Railroad Crossings, SPR-1716 Assessing System Performance of the Michigan Trunkline: Measures and Analytical Procedures for Planning and Operations, SPR-1720 Quantifying the Impact of Wide Base Tires on Pavement Performance in Michigan, SPR-1698 Effects of Concrete Cure Time on Epoxy Overlay and Sealant Performance, SPR-1725 Evaluating the Performance and Safety Effectiveness of Roundabouts - An Update, SPR-1722 Evaluation of MDOT's Long-Life Pilot Projects, SPR-1727 Determining State and Federal Transportation Responsibilities to Residents on Islands, and SPR-1703 Concrete Deterioration of Prestressed Bridge Beams. Completed a promotional video to highlight the roles of RAd's project managers that lead innovative research efforts and to promote participation in the Research Program Development Cycle to build RAd's fiscal year program. Updated the ArcGIS StoryMap for the Transportation Pooled Fund program which highlight MDOT's collaboration with other states on research projects. Developed needed communication distribution strategies for spotlight newsletters and videos. Continued providing technical editing and graphic needs for final research project reports on Innovative Contracting.

FISCAL YEAR 2024 PROPOSED ACTIVITIES

Expect completion of additional spotlight newsletters, production of additional video spotlights, continued development of distribution strategies for communicating innovative research findings and providing technical/editing writing services. CTC & Associates, LLC. will assist our office with other services as needed. RAd and CTC will continue to meet quarterly for status updates to discuss progress on communication projects; the Project Manager and CTC will continue to remain in contact via email/phone between meetings for day-to-day activities.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project expected completion FY 2025.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2023**

PROJECT TITLE: Assessing System Performance of the Michigan Trunkline: Measures and Analytical Procedures for Planning and Operations

FUNDING SOURCE: SPR, Part II OTHER (PLEASE EXPLAIN)

PROJECT MANAGER: Robert Maffeo

CONTRACT/AUTHORIZATION NO.	2020-0783	PROJECT START DATE	8/1/2020
PROJECT NO.	210791	COMPLETION DATE (Original)	7/31/2022
OR NO.	OR20-005	COMPLETION DATE (Revised)	12/31/2022
RESEARCH AGENCY	Michigan State University (MSU)		
PRINCIPAL INVESTIGATOR	Ali Zockaie		

BUDGET STATUS

FY 2023 Budget		Total Budget	
Vendor Budget FY 2023	\$43,525.59	Total Vendor Budget	\$180,204.74
MDOT Budget FY 2023	\$0.00	Total MDOT Budget	\$0.00
Vendor FY 2023 Expenditures	\$43,523.18	Total Budget	\$180,204.74
MDOT FY 2023 Expenditures	\$0.00	Total Expenditures	\$180,202.33
		Total Amount Available	\$2.41

PURPOSE AND SCOPE

Since 1961, the Michigan Department of Transportation had been conducting yearly Sufficiency Reviews of the trunkline system, which included a systematic evaluation of the condition and relative operational performance of individual highway segments. This process produced a yearly Sufficiency Report that was a single-source document containing a variety of condition and operational data. The information found in this Report was intended to serve as an initial planning tool for MDOT staff and management to guide development of more comprehensive studies. As part of an MDOT Systems and Process Improvement Review (2010-2014), it was determined that the 2015 Sufficiency field reviews would be the last to be completed. Thus, the Sufficiency Program was retired after the release of the 2015 Report, with most data items provided by this program to be accessible in the future from various sources within MDOT. Two data items that were part of the Sufficiency Program that were not designated as having an alternate source were the "Capacity Volume" and "Level of Service" metrics. Internal MDOT "customers" continue to utilize the values provided in the 2015 Sufficiency Report, which are quickly becoming outdated. A review of past practices and recommendations for moving forward, based on MDOT staff needs, is critical for maintaining current and future trunkline condition assessment capabilities for planning and operational analysis purposes. The scope of work includes the following:

1. Conduct a review of MDOT past practices for calculating Sufficiency "Capacity Volume" and "Level of Services" metrics, and conduct a survey of the internal MDOT customers that identifies pertinent staff and their informational needs regarding performance measurement,
2. Conduct a traditional literature search / review regarding system performance metrics; Conduct a review of other agency (FHWA, State DOT, MPO) plans and documents regarding system performance metrics
3. Develop an Interim Project Status Report
4. State of the Practice Review, including: What performance metrics / measures meet our needs? What thresholds / targets are appropriate; What are the quantitative / qualitative approaches used to calculate PMs; Perform a data needs and gap analysis, including cost assessment,
5. Develop an Interim Project Status Report
6. Develop a Technical Report - Guidance Document, that: Documents the recommendations based on MDOT past practices and the state of the practice review; details the methodologies for calculating performance metrics; provides guidance regarding appropriate thresholds and target values; provides a data needs and gap analysis summary; and includes an implementation strategy.

FISCAL YEAR 2020 ACCOMPLISHMENTS

Fiscal year 2020 accomplishments included the project kick-off meeting held September 30th, 2020. The meeting provided an opportunity for RAP and PI team introductions, a review of the contract specifics and deliverables, a review of the objectives, Gantt chart and work plan for the research project. The Principal Investigator (PI) and research team provided information on the following research tasks:

Task 1 – Literature Review: The key literature from federal guidelines, state DOTs, MDOT, and other agencies were carefully reviewed as part of developing the research plan for this project.

FISCAL YEAR 2021 ACCOMPLISHMENTS

Fiscal year 2021 activities included the following research tasks:

Task 1 – Literature Review. Completion of a comprehensive literature review of documented measures and targets suggested by FHWA, MPO, and NCHRP, other state DOTs via plans and documents and applicable journal publications, project reports, conference proceedings, to capture the following information: 1) Federal requirements, 2) Implementation of operational performance measures 3) Guidelines and strategies, 4) Data sources, needs and costs to calculate measures, 5) Calculations methods and estimation approaches, 6) Tools and methodologies, and 7) Threshold and target values used by other agencies.

Task 2 – Nationwide State DOT Survey. Developed and distributed an online survey for state DOTs and MPOs to capture the following information: 1) Performance measures, 2) Threshold and target values for performance measures, 3) Data sources used for calculations and estimation of mobility related performance measures, 4) Costs associated with data collection, storage, and analysis, 5) Tools, methodologies, and platforms used for data analysis and 6) Current approaches in reporting and communication of measures.

Task 3 – Review Current / Historical MDOT Practices & Available Data for MI Trunkline Performance. A review of the following items was completed: 1) Available data sources for calculating mobility related trunkline performance measures including, but not limited to RITIS, MVDS, GIS, 2) The MDOT sufficiency report including, but not limited to AADT, DHV, Capacity Volume, LOS, 3) Comparison of alternative performance measures to sufficiency report, and 4) Identify MDOT divisions pertinent to the highway systems assessment.

Task 1 thru 3 – Completion of a DRAFT Interim Report summarizing the results of Task 1, 2, and 3, and a work plan for subsequent tasks.

Task 4 – Perform MDOT Staff Interviews. Began to develop the survey, and a listing of staff, for interviews of pertinent MDOT divisions and Michigan MPOs that will be performed [next fiscal year] through phone calls and an online questionnaire to identify Michigan’s current needs and practices. Topics of inquiry may include, but are not limited to, the following: 1) Utilized and recommended performance measures, 2) Thresholds and target values, 3) Data needs and assessments, 4) Tools and methodologies for data analysis and reporting.

FISCAL YEAR 2022 ACCOMPLISHMENTS

Fiscal year 2022 activities include the following research tasks:

Task 1 thru 3 – Completion of Final Interim Report summarizing the results of Task 1, 2, and 3, along with a work plan for subsequent tasks.

Task 2 – Initiate and complete a follow-up [nationwide] survey of select State DOTs to obtain further clarification as to: 1) Performance measures used and their purpose, 2) Threshold and target values for performance measures, 3) Data sources used for calculations and estimation of mobility related performance measures, 4) Costs associated with data collection, storage, and analysis, 5) Tools, methodologies, and platforms used for data analysis and 6) Current approaches in reporting and communication of measures.

Task 4 – Perform MDOT Staff Interviews. Finalize the survey and complete interviews of pertinent MDOT divisions and Michigan MPOs through phone calls and an online questionnaire to identify Michigan’s current needs and practices. Topics of inquiry may include, but are not limited to, the following: 1) Utilized and recommended performance measures, 2) Thresholds and target values, 3) Data needs and assessments, 4) Tools and methodologies for data analysis and reporting.

Task 5 – Identify Potential Performance Measures. The information collected in the previous tasks will be synthesized to determine the potential set of operational performance measures for MDOT trunklines. In addition to the performance measures, associated appropriate thresholds and target values will also be determined. Finally, the methodologies and tools to estimate/calculate, store, and report these potential performance measures to technical and non-technical audiences will be explored. In this step, the team will also seek to propose a consistent approach for communicating the performance measures between the various platforms to which they are published.

Task 6 – Perform a Needs Assessment, Gap Analysis and Cost Assessment. The project team will compare the different potential performance measures identified in Task 5 with performance needs and available data for the Michigan trunkline system. For each potential performance measure, the project team will compare the data needs with the available datasets to identify any data gaps. Furthermore, the cost associated to fill these data gaps for each potential performance measures will be assessed.

Task 4 thru 6 – Completion of a Draft and Final Interim Report summarizing the results of Task 4, 5, and 6, along with a work plan for subsequent tasks.

FISCAL YEAR 2023 ACCOMPLISHMENTS

Fiscal year 2023 activities included the following research tasks:

Task 7 – Recommendation of Performance Measures and Guidelines for Implementation and Evaluation. The final recommended performance measures were presented, with adequate justification provided for performance measures and/or data sources recommended for replacement/upgrading.

Task 8 – Deliver Final Report. The final project report includes the literature review and current practices of state DOTs and MDOT for highway system assessment. The synthesis of these data collection efforts provided a potential set of performance measures and their associated target values, calculation approach, data needs, and demonstration of tools and methodologies. Finally, the

team provided concluding remarks, as well as final recommendations and an implementation strategy for the operational performance measures.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

A no-cost time extension was approved in April 2022 due to the below:

- There were unexpected delays in conducting task 2 of the research plan “Perform Nationwide State DOT Survey”. Identifying proper listserv to receive an acceptable response rate from different states required multiple rounds of survey distribution.
- After conducting the survey for task 2, the research team, after consulting with the project manager and RAP members, decided included a follow up survey after conducting task 4 of the research plan and perform MDOT Staff Interviews.
- Based on the task 2 feedback, the research team, in consultant with the project manager and RAP members, decided to select a different hybrid strategy for the MDOT staff interviews, which would address the remote work with the department, but including multiple virtual meetings and distributing an on-line survey. This hybrid strategy calls for additional time to conduct this research task successfully.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

The recommendations set forth in the final report indicate a migration away from past practices and methodology, and moving forward with new metrics, definitions, and reporting techniques while allowing for a transition period from our existing metrics to the new. Previous methodology was based on the 2000/2010 Highway Capacity Manual, and it was suggested that we should abandon this and transition to utilizing archived real-time speed [big] data that is now prevalent in the industry. Mobility analysis (congestion and travel time reliability) should be based upon speed data. Adding metrics to measure travel time reliability is becoming common place, complementing the congestion-related metrics, for a broader picture of operational roadway system performance. In addition, we can forecast these metrics using our travel demand modeling tools/techniques that we currently maintain in-house, correlating these new metrics with roadway and demographic characteristics and model outputs.

The research recommendations are based on a nation-wide DOT/MPO agency literature review and staff survey/interviews, reviews of our [MDOT] past and current practices, and an extensive [MDOT] needs assessment. Research findings highlighted the practices of other State DOTs and MPOs relating to congestion and travel time reliability analysis, the metrics they use, the applications for their analysis (e.g., long range/short range planning, project prioritization) and other details on the specifications of the metrics/measures.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2023**

PROJECT TITLE: Electronic Water Level Sensors for Monitoring Scour Critical Structures

FUNDING SOURCE: SPR, Part II OTHER (PLEASE EXPLAIN)

PROJECT MANAGER: Zwolinski, Andrew

CONTRACT/AUTHORIZATION NO.	2019-0312 Z5	PROJECT START DATE	4/1/2021
PROJECT NO.	211053	COMPLETION DATE (Original)	12/31/2023
OR NO.	OR21-003	COMPLETION DATE (Revised)	Extension Pending
RESEARCH AGENCY	University of Michigan (UM)		
PRINCIPAL INVESTIGATOR	Kerkez		

BUDGET STATUS

FY 2023 Budget		Total Budget	
Vendor Budget FY 2023	\$258,011.19	Total Vendor Budget	\$442,505.15
MDOT Budget FY 2023	\$16,800.00	Total MDOT Budget	\$0.00
Vendor FY 2023 Expenditures	*\$258,011.19	Total Budget	\$442,505.15
MDOT FY 2023 Expenditures	\$0.00	Total Expenditures	\$442,505.15
*15% of contract costs incurred are on hold pending receipt of deliverables.		Total Amount Available	\$0.00

PURPOSE AND SCOPE

During widespread or long-term rain events, it is difficult to reach every scour critical structure for observation. Although numerous USGS/NOAA stream gauges exist throughout Michigan, additional installations and maintenance can cost upwards of \$23,000 per sensor, and \$6,000 annually for maintenance and calibration. A more cost-effective system of remote sensors capable of providing live data to bridge owners would help efficiently prioritize site visits, on-site monitoring, and closures/detours. The scope of work includes the following:

1. Conduct literature search on remote water surface monitoring devices, alert, data logging and power systems.
2. Survey other state DOTs on the utilization of remote systems
3. Catalog the attributes of scour critical bridges to identify the conditions for sensor performance.
4. Select ideal system to satisfy the research problem including life cycle costs.
5. Based on performance in Michigan river and weather conditions and other critical factors such as tamper resistance, perform modifications if improvement is needed.
6. Install the sensor systems on 20 MDOT bridges and monitor for 18-24 months.
7. Monitor network and data transfer performance, if necessary, modify the system to improve performance, reliability, and connectivity.
8. Develop an implementation plan with cost and phasing to install sensors on all recommended bridges.
9. Develop a research report documenting the study and recommendations.

FISCAL YEAR 2021 ACCOMPLISHMENTS

Tasks 1-3 were rescheduled to accommodate initiating Tasks 4-6. An initial installation of five sensors was performed to expose the units to the longest duration in varying seasonal conditions. Improved functionality of solar panels and battery, cellular connectivity, and improvement and standardization of the deployment process. Data dashboards and streamlining data capture was also improved.

Site scoping was performed for optimal locations and installation process. Right of Way permitting was acquired through MDOT. After installing these sensors, data capture and improvements to processing were being developed.

FISCAL YEAR 2022 ACCOMPLISHMENTS

Task 4-6 are complete. Ongoing monitoring as part of Task 7 will continue until the end of the project. Task 1 has been provided to the panel as a draft, open for comment. Tasks 2, 3, 8 and 9 are ongoing

FISCAL YEAR 2023 ACCOMPLISHMENTS

FY23 focused on tasks 7-9. Interviews with bridge owners and data users improve design of data display, alerts and incorporate future estimates. MDOT Regions have gained an understanding of the use of the sensors and rely on the gages to monitor equipped bridges during high flows.

FISCAL YEAR 2024 PROPOSED ACTIVITIES

A no-cost time extension to continue the project further into FY24 is expected. This will allow additional monitoring through another season while also providing additional time to adopt the sensor network and monitoring system into MDOT and MDOT IT processes. This will give the project manager time to identify additional options to keep the network active and available into the future.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

A no-cost time extension is in progress to allow the Principal Investigator to continue maintaining the network while MDOT determines a method of adoption.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project expected completion FY 2024.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2023**

PROJECT TITLE: Utilizing Video Analytics w/Connected Vehicles for Improved Safety

FUNDING SOURCE: SPR, Part II OTHER (PLEASE EXPLAIN)

PROJECT MANAGER: Mueller, Michele

CONTRACT/AUTHORIZATION NO.	2021-0250	PROJECT START DATE	2/15/2021
PROJECT NO.	211056	COMPLETION DATE (Original)	1/31/2024
OR NO.	OR21-005	COMPLETION DATE (Revised)	
RESEARCH AGENCY	Kimley Horn of Michigan Inc.		
PRINCIPAL INVESTIGATOR	Good, Amanda		

BUDGET STATUS

FY 2023 Budget		Total Budget	
Vendor Budget FY 2023	\$117,205.15	Total Vendor Budget	\$349,662.20
MDOT Budget FY 2023	\$91,868.12	Total MDOT Budget	\$209,713.11
Vendor FY 2023 Expenditures	\$88,082.17	Total Budget	\$559,375.31
MDOT FY 2023 Expenditures	\$0.00	Total Expenditures	\$233,123.67
		Total Amount Available	\$326,251.64

This project will investigate the use of video analytics to operate in a proactive way by identifying crash challenges in real time to help form an understanding of near misses and crashes. The research will include installing a video analytics system along a test corridor to analyze, evaluate, and validate the effectiveness and improved traffic efficiencies when implementing solutions at MDOT's most challenging signalized intersections. The system could take this information and provide a notification through connected vehicle technology to vehicles, pedestrians, and other non-motorized users. Initially, this notification capability would be set up in test vehicles and MDOT could expand installations to other vehicles once proven effective.

FISCAL YEAR 2021 ACCOMPLISHMENTS

Completed a draft Market Assessment memo by interviewing multiple agencies and researching various vendors. Drafted a Request for Information (RFI) to obtain additional input from vendors on the industry capabilities. Developed several use cases and presented a Use Case Memo. Began development on initial functional requirements that will be used to identify and potentially select a vendor(s) to implement at selected corridor(s)/intersection(s). Began to identify the process of evaluating potential locations (corridor/intersection based).

FISCAL YEAR 2022 ACCOMPLISHMENTS

Completed work necessary for the RFI proposals to be received. Solicitation pending where after vendor solicitation, vendors will be afforded an opportunity to demonstrate their system per the RFI information (during FY 2023).

FISCAL YEAR 2023 ACCOMPLISHMENTS

Information gathered from vendor's demonstrations for use in supporting the final development of functional requirements and finalization of the Market Assessment Memo. Identified nuances that need to be considered for the Corridor Evaluation process and worked in identifying locations for implementation. A Request for Proposal (RFP) style process will be used to identify vendor(s) to implement their system at those locations. Began initial analysis of the data and performance.

FISCAL YEAR 2024 PROPOSED ACTIVITIES

An Assessment Report will be developed based on the Vendors' analytic data from the demonstration as they pertain to meeting the documented use cases and confirming potential capabilities of the Vendors. An Implementation Guide will be developed based on the feedback received from the Vendors per the demonstration and noted concerns and lessons learned through the process.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

In July 2023, budgeted funds were shifted from the prime contract to subcontractor Integral Blue due to a change in technical approach within the existing project scope. This change stems from moving from a static video analytics installation to a mobile installation.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project expected completion fiscal year 2024.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2023**

PROJECT TITLE: Effective Bridge Deck Weather Warning Technologies

FUNDING SOURCE: SPR, Part II OTHER (PLEASE EXPLAIN)

PROJECT MANAGER: Smith, Dave

CONTRACT/AUTHORIZATION NO.	2021-0412	PROJECT START DATE	2/15/2021
PROJECT NO.	211058	COMPLETION DATE (Original)	7/31/2023
OR NO.	OR21-016	COMPLETION DATE (Revised)	12/31/2023
RESEARCH AGENCY	Michigan State University (MSU)		
PRINCIPAL INVESTIGATOR	Tim Gates		

BUDGET STATUS

FY 2023 Budget		Total Budget	
Vendor Budget FY 2023	\$ 323,657.58	Total Vendor Budget	\$351,167.11
MDOT Budget FY 2023	\$4,000.00	Total MDOT Budget	\$4,000.00
Vendor FY 2023 Expenditures	\$ 275,060.99	Total Budget	\$355,167.11
MDOT FY 2023 Expenditures	\$0.00	Total Expenditures	\$302,570.52
		Total Amount Available	\$52,596.59

PURPOSE AND SCOPE

Weather related crashes continue to be a problem on Michigan roadways. Crashes caused by inclement weather are especially problematic on bridges where historically, MDOT has mounted seasonal warning signs to warn drivers of such conditions. Recently, MDOT has begun installing new condition-responsive technology that uses environmental sensors to detect icy bridge decks and roadways that when the correct conditions are met, will light up flashing yellow or Light-Emitting Diode (LED) lights on nearby warning sign) to help the motoring public understand the upcoming road conditions. This research project will explore more dynamic messaging strategies, such as displaying a warning message on a nearby Dynamic Message Sign (DMS) or incorporating vehicle to infrastructure communication to improve driver's behavior response to adverse weather conditions thereby hoping to reduce the number of these types of crashes.

FISCAL YEAR 2021 ACCOMPLISHMENTS

- Worked to determine guidelines for weather related DMS ad Static sign parameters, including location, messaging, and communication needs.
- Survey questions for other states and/or countries pertaining to what they are doing with weather related DMS and static sign parameters have been sent out to approximately 50 different locations.
- Testing has not yet started on materials and technology
- Began investigating crash data for the three known existing locations.
- Review of the driver behavior assessment study has not yet started.

FISCAL YEAR 2022 Accomplishments

Continued work on project objectives noted above and selected locations for field study. Overall research work is approximately 45% complete.

FISCAL YEAR 2023 ACCOMPLISHMENTS

Researcher worked with MDOT experts to install the additional test Bridge Deck Warning System (BDWS) sign at the selected Lansing area site on NB 127 at Willoughby Rd.

- Collected data - winter 2022/2023
- Coordinated with the State Transportation Operations Center (STOC) to test DMS messaging strategies
- Surveyed members of the Aurora project
- Updated the report

FISCAL YEAR 2024 PROPOSED ACTIVITIES

Schedule and hold a project wrap up meeting to review/discuss Chapters 5 and 7 from the draft final report. RAP/PM will provide comment feedback to the PI for revisions to draft by early December. Final report will be submitted, reviewed, and accepted by December 31, 2023. Accessibility review and spotlight publication will also be completed by the project end date.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project completion expected FY 2024.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL
YEAR 2023**

PROJECT TITLE: Determining State and Federal Transportation Responsibilities to Residents on Islands

FUNDING SOURCE: SPR, Part II OTHER (PLEASE EXPLAIN)

PROJECT MANAGER: Shultz, Valerie

CONTRACT/AUTHORIZATION NO.	2021-0207	PROJECT START DATE	1/15/2021
PROJECT NO.	211059	COMPLETION DATE (Original)	4/30/2023
OR NO.	OR21-012	COMPLETION DATE (Revised)	6/30/2023
RESEARCH AGENCY	Michigan State University (MSU)		
PRINCIPAL INVESTIGATOR	Zockaie		

BUDGET STATUS

Vendor Budget FY 2023	\$22,171.45	Total Vendor Budget	\$160,573.35
MDOT Budget FY 2023	\$0.00	Total MDOT Budget	\$0.00
Vendor FY 2023 Expenditures	\$22,171.45	Total Budget	\$160,573.35
MDOT FY 2023 Expenditures	\$0.00	Total Expenditures	\$160,573.35
		Total Amount Available	\$0.00

PURPOSE AND SCOPE

Michigan residents are choosing to live on Drummond, Neebish, and Sugar Islands located in St. Mary's River in the eastern Upper Peninsula, and on Beaver Island located in Lake Michigan off the coast of Charlevoix. The residents expect the same access to work, emergency services, and economic opportunities on the mainland as mainland residents receive. The purpose of this research project is to determine the State and Federal transportation responsibilities to residents residing on islands in the State of Michigan.

The tasks outlined below from Michigan State University are in response to the following objectives of this Ferryboat Research Project: (1) level of service provided to the island residents, (2) repair/maintenance of docks on the islands, (3) number of back-up ferries needed, as ferries are required to be removed to drydock every five years for Coast Guard inspection/repair, (4) the requirement/need for maintaining a ferry with crew 24/7 for emergency services, and (5) whether ferries on all islands need to be able to accommodate logging trucks. The tasks are tracked and evaluated to determine the status of this research project.

Task 1: Literature Review

Task 2: Review of Michigan Regional Background

Task 3: Perform a Nationwide State DOTs and Ferry Operators Survey

Task 4: Survey/Interview of Island Residents and Ferry Operators

Task 5: Island Residents Mobility Gap Analysis

Task 6: Assessment of Current Ferry Operations and Developing Maintenance Plan

Task 7: Evaluate Ferry Operation in Other Islands

Task 8: Final Recommendation for Michigan Island Accessibility

Task 9: Develop and Deliver Draft and Final Reports

FISCAL YEAR 2021 ACCOMPLISHMENTS

Task 1 - Literature Review- Reviewed key literature from previous studies, federal guidelines, state DOTs, MDOT, other agencies and information collected by researchers.

Task 2 - Review of Michigan Regional Background: Provided data by MDOT were analyzed to review the financial and ridership data. The ridership data were compared with predicted values in the earlier published reports for the islands of interest in this study. The research team also followed up with Beaver Island Transportation Authority (BITA) and Eastern Upper Peninsula Transportation Authority (EUPTA) to get their operational data.

Task 3 – Perform a Nationwide State DOTs and Ferry Operators Survey: To review the state-of-the-practice the developed on-line state DOT survey was further updated to address the MDOT Research Administration Panel (RAP) feedback. Various approaches were explored to distribute the survey to relevant DOT staff. A combination of on-line search and inquiry from the American Association of State Highway and Transportation Officials (AASHTO) committees was used to distribute the survey. Multiple rounds of reminders including group emails, individual emails, and phone calls were used to increase the survey response rate.

FISCAL YEAR 2022 ACCOMPLISHMENTS

Task 4 - Survey/Interview of Island Residents and Ferry Operators: The research team conducted in person data collections for three islands serviced by EUPTA in July 2022 (July 7th-9th). The collected survey results were processed and analyzed. The initial analyzed results were presented at the MDOT RAP meeting.

Task 5 - Island Residents Mobility Gap Analysis: The collected data was part of the survey of residents of Michigan islands, in addition to conducted interviews with business owners and different groups of users and ferry operators were analyzed to identify service gaps and mobility needs for the main islands of interest in this study.

Task 6- Assessment of Current Ferry Operations and Developing Maintenance: Ferry operations were assessed to determine their current expenditure on maintenance.

Task 7- Evaluate Ferry Operations in Other Islands: The basic operational details and island profiles were collected for these other island (Manitou, Bois Blanc, Grand and Harsens). This was followed up with interviews with ferry operators and several members of the Great Lakes Islands Alliance (GLIA) who connected the researchers to certain stakeholders in these islands.

FISCAL YEAR 2023 ACCOMPLISHMENTS

Task 4- Survey/Interview of Island Residents and Ferry Operators: The research team summarized ferry operators' and owners' interviews. Additionally, further cross reference analysis was made on the data from the users' surveys.

Task 5 - Island Residents Mobility Gap Analysis: The identified service gaps and mobility needs for the main islands of interest in this study were finalized and alternative modes of transportation were compared to ferry operations at different islands.

Task 6- Assessment of Current Ferry Operations and Developing Maintenance: Further information was analyzed to assess and predict the maintenance plans for BITA and EUPTA.

Task 8 – Final Recommendation for Michigan Island Accessibility: A draft of the final recommendations was prepared and shared with MDOT for comment. These recommendations were developed based on Tasks 1-7 outcomes which included the survey of state DOTs, ferry operators' interviews, and users' survey.

Task 9 – Develop and Deliver Draft and Final Reports: The draft final report for the research project was shared with MDOT for comment and distributed to a few select transit agencies for comment. The draft final report summarized activities and outcomes from Tasks 1-7 and the Task 8 recommendations. Based on feedback provided to the research team the draft final report was updated and a final report for the project was submitted by the contract deadline.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

The end date of the project was extended due to the COVID-19 pandemic postponing data collection.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Results of the research project provided key insights on existing ferry operations on the islands of interest, mobility gaps of island residents, maintenance spending forecast and funding needs through 2032. Additionally, the results provided recommendations regarding the ideal roles of state and federal authorities to ensure island residents' welfare and mobility needs. While the research was conducted on certain islands, study findings could have wider applications on other island communities beyond those studied and analyzed in the report.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2023**

PROJECT TITLE: Evaluation of MDOT's Methodologies for both Quantifying Pavement Distress & Modeling Pavement Performance for LCC and RSL Estimation Purposes

FUNDING SOURCE: SPR, Part II OTHER (PLEASE EXPLAIN)

PROJECT MANAGER: Eacker, Michael

CONTRACT/AUTHORIZATION NO.	2021-0288	PROJECT START DATE	2/2/2021
PROJECT NO.	211061	COMPLETION DATE (Original)	5/31/2023
OR NO.	OR21-007	COMPLETION DATE (Pending)	05/31/2024
RESEARCH AGENCY	Michigan State University (MSU)		
PRINCIPAL INVESTIGATOR	Kutay		

BUDGET STATUS

FY 2023 Budget		Total Budget	
Vendor Budget FY 2023	\$240,582.53	Total Vendor Budget	\$543,031.80
MDOT Budget FY 2023	\$22,360.00	Total MDOT Budget	\$29,796.33
Vendor FY 2023 Expenditures	\$196,822.19	Total Budget	\$572,828.13
MDOT FY 2023 Expenditures	\$5,254.53	Total Expenditures	\$511,962.32
		Total Amount Available	\$60,865.81

PURPOSE AND SCOPE

Since the inception of its pavement management system in the early 1990's, the Michigan Department of Transportation (MDOT) has been using the Distress Index (DI) as a measure of surface condition for pavements. The DI is based on an assignment of increasing-value numeric "points" to specific distress type-and-severity observations obtained through detailed surveys; the more detrimental a distress type/severity observation is to pavement structural condition, the higher the assigned point value. The distress information is collected via digital images by vendors on roughly half the MDOT network every year. There appears to be a gap between what the state of the practice in the pavement data collection industry typically provides nationwide, and the complexity of the distress information MDOT asks for. MDOT has decided to suspend collection of the full extent of the distresses typically requested and to suspend the use of DI as the pavement condition measure. This research is expected to investigate and recommend a new condition measure, or revisions to the existing DI system, that MDOT can utilize moving forward. This new/revised measure is expected to be compatible with what the pavement data collection industry can deliver in an accurate and timely manner. It is also expected to have low impact on MDOT's business practices and processes, including the Remaining Service Life (RSL) estimation process and the Life-Cycle Cost Analysis (LCCA) process.

FISCAL YEAR 2021 ACCOMPLISHMENTS

The research team did an exhaustive literature search to find what other states are using as measures of pavement performance. Typically, most states hire one of a small set of vendors to survey their pavements for condition assessment. The capabilities and standard practices of these vendors was investigated and assessed. The pavement condition assessment methodologies of 18 different states were studied to evaluate the details of the types of pavement distresses they assess. Based on this investigation, the research team narrowed it down to the five most promising methodologies.

The team began using detailed data from MDOT's Pavement Management System database for specific sections of pavements to create the pavement condition index using the selected five methodologies. These index values were compared to MDOT's DI values to create an initial assessment of applicability to Michigan's pavements.

Finally, the research team created a survey that will be sent to MDOT staff most closely involved with the pavement evaluation and scoping for fix type selection.

FISCAL YEAR 2022 ACCOMPLISHMENTS

Out of five choices from other states for distress index methodologies, the Minnesota method was chosen to implement in Michigan. The distress definitions and severity levels were finalized, and calibration of the point system was begun. MDOT decided that the new index will be called the Pavement Distress Score (PDS).

The research team also began reviewing different methods for modeling the predicted performance for families of pavements (reconstructs, rehab fixes, etc.). MDOT's method for splitting project lists into families were utilized with the PDS numbers to see the fix life predictions from each of the models. These fix life values were compared with MDOT's existing fix lives to judge reasonableness of each of the models. These families, however, were based on the old Distress Index (DI) scores. So, the research team began working on a method to break project groups into families using the PDS.

The research team delivered the first draft of one of the three anticipated computer modules for the PDS. This first module is intended to take MDOT's previous distress data and convert it to the new PDS distress types and severities. MDOT began reviewing that JAVA code.

Lastly, the research team began reviewing literature for ways to model International Roughness Index (IRI) data to predict future IRI values.

FISCAL YEAR 2023 PROPOSED ACTIVITIES

The proposed PDS and performance model methodologies were presented to internal and external stakeholders on December 12, 2022. Distress definitions to be used for future data collections were finalized, and the final calibration of the deduct point system for calculating the PDS values was completed.

The computer code (JAVA) for converting historical MDOT distress raw data to the PDS definitions was delivered. Service life modeling of IRI, rutting and faulting occurred with estimated fix and service life values for each. Network-level modeling of IRI began.

Began drafting the final project report.

FISCAL YEAR 2024 PROPOSED ACTIVITIES

Network level modeling for IRI, % cracking, rutting, and faulting will be completed. Computer code for calculating PDS and creating life-cycle performance curves will be delivered. Final report will be completed.

A presentation to MDOT and industry paving groups of the IRI service life modeling is planned for October.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

A time extension was granted in December 2022 to fine tune work on task 5 (service life curves for our different pavement fixes), develop and deliver task 6 (application to create service life curves), and work on task 7 (network modeling of IRI, cracking, faulting, and rutting). The project end date was extended again in December 2023 to complete Task 7 and provide more time for MDOT engineers/regions and industry to evaluate/ comment on PDS magnitudes, fix lives, and LCCA methodology so they can be refined and perfected.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project expected completion FY 2024.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2023**

PROJECT TITLE: Quantifying the Impact of Super Single (Wide Base) Tires on Pavement Damage in Michigan

FUNDING SOURCE: SPR, Part II OTHER (PLEASE EXPLAIN)

PROJECT MANAGER: Schenkel, Justin

CONTRACT/AUTHORIZATION NO.	2019-0311 Z2	PROJECT START DATE	3/15/2021
PROJECT NO.	211062	COMPLETION DATE (Original)	8/31/2022
OR NO.	OR21-008	COMPLETION DATE (Revised)	12/31/2022
RESEARCH AGENCY	Michigan Technological University (MTU)		
PRINCIPAL INVESTIGATOR	You		

2022 BUDGET STATUS

FY 2023 Budget		Total Budget	
Vendor Budget FY 2023	\$53,407.85	Total Vendor Budget	\$244,484.26
MDOT Budget FY 2023	\$16,800.00	Total MDOT Budget	\$16,073.02
Vendor FY 2023 Expenditures	\$53,212.51	Total Budget	\$260,557.28
MDOT FY 2023 Expenditures	\$4,601.8	Total Expenditures	\$260,361.94
		Total Amount Available	\$195.34

PURPOSE AND SCOPE

Dual tires have been the trucking industry standard for many decades. For this reason, existing modelling of the stresses imparted to the pavement through the tires is based on dual tires. However, the freight industry has started to use wide-base single tires (WBT), also known as super single tires (SST) because of their economic benefits and safety advantages. Therefore, SSTs may gradually replace conventional dual tires. Early design types of SSTs induced excessive pavement damage, especially to flexible pavements. These types of SSTs can generate much higher vertical contact stresses as compared to traditional dual tires, resulting in more significant deformations and more severe damage in bound and unbound layers within a pavement structure. Subsequently, the latest generation of SSTs now have contact areas that are like traditional dual tires and potentially offer improved performance. Therefore, these SSTs would deflect less bottom-up cracking in the asphalt concrete layer and less permanent deformation in all pavement layers. It is not clear what effect SSTs have on dynamic loading when the pavement surface exhibits high surface roughness, (measured in terms of the International Roughness Index (IRI)). Moreover, weight measurements obtained by roadway Weigh-in-Motion (WIM) sensors may have errors as compared to the actual axle load for such tires. Therefore, there is a need to investigate the impact of such wide-based tires on pavement performance for Michigan's climate and construction practices, identifying the impacts that these have on the current MDOT flexible and rigid pavement design methods. For example, the presence of SSTs may influence the axle load spectra (ALS) to be used in ME analysis and load equivalency factors (LEF) for the AASHTO design method. The scope of work per task number includes the following, (which can be reordered as needed per the Principal Investigator (PI)).

- Literature review.
- Investigate WBT usage in Michigan pavements.
- Determine the impacts of WBT have on pavement performance.
- Update of the Michigan Department of Transportation (MDOT) permanent traffic recorder (PTR) data.
- Identify the WBT trucks in the mix of Federal Highway Administration classification.
- Final report and summarizes the recommendations.

FISCAL YEAR 2021 ACCOMPLISHMENTS

During this fiscal year, the following tasks have been accomplished:

- The research team completed the literature review task, (Task 1). Review of published documents pertaining to WBT in the US, provinces in Canada, and a few countries in Europe. Research subject matter consisted of tire-pavement contact loads, pavement response and damage, life-cycle assessment, and lifecycle costing.
- The research team obtained the annual construction permit for operations within the state highway right-of-way and trial take videos in US41, M26, and Mackinaw Bridge using a GoPro video camera. The research team also visited sites in Fowlerville, Grass Lake, Monroe, New Buffalo, Coldwater weigh stations to study the percentage of wide-based tires.
 - Therefore, videos were taken at five different weigh stations, rest areas, and truck stops downstate to obtain the percentage of trucks with wide-base tires. Additionally, data was obtained in three key locations in the upper peninsula to accomplish the same task.
- Using the video imagery, the research team wrote a Materials Laboratory (MATLAB) code to complete the image processing to distinguish the various truck classes and identify the percentage of trucks utilizing wide-base tires using neural network (CNN) technology.
- The research team also finalized and distributed the WBT survey form (tire manufacturer version and user versions). Accordingly, responses have been catalogued for evaluation and reporting.
- The research team received the AASHTO Pavement ME software to prepare for assessment of the impacts of WBT on pavement performance.

Therefore, to summarize, Task 1 is complete, Task 2 is nearing completion, and Task 3 is underway. The project is slightly behind schedule as of September 30, 2021, with approximately 27 percent of the planned work complete and approximately 35 percent of the project duration complete.

FISCAL YEAR 2022 ACCOMPLISHMENTS

During this fiscal year, the following tasks have been accomplished:

- The research team obtained survey results from different tire manufacturers and dealers. Accordingly, this data with previously collected data was consolidated to conclude their investigation of WBT usage in Michigan (Task 2).
 - For Task 3, the team conducted analysis of WBT and dual tire arrangements using JULEA and ILLISLAB for flexible and rigid pavement structures, respectively. Accordingly, the team conducted Pavement ME analysis based on the mechanistic inputs and database from MDOT to account for the measured WBT usage found on Michigan trunkline routes. Accordingly, the research team derived recommendations for potential pavement design adjustments to account for WBT.
 - The research team summarized possible PTR equipment refinement that will help MDOT track WBT in the future.
 - Draft final reporting was worked on to account for all project findings.
-

FISCAL YEAR 2023 ACCOMPLISHMENTS

The research team completed their final report and submitted all deliverables to MDOT.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

A time extension was granted in May 2022 due to delays from workforce shortages during COVID-19. This additional time also enabled MTU to conduct additional analysis looking into the temperature gradient distribution and pavement thickness impact to rigid pavement under different tire configurations.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Field investigation at weigh stations in the Lower Peninsula shows the percentage of trucks with any WBTs is 11% on average, mainly on Class 9 trucks. The percentage of load axles with WBTs in all load axles in the Lower Peninsula is 7.32%, from the limited data set in this study. The percentage of trucks using any WBTs is 5.8% on average in the Upper Peninsula, and it is estimated that less than 5% of load axles would contain WBTs. Based on field investigation, the research team recommends assuming 10% as the current proportion of WBTs in the quantitative impact analysis to account for near-term growth during the pavement design life and conservativeness in design.

The impact of WBT loads on pavement distress are all related to the proportion of WBTs, such that more WBTs would cause more risk of pavement failure.

To account for WBT increased potential for pavement distress, the research team proposes adjustment of the design threshold(s) in Pavement ME, considering different WBT load impacts. An impact of less than 2.5% is considered minor in this approach, and no action is recommended in the design process. However, if the impact exceeds 5% for a given distress prediction, the adjusted Pavement ME design threshold is recommended. Specific adjustment(s) will be denoted in final reporting.

For American Association of State Highway and Transportation Officials 93 pavement design, the research team proposes adjustment of the terminal PSI (from 2.5) to indirectly account for additional loss in serviceability due to WBT loads. Specific adjustment(s) will be denoted in final reporting.

Some advanced WIM technologies from Kistler, OptiWIM, and Fiscal Tech America show potential in identifying WBTs in addition to other factors such as wheel spacing and tire pressure that can further help to identify critical factors that affect pavement response and distress development.

MDOT will consider these recommendations for potential changes to pavement design procedures and placement of future WIM technology.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2023**

PROJECT TITLE: Corridor and Systemwide Application of Performance Based Practical Design

FUNDING SOURCE: SPR, Part II OTHER (PLEASE EXPLAIN)

PROJECT MANAGER: Miller, Nathan

CONTRACT/AUTHORIZATION NO.	2021-0221	PROJECT START DATE	2/1/2021
PROJECT NO.	211063	COMPLETION DATE (Original)	1/31/2024
OR NO.	OR21-015	COMPLETION DATE (Revised)	
RESEARCH AGENCY	WSP Michigan, Inc.		
PRINCIPAL INVESTIGATOR	Wendling		

BUDGET STATUS

FY 2023 Budget		Total Budget	
Vendor Budget FY 2023	\$91,731.69	Total Vendor Budget	\$246,705.08
MDOT Budget FY 2023	\$23,040.00	Total MDOT Budget	\$23,040.00
Vendor FY 2023 Expenditures	\$90,843.9	Total Budget	\$269,745.08
MDOT FY 2023 Expenditures	\$0.00	Total Expenditures	\$234,791.94
		Total Amount Available	\$34,953.14

PURPOSE AND SCOPE

Performance Based Practical Design (PBPD) represents a change in mindset from traditional design techniques that mainly focused on meeting specific standards. PBPD places an emphasis on planning-level corridor or system performance needs and objectives to be utilized when scoping and developing individual projects. It is an outcome-oriented approach to design by development of performance-based goals for a corridor or system, and then utilizing practical design to meet those goals. Performance measures such as: safety, system reliability, congestion reduction, freight movement/economic vitality, accessibility, context sensitivity, life cycle costs, long range corridor goals, livability, environmental sustainability, operational performance/Level of Service, infrastructure integrity, and maintenance are some of the components to evaluate. The use of data driven analysis tools, balanced with stakeholder input, can be utilized to objectively develop the purpose, and need (performance-based goals and objectives) for the corridor or system. Specific scope for this project includes the following:

1. Conduct a survey of literature to identify best practices.
2. Conduct a state of the practice survey of other DOT's, MPOs, and FHWA.
3. Evaluate MDOT's current state of the practice and documentation needs.
4. Identify performance data sources that could be used as thresholds to establish design performance measures.
5. Identify predictive tools that can be used to establish performance measures.
6. Develop and recommend design tools that MDOT can implement.
7. Develop a guidance document for use statewide that outlines PBPD practices for MDOT staff.
8. Develop a Research Report.

FISCAL YEAR 2021 ACCOMPLISHMENTS

Initiation of the research project was delayed several months due to a change in the MDOT project manager. Despite this, the team has been working expeditiously to remain on schedule and had generated and submitted a list of survey questions to AASHTO state participants to benchmark current initiatives. All responses will be received at the end of this year.

FISCAL YEAR 2022 ACCOMPLISHMENTS

In 2022, all current benchmarking with other DOTs has been completed and communicated out to the RAP. Additionally, existing process identification has been completed at MDOT. This information has been amalgamated into a report that was sent out for review to the RAP members.

FISCAL YEAR 2023 ACCOMPLISHMENTS

In 2023, the research project wrapped up the investigation and submitted two drafts of the final report for review by MDOT. Draft comments were received by WSP. Recommendations were compiled and these have been the topic of discussion both internally and with the research team on how to implement.

FISCAL YEAR 2024 PROPOSED ACTIVITIES

The report will be finalized and submitted by the contract expiration date in January 2024.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

There was a change in Project Manager at the beginning of the project due to staff changes at MDOT.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project expected completion fiscal year 2024.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2023**

PROJECT TITLE: Right of Way Mapping Conversion to Graphic Information System (GIS)

FUNDING SOURCE: SPR, Part II OTHER (PLEASE EXPLAIN)

PROJECT MANAGER: Matthew Fitch

CONTRACT/AUTHORIZATION NO.	2021-0272	PROJECT START DATE	2/1/2021
PROJECT NO.	211064	COMPLETION DATE (Original)	11/30/2022
OR NO.	OR21-002	COMPLETION DATE (Revised)	4/30/2023
RESEARCH AGENCY	Michigan State University (MSU)		
PRINCIPAL INVESTIGATOR	Bunting		

BUDGET STATUS

FY 2023 Budget		Total Budget	
Vendor Budget FY 2023	\$196,070.25	Total Vendor Budget	\$386,327.00
MDOT Budget FY 2023	\$600.00	Total MDOT Budget	\$0.00
Vendor FY 2023 Expenditures	\$153,817.95	Total Budget	\$386,327.00
MDOT FY 2023 Expenditures	\$0.00	Total Expenditures	\$344,074.70
		Total Amount Available	\$42,252.3

PURPOSE AND SCOPE

Current MDOT Right-of-Way (ROW) Maps are outdated and do not support integration with current MDOT Design and Survey Initiatives and processes. There is no integration with public information or MDOT's current Real Estate IT database. Internal and external users rely on the ROW Maps to determine ownership and are not able to make accurate decisions based on the inaccuracy of the ROW Maps. It is difficult to search for information on the ROW Maps and several resources must be utilized. The scope of the research includes the following:

1. Identify mapping best practices from other state DOT's and agencies.
2. Catalog map data that would be useful for map modernization.
3. Assess the status of MDOT's current efforts to modernize maps.
4. Determine the business needs and functions that an updated map should support.
5. Prioritize requirements for ROW map system.
6. Devise ROW map modernization designs and costs.
7. Implement modernization pilot.
8. Test the maps developed to see if they support MDOT's business needs and search functionality.
9. Adapt design to feedback from Beta testing.
10. Track work required for modernization and developing a statewide implementation plan.
11. Implement modernization in 2 counties.
12. Report on process and recommendations.

FISCAL YEAR 2021 ACCOMPLISHMENTS

Subcontractor DLZ has identified best practices utilized in other states, mainly Wisconsin, Ohio, Indiana, and Oregon. They have also contacted AASHTO and JCG Land Services, Inc. regarding best practices. Several forums were administered, receiving input from MDOT employees regarding their opinions on ROW Maps. Meetings with LAMDA representatives were held to determine proper integration with the new LAMDA database.

FISCAL YEAR 2022 ACCOMPLISHMENTS

Altered "Modernize data for two counties" to "Developing Methodologies for Incorporating New Data into the GIS." Identified and cataloged MDOT ROW map data. Assessed current MDOT modernization plan. Needs assessment and follow-up interviews. Established Project Requirements. ROW Map Modernization Design. Pilot Study.

FISCAL YEAR 2023 ACCOMPLISHMENTS

The research team worked with methodologies for static and new data while continuing meetings with MDOT Real Estate, MDOT GIS and the Michigan Department of Technology Management and Budget to ensure integration. The implementation plan and modernization implementation were a result of a collaborative effort along with the Software Solution and Final Report. To facilitate the full implementation, a new position was created at MDOT Real Estate Central Office. Students assisted in linking ROW map sheets to parcel information in LAMDA and MDOT Real Estate applied for a grant with Advanced Digital Construction Management Systems (ADCMS) to further implementation. Additionally, MDOT Surveys, is incorporating requirements from the research to create shapefiles for legacy data in all future projects.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

The end date was extended to April 30th, 2023, due to lack of personnel available to assist MSU's RS & GIS Division and to provide time for the LAMDA group and MDOT GIS to integrate processes and data.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

There are two main methods of implementation – the first is for existing ROW maps to be georeferenced into a GIS environment. LAMDA data and associations can be applied to each sheet and parcels on said sheet. The second implementation method, which could be an additional step to the first method, is to create shapes at the Parcel level. This can be done by either tracing over existing parcel lines on a ROW sheet, or integrating shapefiles created from P.A. 132s or future projects that require this step for legacy parcels.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2023**

PROJECT TITLE: Evaluating the Performance and Safety Effectiveness of Roundabouts - An Update

FUNDING SOURCE: SPR, Part II OTHER (PLEASE EXPLAIN)

PROJECT MANAGER: Jason Ealy

CONTRACT/AUTHORIZATION NO.	2021-0403	PROJECT START DATE	3/1/2021
PROJECT NO.	211065	COMPLETION DATE (Original)	1/31/2023
OR NO.	OR21-009	COMPLETION DATE (Revised)	4/30/2023
RESEARCH AGENCY	Michigan State University (MSU)		
PRINCIPAL INVESTIGATOR	Peter T. Savolainen		

BUDGET STATUS

FY 2023 Budget		Total Budget	
Vendor Budget FY 2023	\$113,189.67	Total Vendor Budget	\$249,999.99
MDOT Budget FY 2023	\$2,500.00	Total MDOT Budget	\$0.00
Vendor FY 2023 Expenditures	\$113,189.67	Total Budget	\$249,999.99
MDOT FY 2023 Expenditures	\$0.00	Total Expenditures	\$249,996.49
		Total Amount Available	\$3.50

PURPOSE AND SCOPE

The purpose of this project is to study current roundabout environmental, operational and safety performance efficacies, along with maintenance best practices and costs to determine the future application of roundabouts in Michigan.

FISCAL YEAR 2021 ACCOMPLISHMENTS

Kickoff meeting was held on March 15, 2021. Literature review is nearly complete. Specific study locations have been identified and preliminary data collection has begun. Crash, geometric, and volume information has also been collected.

FISCAL YEAR 2022 ACCOMPLISHMENTS

Literature review has been finalized. Data collection from study locations has been completed. Other data related to environment, operations, safety, maintenance, and construction costs have also been compiled. All data has been analyzed, and results and conclusions drawn.

FISCAL YEAR 2023 ACCOMPLISHMENTS

Draft report was submitted and reviewed by the Research Advisory Panel (RAP). Final report was submitted and reviewed, including an accessibility review. All deliverables have been received and accepted, including a project presentation, background data and SPF worksheet.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Report has been shared with many areas, with summary data being shared with specialty units. SPF worksheet will be shared to other units. SPFs used by the department in the evaluation roundabouts will be updated. The Roundabout Aid will be revised accordingly.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2023**

PROJECT TITLE: Influence of Revising CFCC Guaranteed Strength on Performance of CFCC Prestressed Highway Bridge Beams Subjected to Various Environmental Conditions

FUNDING SOURCE: SPR, Part II OTHER (PLEASE EXPLAIN)

PROJECT MANAGER: Steve Kahl

CONTRACT/AUTHORIZATION NO.	2019-0309 Z3	PROJECT START DATE	10/1/2021
PROJECT NO.	213122NI	COMPLETION DATE (Original)	9/30/2024
OR NO.	OR21-018	COMPLETION DATE (Revised)	
RESEARCH AGENCY	Lawrence Technological University (LTU)		
PRINCIPAL INVESTIGATOR	Nabil Grace		

BUDGET STATUS

FY 2023 Budget		Total Budget	
Vendor Budget FY 2023	\$162,890.00	Total Vendor Budget	\$481,165.90
MDOT Budget FY 2023	\$3,333.33	Total MDOT Budget	\$3,333.33
Vendor FY 2023 Expenditures	\$70,829.12	Total Budget	\$484,499.23
MDOT FY 2023 Expenditures	\$0.00	Total Expenditures	\$136,195.90
		Total Amount Available	\$348,303.33

This project includes \$94,496.40 in University Matching Funds over and above the reported project budget.

University Match				
By Fiscal Year	Annual Budget	Annual Expenditures	Total Expenditures	Total Amount Available
2022	\$31,180.80	\$13,121.52	\$13,121.52	\$81,374.88
2023	\$31,274.88	\$14,218.00	\$27,339.52	\$67,156.88

PURPOSE AND SCOPE

The current manufacturer of carbon fiber composite cable (CFCC) has introduced a 0.7" diameter strand, which is more of a one-to-one replacement for steel strands, and MDOT is pursuing using these strands. Based on extensive tensile test results, the manufacturer of CFCC strands updated the guaranteed breaking load of different strand diameters to reflect the current material strength with the proper safety margin. The increase in the guaranteed strength ensures an efficient and economical use of the material. Implementing the new value in the design and construction of highway bridge beams necessitates the support of comprehensive experimental and analytical investigations to adequately predict the performance of the constructed beams under different loads and environmental conditions. LTU is conducting an extensive experimental program, including breaking load tests, elongation tests, creep rupture tests, fire load tests, environmental chamber tests, and full-scale bridge model tests. These results will then be compared to numerical modeling results using complex finite element analysis software to calibrate the material resistance factors for use in bridge design applications. Mathcad calculation templates, and specifications will be developed to aid designers.

FISCAL YEAR 2021 ACCOMPLISHMENTS

Project start was delayed until FY 2022 due to COVID, and the impacts on LTU's abilities to onboard research assistants. Project kickoff meeting was held on 10/26/2022. Experimental program has already begun with the procurement of 0.7" diameter strand from the manufacturer and loading into hydraulically controlled load frames from creep rupture testing and strain recordings.

FISCAL YEAR 2022 ACCOMPLISHMENTS

The research team worked on Tasks 2, 3, 4, 6, and 7.

Task 2: Creep/relaxation/prestress loss: The test specimens for creep and relaxation have been under continuous monitoring since 2017. The research team continued to evaluate the prestress loss in relaxation specimens and performed the necessary maintenance on the test setup to ensure that the creep specimens are still subjected to a constant load level.

Task 3 Transfer and Development Length: The research team is analyzing the test results of the three decked bulb T beams in the light of the test results obtained from pull-out testing and the ongoing shear testing of the end zone of similar decked bulb T beams. The objective of the research is to evaluate the end zone and establish the minimum amount of confinement reinforcement to avoid concrete cracking/splitting at beams ends.

Task 4: Decked bulb T beam shear testing: The research team completed the shear testing of one end of a decked bulb T beam with steel stirrups at a spacing of 3.0 in. Test results showed that the shear capacity exceeded the flexural capacity and that the modified compression field theory for shear capacity calculations underestimated the capacity of the section. The team is currently evaluating the other end of the beam with CFCC stirrups at a spacing of 3.0 in.

Task 6: Freeze-thaw test: Like the Beams under Task # 3, three half-scale decked bulb T beams were constructed with lengths

of 8,12, and 16 ft. The beams will be placed in the environmental chamber and exposed to 300 cycles of freezing and thawing. After completing the cycles, the beams will be tested under three-point loading to failure. Test results will be compared to those from Task 3 to evaluate the impact of freeze-thaw cycles on development length and bond strength between concrete and CFRP strands. Due to hardware malfunction, the environmental chamber has gone under extensive maintenance and the freeze-thaw test is delayed until the repair of the chamber is completed.

Task 7: Full-scale precast beams: The research team constructed two full-scale AASHTO I beams prestressed with CFCC strands using the new guaranteed strength and the new prestressing force. The first beam was tested to failure, while the second beam is currently under testing.

FISCAL YEAR 2023 ACCOMPLISHMENTS

The research team worked on Tasks 2, 4, 5, 6, 7, and 8.

Task 2: Creep/relaxation/prestress loss: The test specimens for creep and relaxation have been under continuous monitoring since 2017. The research team continued to evaluate the prestress loss in relaxation specimens and performed the necessary maintenance on the test setup to ensure that the creep specimens are still subjected to a constant load level. Two of the five 0.6" CFCC specimens have been experiencing a slight drop in the load due to leakage of the pump system. The team continues to adjust the force monthly and bring it back to the initial prestress level.

Task 4: Decked bulb T beam shear testing: The research team continued to test decked bulb T beam with different stirrup material and spacing under shear loading. Four beams were prepared for testing with stirrup spacings of 3, 4, 6, and 8 in. In addition, half of each beam is provided with steel stirrups, while the other half is provided with CFCC stirrups of the same diameter. Both sides with CFCC and steel stirrups achieved and exceeded the theoretical shear capacity calculated using available codes and guidelines. The research team is currently analyzing the test results to provide guidelines for the design of the beam end zones and recommendations for the transfer and development lengths.

Task 5: Fire Testing: The research team completed the testing of another AASHTO beam specimen. The beam was exposed to one hour of fire followed by loading the beam to failure at ambient conditions and evaluate the prestress loss and strength loss due to fire exposure.

Task 6: Freeze-thaw test: The research team has completed the flexural testing of the three beams after exposure to 300 cycles of freezing/thawing. The team continue to analyze the failure modes and the residual strength in comparison to identical control beams not exposed to freeze-thaw cycles (Beams under Task # 3). In addition, the research team is testing on identical beams with steel prestressing strands to serve as a benchmark in the comparison.

Task 7: Full-scale precast beams: The research team is gathering the results of testing two AASHTO I beams prestressed with CFCC strands and is performing an in-depth comparison between the beams and similar beams that were constructed and tested under an earlier research project. The comparison addresses aspects such as energy absorption capacity, failure modes, and effect of increasing prestressing force per strand on the overall beam design and performance.

Task 8: Design concepts: The research team is gathering the results from different test programs to evaluate the impact of increasing the guaranteed strength and the prestressing force per strand on the overall design of CFCC prestressed beams. The team focuses on the design of the beam end zone including establishing the appropriate transfer and development lengths.

FISCAL YEAR 2024 PROPOSED ACTIVITIES

It is expected that the research team will work on Tasks 2, 3, 4, 6, and 7 and continue to share and discuss test results with MDOT Engineers.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

There was a change in Project Manager due to staff changes at MDOT.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project expected completion FY 2024.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2023**

PROJECT TITLE: Repair of Bridge Deck Fascias

FUNDING SOURCE: SPR, Part II OTHER (PLEASE EXPLAIN)

PROJECT MANAGER: Beatty, Matt

CONTRACT/AUTHORIZATION NO.	2019-0314 Z2	PROJECT START DATE	10/1/2021
PROJECT NO.	213309NI	COMPLETION DATE (Original)	9/30/2023
OR NO.	OR22-002	COMPLETION DATE (Revised)	
RESEARCH AGENCY	Wayne State University (WSU)		
PRINCIPAL INVESTIGATOR	Menkulasi		

BUDGET STATUS

FY 2023 Budget		Total Budget	
Vendor Budget FY 2023	\$128,432.83	Total Vendor Budget	\$234,817.00
MDOT Budget FY 2023	\$10,000.00	Total MDOT Budget	\$6,995.24
Vendor FY 2023 Expenditures	\$128,432.83	Total Budget	\$241,812.24
MDOT FY 2023 Expenditures	\$0.00	Total Expenditures	\$241,812.24
		Total Amount Available	\$0.00

PURPOSE AND SCOPE

The deck fascia on bridges deteriorates more quickly than other portions of the bridge. This causes the fascia concrete to become de-bonded from the reinforcement and over time concrete can spall off the fascia. These spalled pieces of concrete can fall onto traffic lanes or pedestrian walkways posing a safety risk to the public. The current maintenance strategy has limitations. Our current practice is not to patch these areas, overhead patches can spall off posing a safety risk, and there is not a method to anchor false decking in these areas. Delaminated concrete can be removed to prevent debris from falling unexpectedly, but when reinforcement is left exposed it leads to increased degradation of the bridge deck fascia and traffic barrier. Over time continually scaling these areas can cause the traffic barrier to become undermined without any option for repair. These current methods lead to the need for continual scaling in these areas. The research includes the following tasks:

1. Review existing research studies on similar projects. Survey state Departments of Transportation (DOTs) regarding best practices for design, construction, maintenance and long term repair. Document Michigan Department of Transportation (MDOT) current practices.
2. Identify at least 20 bridges that show signs of fascia deterioration.
3. Gather new data related to potential causes of fascia degradation.
4. Develop small scale laboratory simulations of the proposed maintenance and long term repair techniques and evaluate how they respond to long term accelerated weathering.
5. Analyze data and report on findings.
6. Draw conclusions in order to develop solutions to the research objectives.
7. Finalize report detailing research results, conclusions, solutions to objectives, and an implementation plan

FISCAL YEAR 2022 ACCOMPLISHMENTS

- Task 1. Conducted a literature review of existing research studies on similar projects was completed. A survey of other state DOTs regarding best practices for design, construction, maintenance, and long-term repair was conducted. MDOT's current practices were reviewed.
- Task 2. Compiled a list of greater than 20 bridges that show signs of fascia deterioration was identified and examined to draw correlations on the cause of deterioration.
- Task 3. Completed field visits and sampling was conducted. The field data and information gathered from reviewing bridges in item 2 were analyzed to gather new data related to potential causes of fascia degradation.
- Task 4. Small scale laboratory simulations were developed and tested to examine the materials and methods of the proposed repair. These tests included accelerated weathering. The concept for large scale testing was developed and discussed.

FISCAL YEAR 2023 ACCOMPLISHMENTS

- Task 4. Completed analysis of small-scale testing and conducted large-scale testing of repair and materials.
- Task 5. Analyzed data and provided report on findings, including the repair technique(s) and options for improved MDOT practices for future construction.
- Task 6. Conclusions were drawn to develop solutions in line with research objectives.
- Task 7. Final report detailing research results, conclusions, solutions, and an implementation plan was completed.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Identify a bridge experiencing fascia deterioration. Visit the site and document damage. Input damage data into the computer program created by the research project. If the program indicates repair is required, follow the details described in the report to create a Project Package for repair. Contract through MDOT's letting process and utilize the contract to perform the repair. Monitor repair performance over time.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2023**

PROJECT TITLE: Establish Policies and Procedures for Use of Subgrade Stabilization in Michigan

FUNDING SOURCE: SPR, Part II OTHER (PLEASE EXPLAIN)

PROJECT MANAGER: Eacker, Michael

CONTRACT/AUTHORIZATION NO.	2019-0309 Z4	PROJECT START DATE	10/1/2021
PROJECT NO.	213313NI	COMPLETION DATE (Original)	3/31/2023
OR NO.	OR22-003	COMPLETION DATE (Revised)	9/30/2023
RESEARCH AGENCY	Lawrence Technological University (LTU)		
PRINCIPAL INVESTIGATOR	Bandara		

BUDGET STATUS

FY 2023 Budget		Total Budget	
Vendor Budget FY 2023	\$119,204.28	Total Vendor Budget	\$164,918.18
MDOT Budget FY 2023	\$12,666.67	Total MDOT Budget	\$0.00
Vendor FY 2023 Expenditures	\$115,852.34	Total Budget	\$164,918.18
MDOT FY 2023 Expenditures	\$0.00	Total Expenditures	\$161,566.24
		Total Amount Available	\$3,351.94

PURPOSE AND SCOPE

The Michigan Department of Transportation (MDOT) has, on occasion, stabilized the subgrade as part of a pavement reconstruction project. These have generally been in situations where it was more cost-effective than undercutting the subgrade, or when building a longer life pavement. MDOT would like to explore the use of subgrade stabilization more often. Projects where subgrade stabilization has been used appear to be performing very well. However, MDOT does not have any criteria for when/where subgrade stabilization would be a cost-effective choice to improve the performance of the constructed pavement. Where it has been used, special provisions outline the mix design process and testing protocol, but is this the optimum methodology? Multiple versions of these specifications with different allowable stabilization agents, acceptance methods and testing requirements have been used. These need to be unified.

Traditionally, fine-grained soils have been viewed as candidates for stabilization due to their lower support characteristics and high loss of modulus in moist conditions. There has been some interest in exploring stabilization of coarse-grained soils to see if pavement performance can be increased. However, does the potential loss of drainage through the subgrade outweigh the potential increase in support?

The work completed and documented in research report RC-1635, "Performance Evaluation of Subgrade Stabilization with Recycled Materials" started some of this analysis. This project will use the information from this previous project to create policies for when stabilization of the subgrade can be used, what the construction procedures should be, and finalize inputs used in the pavement design process. The research includes the following tasks:

- Literature search with a particular emphasis on research already completed in Michigan (RC-1635, etc.).
- Review Michigan DOT stabilized subgrade specifications and how stabilized subgrade is accounted for in pavement design.
- Interview MDOT personnel to gather lessons learned from previous stabilized subgrade projects.
- Develop specifications.
- Develop guidance for project selection including drainage.
- Finalize pavement design inputs.
- Final report.

FISCAL YEAR 2022 ACCOMPLISHMENTS

This research project was authorized to begin in FY 2022. The list of accomplishments for FY 22 are as follows:

- Literature search with results divided into literature specific to Michigan and literature outside of Michigan.
- Discovery of past MDOT projects that utilized subgrade stabilization and the specification used.
- Review of other state's subgrade stabilization specifications.
- Sent a survey to MDOT construction personnel, other states, and MDOT contractors to gather best practices, problems encountered, etc.
- Compiled the survey results.
- Initiated development of guidance documents for subgrade stabilization. The guidance is focused on three main areas:
 - Project selection.
 - Mix design.
 - Construction.
- Initiated development of draft specifications.

In addition to these accomplishments, several meetings were held between the research team and the MDOT Research Advisory Panel (RAP). These meetings included the kickoff, regular quarterly update, and guidance document feedback meetings.

FISCAL YEAR 2023 ACCOMPLISHMENTS

Guidance documents for project selection, mix design, and construction were drafted and provided to MDOT. Various stakeholders within MDOT provided suggestions and edits on each one. Final proposed versions from the researchers were submitted in the final report. The same process occurred for a new unified special provision to cover the work of subgrade stabilization.

Stabilized subgrade data was collected on two MDOT projects that had subgrade stabilization occurring during Spring and early Summer. This consisted of dynamic cone penetrometer and lightweight deflectometer testing before and after stabilization to assess subgrade property improvement and strength gain over time.

Various methods for incorporating improve subgrade properties into the mechanistic-empirical design method were investigated. One method was recommended by the research team.

The draft report was delivered and is under review for acceptance expected during the first quarter of 2024.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

One contract revision was completed during FY 2022 to correct the vendor's Indirect Cost Rate. In December 2022, the project end date was extended to allow additional time for refining guidance documents, specifications, and pavement design inputs. There was also a budget shift in university labor costs to move unused supply, travel and student assistant costs to cover additional work completed by primary researchers.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Anticipate completion of RAP/PM review and acceptance of final report during first quarter of FY 2024. Recommended pavement design inputs can be immediately adopted into usage. Guidance documents and the special provision will be provided to region personnel for use in selecting and administering future projects that contain subgrade stabilization.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2023**

PROJECT TITLE: Effective Pedestrian/Non-Motorized Crossing Enhancements Along Higher Speed Corridors

FUNDING SOURCE: SPR, Part II OTHER (PLEASE EXPLAIN)

PROJECT MANAGER: Bott, Mark

CONTRACT/AUTHORIZATION NO.	2019-0313 Z6	PROJECT START DATE	10/1/2021
PROJECT NO.	213314NI	COMPLETION DATE (Original)	9/30/2023
OR NO.	OR22-004	COMPLETION DATE (Revised)	
RESEARCH AGENCY	Western Michigan University (WMU)		
PRINCIPAL INVESTIGATOR	Ron Van Houten		

BUDGET STATUS

FY 2023 Budget		Total Budget	
Vendor Budget FY 2023	\$124,663.83	Total Vendor Budget	\$209,770.69
MDOT Budget FY 2023	\$3,650.00	Total MDOT Budget	\$0.00
Vendor FY 2023 Expenditures	\$110,332.70	Total Budget	\$209,770.69
MDOT FY 2023 Expenditures	\$0.00	Total Expenditures	\$195,439.56
		Total Amount Available	\$14,331.13

PURPOSE AND SCOPE

MDOT desires solutions for enhanced pedestrian/non-motorized crossings along highway corridors with speeds 45 mph or greater at both signalized and unsignalized intersections. Specific treatments are desired (rapid flashing beacon, High-Intensity Activated Crosswalk (HAWK) signal beacon, etc.) but do not meet minimum warrants per various guidance documents. In response, MDOT must rely on its judgment as to what we believe will work for additional enhancement features. MDOT would like research on effective treatments where pedestrian/non-motorized crossing warrants are not met for the bigger enhancements on corridors with speeds 45 mph or greater. The research includes the following items:

- National synthesis of crossing treatments
- Data analysis of pedestrian crashes/risks to determine types of crossings needed/types of locations needed
- Discussion of treatments and how they correspond to the Manual on Uniform Traffic Control Devices (MMUTCD) and MDOT Crosswalk Guidance
- Graphic typical development of treatment options (displaying markings, signs, enhancements, etc.)
- Summary and breakdown of findings and best use situations
- Summary of relative cost of overall treatments and effectiveness
- Discussion points/presentation material for public involvement/public education

FISCAL YEAR 2022 ACCOMPLISHMENTS

To date approximately 53% of the overall research work is completed.

Task 1 – National and International Synthesis – Completed.

Task 2 – Review of Related Guidelines – Write up completed.

Task 3 – Crash Analysis – Initial analysis of crashes completed.

Task 5 – Development of Best Practices – Task started, collected speed data, and examined speeds before and after installation of the gateway, consisting of side mounts.

FISCAL YEAR 2023 ACCOMPLISHMENTS

Task 3 – Crash Analysis - Completed.

Task 4 – Determination of Cost Effectiveness - Completed.

Task 5 – Best Practices Findings - Completed.

Task 6 – Development of Outreach and Educational Materials – Completed

Task 7 – Final Report Preparation and Implementation Plan - Completed.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

The project has provided MDOT with clearer direction in addressing pedestrian/nonmotorized type crashes along high-speed corridors with the identification of locations of concern, their common characteristics, and a tool for practitioners to use to address locations with the appropriate improvements. The educational materials will be used to enhance and update existing MDOT materials used in our communication with the public.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2023**

PROJECT TITLE: Michigan Hydrologic Calculation Procedures

FUNDING SOURCE: SPR, Part II OTHER (PLEASE EXPLAIN)

PROJECT MANAGER: Erik Carlson

CONTRACT/AUTHORIZATION NO.	2019-0311 Z3	PROJECT START DATE	11/1/2021
PROJECT NO.	213316NI	COMPLETION DATE (Original)	12/31/2024
OR NO.	OR21-019	COMPLETION DATE (Revised)	
RESEARCH AGENCY	Michigan Technological University (MTU)		
PRINCIPAL INVESTIGATOR	David W. Watkins		

BUDGET STATUS

FY 2023 Budget		Total Budget	
Vendor Budget FY 2023	\$230,302.18	Total Vendor Budget	\$556,935.71
MDOT Budget FY 2023	\$23,000.00	Total MDOT Budget	\$28,000.00
Vendor FY 2023 Expenditures	\$183,846.08	Total Budget	\$584,935.71
MDOT FY 2023 Expenditures	\$0.00	Total Expenditures	\$317,504.32
		Total Amount Available	\$267,431.39

PURPOSE AND SCOPE

The Federal Highway Administration (FHWA), the Michigan Department of Environment, Great Lakes, and Energy (EGLE) and the Michigan Department of Transportation (MDOT) reviewed the approved procedures for calculating discharges from simulated Michigan rainfall events. The current hydrologic methods rely on older data sets where newer data is available. The purpose of this project is to update these methods to incorporate modern data sets and improve calculated discharge results.

1. Interview MDOT and EGLE staff to understand the current hydrologic methods and their application.
2. Update and validate the method outlined in "Computing Flood Discharges for Small Ungauged Watersheds" (Sorrell, 2010)
3. Identify GIS data for developing SCS Curve Numbers
4. Update the regression equation from the 1984 Michigan linear regression for large watersheds greater than 10 square miles aka "Statistical Models for Estimating Flow Characteristics of Michigan Streams."
5. Investigate alternative hydrologic techniques to calculate recurrence interval peak discharges at ungauged sites.
6. Report on findings

FISCAL YEAR 2021 ACCOMPLISHMENTS

The start of this project was delayed until FY 2022.

FISCAL YEAR 2022 ACCOMPLISHMENTS

The following activities were completed in FY 2022:

- 1) Task 1: Interview MDOT and EGLE staff to understand the current hydrologic methods and their application is complete.
- 2) Task2: Update and validated the method outlined in "Computing Flood Discharges for Small Ungauged Watersheds" (Sorrell, 2010) using current National Oceanic and Atmospheric Administration (NOAA) "Atlas 14" rainfall and recommended distributions had the following progress:
 - a. Developed an understanding of the existing methodology that uses "Rainfall Atlas of the Midwest (Bulletin 71)" rainfall and Type II Soil Conservation Service (SCS) rainfall distribution including records that EGLE has from when the method was developed.
- 3) Task 3: GIS data for developing SCS Curve Numbers had the following progress:
 - a. Collected information on the following:
 - i. Existing 1978 land use dataset
 - ii. United States Geological Service (USGS) Multi-Resolution Land Characteristics Consortium's Land Cover raster set.
 - iii. EGLE's process for preprocessing curve numbers by county, based on merged soils and land use datasets.
 - b. Identified where the 1978 land use data could be substituted with the more recent land cover datasets to improve hydrologic calculations.
 - c. Considered other GIS data sets that could be used for SCS curve number development.
 - d. Became familiar with current RCN procedures and evaluate data sets to provide automated workflows for developing SCS Curve Numbers in GIS.

-
- 4) Task 4: Update the regression equation from the 1984 Michigan linear regression for large watersheds greater than 10 square miles aka “Statistical Models for Estimating Flow Characteristics of Michigan Streams” had the following progress:
 - a. Developed an understanding of the existing linear regression calculations that used data from 180 gages and identified parameters for calculating discharge. The current method uses Quaternary Geology parameters. There should be a focus on reconsidering the use of this dataset, and consideration of other parameters to replace these parameters. Other key parameters include drainage area, slope of watershed, percent of length that is swamp, slenderness ratio, and rainfall.
 - b. Identified parameters and collect data now available in GIS that should be considered in a regression update.

FISCAL YEAR 2023 ACCOMPLISHMENTS

The following activities were completed in FY 2024:

- 1) Task 1 is complete, and no additional work is anticipated on this task.
- 2) Task 2: Update and validate the method outlined in “Computing Flood Discharges for Small Ungauged Watersheds” (Sorrell, 2010) using current National Oceanic and Atmospheric Administration (NOAA) “Atlas 14” rainfall and recommended distributions will have the following activity:
 - a. Collected and evaluated data from existing and discontinued USGS gages with small drainage areas and a sufficient period of record. Compiled rainfall data from gaged watersheds.
 - b. Developed updated methods following guidelines outlined in The United States Department of Agriculture’s National Engineering Handbook Part 630 (Hydrology) using current NOAA Atlas 14 rainfall and recommended distributions.
 - i. Evaluated unit hydrograph peak rate factors for various sites across the State.
 - ii. Evaluated rainfall distribution options with input from USDA.
 - iii. Performed preliminary investigation of potential precipitation climate zones.
- 3) Task 3: GIS data for developing SCS Curve Numbers:
 - a. Developed GIS tool for automatic watershed delineation. The tool requires accurate hydrography to hydro enforced Light Detection and Ranging (LiDAR) derived Digital Elevation Models (DEMs).
 - b. Developed GIS tool for derivation of curve numbers for the SCS method. The tool was developed for ArcPro 2.9.5 and 3.1.
 - c. Provided in-person training to EGLE and MDOT staff on both tools.
- 4) Task 4: Updated the regression equation from the 1984 Michigan linear regression for large watersheds greater than 10 square miles aka “Statistical Models for Estimating Flow Characteristics of Michigan Streams” will have the following activity:
 - a. Collected discharge data from the original set of gages and any newer gages with 15 years of record and at least one significant event or 20 years of record regardless of the existence of a significant event.
 - b. Started to update additional data sets necessary such as rainfall.
 - c. Conducted a parametric data analysis using gage data on new identified parameters to find the parameters of statistical significance.
- 5) Task 5: Investigated alternative hydrologic techniques to calculate recurrence interval peak discharges at un-gaged sites will explore the following techniques:
 - a. Rain on grid
 - i. Performed literature search.
 - ii. Investigated potential watersheds.
 - b. Non-stationarity
 - i. Performed literature search.
 - ii. Will evaluate FHWA’s CMIP tool in FY2024.

FISCAL YEAR 2024 PROPOSED ACTIVITIES

The following activities are proposed for FY 2024:

- 1) Task 1 is complete, and no additional work is anticipated.
 - 2) Task 2: Update and validate the method outlined in “Computing Flood Discharges for Small Ungauged Watersheds” (Sorrell, 2010) using current National Oceanic and Atmospheric Administration (NOAA) “Atlas 14” rainfall and recommended distributions will have the following activity:
 - a. Develop updated methods following guidelines outlined in The United States Department of Agriculture’s National Engineering Handbook Part 630 (Hydrology) using current NOAA Atlas 14 rainfall and recommended distributions.
 - b. Evaluate and update (if necessary) the time of concentration method.
 - c. Calibrate updated method using the new rainfall data, recommended rainfall distribution, and discharges from gaged watersheds.
 - d. Review data from additional gaged watersheds to validate the calibration.
 - e. Develop an automated process.
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- f. Conduct a comparison analysis between the developed method and the Army Corps of Engineers' HEC-HMS and EPA's SWMM. Identify differences and report on findings.
 - g. Develop guidance documents for EGLE and MDOT.
 - h. Provide training to EGLE and MDOT staff.
- 3) Task 3: GIS data for developing SCS Curve Numbers will have the following activity:
- a. Continue to evaluate and calibrate developed tools.
 - b. Finalize guidance documents for EGLE and MDOT.
- 4) Task 4: Update the regression equation from the 1984 Michigan linear regression for large watersheds greater than 10 square miles aka "Statistical Models for Estimating Flow Characteristics of Michigan Streams" will have the following activity:
- a. Updated additional data sets necessary such as rainfall.
 - b. Develop an automated process.
 - c. Develop guidance documents for EGLE and MDOT.
 - d. Provide training to EGLE and MDOT staff.
- 5) Task 5: Investigate alternative hydrologic techniques to calculate recurrence interval peak discharges at ungagged sites will explore the following techniques:
- a. Perform rain on grid analysis.
 - b. Evaluate non-stationarity concepts using FHWA's CMIP tool.
 - c. Report on findings.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project expected completion FY 2025.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2023**

PROJECT TITLE: Michigan Cone Penetrometer Test Calibration

FUNDING SOURCE: SPR, Part II OTHER (PLEASE EXPLAIN)

PROJECT MANAGER: Ryan Snook

CONTRACT/AUTHORIZATION NO.	2019-0312 Z8	PROJECT START DATE	1/1/2022
PROJECT NO.	213318NI	COMPLETION DATE (Original)	11/30/2024
OR NO.	OR21-020	COMPLETION DATE (Revised)	
RESEARCH AGENCY	University of Michigan (UM)		
PRINCIPAL INVESTIGATOR	Roman Hryciw & Estefan Garcia		

BUDGET STATUS

FY 2023 Budget		Total Budget	
Vendor Budget FY 2023	\$305,021.06	Total Vendor Budget	\$503,426.52
MDOT Budget FY 2023	\$4,800.00	Total MDOT Budget	\$5,142.05
Vendor FY 2023 Expenditures	\$81,098.7	Total Budget	\$508,568.57
MDOT FY 2023 Expenditures	\$342.05	Total Expenditures	\$139,259.75
		Total Amount Available	\$369,308.82

PURPOSE AND SCOPE

MDOT purchased Cone Penetration Test (CPT) equipment in 2019 to better define the geotechnical conditions at project sites. Statistical comparison is needed to calibrate the Michigan CPT test and identify procedures that should be followed to produce and interpret Michigan soil data reliably. In addition, MDOT could benefit from a standardized procedure that stores data in the Data Interchange for Geotechnical and Geo-Environmental Specialists (DIGGS) data storage format and provides automated output that assists with risk-based design. Further identifying site variability may help with appropriate site characterization and design savings. The scope of work includes the following items:

- Conduct literature search and survey of state DOT state of the practice.
- Collect existing datasets from MDOT, published literature, and other sources.
- Evaluate correlation of MDOT CPT data to published soil type behavior charts and other published CPT charts.
- Make recommendations on how to apply published correlations to Michigan soils, and/or what corrections might be needed.
- Develop MDOT CPT procedures for bridge foundation design using direct design as well as CPT correlations.
- Develop a DIGGS based data storage system.
- Identify frameworks to characterize sites and group site variability.
- Identify how to apply CPT to reduce uncertainty in foundation design decisions.
- Identify an acceptable software package(s) that assists with data visualization.
- Identify software package(s) that provide an automated output with statistical risk-based foundation design.
- Provide training, manuals, and implementation guidance.

FISCAL YEAR 2021 ACCOMPLISHMENTS

This project was delayed starting FY 2022.

FISCAL YEAR 2022 ACCOMPLISHMENTS

- Conducted literature search and survey of state DOT state of the practice.
- Collected existing datasets from MDOT, published literature, and other sources.
- Began to statistically compare MDOT's soil boring data and lab test data to MDOT's CPT data. Analysis methodology should allow for continuous import of new CPT data to refine/update correlations.
- Began to evaluate correlation of MDOT CPT data to published soil type behavior charts and other published CPT charts.
- Made preliminary recommendations on how to apply published correlations to Michigan soils, and/or what corrections might be needed.

FISCAL YEAR 2023 ACCOMPLISHMENTS

- Finished statistically comparing MDOT's soil boring data and lab test data to MDOT's CPT data. Analysis methodology should allow for continuous import of new CPT data to refine/update correlations.
- Finished evaluating correlation of MDOT CPT data to published soil type behavior charts and other published CPT charts.
- Made final recommendations on how to apply published correlations to Michigan soils, and/or what corrections might be needed.
- Developed a MDOT CPT procedures for bridge foundation design using direct design methods.
- Developed a DIGGS base data storage system using Data forensics services/software.
- Began to identify frameworks to characterize sites and group site variability.

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- Began to identify how to apply CPT to reduce uncertainty in foundation design decisions.
 - Began to identify an acceptable software package(s) that assist with data visualization.

FISCAL YEAR 2024 PROPOSED ACTIVITIES

It is expected that UM will do the following:

- Continue work to identify frameworks to characterize sites and group site variability.
- Continue work to identify how to apply CPT to reduce uncertainty in foundation design decisions.
- Continue work to identify an acceptable software package that will assist with data visualization.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

There was a change in Project Manager due to staff changes at MDOT.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project expected completion FY 2025.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2023**

PROJECT TITLE: Operational Baseline for the 2nd Avenue Network Arch Bridge

FUNDING SOURCE: SPR, Part II OTHER (PLEASE EXPLAIN)

PROJECT MANAGER: Purush Pakala

CONTRACT/AUTHORIZATION NO.	2019-0313 Z8	PROJECT START DATE	1/1/2022
PROJECT NO.	213321NI	COMPLETION DATE (Original)	5/31/2024
OR NO.	OR22-008	COMPLETION DATE (Revised)	
RESEARCH AGENCY	Western Michigan University (WMU)		
PRINCIPAL INVESTIGATOR	Attanayake		

BUDGET STATUS

FY 2023 Budget		Total Budget	
Vendor Budget FY 2023	\$169,107.92	Total Vendor Budget	\$258,887.71
MDOT Budget FY 2023	\$3,360.00	Total MDOT Budget	\$7,749.72
Vendor FY 2023 Expenditures	\$114,970.57	Total Budget	\$266,637.43
MDOT FY 2023 Expenditures	\$2,350.69	Total Expenditures	\$168,897.97
		Total Amount Available	\$97,739.46

PURPOSE AND SCOPE

A skewed, unbraced network arch bridge is being constructed to carry the 2nd Avenue over I-94. This 245 ft long, 96 ft wide structure will carry vehicular traffic, bicycles, and pedestrians in separate dedicated lanes. The unique structural configuration and the use of innovative accelerated bridge construction (ABC) techniques make this one of the most significant projects in the United States. The bridge skeleton, consisting of trapezoidal steel arch ribs, tie girders, end diaphragms, and steel floor beams will be assembled in a staging area near the bridge site. This bridge skeleton will be moved into place using self-propelled modular transporters (SPMTs) during a weekend closure of I-94. Following SPMT move and placement of the skeleton on permanent bearings, the rest of the construction activities will be completed. The stresses in several major structural elements are monitored using a structural health monitoring (SHM) system to capture the stresses during construction and in service. The research includes the following tasks:

1. Develop an understanding of the structure by studying as-built drawings and taking necessary measurements
2. Evaluate the performance of instrumentation.
3. Evaluate the data collected during construction.
4. Collect data from instruments on a regular basis for two years providing MDOT quarterly updates.
5. Store and evaluate seasonal trends in data.
6. Conduct load testing to establish an operational baseline for the structure.
7. Develop finite element models for intrinsic and live loads to predict the envelope of performance and calibrate models to this structure. A) Compare assumptions in research model to Engineer of Record model. B) Perform parametric studies to evaluate the effect of different parameters (ex: temperature, loading cycles or fatigue, creep, overload traffic etc.) on the structural response of the bridge C) Perform analysis to evaluate the residual capacity of the tied-arch system subjected to failure of critical member(s) of the tied arch network. The number of failed members could be more than one based on the critical locations identified.
8. Identify instrumentation output envelopes within which the structure can be maintained.
9. Develop a long-term sampling plan and transfer responsibility and training to MDOT for long term instrument monitoring of the structure

FISCAL YEAR 2022 ACCOMPLISHMENTS

- Instrumentation of the bridge is completed along with the installation of data acquisition system. Data has been collected continuously, reviewed frequently and compared with the data from laboratory and field specimens.
- Tie girder concrete specimens were collected and used for evaluating the properties such as shrinkage, creep, strength, and modulus of elasticity. Data from the tests was used to develop material property models.
- Analysis model developed by Janssen & Spaans was reviewed and a summary report was developed.
- User-defined material models in refined analysis models was reviewed. Simple models were used to evaluate the application of user-defined models to simulate shrinkage, creep, and combined effects before implementing such models in bridge components.
- Field visit and two progress meetings were conducted.

FISCAL YEAR 2023 ACCOMPLISHMENTS

- Evaluation of the performance of instrumentation occurred. Though this task is complete, WMU is still evaluating the performance since the system is being operated on solar power and intermittent interruptions are observed.
- Collected data from instruments. This is an ongoing process to collect data from instruments for two years.

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- Storage and evaluation of seasonal trends in instrumentation data. Data from the instruments is evaluated on a regular basis to make sure that the concrete compression and tension limits measured from the instrumentation are within the design limits. Results of the findings have been regularly communicated during project progress meetings.
 - The PI and his team continued developing a refined 3D finite element model of concrete frame including tie girders and end diaphragms to simulate the construction process and evaluate the assumptions used in the engineer of record (EOR) models.
 - A detailed model in LARSA was developed by the PI's team to compare results from this model to that obtained from EOR model.

FISCAL YEAR 2024 PROPOSED ACTIVITIES

- Evaluate the performance of instrumentation.
- Collect data from instruments as well as evaluate seasonal trends in the data.
- Conduct load testing to establish an operational baseline for the structure.
- Continue developing and refining finite element model of the bridge for intrinsic and live loads to predict the performance envelope and calibrate model from field/lab test data.
- Develop a long-term data acquisition plan and transfer responsibility and training to MDOT for long-term monitoring of the structure.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project expected completion FY 2024.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2023**

PROJECT TITLE: Analysis and Deployment of an Unmanned Traffic Management System in Michigan – Phase 1 Feasibility Analysis

FUNDING SOURCE: SPR, Part II OTHER (PLEASE EXPLAIN)

PROJECT MANAGER: Smith, Linn

CONTRACT/AUTHORIZATION NO.	220000000211	PROJECT START DATE	2/1/2022
PROJECT NO.	216349	COMPLETION DATE (Original)	1/31/2023
OR NO.	OR22-011	COMPLETION DATE (Revised)	
RESEARCH AGENCY	Airspace Link		
PRINCIPAL INVESTIGATOR	Free		

BUDGET STATUS

FY 2023 Budget		Total Budget	
Vendor Budget FY 2023	\$107,424.97	Total Vendor Budget	\$257,424.97
MDOT Budget FY 2023	\$0.00	Total MDOT Budget	\$0.00
Vendor FY 2023 Expenditures	\$0.00	Total Budget	\$257,424.97
MDOT FY 2023 Expenditures	\$0.00	Total Expenditures	\$150,000.00
		Total Amount Available	\$107,424.97

PURPOSE AND SCOPE

The Michigan Department of Transportation (MDOT) Office of Aeronautics (AERO), with support from the Michigan Economic Development Corporation (MEDC), and the Michigan Office of Future Mobility and Electrification (OFME) is committed to the advancement, integration, and deployment of technologies needed to prepare for the future of mobility in Michigan. AERO is collaborating with the OFME to identify opportunities to establish foundational aerial mobility infrastructure to support a range of commercial, civic, and future urban air mobility use cases and working towards the commitment to creating a multimodal operating system for the Mobility Innovation district at Michigan Central Station and Ford Motor Company. The proposed scope of work for this project includes a complex and comprehensible feasibility assessment AND A recommendation of three (3) areas for advanced aerial mobility deployments in the state. In conjunction with existing autonomous ground-based vehicle deployment near the proposed connected corridor between Detroit and Ann Arbor MDOT Aeronautics seeks analysis and recommendations for deployment of infrastructure needed to ensure safe operation and regulatory approval of limited unmanned aircraft-based deliveries as part of a pilot study. This initial analysis and recommended deployment would provide the basis for establishing a statewide unmanned aircraft traffic management system. Research tasks include the following:

1. Preliminary assessment of three locations to determine feasibility of deployment of an unmanned aircraft systems corridor including:
 - a) Assessment of economic, environmental, and community impacts.
 - b) Assessment of existing air and ground infrastructure available to support deployment of the corridor.
 - c) Assessment of air traffic and ground risk based on three use case scenarios.
 - d) Assessment of communications network, command and control options, and real time tracking capability.
 - e) Assessment of existing transportation network and demand for each mode of travel.
 - f) Assessment of impacts a deployed UAS corridor would have on existing travel demand for each mode.
 - g) Assessment of both United States and Canadian regulatory approval process to deploy the corridors.
2. Technology Assessment and Capital Infrastructure Development Strategy including:
 - a) Strategy for establishment of an appropriate command and control structure.
 - b) Strategy for, if applicable, enhancement for collocated communications infrastructure.
 - c) Strategy for the deployment of supplemental airspace surveillance technology.
 - d) Analysis of fully deployed capital infrastructure safety, security, and resiliency.
3. Safety case development to secure federal approval of corridor deployment.
4. Analysis of Michigan's UAS corridor deployment and its ability to coordinated efforts and potential buildout strategies with MDOT's connected and autonomous ground-based vehicle projects

FISCAL YEAR 2022 ACCOMPLISHMENTS

- Milestone 1 – Contract Award – Completed 2/1/22
- Milestone 2 – Acceptance of Project Management Plan – Completed 3/2/22
- Milestone 3 – Completion of Preliminary Assessment of Three Locations – Completed 3/11/22
- Milestone 4 – 1/3 Completion of Actionable Technology Assessment, Capital Infrastructure Deployment Strategy & Safety Case Plan – Completed 9/30/22

FISCAL YEAR 2023 ACCOMPLISHMENTS

- Milestone 5 – Final 2/3 Completion of Actionable Technology Assessment, Capital Infrastructure Deployment Strategy & Safety Case Plan – Completed 10/31/22
- Milestone 6 – Acceptance of Actionable Technology Assessment, Capital Infrastructure Deployment Strategy & Safety Case Plan. Completed 12/28/22

Costs for project work were not charged to SPR, Part 2 funding during FY 2023.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

The results of the feasibility study identified 1) where the state stands in its current capabilities, 2) emerging best practices and how they may be utilized, 3) assessed safety, regulatory, and operation challenges, and 4) revealed that the adoption and advancement of drones for broad use cases can be directly integrated with other modes of transportation, reducing costs, and increasing benefits for all mobility solutions. The results not only address these feasibility needs, but also provides the State of Michigan a blueprint that shows how it plays a key role as the US mobility innovation leader by spearheading the implementation of new shared transportation infrastructure. The results also revealed that the adoption and advancement of drones for broad use cases can be directly integrated with other modes of transportation, reducing costs, and increasing benefits for all mobility solutions. By applying the blueprint across the drone integration framework, Michigan can build an infrastructure that provides a platform where operators, public organizations, communities, and customers are able to work together in building a sustainable drone ecosystem that reaches its full potential in generating the broad benefits of drones socially, environmentally, and economically. MDOT is now well positioned to take action following the completion of this feasibility study to lead the drone ecosystem towards the vision of broad and scaled adoption.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2023**

PROJECT TITLE: Leveraging Crowd-sourced Data in Planning, Design, Analysis, and Evaluation of Pedestrian and Bicycle Traffic

FUNDING SOURCE: SPR, Part II OTHER (PLEASE EXPLAIN)

PROJECT MANAGER: DeBruyn, Josh

CONTRACT/AUTHORIZATION NO.	2019-0312 Z6	PROJECT START DATE	6/21/2023
PROJECT NO.	217331NI	COMPLETION DATE (Original)	5/31/2024
OR NO.	OR22-006	COMPLETION DATE (Revised)	
RESEARCH AGENCY	University of Colorado (UC Denver) – Formerly University of Michigan (UM)		
PRINCIPAL INVESTIGATOR	Misra		

BUDGET STATUS

FY 2023 Budget		Total Budget	
Vendor Budget FY 2023	\$46,604.27	Total Vendor Budget	\$170,882.34
MDOT Budget FY 2023	\$0.00	Total MDOT Budget	\$0.00
Vendor FY 2023 Expenditures	\$4,983.98	Total Budget	\$170,882.34
MDOT FY 2023 Expenditures	\$0.00	Total Expenditures	\$4,983.98
		Total Amount Available	\$165,898.36

PURPOSE AND SCOPE

Collecting data on the number of people walking or bicycling along or across Michigan's vast transportation network is difficult to achieve, it can be time consuming and expensive. However, knowing the numbers of people walking or bicycling would be immensely useful in project planning, design, analysis, and evaluation of the transportation network for safety and accessibility among other measures. This research will help improve the assessment of the pedestrian and bicycle traffic exposure and help make informed decisions when planning, designing, and evaluating projects. The research includes the following tasks:

1. Literature review
2. Evaluation of the different types of crowd-sourced data pertinent to capturing data on activity related to people walking and bicycling.
3. Acquire crowd sourced data
4. For select urban areas acquire, analyze and map samples of crowd-sourced data from different platforms and assess the data captured
5. produce reports and analysis including validation/adjustment factors for rectifying discrepancies in data collection methods
6. Investigate commonly used models, count data storage programs and other similar types of programs for their ability to incorporate crowd-sourced data.
7. Produce guidelines on how the Michigan Department of Transportation (MDOT), Metropolitan Planning Organizations (MPOs), and local agencies can utilize and import crowd-sourced data in their planning and design processes.

FISCAL YEAR 2023 ACCOMPLISHMENTS

- New contract with UC-Denver was established to complete remaining tasks/deliverables (see note below).
- Collection, evaluation, and analysis of the selected crowdsourced data and field collected data was initiated.
- Drafting of findings and the final report were completed.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

This project was formally with the University of Michigan (UM) (213124NI). However, the Principal Investigator accepted a position with the University of Colorado – Denver (UC Denver). UM expressed they would not be able to adequately fulfill remaining project tasks/deliverables and canceled the project effective 7/15/2022. MDOT obtained sole source approval from the Federal Highway Administration (FHWA) to move remaining contract balance and establish a new contract with UC-Denver to complete remaining tasks/deliverables.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project expected completion FY 2024.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2023**

PROJECT TITLE: Capacity Prediction of Repaired and Unrepaired Bridge Beams with Deteriorated Ends

FUNDING SOURCE: SPR, Part II OTHER (PLEASE EXPLAIN)

PROJECT MANAGER: Don Tempinson

CONTRACT/AUTHORIZATION NO.	2022-0434 Z1	PROJECT START DATE	10/1/2022
PROJECT NO.	217419NI	COMPLETION DATE (Original)	9/30/2024
OR NO.	OR21-001	COMPLETION DATE (Revised)	
RESEARCH AGENCY	Western Michigan University (WMU)		
PRINCIPAL INVESTIGATOR	Upul Attanayake, Ph.D., P.E.		

BUDGET STATUS

FY 2023 Budget		Total Budget	
Vendor Budget FY 2023	\$191,114.72	Total Vendor Budget	\$355,930.69
MDOT Budget FY 2023	\$25,400.00	Total MDOT Budget	\$24,500.00
Vendor FY 2023 Expenditures	\$79,228.21	Total Budget	\$380,430.69
MDOT FY 2023 Expenditures	\$0.00	Total Expenditures	\$79,228.21
		Total Amount Available	\$301,202.48

PURPOSE AND SCOPE

From the problem statement – Revise as needed.

Deterioration of the ends of bridge beams can compromise the structural integrity of the beam itself and that of the superstructure system. It is important to know when actions, such as an updated load rating analysis, additional monitoring, installation of temporary supports, beam retrofit, or bridge closure, are needed. Load rating engineers must be able to determine the capacity of the beam in the deteriorated and repaired states to ensure the bridge can safely carry Michigan legal and permitted loads. Programming and resource challenges highlight the importance of employing the strategy that best addresses capacity concerns, makes efficient use of limited resources and is in alignment with the remaining life span of the bridge. This will ensure that public safety is maintained, while also avoiding potentially unnecessary restrictions on the motoring public. This research will focus primarily on concrete beams and specific areas of concern for steel beams.

FISCAL YEAR 2023 ACCOMPLISHMENTS

- Literature review was completed.
- Review of MDOT processes and guidance was completed.
- Data from MDOT was shared with WMU.
- Several on-site data collection efforts were completed, through scans and images.
- Both concrete and steel beam end deterioration repair types have been identified.
- A preliminary calculation sheet was developed for prestressed beam ends.

FISCAL YEAR 2024 PROPOSED ACTIVITES

- Additional data is expected to be collected for further analysis.
- Additional data from MDOT is expected to assist in helping categorize beam end deterioration repair types.
- A better model for representing beam ends with deterioration is expected through a sensitivity study using a refined finite element analysis procedure.
- It is expected that final products will be developed

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project expected completion FY 2024.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2023**

PROJECT TITLE: Construction Digital Delivery Technology Scan

FUNDING SOURCE: SPR, Part II OTHER (PLEASE EXPLAIN)

PROJECT MANAGER: Bowerman, Glenda

CONTRACT/AUTHORIZATION NO.	2022-0986	PROJECT START DATE	12/9/2022
PROJECT NO.	217421NI	COMPLETION DATE (Original)	12/31/2023
OR NO.	OR22-013	COMPLETION DATE (Revised)	6/30/2024
RESEARCH AGENCY	CRAFT		
PRINCIPAL INVESTIGATOR	Ketterl		

BUDGET STATUS

FY 2023 Budget		Total Budget	
Vendor Budget FY 2023	\$119,209.00	Total Vendor Budget	\$186,137.52
MDOT Budget FY 2023	\$24,500.00	Total MDOT Budget	\$24,500.00
Vendor FY 2023 Expenditures	\$146,181.33	Total Budget	\$210,637.52
MDOT FY 2023 Expenditures	\$0.00	Total Expenditures	\$146,181.33
		Total Amount Available	\$64,456.19

PURPOSE AND SCOPE

MDOT is embarking on a digital delivery initiative to move from PDF-based processes to digital. Research is necessary to determine the impact of this change on statewide construction inspection activities including the surveying and computing technology that will be necessary in the field. Technology needs may differ by Transportation Service Center (TSC) depending on their percentage of consultant vs. internal inspection activities, the number of MDOT construction staff and the complexity of typical projects. This technology may include GPS units, Total Stations, Levels, Laptops, Tablets, Smartphones, Monitors (UAVs and virtual reality are currently out of scope) and the proper software to consume digital deliverables, document inspection measurements and create content for downstream asset management functions. Digital delivery methods will rely on field connectivity to the internet. There are issues with the use of cell phone hotspots so other means of connectivity should be investigated. Research Tasks include the following:

- Review and evaluate on going and recently completed research in digital construction inspection technology without a dependence upon virtual paper plans.
- Survey other state departments of transportation and MDOT prequalified Construction Engineering and Construction Staking consultants to identify software and equipment used by industry leaders in digital delivery and the strengths and weaknesses of the equipment used.
- Identify best practices among state departments of transportation for funding construction inspection equipment purchases.
- Assess MDOT's Digital Delivery plans and goals and current practices. Document construction inspection services that could benefit from new technologies. Identify technology gaps.
- Assess each TSC's current construction inspection equipment, equipment sharing practices and future needs.
- Evaluate technologies currently on the market.
- Recommend and quantify software and equipment to meet current needs and identify future equipment needed to meet future goals.
- Demonstrate software that may be beneficial for use by MDOT construction staff.
- Evaluate our current cellular/Wi-Fi technology available to connect construction sites to cloud based software and make recommendations for improvements. Demonstrate recommendations for cellular/Wi-Fi technology.
- Document research and recommendations.

FISCAL YEAR 2022 ACCOMPLISHMENTS

This project was added to MDOT's program via Amendment 3. Contracting was delayed so project did not begin in FY 2022.

FISCAL YEAR 2023 ACCOMPLISHMENTS

The following activities were done this fiscal year:

- Met with MDOT stakeholders to hear the needs of MDOT and establish use cases for engagements with other agencies or vendors.
- Conducted several meetings with other State DOT agencies regarding their journey in digital delivery of projects.
- Established success criteria to help evaluate technology demos from outside vendors.

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- Several onsite and virtual technology demos were completed with stake holders.
 - I-Heep and Design Conference presentations regarding the ongoing research yielded a lot of positive feedback.

FISCAL YEAR 2024 PROPOSED ACTIVITIES

Finish stakeholder engagement meetings, develop the solution design, and plan future evaluation of digital delivery.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

The project end date was extended during FY 2023 to allow time for completing program-critical tasks such as additional DOT interviews with Iowa, Utah, Minnesota, Georgia, and Florida. This also allowed time to align calendars of critical stakeholders and extend technology vetting processes.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project expected completion FY 2024.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2023**

PROJECT TITLE: Enhanced Bridge Cost Estimating

FUNDING SOURCE: SPR, Part II OTHER (PLEASE EXPLAIN)

PROJECT MANAGER: Kelly Davis

CONTRACT/AUTHORIZATION NO.	2022-0435 Z1	PROJECT START DATE	10/15/2022
PROJECT NO.	217455NI	COMPLETION DATE (Original)	9/30/2023
OR NO.	OR22-012	COMPLETION DATE (Revised)	1/30/2024
RESEARCH AGENCY	Wayne State University (WSU)		
PRINCIPAL INVESTIGATOR	Chris Eamon		

BUDGET STATUS

FY 2023 Budget		Total Budget	
Vendor Budget FY 2023	\$175,665.00	Total Vendor Budget	\$175,665.00
MDOT Budget FY 2023	\$16,800.00	Total MDOT Budget	\$16,800.00
Vendor FY 2023 Expenditures	\$158,865.66	Total Budget	\$192,465.00
MDOT FY 2023 Expenditures	\$0.00	Total Expenditures	\$158,865.66
		Total Amount Available	\$33,599.34

PURPOSE AND SCOPE

The estimation of project cost plays an essential role in authorizing bridge repair and replacement projects. Estimating this cost efficiently and as accurately as possible is critical for the department to properly allocate funding and resources. This project will explore bid costs and bridge data to find correlations that can be used for more accurate estimates. The research tasks include the following:

1. Develop a method to efficiently analyze the annual weighted average item prices to produce an accurate forecast of the coming years pay item prices and appropriately handles outliers. This method will need to be repeatable using MDOT staff with minimal effort each year.
2. Develop a method to evaluate lump sum prices which produces an accurate estimate of those cost. This method will need to be repeatable using MDOT staff with minimal effort each year.
3. Develop a method to estimate the proposed replacement or rehabilitation costs for a given bridge using National Bridge Inventory (NBI) data, weighted average item prices and other variables. This method will need to be repeatable using MDOT staff with minimal effort each year.
4. Evaluate bridge scoping work types and identify pay items and quantities needed for specific work types. Develop spreadsheets that accurately estimate the cost of the specific work type based on current pay item prices but using the information typically available during scoping.
5. Produce an interactive computer-based worksheet that allows the user to input data and generate a rehabilitation scenario.
6. Provide a guidance document for performing these steps as the process will be repeated each year.

FISCAL YEAR 2022 ACCOMPLISHMENTS

This project went through the contracting process during FY 2022 with a delayed start date into FY 2023.

FISCAL YEAR 2023 ACCOMPLISHMENTS

- Developed a method to efficiently analyze the annual weighted average item prices to produce an accurate forecast of the coming year's pay item prices and appropriately handles outliers. This method will need to be repeatable using MDOT staff with minimal effort annually.
- Created a method to evaluate lump sum prices that produces an accurate estimate of those costs. This method will need to be repeatable using MDOT staff with minimal effort annually.
- Developed a method to estimate the proposed replacement or rehabilitation costs for a given bridge using NBI bridge data, weighted average item prices and other variables. This method will need to be repeatable using MDOT staff with minimal effort annually.
- Evaluated bridge scoping work types and identified pay items and quantities needed for specific work types. Developed spreadsheets that accurately estimate the cost of specific work types based on current pay item prices using the information typically available during scoping.
- Drafted an interactive computer-based worksheet that allows the user to input data and generate a rehabilitation scenario.

FISCAL YEAR 2024 PROPOSED ACTIVITIES

- Finalize the interactive computer-based worksheet that allows the user to input data and generate a rehabilitation scenario.
- Provide a guidance document for performing these steps as the process will be repeated annually.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

Due to a delay in working out the Data Sharing Agreement, a time extension was granted to allow additional time for receiving cost data to begin the analysis.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project expected completion FY 2024.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2023**

PROJECT TITLE: Efficacy of Speed Warning Technologies

FUNDING SOURCE: SPR, Part II OTHER (PLEASE EXPLAIN)

PROJECT MANAGER: Alonso Uzcategui

CONTRACT/AUTHORIZATION NO.	2023-0135	PROJECT START DATE	1/23/2023
PROJECT NO.	217934NI	COMPLETION DATE (Original)	2/15/2025
OR NO.	OR23-010	COMPLETION DATE (Revised)	
RESEARCH AGENCY	Michigan State University (MSU)		
PRINCIPAL INVESTIGATOR	Timothy J. Gates, Ph.D., P.E.		

BUDGET STATUS			
FY 2023 Budget		Total Budget	
Vendor Budget FY 2023	\$107,227.15	Total Vendor Budget	\$234,139.79
MDOT Budget FY 2023	\$30,306.84	Total MDOT Budget	\$21,493.16
Vendor FY 2023 Expenditures	\$11,601.95	Total Budget	\$255,632.95
MDOT FY 2023 Expenditures	\$0.00	Total Expenditures	\$11,601.95
		Total Amount Available	\$244,031.00

PURPOSE AND SCOPE

Crashes related to speed-change areas occur at locations where a change in speed is required to safely navigate, including horizontal curves, work zones, and when entering communities. A variety of factors contribute to the occurrence of crashes at these locations, including poor pavement surface conditions, limited visibility, driver distraction, drowsiness, and intoxication. While traditional warning treatments, including signs, delineation, and beacons have been used for decades, MDOT has recently expanded implementation of new technologies to warn motorists on the approach to such areas, including speed feedback signs, flashing chevrons, and other warning technologies that are activated by sensors when approaching vehicles exceed a preset speed threshold.

Previous MDOT research on the use of radar speed feedback signs has shown promising results but is limited to the use of such devices on freeway interchange ramps and only during favorable weather conditions. Current MDOT research is strictly focused on the driver behavioral aspects and does not include evaluation of crashes and injuries.

The purpose of this research is to broadly assess the effectiveness of speed warning technologies across a variety of roadway configurations and weather conditions. The project work includes a literature review of nationwide practices for the use of speed warning technologies; determination of viable speed warning technologies and applicable location types for implementation; evaluation of the effectiveness of speed warning technologies on driver behavior across a variety of roadway configurations and weather conditions in Michigan; review of the impacts of existing speed warning technologies on crashes and injuries in Michigan; evaluation of maintenance and operational performance of selected speed warning technologies; and development of guidelines and support tools for the use of such technologies in the state.

FISCAL YEAR 2023 ACCOMPLISHMENTS

Collecting data as required on the scope of work. Complete tasks 1 through 3 and started work on task 4.

FISCAL YEAR 2024 PROPOSED ACTIVITES

Continue task 4 and begin tasks 5 through 8 during FY 2024. Begin drafting final report.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project expected completion FY 2025.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2023**

PROJECT TITLE: Winter Severity Index with Winter Maintenance Expenses and Material Usage

FUNDING SOURCE: SPR, Part II OTHER (PLEASE EXPLAIN)

PROJECT MANAGER: James Roath

CONTRACT/AUTHORIZATION NO.	2023-0155	PROJECT START DATE	2/6/2023
PROJECT NO.	217937NI	COMPLETION DATE (Original)	2/6/2025
OR NO.	OR23-003	COMPLETION DATE (Revised)	
RESEARCH AGENCY	Michigan State University (MSU)		
PRINCIPAL INVESTIGATOR	Ali Zockaie, Ph.D.		

BUDGET STATUS

FY 2023 Budget		Total Budget	
Vendor Budget FY 2023	\$93,483.91	Total Vendor Budget	\$190,000.61
MDOT Budget FY 2023	\$23,750.00	Total MDOT Budget	\$36,250.00
Vendor FY 2023 Expenditures	\$43,536.34	Total Budget	\$226,250.61
MDOT FY 2023 Expenditures	\$0.00	Total Expenditures	\$43,536.34
		Total Amount Available	\$182,714.27

PURPOSE AND SCOPE

Inclement weather conditions require proper planning for winter maintenance services, including materials and available budget for maintenance personnel and equipment. Overspending on materials in the beginning and during the winter season might lead to materials shortages or budget dollars from strong storms at the end season going into spring and summer. A winter weather index can improve estimates and allocation predictions for resources based on observed trends and predicted weather conditions. This research will define a weather index to assist in forecasting funds and materials needed for the winter season, improve alignment and consistency between service providers, and identify current uses of Winter Severity Indices (WSIs) and weather condition applications by other states. Tasks will include surveying other state agencies on their current uses of a WSI (Iowa, Minnesota, Wisconsin, etc.), review the current index, study winter severity from the last ten seasons for MDOT and compare with budget and materials used, develop a new WSI for MDOT, and pilot the index during the first winter season to evaluate and improve the index.

FISCAL YEAR 2023 ACCOMPLISHMENTS

- Kick-Off Meeting with MDOT Research Advisory Panel (RAP) on February 27, 2023
- Meeting with Project Manager (PM) to get access and information on Maintenance Decision Support System (MDSS) on April 11, 2023
- Meeting with PM and RAP members to provide an update on project progress, discuss feedback on state DOT survey, and explore data needs from MDOT on September 19, 2023
- Reviewing Michigan current practices. Data was collected and analyzed along with additional information requested.
- The Nationwide State DOTs Survey was drafted and reviewed by MDOT and then distributed to state contacts.
- Based on available data, some initial progress was made on developing a preliminary modified WSI and rating scheme. Michigan's available data and other state's data was used to explore the relationships between WSI and winter maintenance costs and material usage.

FISCAL YEAR 2024 PROPOSED ACTIVITIES

- Continue Review of Michigan Current Practices: The remaining data needs from MDOT will be collected and analyzed to provide input for Task 5.
- Perform a Nationwide State DOTs Survey: The results will be analyzed to provide input for Task 5 and assist in developing the survey/interview with local service providers in Michigan.
- Survey/Interview with Local Service Providers in Michigan: Once the state DOT survey is conducted, the research team will focus on developing a separate survey with local agencies in Michigan. Then an on-line meeting will be set up to get further feedback from these local agencies based on the information provided in the survey.
- Develop Preliminary Modified WSI and Rating Scheme: The research team will continue to explore more WSIs for state level analyses, in addition to county-level analyses in Michigan.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project expected completion FY 2025.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2023**

PROJECT TITLE: Identifying Mapping Techniques of Invasive Plant Species Within the MDOT Right-of-Way

FUNDING SOURCE: SPR, Part II OTHER (PLEASE EXPLAIN)

PROJECT MANAGER: Carla Ahlschwede

CONTRACT/AUTHORIZATION NO.	2022-0432 Z2	PROJECT START DATE	10/11/2023
PROJECT NO.	218359NI	COMPLETION DATE (Original)	9/30/2025
OR NO.	OR23-004	COMPLETION DATE (Revised)	
RESEARCH AGENCY	Michigan Technological University (MTU)		
PRINCIPAL INVESTIGATOR	Richard Dobson		

BUDGET STATUS

FY 2023 Budget		Total Budget	
Vendor Budget FY 2023	\$119,682.86	Total Vendor Budget	\$212,451.62
MDOT Budget FY 2023	\$416.67	Total MDOT Budget	\$10,000.00
Vendor FY 2023 Expenditures	*\$0.00	Total Budget	\$222,451.62
MDOT FY 2023 Expenditures	\$0.00	Total Expenditures	\$0.00
*Project start was delayed		Total Amount Available	\$222,451.62

PURPOSE AND SCOPE

Invasive species in habitats and migration corridors near MDOT roadways can create obstacles for routine road maintenance, jeopardize MDOT's compliance with state and federal environmental regulations, and occasionally pose a health risk to maintenance and construction workers. Routine activities such as mowing, plowing, and grading may create additional opportunities for invasive species to spread within MDOT right-of-way and to neighboring properties. This research seeks to assist with proper location identification (mapping) of invasive species to help MDOT effectively monitor invasive species, contain their spread, and manage roadway vegetation to discourage invasive species and promote preferable species. Scoped tasks for this project include reviewing current academic literature on mapping locations of invasive species such as Japanese Knotweed (*Fallopia japonica*), Leafy Spurge (*Euphorbia esula*), and Common Reed (*Phragmites australis*); provide a summary of remote mapping alternatives for one or more species (i.e.: remote sensing, drone photography, etc.); demonstrate one or more mapping alternatives and their accuracy; and provide recommendations of mapping methods based on their accuracy, availability and ease of access of technology, and other factors deemed appropriate by the research team.

FISCAL YEAR 2023 ACCOMPLISHMENTS

Project start was delayed beyond FY 2023. The kickoff meeting was held on 10/31/2023.

FISCAL YEAR 2024 PROPOSED ACTIVITIES

Continue work on Tasks 3 through 6. Literature review (task 1) will be continuous throughout the duration of the project. Interim reporting to the Project Manager (PM) and Research Advisory Panel (RAP) members will be required.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project expected completion FY 2025.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2023**

PROJECT TITLE: MDOT Fleet Electrification Strategies

FUNDING SOURCE: SPR, Part II OTHER (PLEASE EXPLAIN)

PROJECT MANAGER: Diane Sevigny

CONTRACT/AUTHORIZATION NO.	2023-0418	PROJECT START DATE	6/21/2023
PROJECT NO.	218361NI	COMPLETION DATE (Original)	2/28/2025
OR NO.	OR23-011	COMPLETION DATE (Revised)	
RESEARCH AGENCY	Hatch Associates Consultants (Michigan), Inc.		
PRINCIPAL INVESTIGATOR	Mihir Bodarya, P.E.		

BUDGET STATUS

FY 2023 Budget		Total Budget	
Vendor Budget FY 2023	\$51,565.88	Total Vendor Budget	\$226,889.86
MDOT Budget FY 2023	\$3,409.09	Total MDOT Budget	\$15,000.00
Vendor FY 2023 Expenditures	\$53,715.77	Total Budget	\$241,889.86
MDOT FY 2023 Expenditures	\$0.00	Total Expenditures	\$53,715.77
		Total Amount Available	\$188,174.09

PURPOSE AND SCOPE

Reliance on petroleum-based fueled fleet creates financial risk of dependency on a sole product, reliance on a limited natural resource, and contributes to a major source of air pollution. MDOT's goal is to enter the electrification or alternate fueled vehicle (AFV) market by establishing a set of criteria that can be used to make future decisions on equipment procurement. This research will create a baseline for MDOT's minimum operational needs of each equipment type. As alternate fueled fleet and electrified equipment options continue to enter the commercial fleet industry, MDOT will need dedicated resources to keep up to date with the evolving market to investigate the viability of AFVs, or the expertise to perform cost/benefit/impact studies to make informed decisions.

This research study will document current and emerging technologies in the alternative fuel and electric markets. Primary objectives will be to determine the operational capabilities of these technologies, assess their suitability for MDOT's purposes, identify risks/rewards and cost/benefit for each vehicle type. Deliver a best practice report to guide MDOT future efforts with equipment procurements, utilizing a blended mix strategy.

FISCAL YEAR 2023 ACCOMPLISHMENTS

The project kick off meeting was held, and major progress was made in collecting data. A request for information was developed and submitted to gather information pertaining to MDOT fleet with a preliminary analysis conducted on the received information. The data was analyzed and organized to facilitate workshops with user groups. A series of eleven information gathering meetings were held with MDOT end-users (Transportation Maintenance Workers, Garage Supervisors, Mechanics, Equipment Foremen, Statewide Crews, Statewide Maintenance, Electricians, Construction Engineers, and Bridge Crews) to provide the researchers with a real case use understanding and baseline for MDOT's minimum operational requirements for various equipment types in MDOT's fleet. Formal structured questionnaires were developed as a part of the preparation for workshops. Peer group workshops were then conducted to understand and document the use case of vehicles by each user group. Additional workshops were conducted with supervisors and foremen to understand fleet maintenance and storage. Notes were consolidated and organized to be utilized for assessing levels of public engagement, which was initiated. Some initial analysis was conducted on the available AFV vehicles that are similar in size and capacity to the most common trucks in MDOT's fleet. The project is moving forward on time and within budget and through collaborative efforts, MDOT and the research team consolidated the schedule to make up for later than planned contract execution.

FISCAL YEAR 2024 PROPOSED ACTIVITIES

Tasks for this fiscal year will include completion of necessary data gathering with research done on similar transition planning initiatives by other DOTs and municipalities. Analysis of available vehicles will also be completed, including MDOT fleet's operational analysis and feasibility analysis. Work will begin on documenting findings.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Expected project completion FY 2025.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2023**

PROJECT TITLE: Examination of Lighting Practices at Crosswalks

FUNDING SOURCE: SPR, Part II OTHER (PLEASE EXPLAIN)

PROJECT MANAGER: Tim Smerdon

CONTRACT/AUTHORIZATION NO.	2022-0434 Z3	PROJECT START DATE	4/24/2023
PROJECT NO.	218362NI	COMPLETION DATE (Original)	1/31/2025
OR NO.	OR23-015	COMPLETION DATE (Revised)	
RESEARCH AGENCY	Western Michigan University (WMU)		
PRINCIPAL INVESTIGATOR	Ron Van Houten, Ph.D.		

BUDGET STATUS

FY 2023 Budget		Total Budget	
Vendor Budget FY 2023	\$77,107.31	Total Vendor Budget	\$170,638.15
MDOT Budget FY 2023	\$4,800.00	Total MDOT Budget	\$12,800.00
Vendor FY 2023 Expenditures	\$40,730.86	Total Budget	\$183,438.15
MDOT FY 2023 Expenditures	\$0.00	Total Expenditures	\$40,730.86
		Total Amount Available	\$142,707.29

PURPOSE AND SCOPE

Fatality Analysis Reporting System (FARS) data show that most increases in pedestrian fatalities occurred at night on urban arterials (Tefft, Arnold, & Horrey (2021); Hu, & Cicchino, (2018). Improved street lighting as one way to decrease pedestrian crashes at night is available at or near crosswalk or intersection locations but does not always illuminate pedestrians in the crosswalks. Since pedestrian safety is a priority for MDOT and the traffic safety community across the state, this research aims to address the high proportion of pedestrian crashes that occur in conditions with inadequate lighting and how MDOT can better illuminate crosswalks to identify crosswalk users. The scope of the project will include determining what type of lighting is needed at crosswalks to identify pedestrians that can easily be seen by drivers; identify a methodology or approach to best accomplish this goal; locate vendors who can offer smart lighting solutions for crosswalks and potentially provide data on the efficacy of this approach to promote development of additional products; and evaluation and analyze new prototypes and their measured effectiveness on crosswalk lighting.

FISCAL YEAR 2023 ACCOMPLISHMENTS

Held the project kick-off meeting. Completed task 1 (literature review and product list) and made significant progress on Task 2 (gather new information/data on the efficacy of crosswalk lighting solutions).

FISCAL YEAR 2024 PROPOSED ACTIVITES

Hold at least two progress meetings (fall/winter of 2023 and spring 2024). Complete tasks 2 and 3 (determine whether crashes during lighted conditions occur during said conditions) and begin work on tasks 4 and 5 (prepare technical report and strategic plan). Field observations, testing, and data collection also to occur in FY24 Spring/Summer.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project expected completion FY 2025.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2023**

PROJECT TITLE: Evaluation of MDOT's Methodology for Estimating Work Zone User Delay Times & Costs

FUNDING SOURCE: SPR, Part II OTHER (PLEASE EXPLAIN)

PROJECT MANAGER: Ben Krom and Sarah Hoffman

CONTRACT/AUTHORIZATION NO.	2022-0434 Z4	PROJECT START DATE	5/3/2023
PROJECT NO.	218364NI	COMPLETION DATE (Original)	2/28/2026
OR NO.	OR23-013	COMPLETION DATE (Revised)	
RESEARCH AGENCY	Western Michigan University (WMU)		
PRINCIPAL INVESTIGATOR	Jun-Seok Oh, Ph.D.		

BUDGET STATUS

FY 2023 Budget		Total Budget	
Vendor Budget FY 2023	\$75,670.82	Total Vendor Budget	\$347,947.58
MDOT Budget FY 2023	\$35,294.1	Total MDOT Budget	\$105,882.35
Vendor FY 2023 Expenditures	\$72,392.00	Total Budget	\$497,947.58
MDOT FY 2023 Expenditures	\$0.00	Total Expenditures	\$72,392.00
		Total Amount Available	\$425,555.58

PURPOSE AND SCOPE

MDOT uses a macro-enabled spreadsheet called Construction Congestion Cost (CO3) created in the late 1990's to estimate user delay times and costs that the traveling public can expect to experience while traveling through or around construction work zones. This research will allow MDOT to make an informed decision on how best to move forward after evaluating whether CO3 can be updated to ensure future viability or other sustainable software solutions should be implemented to best meet MDOT's business needs.

The scope of the project includes performing an evaluation and analysis of the current CO3 method of estimating user delay times and costs for future viability and accuracy; reviewing and evaluating alternate methods/software to estimate user delay times and costs; and recommending other viable methodology/software options that meet MDOT's business needs.

FISCAL YEAR 2023 ACCOMPLISHMENTS

Finished development of the final work plan and held the project kick-off meeting in May of 2023.

Other accomplishments include:

- Completion of the literature review.
- Development & subsequent distribution of a work zone survey questionnaire to MDOT and consultant stakeholders.
- Started collecting, organizing, and analyzing work zone data.

FISCAL YEAR 2024 PROPOSED ACTIVITIES

The WMU research team plans on concluding the work zone survey and conducting focus group meeting(s) with a select group of survey participants to gather their feedback on the needs for a software tool. Working with MDOT, work zone data collection activities will be completed. Finally, an analysis of various work zone scenarios will be conducted using several software tools with an evaluation being provided for MDOT's review.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Expected project completion FY 2026.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2023**

PROJECT TITLE: Improving MDOT's Movable Bridge Reliability and Operations

FUNDING SOURCE: SPR, Part II OTHER (PLEASE EXPLAIN)

PROJECT MANAGER: Mike Halloran

CONTRACT/AUTHORIZATION NO.	2023-0281	PROJECT START DATE	3/17/2023
PROJECT NO.	218367NI	COMPLETION DATE (Original)	5/31/2024
OR NO.	OR23-016	COMPLETION DATE (Revised)	
RESEARCH AGENCY	HDR Michigan, Inc.		
PRINCIPAL INVESTIGATOR	Matt Longfield		

BUDGET STATUS

FY 2023 Budget		Total Budget	
Vendor Budget FY 2023	\$128,427.29	Total Vendor Budget	\$349,434.06
MDOT Budget FY 2023	\$10,000.00	Total MDOT Budget	\$10,000.00
Vendor FY 2023 Expenditures	\$46,947.00	Total Budget	\$359,434.06
MDOT FY 2023 Expenditures	\$0.00	Total Expenditures	\$46,947.00
		Total Amount Available	\$312,487.06

PURPOSE AND SCOPE

MDOT's movable bridges occasionally experience unscheduled downtime due to electrical and mechanical component malfunction. Responding, troubleshooting, and performing repairs can be costly, and more importantly, be disruptive to users of the bridge. Unscheduled downtime of movable bridges has negative mobility impacts, affecting emergency response services, the motoring public as well as marine traffic. Component malfunction also often results in MDOT personnel responding outside of normal working hours to troubleshoot the problem and perform repairs, including nights, weekends, and holidays.

This research will:

- identify best practices throughout the nation on movable bridge reliability and maintenance.
- determine what performance data to collect and parameters to track to allow workers to predict component malfunction proactively, and how best to collect and display that information.
- identify enhancements or modifications to movable bridge components/hardware to improve reliability.
- validate MDOT's current maintenance strategy and determine opportunities for improvement based on benefit-cost analysis.
- determine effective ways to optimize traffic operations during movable bridge downtime. A strategy using Intelligent Transportation Systems (ITS) to improve customer messaging is appealing to allow users to make more informed decisions on when to seek an alternate route or wait for services to be restored.

FISCAL YEAR 2023 ACCOMPLISHMENTS

The research team developed surveys/questionnaires related to movable bridge reliability and distributed to several bridge owners throughout the nation. The team is reviewing survey results that have come in so far. A draft literature review has been completed for the final report. A list of questions for MDOT staff and vendors for use in troubleshooting bridges has been developed.

FISCAL YEAR 2023 PROPOSED ACTIVITIES

Interviews with MDOT staff and vendors will be scheduled and held to help the research team understand the common issues and develop strategies to mitigate them. The team will continue reviewing survey results from other agencies and compile the data for review. They will identify vulnerabilities in the network, make recommendations to MDOT, and update existing maintenance procedures and recommendations. The final report will also be developed.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Expected project completion FY 2024.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2023**

PROJECT TITLE: Socio Economic Impacts of Technology Based Stakeholder Engagement Platforms and Their Effects

FUNDING SOURCE: SPR, Part II OTHER (PLEASE EXPLAIN)

PROJECT MANAGER: John Martin

CONTRACT/AUTHORIZATION NO.	2023-0566	PROJECT START DATE	8/21/2023
PROJECT NO.	218391NI	COMPLETION DATE (Original)	8/21/2026
OR NO.	OR23-017	COMPLETION DATE (Revised)	
RESEARCH AGENCY	Michigan State University (MSU)		
PRINCIPAL INVESTIGATOR	Peter T. Savolainen, Ph.D., P.E.		

BUDGET STATUS

FY 2023 Budget		Total Budget	
Vendor Budget FY 2023	\$20,172.46	Total Vendor Budget	\$353,967.92
MDOT Budget FY 2023	\$416.67	Total MDOT Budget	\$5,000.00
Vendor FY 2023 Expenditures	*\$0.00	Total Budget	\$358,967.92
MDOT FY 2023 Expenditures	\$0.00	Total Expenditures	\$0.00
*MSU confirmed no costs posted during FY 2023.		Total Amount Available	\$358,967.92

PURPOSE AND SCOPE

Michigan and the nation have been forever changed because of social interaction ripples created by the Covid pandemic. Isolation and distance have been a few of the tools utilized to slow the virus spread. This research seeks to answer several questions. Has the pandemic environment of technology-based communication platforms promoted a dichotomy in stakeholder involvement? Are socio-economic challenged neighborhoods/census tracts able to utilize new tech platforms? Or, has their voice been further diminished via socio economic in-equality? Are there thresholds at which point socio-economic groups simply 'shut down'? Hearing stakeholders is the foundation from which well-designed transportation solutions are built. However, if the abilities and limits of the stakeholders are not understood, can or are engagement techniques effective?

This project will inventory current MDOT guidance and engagement tools used in the field prior to the pandemic; identify performance measures currently tracked and offer reliable data sets to be tracked moving forward; inventory engagement shifts from face-to-face pre-pandemic norms to a virtual environment as a result of early pandemic social condition requirements; evaluate current engagement techniques used in a post-pandemic (new normal) environment; formulate guidance for engagement methods with Michigan's divorce population and context sensitive factors; evaluate potential markers for social stress impacting engagement success; and provide guidance, tools, and performance measures to be updated clarifying populations accessing MDOT public participation opportunities throughout MDOT's development process.

FISCAL YEAR 2023 ACCOMPLISHMENTS

- Kick-off meeting was held.
- Initiated literature search.
- MSU began the interaction process with MDOT to determine staff members to interview and create a list for future meetings.
- Began developing questions for the survey.

FISCAL YEAR 2024 PROPOSED ACTIVITES

- It is expected that MSU will complete the following:
 - Review of MDOT Practices.
 - Assessment of National State-of-the-Practice.
 - Attend several community engagement events.
 - Complete data assessment of statewide levels of public engagement.
 - Determine stressed user group characteristics.
- It is expected that MSU will begin working on testing strategies in community focus groups.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project expected completion FY 2026.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2023**

PROJECT TITLE: Multimodal Airport Charging Station Deployment – Phase I

FUNDING SOURCE: SPR, Part II OTHER (PLEASE EXPLAIN)

PROJECT MANAGER: Linn Smith

CONTRACT/AUTHORIZATION NO.	2023-0205	PROJECT START DATE	4/3/2023
PROJECT NO.	218392NI	COMPLETION DATE (Original)	8/31/2024
OR NO.	OR23-019	COMPLETION DATE (Revised)	
RESEARCH AGENCY	C&S Engineers, Inc.		
PRINCIPAL INVESTIGATOR	John Trendowski		

BUDGET STATUS

FY 2023 Budget		Total Budget	
Vendor Budget FY 2023	\$112,769.77	Total Vendor Budget	\$ 214,404.20
MDOT Budget FY 2023	\$5,406.32	Total MDOT Budget	\$7,433.68
Vendor FY 2023 Expenditures	\$85,822.91	Total Budget	\$221,837.88
MDOT FY 2023 Expenditures	\$0.00	Total Expenditures	\$85,822.91
		Total Amount Available	\$136,014.97

PURPOSE AND SCOPE

Newly emerging aircrafts will rely on electric propulsion; however, virtually no airports or similar facilities maintain capital infrastructure needed to provide aircraft and vehicle charging. Fielding a first in the state (and only a few in the nation) electric aircraft and vehicle charging station would be beneficial to the traveling community and MDOT as we prepare for implementation of new charging stations, creating a multi-modal opportunity. Success from this work would drive the development of the revised Michigan Aviation System Plan and future deployments of charging stations to drive Michigan’s attractiveness for new more environmentally conscious. This would provide an avenue for new electric aircraft a charging location in Michigan, drive development and attractiveness of new aircraft and provide the department with an understanding of the design requirements for establishing a charger at an airport that can service both aircraft and automobiles.

Phase 1: Initial analysis/recommendations for deployment and provide the basis for establishing multi-modal charging stations for the state.

1. Assessment of applicable locations.
2. Assessment of economic, environmental, and community impacts.
3. Assessment of existing infrastructure.
4. Assessment of applicable regulatory and approval processes for deployment.
5. Strategy for establishing/deploying an appropriate charging station structure including securing any federal/state approval.

FISCAL YEAR 2023 ACCOMPLISHMENTS

- A kickoff meeting was held on April 3, 2023, to provide opportunity for the Research Advisory Panel (RAP) and C&S Engineers research team to:
 - Make introductions
 - Review the research plan, deliverables, and timeline for activities
 - Establish communication protocols
 - Clarify team roles/responsibilities
 - Confirm QA/QC procedures and management of project administration
- On April 10, 2023, C&S introduced the MDOT RAP to the Hovecon team subcontracting on the research project and discussed:
 - The list of individual contact information for Michigan Airports
 - A list of airports or other entities that have expressed interest in working with MDOT (i.e., aircraft manufacturers or charging companies)
 - Establish communication protocols
 - Any additional research reports on electrification like the previously forwarded reports on Electric Vehicle Charger Placement Optimization in Michigan (Phase I and II).
- On June 28, 2023, C&S and the MDOT RAP met to discuss the Initial Airport Assessment Survey that was sent out in early June for Tier 1 and Tier 2 airports as identified in the Michigan Aviation System Plan. C&S subsequently followed up with those that did not respond. Total results yielded 25 respondents and C&S provided MDOT a memo documenting the survey activities and results.

- On July 17, 2023, C&S and the MDOT RAP met to review the assessment of applicable locations that will include:
 - The list of individual contact information for Michigan Airports
 - A review the Airport Layout Plan (ALP)
 - A detailed electrical analysis
 - An infrastructure analysis
 - Discuss potential economic, environmental and community impacts

C&S proposed a decision tree or matrix ranking process for assessing airport locations which would look to examine specific variables within the assessment that can be linked to actual airport locations and narrow the location selection to 5-6 airports.

Variables included:

- Cargo/passenger delivery market
 - Available data
 - Aviation infrastructure
 - Social impact
 - EV charging category
 - The Airport Assessment Survey
 - Quantitative/qualitative data
 - The 10 prosperity regions
- On September 12, 2023, C&S presented at the Michigan Association of Airport Executives (MAAE) Conference. The research team addressed airport electrification and provided the status of the Multimodal Airport Charging Station Deployment project.
 - On October 9, 2023, C&S and the MDOT RAP met to discuss:
 - The existing infrastructure. C&S met with several aircraft and charging manufactures (i.e., Joby Aviation, Volatus Infrastructure, SkyPorts, ChargePoint, Beta Technologies, and Ferrovial). An overview of existing conditions and future plans for these vendors was provided and C&S provided MDOT a memo documenting the findings.
 - Discuss and concurrence on the shortlist of the candidate airports, as identified through the decision matrix. The metrics ranking process was able to narrow 95 possible Michigan airports down to 6 locations for a more detailed assessment and C&S will conduct on-site visits with the proposed candidates.

Airport	Airport Code	MI Prosperity Region	Airport Type
Battle Creek Executive Airport at Kellogg Field	BTL	8	General Aviation
Ann Arbor Municipal Airport	ARB	9	General Aviation
Gerald R. Ford International	GRR	4	Primary – Non-Hub *
Capital Region Int'l Airport	LAN	7	Primary – Non-Hub
Cherry Capital Airport	TVC	2	Primary – Non-Hub
Willow Run Airport	YIP	10	General Aviation

* Gerald Ford is Primary - Small Hub.

FISCAL YEAR 2024 PROPOSED ACTIVITIES

Proposed activities for FY24 include:

- Baseline design
- Site visits of shortlist airports
- Preliminary development of costs
- Evaluation of assessment criteria
- Draft selection of pilot locations
- Completion of any remaining tasks
- Submittal of draft and final project report, along with project closeout

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Expected project completion FY 2024.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2023**

PROJECT TITLE: Design Guidance Development for Continuous Prestressed CFCC Strand Beams

FUNDING SOURCE: SPR, Part II OTHER (PLEASE EXPLAIN)

PROJECT MANAGER: Steve Kahl

CONTRACT/AUTHORIZATION NO.	2022-0431 Z2	PROJECT START DATE	10/1/2023
PROJECT NO.	218394NI	COMPLETION DATE (Original)	9/30/2026
OR NO.	OR23-023	COMPLETION DATE (Revised)	
RESEARCH AGENCY	Lawrence Technological University (LTU)		
PRINCIPAL INVESTIGATOR	Nabil F. Grace		

BUDGET STATUS			
*FY 2023 Budget		Total Budget	
Vendor Budget FY 2023	\$0.00	Total Vendor Budget	\$385,875.00
MDOT Budget FY 2023	\$0.00	Total MDOT Budget	\$24,000.00
Vendor FY 2023 Expenditures	\$0.00	Total Budget	\$409,875.00
MDOT FY 2023 Expenditures	\$0.00	Total Expenditures	\$0.00
* Project start was delayed		Total Amount Available	\$409,875.00

University Match – Total \$83,750.00

Fiscal Year	Budget	Expenditures	Total Match
2023	\$0.00	\$0.00	\$0.00

PURPOSE AND SCOPE

The analysis of continuous bridge beams is more complicated than that of simply-supported beams, yet continuous beam spans can be the best option in unique bridge projects. Carbon Fiber Composite Cable (CFCC) has not been utilized in Michigan in draped conditions required for continuous beams, so the configuration and design requirements need to be developed. This project will explore the possible application of new materials and new designs in a combined effort. This will be accomplished by assessing the feasibility of using CFCC post-tension strand beams to achieve continuity, considering the benefits of continuous CFCC prestressed beams with pretensioned draped and top CFCC strands, and developing design guidance for continuous beams prestressed with bonded draped CFCC strands.

FISCAL YEAR 2023 ACCOMPLISHMENTS

Contracting for this project was delayed pushing the date to begin work into FY 2024.

FISCAL YEAR 2024 PROPOSED ACTIVITIES

- Kickoff meeting to be held,
- Literature review completed,
- Evaluation and beginning of reporting on Draped Pretensioned CFCC,
- Evaluation of anchorage system for Post-Tensioned CFCC,
- Evaluation of Decked Bulb T-Beams with Pre-tensioned Straight/Draped Stand,
- Begin documentation of analysis and design concepts,
- Hold progress meetings throughout project duration.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project expected completion FY 2026.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2023**

PROJECT TITLE: Identify best locations for new Flex-Route projects throughout the state of Michigan

FUNDING SOURCE: SPR, Part II OTHER (PLEASE EXPLAIN)

PROJECT MANAGER: Jason Firman

CONTRACT/AUTHORIZATION NO.	2023-0458	PROJECT START DATE	6/14/2023
PROJECT NO.	218396NI	COMPLETION DATE (Original)	6/14/2025
OR NO.	OR23-006	COMPLETION DATE (Revised)	
RESEARCH AGENCY	Michigan State University (MSU)		
PRINCIPAL INVESTIGATOR	Peter T. Savolainen, Ph.D., P.E.		

BUDGET STATUS			
FY 2023 Budget		Total Budget	
Vendor Budget FY 2023	\$80,000.00	Total Vendor Budget	\$300,000.01
MDOT Budget FY 2023	\$8,350.00	Total MDOT Budget	\$25,050.00
Vendor FY 2023 Expenditures	\$5,193.80	Total Budget	\$325,050.01
MDOT FY 2023 Expenditures	\$0.00	Total Expenditures	\$5,193.80
		Total Amount Available	\$319,856.21

PURPOSE AND SCOPE

Travel demand variation is one of the main sources of traffic congestion. It is essential to study state-wide congestion distribution to identify the best locations for assigning the highest priority project candidates for future flex-routes or other managed lane strategies. This project also investigates developing a viable project rollout strategy that would support increasing the number of managed lanes, including temporary shoulder use, throughout the state. The research will provide a methodology for determining statewide congestion distributions to identify best locations for new managed lanes and temporary shoulder use projects throughout the state, study temporal and spatial congestion patterns to identify candidate locations for a new managed lane and temporary shoulder use application, review impact on secondary routes/roadway infrastructure and safety due to traffic spillover effects, and define needed resources (i.e. cost, staffing, equipment/software tools, etc.) as a result of proposed managed lane and temporary shoulder use.

FISCAL YEAR 2023 ACCOMPLISHMENTS

- Literature Review - The MSU team has completed a review of the research literature regarding the use of hard shoulder running and associated operational and safety impacts, as well as criteria impacting the selection of candidate locations for part-time shoulder use.
- State DOT Survey - A state agency survey was disseminated with a total of 38 responses received to date. This survey sought to determine which DOTs have experience with static and/or dynamic part-time shoulder use. Information was also collected on screening and decision criteria, along with pertinent aspects of the design and operation of such facilities.
- Data Collection and Analysis - Data has been collected for the MDOT freeway network detailing geometric and operational characteristics. This includes details such as roadway cross-sectional characteristics (e.g., lane width, shoulder width, median width) and speed/travel time data from the Regional Transportation Information System (RITIS). This data is being used to prepare summary files for use in meetings with MDOT Regional Staff.

FISCAL YEAR 2024 PROPOSED ACTIVITIES

- State DOT Survey - The research team is following up with the remaining agencies who have not yet responded to the survey. Survey results will be used to prepare a technical memorandum detailing state practices.
- Safety Analysis - Data is being collected on traffic crash frequency and severity data across the freeway system. This data will be integrated with the geometric, operational, and traffic volume data for the purposes of a screening analysis detailing the safety performance of candidate corridors.
- MDOT Regional Meetings - MSU is preparing a short survey to be disseminated across MDOT regional offices in advance of meetings to discuss potential candidate corridors for further investigation.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project expected completion FY25.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2023**

PROJECT TITLE: Revenue Opportunities from MDOT Fiber Infrastructure and Other Utility Types

FUNDING SOURCE: SPR, Part II OTHER (PLEASE EXPLAIN)

PROJECT MANAGER: Joe Gorman

CONTRACT/AUTHORIZATION NO.	TBD	PROJECT START DATE	
PROJECT NO.	218397NI	COMPLETION DATE (Original)	
OR NO.	OR23-012	COMPLETION DATE (Revised)	
RESEARCH AGENCY	KPMG LLP		
PRINCIPAL INVESTIGATOR	Prakash Ganesh		

BUDGET STATUS			
*FY 2023 Budget		Total Budget	
Vendor Budget FY 2023	\$0.00	Total Vendor Budget	\$435,000.00
MDOT Budget FY 2023	\$0.00	Total MDOT Budget	\$10,000.00
Vendor FY 2023 Expenditures	\$0.00	Total Budget	\$460,000.00
MDOT FY 2023 Expenditures	\$0.00	Total Expenditures	\$0.00
* Project start was delayed		Total Amount Available	\$435,000.00

PURPOSE AND SCOPE

Various state highway agencies permit telecommunications to be located longitudinally along freeway rights-of-way (ROW). MDOT is interested in a study of alternative sources of transportation revenues that could be phased in over time to replace revenue lost as motor and diesel fuel decline become obsolete. MDOT focus would be on non-vehicle related revenue streams, such as, leasing rights-of-way for Fiber Communications and/or other utility types, possibly private transportation facilities, and/or public-private partnerships. This research seeks to explore access to advanced telecommunications technologies and services for remote communities enabling them to remain vital and prosperous, viable cost sharing assistance with the installation of fiber optics networks along state highway ROW, and assistance in funding ITS applications as MDOT seeks more convergence of ITS implementation and roadway ROW access via smart partnerships with telecommunications and other utility types in the industry. This will be accomplished by:

- Performing a synthesis to identify merits of viable alternative approaches to supplement and/or replace current revenue streams to construct, operate, and maintain the state transportation infrastructure.
- Developing a strategic investment plan for MDOT to improve accessibility of advanced telecommunications technologies to rural communities, including both short term and long- term deployments.
- Determining a methodology to evaluate/calculate a B/C measure for implementing a cost sharing practice for installing telecommunication and/or other utility type services along state highway ROW.

FISCAL YEAR 2023 ACCOMPLISHMENTS

Contracting for this project was delayed pushing the date to begin work into FY 2024.

FISCAL YEAR 2024 PROPOSED ACTIVITES

It is expected that a current state assessment and alternative revenue opportunities assessment will be completed and work on a project report will begin

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project expected completion FY24 or 25.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2023**

PROJECT TITLE: Pavement ME Rehabilitation Design Protocols for MDOT Implementation

FUNDING SOURCE: SPR, Part II OTHER (PLEASE EXPLAIN)

PROJECT MANAGER: Justin Schenkel

CONTRACT/AUTHORIZATION NO.	2023-0342	PROJECT START DATE	7/13/2023
PROJECT NO.	218398NI	COMPLETION DATE (Original)	7/13/2025
OR NO.	OR23-014	COMPLETION DATE (Revised)	
RESEARCH AGENCY	Michigan State University (MSU)		
PRINCIPAL INVESTIGATOR	Syed Waqar Haider, Ph.D., P.E.		

BUDGET STATUS

FY 2023 Budget		Total Budget	
Vendor Budget FY 2023	\$135,777.43	Total Vendor Budget	\$402,903.80
MDOT Budget FY 2023	\$28,875.00	Total MDOT Budget	\$71,697.02
Vendor FY 2023 Expenditures	\$39,616.48	Total Budget	\$474,600.82
MDOT FY 2023 Expenditures	\$1,572.02	Total Expenditures	\$41,188.5
		Total Amount Available	\$433,412.32

PURPOSE AND SCOPE

MDOT is undergoing the process to fully implement Mechanistic-Empirical (ME) pavement design per the American Association of State Highway and Transportation Officials (AASHTO) Mechanistic-Empirical Pavement Design Guide (MEPDG) and its associated software, AASHTOWare Pavement ME Design (Pavement ME). For pavement rehabilitation design, MDOT is using the AASHTO 1993 (A93) method, and this empirical approach limits the effectiveness as a modern pavement design method as compared to Pavement ME that utilizes site-specific conditions such as traffic, climate, and existing pavement conditions, in creating the final design. ME rehabilitation pavement design is more complex and requires characterization of existing materials and their thicknesses. Past projects used various mix types that are no longer used or have adjusted their requirements (such as air voids or gradations). Therefore, it is difficult to standardize or provide guidelines related to Pavement ME pavement rehabilitation design without extensive investigation. This research will provide recommendations for how to most accurately model rehabilitation fixes within Pavement ME, characterize existing materials given the standard available project information, and streamline the process so that MDOT can use Pavement ME for rehabilitation design decisions. This project will expand on findings from MDOT report, RC-1594 "Preparation for Implementation of the Mechanistic-Empirical Pavement Design Guide in Michigan Part 2: Evaluation of Rehabilitation Fixes" by detailing the pavement design protocols necessary for Pavement ME design which will be the basis for implementing Pavement ME in designing rehabilitation projects.

Project scope will include evaluating current MDOT pavement design practices, protocols, data, and past research for reconstruction and rehabilitation; recommend appropriate Pavement ME modeling selection (i.e., Pavement ME design type and pavement type categories); compare different input levels for rehabilitation pavement design; evaluate and update Pavement ME calibration coefficients as warranted; provide a comparison of performance predictions and/or design thicknesses for selected pavements designed using the A93 pavement design method against the same pavements designed using Pavement ME to quantify/qualify differences; and provide updated guidance for MDOT pavement design of rehabilitation fixes.

Project tasks are the following:

- Task 1: Literature review & rehab design practices
- Task 2: Characterization of existing layers
- Task 3: Rehabilitation modeling selection for analysis and design
- Task 4: Compare material input levels
- Task 5: Input database
- Task 6: Verification and recalibration of rehab models
- Task 7: Compare Pavement Mechanistic Design (PMED) vs. AASHTO93
- Task 8: Identify limitations of the designs
- Task 9: Final report (including design recommendations) and tech transfer

FISCAL YEAR 2023 ACCOMPLISHMENTS

The team worked on Tasks 1 through 4 and accomplished the following work:

- A comprehensive review of the implementation of PMED rehabilitation analysis and design. The literature includes an overview of the methodologies practiced by other state highway agencies (SHAs).

- Researchers compared different ME analysis options for rubblize pavement, investigating scenarios where it was designed either as a new flexible pavement or as a Hot Mix Asphalt (HMA) overlay over fractured Jointed Plain Concrete Pavement.
- The team is organizing and setting up an inventory of the 2023 rehabilitation project cores and material samples that were provided by MDOT. They also prepared lab samples and formulated testing protocols for subsequent laboratory assessments. The team has started to conduct laboratory testing for the concrete and HMA cores.

FISCAL YEAR 2024 PROPOSED ACTIVITIES

The research team will work on Tasks 3 through 8 to address the essential project objectives, including the following items:

- Test HMA samples for volumetric properties, dynamic modulus $|E^*|$, and indirect tensile test (IDT).
- Test Portland Cement Concrete samples for elastic modulus E and compressive strength f_c' .
- Perform back-calculation analysis using Falling Weight Deflectometer (FWD) deflections to estimate the damaged modulus of the existing pavement layers.
- Compare the damaged modulus master curves obtained from back-calculation of measured FWD data and predicted by PMED at all rehabilitation levels.
- Analyze the impact of input levels on the performance predictions. This analysis will identify the most appropriate/practical input level for the specific design types based on Michigan's local conditions.
- Characterize crushed & shaped materials in the laboratory. The testing procedures and protocol will be established to characterize existing HMA crushed and shape layers.
- Interview MDOT personnel to understand MDOT projects, their readily available data, and expectations. This information will be used for recommendations of MDOT best practices as design methods and their results are assessed.
- Verify if rehab recalibration is warranted and provide updated calibration if so.
- Compare the outputs of AASHTO 93 and PMED rehab designs to identify recommendations for MDOT best practices.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project expected completion FY 2025.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2023**

PROJECT TITLE: Improving Cost Estimation and Budget Planning with New Michigan Highway Construction Cost Index

FUNDING SOURCE: SPR, Part II OTHER (PLEASE EXPLAIN)

PROJECT MANAGER: Kristi Kirkpatrick

CONTRACT/AUTHORIZATION NO.	2022-0434 Z5	PROJECT START DATE	5/30/2023
PROJECT NO.	218401NI	COMPLETION DATE (Original)	12/31/2024
OR NO.	OR23-018	COMPLETION DATE (Revised)	
RESEARCH AGENCY	Western Michigan University (WMU)		
PRINCIPAL INVESTIGATOR	Hexu Liu, Ph.D.		

BUDGET STATUS

FY 2023 Budget		Total Budget	
Vendor Budget FY 2023	\$70,292.64	Total Vendor Budget	\$116,284.36
MDOT Budget FY 2023	\$0.00	Total MDOT Budget	\$0.00
Vendor FY 2023 Expenditures	\$50,946.23	Total Budget	\$116,284.36
MDOT FY 2023 Expenditures	\$0.00	Total Expenditures	\$50,946.23
		Total Amount Available	\$65,338.13

PURPOSE AND SCOPE

MDOT has developed a highway construction cost index (HCCI), including categorical, regional, and statewide indices; however, the future trend of the cost index was forecasted using a time series analysis that cannot consider significant economic factors such as the pandemic, and/or periods of high inflation, leading to low accuracy of the forecasted index value. This makes it difficult to use the current index for engineering estimates and budget planning. With the consumer price index rising in February 2022 to 7.9%, a program analysis template to better understand the impacts of inflation and adaptation to inflation is needed, along with an analysis of labor, logistics, and economic factors that may be affecting pricing. The purpose of this research is to develop a new HCCI, including calculation tool/program, at the project and pay item levels to more accurately adjust the historical price of pay items, improving the accuracy of the historical data-based estimation as well as provide MDOT with a better understanding of why pricing fluctuates for specific materials and/or regions over time. This project will evaluate the impact of the COVID-19 pandemic on the construction cost index trend; develop and advanced approach to predict the construction cost index considering economic factors such as the pandemic and periods of high inflation; develop a project-level and pay item-level construction cost index, including a calculation tool for better cost estimation; create a new HCCI-based construction cost estimation method for engineering estimates; and compare HCCI across different regions and states.

FISCAL YEAR 2023 ACCOMPLISHMENTS

Fiscal year 2023 accomplishments included project kick-off meeting; data requirements review discussion; data sharing agreement review; literature review; and identifying factors in construction pricing.

FISCAL YEAR 2024 PROPOSED ACTIVITIES

Proposed activities include obtaining a fully executed data sharing agreement, data collection, development of a project and pay item cost index, understanding economic factors based on cost index prediction, development of an index-based estimation method and budget planning, completing a state and regional cost index comparison, development of a tool for cost index calculation and price analysis, developing recommendations and an implementation plan, and submitting a draft final report.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project expected completion FY 2025.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2023**

PROJECT TITLE: Bonding Vs. Pay as You Go

FUNDING SOURCE: SPR, Part II OTHER (PLEASE EXPLAIN)

PROJECT MANAGER: Adam Feldpausch

CONTRACT/AUTHORIZATION NO.	2023-0460	PROJECT START DATE	10/30/2023
PROJECT NO.	218402NI	COMPLETION DATE (Original)	2/28/2025
OR NO.	OR23-020	COMPLETION DATE (Revised)	
RESEARCH AGENCY	Texas A&M University Transportation Institute		
PRINCIPAL INVESTIGATOR	Brienne Glover		

BUDGET STATUS			
*FY 2023 Budget		Total Budget	
Vendor Budget FY 2023	\$0.00	Total Vendor Budget	\$160,069.82
MDOT Budget FY 2023	\$0.00	Total MDOT Budget	\$0.00
Vendor FY 2023 Expenditures	\$0.00	Total Budget	\$160,069.82
MDOT FY 2023 Expenditures	\$0.00	Total Expenditures	\$0.00
* Project start was delayed		Total Amount Available	\$160,069.82

PURPOSE AND SCOPE

The purpose of this research is to explore the value of financing infrastructure improvements through bonding versus a program of pay-go improvements and determine which approach should be used to facilitate our capital program, and what the long-term cost/benefit is to that approach. This will include comparing the debt service cost of bonding against the increased costs of inflation, increased costs related to the deterioration from delayed improvements, the on-going costs for targeted maintenance and repairs necessary while waiting for pay-go funding to become available, and user delays due to constraints of the pay-go approach.

FISCAL YEAR 2023 ACCOMPLISHMENTS

Contracting for this project was delayed pushing the date to begin work into FY 2024.

FISCAL YEAR 2024 PROPOSED ACTIVITIES

It is expected that a literature review and review of best practices will be completed, and the comparison study will begin.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project expected completion FY 2025.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2023**

PROJECT TITLE: Marketing and Education Budget for Implementation of New Transit Technology

FUNDING SOURCE: SPR, Part II OTHER (PLEASE EXPLAIN)

PROJECT MANAGER: Ellen Kent and Kevin Hohf

CONTRACT/AUTHORIZATION NO.	2023-0726	PROJECT START DATE	11/27/2023
PROJECT NO.	218403NI	COMPLETION DATE (Original)	8/31/2025
OR NO.	OR23-021	COMPLETION DATE (Revised)	
RESEARCH AGENCY	CRAFT		
PRINCIPAL INVESTIGATOR	Mona Ketterl		

BUDGET STATUS

*FY 2023 Budget		Total Budget	
Vendor Budget FY 2023	\$186,598.57	Total Vendor Budget	\$295,618.22
MDOT Budget FY 2023	\$4,115.00	Total MDOT Budget	\$12,000.00
Vendor FY 2023 Expenditures	\$0.00	Total Budget	\$307,618.22
MDOT FY 2023 Expenditures	\$0.00	Total Expenditures	\$0.00
* Project start was delayed		Total Amount Available	\$307,618.22

PURPOSE AND SCOPE

Transit agencies are introducing new, customer-facing technology such as software and technology systems used in mobile trip planning, ticketing, and payment processing. Meager budgets for marketing and public education result in low adoption of the technology, leading to MDOT-funded investments often being abandoned or under-utilized. There is also lack of realization of the potential benefits from use of the new technology such as improved customer experience, operating efficiencies, data collection opportunities, increased ridership, and better coordination. This research seeks to determine how to appropriately budget for marketing and education when launching a new transit technology, identify best practices for methods to use for marketing and public education regarding new transit technology, and identify the benefit to transit agencies when implementing new marketing and public education technology tools related to transit. This will be accomplished by completing a literature review of best practices for budgeting and marketing related to public transit, investigating current budgeting practices for marketing/education campaigns and marketing standards in used in Michigan and other states, analyzing budgeting and marketing gaps that could be addressed through best practices, identifying best practices and obstacles, and reviewing lessons learned from agencies that recently launched a new transit technology.

FISCAL YEAR 2023 ACCOMPLISHMENTS

Contracting for this project was delayed pushing the date to begin work into FY 2024.

FISCAL YEAR 2024 PROPOSED ACTIVITES

Stakeholder engagement meetings will begin and continue to be held periodically. Research activities and data collection will also begin. Interviews and surveys of transit agencies, along with DOT use cases will be completed. An outline for the final project report will be created.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project expected completion FY 2025.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2023**

PROJECT TITLE: Optimizing Work Zone Conditions to Maximize Safety and Mobility

FUNDING SOURCE: SPR, Part II OTHER (PLEASE EXPLAIN)

PROJECT MANAGER: Steve Brink and Dawn Miller

CONTRACT/AUTHORIZATION NO.	2023-0498	PROJECT START DATE	6/27/2023
PROJECT NO.	218404NI	COMPLETION DATE (Original)	6/27/2025
OR NO.	OR23-022	COMPLETION DATE (Revised)	
RESEARCH AGENCY	Michigan State University (MSU)		
PRINCIPAL INVESTIGATOR	Timothy J. Gates, Ph.D., P.E.		

BUDGET STATUS			
FY 2023 Budget		Total Budget	
Vendor Budget FY 2023	\$40,100.31	Total Vendor Budget	\$196,477.94
MDOT Budget FY 2023	\$7,750.00	Total MDOT Budget	\$23,250.00
Vendor FY 2023 Expenditures	\$8,123.61	Total Budget	\$219,727.94
MDOT FY 2023 Expenditures	\$0.00	Total Expenditures	\$8,123.61
		Total Amount Available	\$211,604.33

PURPOSE AND SCOPE

The purpose of this research is to identify which factors cause some work zones to have fewer crashes and perform better in safety and mobility than others, focusing mitigating crashes occurring within the work zone. The goal is to provide the safest working conditions while providing the best mobility for travelers, as well as identifying the most effective way of spending transportation funds to maximize safety and mobility in future work zones. This will be achieved by determining crash frequency and work zone crash rate by work zone area, providing crash performance of different work zone designs, identifying preferred setups to minimize crash risk, assessing cost effectiveness of different strategies, and determining work zone performance measures.

FISCAL YEAR 2023 ACCOMPLISHMENTS

Task 1a: Began literature review.
 Task 1b: Drafted survey of other states' best practices for work zone safety and mobility.
 Task 2b: Drafted survey for polling MDOT regions for work zone screening information for further review.

FISCAL YEAR 2024 PROPOSED ACTIVITES

Task 1a: Complete literature review.
 Task 1b: Develop survey for other states for best practices for work zone safety and mobility; complete survey for states. Complete synthesis of best practices and provide to MDOT for review.
 Task 2: Select MDOT work zones for review. Review configurations and work zone data. Complete analysis of safety performance within MDOT work zones.
 Task 3: Collect and analyze work zone driver behavioral and operational data.
 Task 4: Begin Synthesis of safety and mobility findings
 Task 5: Begin development of final report

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project expected completion FY 2025.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2023**

PROJECT TITLE: Unmanned Aircraft Systems Communications Mesh Test Deployment

FUNDING SOURCE: SPR, Part II OTHER (PLEASE EXPLAIN)

PROJECT MANAGER: Linn Smith

CONTRACT/AUTHORIZATION NO.	TBD	PROJECT START DATE	TBD
PROJECT NO.	219527NI	COMPLETION DATE (Original)	TBD
OR NO.	OR24-012	COMPLETION DATE (Revised)	
RESEARCH AGENCY	WSP of Michigan		
PRINCIPAL INVESTIGATOR	Paul Wheeler		

BUDGET STATUS

*FY 2023 Budget		Total Budget	
Vendor Budget FY 2023	\$35,895.37	Total Vendor Budget	\$717,907.42
MDOT Budget FY 2023	\$0.00	Total MDOT Budget	\$0.00
Vendor FY 2023 Expenditures	\$0.00	Total Budget	\$717,907.42
MDOT FY 2023 Expenditures	\$0.00	Total Expenditures	\$0.00
* Project start was delayed		Total Amount Available	\$717,907.42

PURPOSE AND SCOPE

In several deployments of Unmanned Aircraft Systems (UAS) and autonomous ground-based vehicle technology, a gap has been discovered when vehicles are transiting between locations that may have strong 4G/5G cellular communication availability and those locations that may have little. Several new technologies exploring the possibility of a communications mesh network have entered the market and may have strong benefit for a variety of connected and autonomous vehicle (air and ground) applications. This research explores the ability of this technology to support beyond visual line of sight unmanned aircraft deployments and may support ground-based applications as well. The selected team will research and field a test scenario of a communications mesh system in a remote environment, including specific locations over water, on remote islands, or other rural communities.

FISCAL YEAR 2023 ACCOMPLISHMENTS

Contracting for this project was delayed pushing the date to begin work into FY 2024.

FISCAL YEAR 2024 PROPOSED ACTIVITIES

The research team will obtain the necessary Federal Communications Commission (FCC), Federal Aviation Administration (FAA), state, and local operating approvals. They will also explore potential sites and finalize demonstration plans. Acquisition and modification of equipment necessary for demonstrations will also occur. A trial with conventional aircraft will be completed and it is expected that demonstration with UAS aircraft may begin.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project expected completion FY 2025.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2023**

PROJECT TITLE: TRB Forum on Preparing for Automated Vehicles and Shared Mobility (AV/SM Forum)

FUNDING SOURCE: SPR, Part II OTHER (PLEASE EXPLAIN)

PROJECT MANAGER: Andre Clover

CONTRACT/AUTHORIZATION NO.	N/A	PROJECT START DATE	10/1/2022
PROJECT NO.	219532NI	COMPLETION DATE (Original)	09/30/2025
OR NO.	OR23-025	COMPLETION DATE (Revised)	
RESEARCH AGENCY	National Academies of Sciences		
PRINCIPAL INVESTIGATOR	Director Brad Wierich		

BUDGET STATUS

FY 2023 Budget		Total Budget	
Vendor Budget FY 2023	\$25,000.00	Total Vendor Budget	\$75,000.00
MDOT Budget FY 2023	\$0.00	Total MDOT Budget	\$0.00
Vendor FY 2023 Expenditures	\$25,000.00	Total Budget	\$75,000.00
MDOT FY 2023 Expenditures	\$0.00	Total Expenditures	\$25,000.00
		Total Amount Available	\$50,000.00

PURPOSE AND SCOPE

The objective of this Forum is to bring public, private and research organizational partners together to discuss, identify, and facilitate fact-based research needed to deploy automated vehicles and shared mobility services in a manner and timeframe that informs policy to best meet long-term goals. These long-term goals include increasing safety, reducing congestion, enhancing accessibility, increasing sustainability, and encouraging economic development and equity. National Academies' Forums are supported by financial contributions from sponsoring organizations with a minimum two-year commitment preferred.

FISCAL YEAR 2023 ACCOMPLISHMENTS

Meetings were held with member participants and issues associated w/AVs and shared mobility services were identified. Development of a research roadmap that identifies research highest priorities was supported and research outcomes were shared that meet long term policy goals. Papers were commissioned that help provide Forum members with new perspectives for discussion. Also sponsored sessions at TRB's Automated Vehicle Symposium.

FISCAL YEAR 2024 PROPOSED ACTIVITES

Continue to focus on impacts on safety, potential adverse impacts on safety due to AVs use, liability of AVs, and safe operations of commercial vehicles. Address social, environmental, energy, and economics impacts of Avs and identify data needs, concerns, and issues, along with protocols for data sharing and management associated with freight supply chains.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project expected completion FY 2025.

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100% FEDERALLY FUNDED PROJECTS

Sequentially Listed by TPF Number

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**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2023**

STUDY TITLE: Development of a Winter Maintenance Decision Support System (Phase 3)

FUNDING SOURCE: FHWA OTHER (PLEASE EXPLAIN)

TPF NO.	Sol. 1562	MDOT START DATE	Under Solicitation
PROJECT NO.	OR22-210	MDOT COMPLETION DATE (Original)	9/30/2027
		ESTIMATED COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Tim Croze 517-243-5977 Email: CrozeT@michigan.gov		
LEAD AGENCY	South Dakota DOT		
PROJECT MANAGER	David Huft 605-773-3358 Email: dave.huft@state.sd.us		
CONTRACTOR			

BUDGET STATUS					
FY 2023 MDOT Budget			MDOT Total Budget		
FY FUNDS	(Original)	\$30,000.00	TOTAL BUDGET	(Original)	\$90,000.00
	(Revised)	\$0.00		(Revised)	
TOTAL FY 2023 EXPENDITURES		\$0.00	TOTAL COMMITTED FUNDS AVAILABLE		\$60,000.00

PARTICIPATING STATES

CT, IL, MI, ND, SD, WI

PURPOSE AND SCOPE

The overall objective is to continue development and trial deployment of a winter maintenance decision support system. Detailed objectives are to:

1. To assess the need, potential benefit, and receptivity in participating state transportation departments for state and regional Maintenance Decision Support Systems.
2. To define functional and user requirements for an operational Maintenance Decision Support System that can assess current road and weather conditions, forecast weather that will affect transportation routes, predict how road conditions will change in response to candidate maintenance treatments, suggest optimal maintenance strategies to maintenance personnel, and evaluate the effectiveness of maintenance treatments that are applied.
3. To build and evaluate an operational Maintenance Decision Support System that will meet the defined functional requirements in the participating state transportation departments.
4. To improve the ability to forecast road conditions in response to changing weather and applied maintenance treatments.

Research tasks include:

1. Meet with the project's technical panel to refine the project scope and work plan.
2. Critically evaluate the results of the Federal Highway Administration's project to develop a prototype operational Maintenance Decision Support System.
3. Interview front-line and mid-level maintenance supervisors from each of the participating states to identify and prioritize needs for maintenance support functionality.
4. Assess the participating states' current and near-term capability to report current roadway conditions and track maintenance activities on specific highway routes.
5. Assess institutional receptivity to maintenance management decision support in the participating states and recommend actions to overcome potential barriers.

-
6. Based on results of previous tasks, propose in a technical memorandum to the project's technical panel the high-level functional and user requirements for an operational Maintenance Decision Support System and propose an architectural framework for the system. Separately identify those requirements that can be immediately satisfied and those that will require fundamental research.
 7. Prepare for approval of the project.

FISCAL YEAR 2023 ACCOMPLISHMENTS

Still under solicitation. The proposed project target budget has not been reached with pledge commitment. Thus, FHWA approval still pending.

FISCAL YEAR 2024 PROPOSED ACTIVITIES

FHWA project approval/assign TPF federal project number and partners transfer funds to lead agency to secure a research vendor.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Expected project completion FY 2027.

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2023**

STUDY TITLE: Mid-America Association of State Transportation Officials (MAASTO) Connected Automated Vehicle (CAV) Steering Committee

FUNDING SOURCE: FHWA OTHER (PLEASE EXPLAIN)

TPF NO.	Sol. 1598	MDOT START DATE	Under Solicitation
PROJECT NO.	OR23-309	MDOT COMPLETION DATE (Original)	
		COMPLETION DATE (Revised)	9/30/2027
MDOT TECHNICAL CONTACT	Niles Annelin and Elise Feldpausch		
LEAD AGENCY:	Michigan Department of Transportation		
PROJECT MANAGER	Niles Annelin and Elise Feldpausch		
CONTRACTOR			

BUDGET STATUS

FY 2023 MDOT Budget			MDOT Total Budget		
FY FUNDS	(Original)	\$30,000.00	TOTAL BUDGET	(Original)	\$150,000.00
	(Revised)			(Revised)	
		\$0.00			\$150,000.00

PARTICIPATING STATES

ABBREVIATE THE PARTICIPATING STATES. IF MDOT IS THE LEAD AGENCY, ALSO LIST THE CONTRIBUTION PERCENTAGE PER STATE.

IL, IN, KS, MI, MN, MO, OH, WI

PURPOSE AND SCOPE

As connected/automated vehicle (CAV) technology and cooperative/automated transportation (CAT) sectors advance, several states have established programs or designated staff to plan and prepare for the changes these technologies bring to transportation. The objective of this study is to provide as needed engineering and/or technical support services for the research, development, deployment, operations, and maintenance of CAV technology, along with advancing various CAV related initiatives. The Mid-America Association of State Transportation Officials (MAASTO) Board unanimously nominated MDOT to lead this initiative to support a collaborative research and project consortium on the topic of CAV technology that will focus on a common direction for the participating states in the Region with consideration for shared values of safety, sustainability, equity, and mobility.

As lead agency, MDOT will perform the program's required administrative duties and tasks, in compliance with the federal program's administrative regulations/laws and guidance.

Committee Major Tasks:

- Develop a CAV regional strategy.
- Direct and guide collaborative information sharing among the member states.
- Review/assess past and present research and testing partnerships and active pooled fund projects, relating to CAV technologies.
- Uniform policies and laws.
- Outreach and education.
- Coordinated policy and pilot projects.
- Organizational alignment and coordination.
- Establishing the "Midwest" region as a leader in CAV.
- A unified vision for CAV.

FISCAL YEAR 2023 ACCOMPLISHMENTS

Still under solicitation. The proposed project target budget has not been reached with pledge commitment. Thus, FHWA approval still pending.

FISCAL YEAR 2024 PROPOSED ACTIVITIES

FHWA project approval/assign TPF federal project number and partners transfer funds to lead agency to secure a research vendor.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Project expected completion FY 2027.

**RESEARCH ADMINISTRATION
TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2023**

STUDY TITLE: AASHTO Engineering Technical Service Programs

FUNDING SOURCE: FHWA OTHER (PLEASE EXPLAIN)

TPF NO.		MDOT START DATE	10/1/2022
FEDERAL PROJECT NO.	SPR1801(179)	MDOT COMPLETION DATE (Original)	9/30/2023
OR NO.	OR23-202	COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Andre Clover, 517-749-9001 CloverA@michigan.gov		
LEAD AGENCY:	American Association of State Highway and Transportation Officials (AASHTO)		
PROJECT MANAGER	Various - Based on technical focus matter		
CONTRACTOR	Not Applicable		

BUDGET STATUS

FY 2023 MDOT Budget			Total Budget		
FY Budgeted Funds	(Original)	\$150,000.00	TOTAL COST	(Original)	\$150,000.00
FY Billed Invoices	(Revised)	\$195,000.00		(Revised)	\$195,000.00
		\$195,000.00	TOTAL COMMITTED FUNDS AVAILABLE		\$0.00

*Includes \$15,000.00 for the addition of the AASHTO FY23 Operations Technical Services Program

PARTICIPATING STATES

Not applicable.

PURPOSE AND SCOPE

As a general practice MDOT technical experts each year analyze the benefits to MDOT of services and information shared by TRB's Technical Service Programs. The programs provide benefits to the member departments through the pooling of resources and expertise from across the country.

MDOT has the opportunity to support the development and continued operation of each of the following critical programs:

- AASHTO Innovation Initiative (A.I.I.) /Technology Implementation Group (TIG) - \$6,000.
- Development of AASHTO Materials Standards (DAMS) - \$10,000.
- Environmental Technical Assistance Program (ETAP) - \$10,000.
- Transportation Curriculum Coordination Council (TC3) - \$20,000.
- Snow and Ice Cooperative Program (SICOP) - \$4,000.
- Transportation System Preservation (TSP2) - \$20,000.
- Equipment Management Technical Services Program (EMTSP) – \$5,000.
- National Transportation Product Evaluation Program (NTPEP) - \$25,000.
- Highway Safety Policy and Management TSP (SAFETY) - \$10,000.
- Load and Resistance Factor Design (LRFD) Bridges and Structures Specification Maintenance (LRFDSM) - \$15,000.
- Operations TSP (NOCOe) - \$30,000.
- CTSO Operations TSP- \$15,000.
- Design Publication Maintenance (DPM) - \$15,000.
- Manual for Assessing Safety Hardware (MASH) Technical Support- \$10,000.

FISCAL YEAR 2023 ACCOMPLISHMENTS

The Subject Matter Expert's (SME's) recommendations were approved by MDOT's Director. SME's shared technology advancements, new improvements, and championed implementation efforts throughout the Department during FY 2023.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Each fiscal year, MDOT will review and assess the return on its investment to the list of AASHTO TSP programs noted above. If value is added and the program benefits MDOT, the experts will continue to recommend contributions continue. If value is not being served from a particular program, MDOT may choose to discontinue its contribution.

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2023**

STUDY TITLE: Highway Safety Manual Implementation

FUNDING SOURCE: FHWA OTHER (PLEASE EXPLAIN)

TPF NO.	TPF-5(255)	MDOT START DATE	11/9/2015
PROJECT NO.	Not Applicable	MDOT COMPLETION DATE (Original)	12/31/2019
OR NO.	OR15-527	COMPLETION DATE (Revised)	12/31/2025
MDOT TECHNICAL CONTACT	Mark Bott 517-335-2625 BottM@michigan.gov		
LEAD AGENCY	Federal Highway Administration (FHWA)		
PROJECT MANAGER	Matthew Hinshaw matthew.hinshaw@dot.gov		
CONTRACTOR	Louisiana Transportation Research Center		

BUDGET STATUS				
FY 2023 MDOT Budget			MDOT Total Budget	
FY FUNDS	(Original)	\$0.00	TOTAL BUDGET	(Original) \$100,000.00
	(Revised)			(Revised)
TOTAL FY 2023 EXPENDITURES		\$0.00	TOTAL COMMITTED FUNDS AVAILABLE	\$0.00

PARTICIPATING STATES

Louisiana Transportation Research Center, CA, CT, ID, IL, KS, KY, LA, MI, MO, MS, NC, NJ, NV, OH, OK, OR, PA, TX, UT, WA

PURPOSE AND SCOPE

The objectives of the study are (1) to advance ongoing efforts by lead states to implement the Highway Safety Manual (HSM), and (2) to expand implementation to all states. This study would be coordinated with other ongoing and planned implementation activities sponsored by AASHTO, FHWA, and TRB, including NCHRP Project 17-50 "Lead States Initiative for Implementing the Highway Safety Manual" It will also be coordinated with projects that develop content for future editions of the HSM including NCHRP Project 17-45 "Enhanced Safety Prediction Methodology and Analysis Tool for Freeways and Interchanges" NCHRP Project 17-54 "Consideration of Roadside Features in the Highway Safety Manual" and Transportation Pooled-Fund Study TPF-5(099) "Evaluation of Low Cost Safety Improvements."

This study would conduct research tasks and develop products that would enable States to accelerate their implementation of the HSM. The specific tasks and products would be identified and prioritized by a Technical Working Group consisting of one representative each from participating agencies. Specific tasks may include: (1) developing a calibration manual to accompany the HSM that provides practical advice and examples on how best to adapt HSM calibration procedures to meet the needs of a particular agency, (2) developing technical guidance for agencies on developing safety performance functions, and (3) developing guidance for agencies on assembling and managing the data needed for safety analyses.

The study would also facilitate Technical Working Group representative's participation in peer exchanges and other forums through which agencies can exchange information, best practices, lessons learned, and remaining challenges in implementing the HSM appropriately into agencies' system planning, project planning and preliminary engineering, design and construction, and operations and maintenance procedures and processes. These exchanges would feed an annual process through which the Technical Working Group identifies and prioritizes future tasks to be conducted under the study.

FISCAL YEAR 2016 ACCOMPLISHMENTS

- A finalized list of State-adapted HSM Part C spreadsheets based upon input from State representatives was developed for posting at the Crash Modification Factor (CMF) Clearinghouse.
- A finalized a list of state developed or calibrated Safety Performance Functions (SPFs) based upon feedback from state representatives was developed for posting at the CMF Clearinghouse.
- A preliminary analysis comparing State developed SPFs and State calibration factors was conducted for HSM SPFs as a first step in an evaluation of the feasibility of a "quick and dirty" method that States could use to determine whether an existing SPF may be suitable for use in the State without calibration.
- The "Model State Policies and Procedures for Use of HSM" contractor delivered the draft final report on June 13, 2016. State representatives and FHWA staff provided review comments on July 5, 2016.
- The "Scale and Scope of HSM Implementation in the Project Development Project" contractor delivered the 3rd draft of the final report on June 19, 2016. State representatives and FHWA staff review comments are due July 15.
- Held a virtual quarterly business meeting on May 16, 2016.
- The payoff from participating in this pooled-fund study is minimizing duplication of efforts by all the states and maximizing our resources based on national priorities of delivering products that support the implementation of the HSM.

FISCAL YEAR 2017 ACCOMPLISHMENTS

- Virtual meetings were held on May 22 and June 27, 2017
- At the June 27th meeting participants provided feedback on the Life Cycle Benefit–Cost Analysis guide and an overview of an existing spreadsheet tool. The group is going through modifications of the tool to perform economic analysis of safety projects.
- A draft of the Safety Performance for Intersection Control Evaluation (SPICE) tool was developed and presented for feedback to state representatives.
- Modifications are being made to the Network Screening Best Practices contract for the NCHRP 17-50 project to enable the contractor to perform work for this study.

FISCAL YEAR 2018 ACCOMPLISHMENTS

Meetings held on January 26 and April 5, 2018. As part of the Highway Safety Benefit Cost analysis tool, the Crash Cost Values report was finalized and is posted at <https://safety.fhwa.dot.gov/hsip/docs/fhwasa17071.pdf>. A Safety Benefit Cost Analysis Guide was completed. A Safety Benefit Cost Analysis (BCA) Tool was finalized. The reports and tool are available online. SPICE version 2.0 was completed and is currently undergoing testing. Safety Analysis Needs Assessment for Performance Based Practical Design (PBPD) and Transportation Systems Management and Operations (TSMO) project draft report was disseminated via webinar in April. Comments were received in May.

FISCAL YEAR 2019 ACCOMPLISHMENTS

The lead agency conducted a project progress meeting with Technical Advisory Committee (TAC) members on May 29, 2019. The peer exchange summary report was completed and posted to pooled fund website. Safety Analysis Needs Assessment for PBPD and TSMO 3rd draft was completed and disseminated in May 2019. Ideas solicited and discussed for future projects.

FISCAL YEAR 2020 ACCOMPLISHMENTS

Meeting held on April 22, 2020. Two final reports presented, and practical approaches guides on Safety Analysis Needs Assessment for PBPD and TSMO. These projects are completed. Further updates were discussed on HSM case Studies, Development of a Data Dictionary was researched, and a statement of work was prepared to be awarded by fall 2020. Development of a Safety Countermeasures Service Life Guide a was awarded, and a kickoff meeting was held on July 6th.

FISCAL YEAR 2021 ACCOMPLISHMENTS

- Meeting held on May 6, 2021.
- Safety Countermeasure Service Life Guide was completed in April 2021
- Continued work on HSM Case studies highlighting projects in Michigan, Wisconsin, Massachusetts, Alabama, and others.
- Continued work on the need for a data dictionary.
- MDOT fulfilled its pledge commitment in FY 2019 and remain an active partner state DOT.
- FHWA will begin work to initiate a new HSM2 Implementation Fund Study anticipated to begin July 2022.

FISCAL YEAR 2022 ACCOMPLISHMENTS

- A kickoff meeting for the Advancing Applications of DDSA task order which included three primary tasks – 1) use of multiple analysis methods in alternatives analysis, 2) implementation approaches for NCHRP 17-62 (Improved prediction Models for Crash Types and Severities), and 3) communications guide for explaining safety analysis to non-safety professionals was held with the contractor (VHB) on April 26. Draft outlines for Tasks 2 and 3 were created and updated based on two rounds of review and comment. Work on all three tasks is progressing.
- The contractor (VHB) on the Data and Analysis Case Studies project has completed three case studies (District of Columbia, Arizona, and Florida) which will be posted to the FHWA RSDP case studies website soon. California and Vermont have been developed and are under review. The purpose of the project is to share information to overcome challenges faced by users attempting to perform HSM project-level safety performance analysis. <https://highways.dot.gov/safety/data-analysis-tools/rsdp/safety-data-case-studies> 14 are posted and 6 more will be posted in the next couple of months.
- On April 22, FHWA posted a new transportation pooled fund solicitation to create a Highway Safety Manual Second Edition (HSM2) Implementation pooled fund, anticipated to begin in 2023.

FISCAL YEAR 2023 ACCOMPLISHMENTS

- Advancing Applications of DDSA project - The contractor (VHB) continued work on all three primary tasks – 2) use of multiple analysis methods in alternatives analysis, 3) implementation approaches for NCHRP 17-62 (Improved Prediction Models for Crash Types and Severities), and 4) communications guide for explaining safety analysis to non-safety professionals. All tasks being reviewed.
- Held first panel meeting for NCHRP 17-127 (Practitioner's Application Guide to the Highway Safety Manual) The objective of this research is to develop a practitioner's guide on the use of the HSM-2 for system planning, project planning, preliminary engineering, final design, construction, maintenance, and operations applications by identifying proper methods and applications and illustrating them with case studies.
- Developed research statements for consideration in 2024.
- Planning started for 2024 Peer Exchange in support of HSM 2nd Edition implementation TPF-5(516)

FISCAL YEAR 2024 PROPOSED ACTIVITIES

- Work on this PF will be done in conjunction with TPF-5(516).
- With new HSM edition will implement Call for Projects schedule calling for two new projects per year.
- Develop pool fund study project idea repository. Such ideas are incorporating the Safe System Approach into the HSM, HSM screening tool, evaluating impact of adopting of HSM among the states.
- Resurrect the SPF Clearinghouse.
- Select and implement research project statements submitted for 2024.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

Based on the last quarterly report, this project will be extended upon FHWA action.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Expected project completion FY 2025.

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2023**

STUDY TITLE: Evaluation of Low-Cost Safety Improvements

FUNDING SOURCE: FHWA OTHER (PLEASE EXPLAIN)

TPF NO.	TPF-5(317)/TPF-5(515)	MDOT START DATE	10/1/2019
PROJECT NO.	OR20-209	MDOT COMPLETION DATE (Original)	9/30/2022
		COMPLETION DATE (Revised)	9/30/2023
MDOT TECHNICAL CONTACT	Mark Bott 517-335-2625 BottM@michigan.gov		
LEAD AGENCY:	Nevada DOT		
PROJECT MANAGER	Kim Woon woon.kim@fhwa.dot.gov		
CONTRACTOR			

BUDGET STATUS

FY 2023 MDOT Budget			MDOT Total Budget		
FY FUNDS	(Original)	\$50,000.00	TOTAL BUDGET	(Original)	\$40,000.00
	(Revised)			(Revised)	\$90,000.00
		\$50,000.00			\$0.00

PARTICIPATING STATES

AL, AR, AZDOT, CA, CO, CT, DC, FL, GADOT, IADOT, IL, IN, KS, KY, LA, MA, MDOT SHA, ME, MI, MN, MO, MS, MT, NC, ND, NE, NHDOT, NV, NY, OH, OK, OR, PADOT, RI, SC, SD, TN, TX, UT, VA, WA, WI, WY.

PURPOSE AND SCOPE

FHWA has initiated the Low-Cost Safety Improvements study to encompass safety-effectiveness evaluations of priority strategies from the NCHRP Report 500. The goal of the proposed research is to develop reliable estimates of the safety effectiveness of safety improvements identified as strategies in the NCHRP Report 500 and guidebooks through scientifically rigorous "Before"- "After" (B/A) evaluations of sites within the U.S. where these strategies are being implemented. The data for the study will be gathered from those states that implement the strategies throughout the US. The methodology utilized will typically be an Empirical Bayes evaluation or other appropriate method, using B/A data to help determine their effectiveness in reducing the number and severity of crashes. The data will be collected, evaluation studies will be performed as strategies are implemented over the course of several years.

Originally a target of 20 strategies totaling \$4.38 million over 5 years was planned for ELCSI-PFS studies in four phases. Currently, this study has outperformed its original goals, and has added four extra phases for a total of eight phases. The original budget of \$4.38 million remains the same. To provide much needed reliable measures for effectiveness of various low-cost safety improvements, this study's performance period has been extended beyond the initial date of 2017. This pooled fund study has contributed over 800 CMFs to the CMF Clearinghouse. This effort is on-going.

FISCAL YEAR 2020 ACCOMPLISHMENTS

- Safety Evaluation of Flashing Yellow Arrows at Signalized Intersections
- Development of Crash Modification Factors for High Friction Surface Treatments (HFST)
- HFST Quick Reference
- Safety Evaluation of Pedestrian Countdown Signals

All of these provide useful information for MDOT to further define our approach to safety. HFST is an area MDOT wants to expand use of and with this information we can make efficient decisions.

FISCAL YEAR 2021 ACCOMPLISHMENTS

The annual meeting was held June 28, 2021. ELCSI-PFS, PHASE X COMPLETED

- This phase was modified for no-cost POP extension to accommodate publication needs and completed July 2021.
- Variable speed limits (VSL).
- Safety Evaluation of Roadside for: Light Poles, Guardrails, and Side Slope Flattening.

FISCAL YEAR 2022 ACCOMPLISHMENTS

The 2022 Annual Technical Advisory Committee (TAC) meeting was conducted virtually on May 25-26, 2022. All presentations and documents were shared with the TAC members by emails and on the Contractor (TTI) website after the meeting.

ELCSI-PFS, PHASE XIII

The FHWA awarded the PHASE XIII task order to the Texas A&M, Transportation Institute (TTI) in July of 2022.

This task order will study:

- Curve Enhanced Delineation (CED),
- Alternative Rumble Strip (ARS), and

- Fixed Objects Delineation of (FOD).
This task order's kickoff meeting is on August 17, 2022.
The Phase XIII is funded by the FHWA and the ELCSI-PFS.

ELCSI-PFS, PHASE XII

Innovative Intersection Design for Pedestrian and Bicycle Safety completion Date is October 30, 2022.

This phase is active. The highlights for this quarter progress are:

- Continued reducing the video data at the three sites in Washington DC.
- Continued to reduce the aerial video data. □
- Explored the possibility of obtaining right-turn speed from the sites with before and after data.
- Received bids for drone video for the Silver Spring, MD site. Selected vendor.
- Met with Montgomery County and the drone vendor to discuss data collection in Silver Spring, MD.

ELCSI-PFS, PHASE XI

This task is in progress (completion on 08/30/22). All deliverables were received, and publication process has started for following studies:

- Safety Evaluation of Mini-Roundabouts.
- Safety Evaluation of Bike Lane Configurations at Intersections.
- Safety Evaluation of Wrong Way Driving (WWD) Low-Cost Safety Improvements.
- Wrong-Way Driving Research and Technical Resources' Workshop (virtual) was conducted on March 9-10, 2022.

The ELCSI-PFS, Phase XI is mostly funded by the FHWA, DCMF program, and Intersection Road map.

PUBLICATIONS

Publications for Phase XI are in progress and expected to be completed by October 2022.

Please see list of all ELCSI-PFS with links at; <https://highways.dot.gov/research/safety/evaluations-low-cost-safety-improvements-pooled-fund-study/publications>

FISCAL YEAR 2023 ACCOMPLISHMENTS

- The 2023 Annual Technical Advisory Committee (TAC) meeting was conducted virtually on July 31st and August 7th. All presentations and documents were shared with the TAC members by emails and on the Contractor (TTI) website after the meeting.
- Solicitation on going for future projects.
- ELCSI-PFS' old number TPF-5(317) is pending project close out and a new pooled fund project number, TPF-5(515) has been created. FHWA Acceptance Memo dated May 8, 2023.

FISCAL YEAR 2024 PROPOSED ACTIVITIES

Planning and holding the 2024 Annual Technical Advisory Committee (TAC) meeting.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

The Evaluation of Low-Cost Safety Improvements pooled fund study has been invaluable to both MDOT and the staff in the Safety Programs area. The annual meeting allows various staff members to attend to learn new and improved low-cost safety improvements and more importantly to network with fellow DOTs and researchers. From these meetings MDOT has expanded on its research of Crash Reduction Factors for our roadways, piloted wrong way electronic devices, developed mini roundabout criteria, established signing standards for all way and two way stops on high-speed non-freeways, increased delineation and sought further safety tools for pedestrians and bicyclists, a heightened awareness area for the department. We have also shared our successes with rumble strips, wider edge lines and reflective strips on signposts with other DOTs. We will continue to review the results of the various studies and support all future research as they can shape the safety program in Michigan.

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2023**

STUDY TITLE: Roadside Safety Research for Mash Implementation

FUNDING SOURCE: FHWA OTHER (PLEASE EXPLAIN)

TPF NO.	TPF-5(343)	MDOT START DATE	10/1/2016
TPF- SOLICITATION NO.	1424	MDOT COMPLETION DATE (Original/ Revised)	12/31/2018
OR NO.	OR15-528	COMPLETION DATE (Pending Revision) *	12/31/2023
MDOT TECHNICAL CONTACT	Carlos Torres, 517-355-2852 TorresC@michigan.gov		
LEAD AGENCY:	Washington DOT		
PROJECT MANAGER	Mustafa Mohamedali 360-704-6307 MOHAMEM@wsdot.wa.gov		
CONTRACTOR			

BUDGET STATUS

FY 2023 MDOT Budget			MDOT Total Budget		
FY FUNDS	(Original)	\$0.00	TOTAL BUDGET	(Original)	\$220,000.00
	(Revised)	\$0.00		(Revised)	\$270,000.00
		\$0.00			\$0.00

PARTICIPATING STATES

AK, AL, CA, CO, CT, DE, FL, IADOT, ID, IL, LA, MA, MDOT SHA, MI, MN, MO, MS, NM, OH, OK, OR, PADOT, TN, TX, UT, WA, WI, WV.

PURPOSE AND SCOPE

The objective of the Roadside Safety Pooled Fund Program is to provide a cooperative, cost-effective, and efficient approach to conducting research on roadside safety hardware meeting the functional needs of participating states. Emphasis will be placed on assisting state DOTs with their implementation of the Manual for Assessing Safety Hardware (MASH), transition to the use of MASH-compliant roadside safety devices in lieu of current National Cooperative Highway Research Program (NCHRP) 350-compliant devices as mandated in the revised Federal Highway Administration (FHWA) - American Association of State Highway Transportation

Officials (AASHTO) Joint Implementation Plan and addressing other roadside safety needs of common interest. Another objective of this pooled fund research is to provide each participating state an opportunity to send a representative to an annual meeting to collaborate with other state DOT safety engineers to assess best practices, new regulatory issues, risk management strategies, and other matters pertaining to roadside safety. Roadside Safety Pooled Fund members will meet, review potential projects for inclusion as part of future MASH crash testing projects, develop a work plan that involves selecting projects for future MASH crash testing, and designate individuals that will serve as team leaders for overseeing these projects.

Specific research activities expected to be addressed within the program include the design, analysis, testing, and evaluation of crashworthy structures, and the development of guidelines for the use, selection, and placement of these structures. Crashworthy structures include bridge railings, guardrails, transitions, median barriers, cable barriers, temporary concrete barriers, end treatments, crash cushions (impact attenuators), culverts, breakaway support structures (e.g., sign supports, luminaire supports, mailboxes), and work zone traffic control devices. In addition, research is expected to address the influence of highway features such as driveways, slopes, ditches, shoulders, medians, and curbs on single vehicle collisions.

FISCAL YEAR 2016 ACCOMPLISHMENTS

Completed the following projects:

- MASH Transition from F-Shape Temporary Concrete Barrier Pinned on Asphalt to Rigid Single-Slope Concrete Barrier
 - Test Report No. 605641-1; Test Report Date: January 2016
 - Benefit: Provides insight on methods to anchor temporary concrete barrier to permanent concrete barrier.
- Guidebook for Use of Pinned-Down Temporary Concrete Barriers in Limited Space Applications
 - Test Report No. 605071-1; Test Report Date: April 2016
 - Benefit: Provides insight on an alternative limited deflection temporary concrete barrier system that meets MASH.
- MASH Finite Element Analysis and Full-Scale Crash testing of Stacked W-Beam Transition for 31-inch Guardrail
 - Test Report No. 604581-1; Test Report Date: May 2016
 - Benefit: Provides information on a MASH-compliant guardrail anchorage that MDOT could use if desired.

The Michigan Department of Transportation (MDOT) joined the Roadside Pooled Fund in mid-2016 and the first Roadside Safety Pooled Fund meeting with MDOT participation is slated to take place in late October 2016. As a result, there was no input or involvement from MDOT in the three completed projects identified above.

FISCAL YEAR 2017 ACCOMPLISHMENTS

Completed Projects:

- Barrier Deflection Characteristics of 31-inch W-Beam Guardrail Systems with 8-inch Blockouts.
 - Test Report No. 603481; Test Report Date: February 2017.
 - Benefit: Provides some insight on impact deflection characteristics for Type MGS-8 guardrail.
- Guidance for Raising Beam Guardrail Composite Blockout for Rail Height Adjustment.
 - Test Report No. TM-605311; Test Report Date: February 15, 2017.
 - Benefit: Provides additional insight regarding guardrail height adjustments.

Pooled Fund Scorecard Development

The pooled fund, in conjunction with TTI, is in the process of developing scorecards for prioritizing MASH testing and evaluation of roadside safety devices. A scorecard (scorecard #1) was completed for guardrail and cast-in-place, permanent concrete barrier systems.

FISCAL YEAR 2018 ACCOMPLISHMENTS

Pooled Fund Scorecards

The pooled fund, in conjunction with TTI, developed and completed a series of scorecards for prioritizing MASH testing and evaluation of roadside safety devices. The following scorecards were completed:

- #2: Guardrail terminals, cable barrier systems, and impact attenuators
- #3a: Transitions
- #3b: Portable barriers
- #3c: Other longitudinal barriers
- #3d: All other terminals
- #3e: Bridge railings

Completed Projects

- Keyed-In, Segmented, Single Slope Reinforced Permanent Concrete Barrier
 - Objective: Perform a MASH, TL-4 (Test 4-12) crash test on a 120-foot-long installation (consisting of three 40-foot segments with no connections between adjacent segments) of 42" tall, Texas DOT (TxDOT), reinforced single slope permanent concrete barrier keyed into 1" thick asphalt pavement.
 - Results: The barrier successfully passed MASH Test 4-12. MASH Tests 4-10 (small car) and 4-11 (pickup truck) were not performed due to successful past testing.
- MASH Testing of Oregon DOT, F-Shape Temporary Concrete Barrier (TCB) Pinned to Concrete Pavement
 - Objectives: Determine a suitable offset between the TCB and the edge of the concrete pavement, and perform a MASH, TL-3 (Test 3-11) crash test on the pinned TCB with the selected offset from the edge of pavement. The F-shape TCB design used on this project was the Oregon DOT, F-shape TCB design.
 - Results: A 9-inch (minimum) offset was determined to be suitable for the design to meet MASH, TL-3 requirements when pinned to an 8-inch thick (minimum) concrete pavement. The barrier successfully passed MASH Test 3-11 with a 9-inch offset from the edge of pavement and pinned to an 8-inch-thick concrete pavement.
- 31-inch Tall Buried-in-Backslope (BIB) Terminal Compatible with MGS Guardrail
 - Objective: Develop a 31" tall buried-in-backslope that is compatible with MGS guardrail, MASH, TL-3 compliant, and suitable for installation on a V-ditch with a 1:4 or flatter foreslope, and a 1:2 or flatter backslope.
 - Results: The BIB terminal successfully passed MASH Tests 3-34 and 3-35.
- MASH TL-3 T-Intersection (Short Radius) System Design Variations (Project Ended on 8/31/18)

A meeting was held in September 2018 in Denver, Colorado with the pooled fund member states and TTI to discuss ongoing projects and select and prioritize future projects.

FISCAL YEAR 2019 ACCOMPLISHMENTS

MASH Testing of W-beam Guardrail in Concrete Mow-Strip

- Objectives: Determine MASH, TL-3 compliance of Type MGS-8 guardrail, with wood and steel posts, as installed in a concrete mow strip.
- Results: Both MASH, TL-3 tests (i.e., tests 3-10 and 3-11) involving the steel post version of Type MGS-8 guardrail passed. However, with the wood post version of Type MGS-8 guardrail, only test 3-10 (i.e., small car test) passed. Test 3-11 (i.e., pickup truck test) failed. A subsequent test (3-11) was performed using a shorter (36" long) wood post, and this test also resulted in a failure. Therefore, additional research is needed to determine if Type MGS-8 guardrail with wood posts can meet MASH, TL-3 criteria when placed in a concrete mow strip.

FISCAL YEAR 2020 ACCOMPLISHMENTS

Completed Projects

- T4541-DA: Administrative Support
- T4541-DI: Determination of Pedestrian Rail Offset Requirements to Eliminate Vehicle Interaction
- T4541-DS: 2019 Travel and Meeting Assistance
- T4541-CU: 2018 MASH Coordination Effort

Ongoing Projects

- Engineering Support Services and Recommendations for Roadside Safety Issues/Problems for Member States
- Testing of MGS System with Reduced Post Spacing for MASH Compliance
- Testing and Evaluation of the MGS System with Maximum Flare at MASH Test
- Thrie-Beam/W-Beam/Tubular Barrier Gap Rail for MASH TL-3
- Placement of Guardrail on Slopes Phase IV: MASH TL-3 Testing of Guardrail
- MASH TL-3 Transition Design with a Storm Drain Inlet
- MASH Coordination Effort
- Testing and Evaluation of Large Sign Slipbase Support on Slope at MASH Test Level 3 Impact Conditions

9. MASH TL-4 Investigation and Testing of the Critical Flare Rate for Cast-in-Place Single Slope 42" Concrete Barrier Flaring around a Fixed Object
10. Review and Investigation of W-Beam Guardrail Terminals with Curbs

Approved Projects

1. Shorter TL-3 MASH W-Beam Transition
2. MASH TL-4 Testing and Evaluation of a Concrete Median Barrier with Fence Mounted on Top of Barrier
3. MASH TL-3 Testing of Guardrail on 6H:1V Slope
4. Length of Need (LON) for Guardrail without Anchorage: Phase 1

FISCAL YEAR 2021 ACCOMPLISHMENTS

Completed Projects

1. 2020 MASH Implementation Support
2. 2020 Administrative Support
3. Engineering Support Services and Recommendations for Roadside Safety Issues/Problems for Member States
4. Testing of Midwest Guardrail Systems with Reduced Post Spacing for MASH Compliance
5. MASH TL-4 Investigation and Testing of the Critical Flare Rate for Cast-in-Place Single Slope 42" Concrete barrier Flaring Around a Fixed Object
6. MASH TL-4 Testing and Evaluation of a Concrete Median Barrier with Fence Mounted on Top
7. T4541-CR: Placement of Guardrail on Slopes Phase IV: MASH TL-3 Testing of Guardrail
8. T4541-DT: Determination of the Length-of-Need for Guardrail Without Anchorage: Phase 1

Ongoing Projects

1. 2021 MASH Implementation Support
2. 2021 Administrative Support
3. T4541-CV: Testing and Evaluation of the MGS System with Maximum Flare at MASH Test
4. T4541-CW: Testing of Midwest Guardrail Systems with Reduced Post Spacing for MASH Compliance
5. T4541-CZ: Thrie/W-Beam/Tubular Barrier Gap Rail for MASH TL-3
6. T4541-DB: Engineering Support Services and Recommendations for Roadside Safety Issues/Problems for Member States
7. T4541-DJ: Testing and Evaluation of Large Signs Slipbase Support on Slope at MASH TL-3 Impact Conditions
8. T4541-DL: A Study of Guardrail Placement on 6:1 Slope
9. T4541-DN: MASH TL-4 Testing and Evaluation of a Concrete Median Barrier with Fence Mounted on Top
10. T4541-DO: Shorter TL-3 MASH W-Beam Transition
11. T4541-DQ: 2019 MASH Coordination Effort
12. T4541-DV: Study of Acceptable Sidewalk Heights and Widths
13. T4541-DW: Design and Testing of a Thrie-Beam Guardrail System at a Fixed Object
14. T4541-DX: Design and Testing of a MASH TL-3 Thrie-Beam System for Roadside and Median Applications
15. T4541-DY: MASH TL-3 Transition Design with a Storm Drain Inlet
16. T4541-DZ: Determination of the Length-of-Need for Guardrail without Anchorage: Phase 2
17. T4541-EA: Development of a Thrie-Beam Retrofit for Upgrading Obsolete Bridge Railings
18. T4541-EB: 2021 Administrative Support
19. T4541-EC: Develop Non-Proprietary MASH-Compliant Three-Pound and Four-Pound Post Systems
20. T4541-ED: Develop Guidelines for Attaching MASH-Compliant Thrie-Beam Transitions to Rigid Concrete Barriers Other than the Rigid Barrier Tested when Evaluating the Thrie-Beam Transition
21. T4541-EE: Exploration into Variations in Beam Guard Approach Transitions to Rigid Barrier
22. T4541-EF: Engineering Support Services and Recommendations for Roadside Safety Issues/Problems for Member States
23. T4541-EG: 2021 Program Development and MASH Coordination Effort

Approved Projects

1. Continued Engineering Support Services and Recommendations for Roadside Safety Issues/Problems for Member States
2. Develop Non-Proprietary MASH-Compliant Three-Pound and Four-Pound Post Systems
3. Develop Guidelines for Attaching MASH-Compliant Thrie-Beam Transitions to Rigid Concrete Barriers Other than the Rigid Barrier Tested when Evaluating the Thrie-Beam Transition
4. Exploration into Variations in Beam Guard Approach Transitions to Rigid Barrier
5. Testing Type III Barricades with Aluminum Panels and Mounted Signs (proposal in development)
6. Transition Between Guardrail and Tangent Anchored Portable Concrete Barriers
7. Multi-Directional Base Design for Steel Beam Non-Proprietary Large Sign Supports
8. Proposal 2021-04-BR: MASH 4-12 Evaluation of a Fence Mounted System for Attachments to Concrete
9. Proposal 2021-06-LSRB (CONT): MASH TL-3 Transition Design with a storm drain inlet (continuation)
10. Proposal 2020-02-BD: Multi-directional base design for steel beam non-proprietary large sign supports—Phase II
11. Proposal 2021-02-LSRB: Crash testing a Guardrail on 1T01 slope
12. Proposal 2021-01-BD: Crashworthy Pedestrian and Small Traffic Signals

FISCAL YEAR 2022 ACCOMPLISHMENTS

Completed Projects

1. T4541-CR: Placement of Guardrail on Slopes Phase IV: MASH TL-3 Testing of Guardrail
2. T4541-DT: Determination of the Length-of-Need for Guardrail Without Anchorage: Phase 1
3. T4541-EQ: 2022 Program Development and MASH Coordination Effort
4. T4541-ER: Engineering Support Services and Recommendations for Roadside Safety Issues/Problems for Member States
5. T4541-ES: MASH 4-12 Evaluation of a Fence Mounted System for Attachments to Concrete Bridge Barrier
6. T4541-ET: MASH Testing of a Guardrail System on 1H:1V Slope
7. T4541-EV: MASH Crashworthy Pedestrian and Small Traffic Signals

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8. T4541-EW: 2022 Administrative Support
 9. T4541-EX: Buried-in-Backslope Terminal Variations in Foreslope, Backslope, and Ditch Configurations
 10. T4541-EO: Washington State I-90 Snoqualmie Pass Barrier Gap Design, Drafting, and Detailing

Ongoing Projects

1. T4541-CV: Testing and Evaluation of the MGS System with Maximum Flare at MASH Test
2. T4541-CW: Testing of Midwest Guardrail Systems with Reduced Post Spacing for MASH Compliance
3. T4541-CZ: Thrie/W-Beam/Tubular Barrier Gap Rail for MASH TL-3
4. T4541-DB: Engineering Support Services and Recommendations for Roadside Safety Issues/Problems for Member States
5. T4541-DG: MASH TL-4 Investigation and Testing of the Critical Flare Rate for Cast-in-Place Single Slope 42" Concrete barrier Flaring Around a Fixed Object
6. T4541-DJ: Testing and Evaluation of Large Signs Slipbase Support on Slope at MASH TL-3 Impact Conditions
7. T4541-DL: A Study of Guardrail Placement on 6:1 Slope
8. T4541-DN: MASH TL-4 Testing and Evaluation of a Concrete Median Barrier with Fence Mounted on Top
9. T4541-DO: Shorter TL-3 MASH W-Beam Transition
10. T4541-DQ: 2019 MASH Coordination Effort
11. T4541-DV: Study of Acceptable Sidewalk Heights and Widths
12. T4541-DW: Design and Testing of a Thrie-Beam Guardrail System at a Fixed Object
13. T4541-DX: Design and Testing of a MASH TL-3 Thrie-Beam System for Roadside and Median Applications
14. T4541-DY: MASH TL-3 Transition Design with a Storm Drain Inlet
15. T4541-DZ: Determination of the Length-of-Need for Guardrail without Anchorage: Phase 2
16. T4541-EA: Development of a Thrie-Beam Retrofit for Upgrading Obsolete Bridge Railings
17. T4541-EI: Crashworthy Enhanced Highway Sign Assemblies
18. T4541-EJ: Design and Evaluation of a MASH TL-2 Compliant Permanent Concrete Low Profile Barrier
19. T4541-EN: Development of a MASH TL-3 Compliant Portable Concrete Barrier System
20. T4541-EO: Washington State I-90 Snoqualmie Pass Barrier Gap Design, Drafting, and Detailing
21. T4541-EP: Evaluation of Long-Span W-Beam Guardrail in Front of Fall-Protection Rail on Concrete Culverts
22. T4541-EB: 2021 Administrative Support
23. T4541-EC: Develop Non-Proprietary MASH-Compliant Three-Pound and Four-Pound Post Systems
24. T4541-ED: Develop Guidelines for Attaching MASH-Compliant Thrie-Beam Transitions to Rigid Concrete Barriers Other than the Rigid Barrier Tested when Evaluating the Thrie-Beam Transition
25. T4541-EE: Exploration into Variations in Beam Guard Approach Transitions to Rigid Barrier
26. T4541-EG: 2021 Program Development and MASH Coordination Effort
27. T4541-EK: Transition Between Guardrail and Tangent Anchored Portable Concrete Barriers
28. T4541-EL: Testing Type III Barricades with Aluminum Panels and Mounted Signs
29. T4541-EM: Multi-Directional Base Design for Steel Beam Non-Proprietary Large Sign Supports: Phase I

Approved Project

- T4541-EH: MASH TL-4 Crash Testing of Bicycle Railing on Constant Slope Parapet

FISCAL YEAR 2023 PROPOSED ACTIVITIES

Completed Projects

1. T4541-CV: Testing and Evaluation of the MGS System with Maximum Flare at MASH Test
2. T4541-ED: Develop Guidelines for Attaching MASH-Compliant Thrie-Beam Transitions to Rigid Concrete Barriers Other than the Rigid Barrier Tested when Evaluating the Thrie-Beam Transition
3. T4541-EG: 2021 Program Development and MASH Coordination Effort
4. T4541-EK: Transition Between Guardrail and Tangent Anchored Portable Concrete Barriers
5. T4541-EL: Testing Type III Barricades with Aluminum Panels and Mounted Signs
6. T4541-EZ: 2022 Travel & Meeting Assistance
7. T4541-DJ: Testing and Evaluation of Large Signs Slipbase Support on Slope at MASH TL-3 Impact Conditions
8. T4541-DZ: Determination of the Length-of-Need for Guardrail without Anchorage: Phase 2
9. T4541-EE: Exploration into Variations in Beam Guard Approach Transitions to Rigid Barrier
10. T4541-DY: MASH TL-3 Transition Design with a Storm Drain Inlet
11. T4541-EC: Develop Non-Proprietary MASH-Compliant Three-Pound and Four-Pound Post Systems

Ongoing Projects

1. T4541-EM: Multi-Directional Base Design for Steel Beam Non-Proprietary Large Sign Supports: Phase I
2. T4541-EQ: 2022 Program Development and MASH Coordination Effort
3. T4541-ER: Engineering Support Services and Recommendations for Roadside Safety Issues/Problems for Member States
4. T4541-ES: MASH 4-12 Evaluation of a Fence Mounted System for Attachments to Concrete Bridge Barrier
5. T4541-ET: MASH Testing of a Guardrail System on 1H:1V Slope
6. T4541-EV: MASH Crashworthy Pedestrian and Small Traffic Signals
7. T4541-EW: 2022 Administrative Support
8. T4541-EX: Buried-in-Backslope Terminal Variations in Foreslope, Backslope, and Ditch Configurations
9. T4541-FB: MASH TL-3 Evaluation of a Median Guide Rail Transition to Median F-Shape Concrete Barrier
10. T4541-FC: Evaluation of a Four Bolt Slip Base for breakaway Luminaire Supports with Various Pole Configurations
11. T4541-FD: Portable Sign Supports for Aluminum Signs with Variations on Mounting Height
12. T4541-FE: MASH Test level 3 Evaluation of a Shorter Thrie-Beam Approach Transition

Approved Projects

1. T4541-FB: MASH TL-3 Evaluation of a Median Guide Rail transition to Median F-Shape Concrete Barrier
2. T4541-FC: Evaluation of a Four Bolt Slip Base for Breakaway Luminaire Supports with Various Pole Configurations
3. T4541-FD: Portable Sign Supports for Aluminum Signs with Variations on Mounting Height
4. T4541-FE: MASH Test Level 3 Evaluation of a Shorter Thrie-Beam Approach Transition
5. T4541-FF: Steel-Post W-Beam Guardrail in Asphalt Mow Strip
6. T4541-FG: Evaluation of Open Joints in Concrete Bridge Rail Systems

A new pooled fund group, TPF-5(501), known as Roadside Safety Pooled Fund – Phase 3, was created to replace the current pooled fund group. MDOT joined TPF-5(501), Roadside Safety Pooled Fund – Phase 3.

FISCAL YEAR 2024 PROPOSED ACTIVITIES

Completion of all ongoing and approved projects from previous fiscal years. Since TPF-5(343) will end on 12/31/23, it is anticipated that no new activities will be proposed in FY 2024 as part of TPF-5(343).

All future pooled fund activities will be done as part of the new pooled fund, TPF-5(501), Roadside Safety Pooled Fund – Phase 3.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Project expected completion FY 2024.

**RESEARCH ADMINISTRATION
TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2023**

STUDY TITLE: Development of Maintenance Decision Support System

FUNDING SOURCE: FHWA OTHER (PLEASE EXPLAIN)

TPF NO.	TPF-5(347)	MDOT START DATE	10/01/2016
PROJECT NO.		MDOT COMPLETION DATE (Original)	09/30/2022
OR NO.	OR14-034	COMPLETION DATE (Revised)	9/30/2024
MDOT TECHNICAL CONTACT	James Roath, 517-230-5361 RoathJ1@michigan.gov		
LEAD AGENCY:	South Dakota Department of Transportation		
PROJECT MANAGER	David Huft, 605-773-3358 Dave.huft@state.sd.us		
CONTRACTOR	Iteris, Inc.		

BUDGET STATUS

FY 2023 MDOT Budget			Total Budget		
FY FUNDS	(Original)	\$0.00	TOTAL COST	(Original)	\$125,000.00
	(Revised)			(Revised)	\$170,000.00
		\$0.00			\$0.00

PARTICIPATING STATES

CA, CO, CT, IL, IN, KY, MD, MI, MN, ND, NE, PA, SD, VA, and WI.

PURPOSE AND SCOPE

Develop a Maintenance Decision Support System (MDSS) winter maintenance operations forecasting tool (computer web-based) that helps reduce winter maintenance costs, increases level of service based on recommendations, and helps provide a reduction in damage to infrastructure and the environment. Under TPF-5(054) pilot the MDSS winter maintenance forecasting tool in the Southwest Region during the 2012 & 2013 winter seasons. Implement the forecasting tool statewide beginning in the 2014 winter season for use in seasons to come. Implementation deployment and enhancements continue under new TPF-5(347).

FISCAL YEAR 2017 ACCOMPLISHMENTS

Completed tasks:

- Incorporated MDSS Graphic User Interface (GUI) functionality into WebMDSS.
- Refined and evaluated the capability and performance of MDSS software components, including surface condition prediction models and MDSS GUI.
- Recommend, developed, and evaluated methods for enhancing highway agencies' management through interfaces between MDSS and other management systems.
- Provided weather forecast support, MDSS configuration support, live MDSS operations, and necessary training for continuing limited deployment field trials.
- Prepared a final report summarizing methodology, findings in performance, conclusions, and recommendations.
- Made an executive presentation to the project's Technical Panel and provide electronic copies of the presentation material to participating states.

FISCAL YEAR 2018 ACCOMPLISHMENTS

Completed tasks:

- Investigated ways to incorporate mobile road weather information system (RWIS) data into MDSS. Developed ways to display the data.
- Performed enhancements & adjustments to existing MDSS module.
- Continued efforts associated with Assessment of Recommendations (AoR) and reported out results to the project's Technical Panel.
- Designed & developed & released an updated mobile application for MDSS.
- Continued to fine tune the WebMDSS interface.
- Explored additional route configuration capabilities to MDSS that will enhance route recommendations.
- Improved understanding of traffic in MDSS.
- Prepared report summarizing research and made an executive presentation to the project's Technical Panel.

FISCAL YEAR 2019 ACCOMPLISHMENTS

Completed tasks:

- New Version of WebMDSS, improved Data Display, added overlay options to maps, favoriting capabilities and new lists views
- Ended the MDSS GUI and transitioned every user over to WebMDSS
- Provided trainings on the new MDSS App and WebMDSS

- Created a new Dashboard feature to improve the sites user ability
- Continued efforts to improve Automatic Vehicle Location (AVL) integration. More agencies will be integrating AVL / Mobile Digital Computer (MDC) data.
- Continued to perform enhancements and adjustments to existing MDSS modules (on-going task).
- Continued MDSS Assessment of Recommendations (AoR) with the addition of AoR capabilities in WebMDSS.
- Assess Version 1 of mobile App. Add new features and fix user issues.
- Redesigned MDSS dashboard.
- Added any modules not yet complete from MDSS GUI into WebMDSS and address any user encountered bugs.
- Added additional routes to MDSS with the additional configurations. Receive more feedback from users on additional configurations.
- Completed two initial studies into traffic/MDSS relationships and identify potential next steps.
- Wrapped up documentation for MDSS-to-Automatic Terminal Information Service (ATIS) data feed.
- Made updates to the MDSS documentation based on activities during Phase 10.
- Prepared report summarizing research and make executive presentation to the project's Technical Panel.

FISCAL YEAR 2020 ACCOMPLISHMENTS

Completed tasks:

- Continued design and development of web-based version of MDSS
- Performed enhancements and adjustments to existing MDSS module
- Developed a method to Collect and Provide Detailed Usage Statistics
- Continued design and development of a Mobile Friendly MDSS Application
- Developed a Route Configuration Optimization Process
- Assessed recommendations based on user feedback in real-time with post-recommendation analysis to improve MDSS modeling
- Conducted an analysis of traffic information within the MDSS modules and the impact of traffic on the MDSS recommendations

FISCAL YEAR 2021 ACCOMPLISHMENTS

Primary research areas selected by the technical panel for Phase XII of the project work plan are:

- Understand how MDSS can better support the use of Tow Plows, which are becoming more prevalent in member state winter operations (Task 14.5)
- Perform enhancements and adjustments to existing MDSS modules (Task 15.10)
- Assess recommendations based on user feedback in real-time with post-recommendation analysis to improve MDSS modeling. (15.13)
- Continue design and develop a mobile friendly MDSS application (15.18)
- Continue design and development of a web-based version of MDSS (Task 15.20)
- Integrate mobile RWIS data into MDSS (Task 15.23)
- Analyze the use of Level of Service in DOT operations and understand how this functionality can be improved within MDSS (Task 15.26)
- Develop MDSS screens to facilitate objective analysis of user acceptance or rejection of recommendations to understand the MDSS factors affecting each situation (Task 15.27)
- Integration of ESS friction into MDSS model (Task 15.28) – Year 2
- Improved forecast verification tools (Task 15.29) – Year 2

FISCAL YEAR 2022 ACCOMPLISHMENTS

Primary research areas selected by the technical panel for Phase XII of the project work plan are:

- Understand how MDSS can better support the use of Tow Plows, which are becoming more prevalent in member state winter operations (Task 14.5)
- Task 14.2: In-Vehicle MDSS Update
- Perform enhancements and adjustments to existing MDSS modules (Task 15.10)
- Assess recommendations based on user feedback in real-time with post-recommendation analysis to improve MDSS modeling. (15.13)
- Continue design and develop a mobile friendly MDSS application (15.18)
- Continue design and development of a web-based version of MDSS (Task 15.20)
- Integrate mobile RWIS data into MDSS (Task 15.23)
- Task 15.24 Develop a Method to Collect and Provide detailed use statistics
- Analyze the use of Level of Service in DOT operations and understand how this functionality can be improved within MDSS (Task 15.26)
- Develop MDSS screens to facilitate objective analysis of user acceptance or rejection of recommendations to understand the MDSS factors affecting each situation (Task 15.27) Including Task 15.29 Improved Forecast Verification Tools
- Integration of ESS friction into MDSS model (Task 15.28) – Year 3
- Improved forecast verification tools (Task 15.29) – Year 3

FISCAL YEAR 2023 ACCOMPLISHMENTS

- DTN will continue to provide operational support for the current VMDSS interfaces that are active in the field today. New development for the in-vehicle MDSS display is not anticipated during Phase XIII.
- Task 14.5 will be moved to operational mode. Guidance developed in the <https://dtn.box.com/s/88jil47jmu77qeho7sekpz2cr2u50kqo> MDSS Pooled Fund Study Phase XII, Task 14.5 Enhanced Tow Plow Support Plan will be utilized to assist additional states with integration of their tow plow data into MDSS. Specific information is available in this document to guide other MDC/AVL providers, in required data feed adjustments to accommodate tow plow data for their clients. The Enhanced Tow Plow Support Plan document will be updated as necessary to ensure all current information and guidelines are available to all PFS members.

- Perform enhancements and adjustments to existing MDSS modules. Task 15.10 will continue to be an ongoing area of focus in the Phase XIII work plan. Funding and resource limitations impact the amount of work that can be done for this Task.
- The assessment of recommendation program will continue in Phase XIII – Year 1 of the project. The initial objectives will be:
 - Expand Trained AoR Collection Program to all agencies.
 - Develop a process to analyze accepts and declines by weather and road conditions.
 - Test the hypothesis that following MDSS recommendations tends to produce a better outcome, achieving the desired level of service at the most economical cost.
 - Review the [Task 15.13 Assessment of Recommendations Plan](#) created in Phase XII to expand analysis in areas where new AoR feedback, verification data and analytic tools are available to expand the research.

The AoR subcommittee will continue to meet regularly to further refine the objectives of the AoR program, define the data required to perform analysis to answer questions, implement targeted analysis procedures to understand both objective and subjective feedback, and incorporate new technologies for validation as available.

Reports from the subcommittee to the larger MDSS PFS membership will be provided at each Technical Panel meeting. Discussions will be held and feedback on the program will be evaluated for inclusion in the AoR program.

Integrate Friction/Grip Data from Static and Mobile RWIS into MDSS - This task was combined with Task 15.28 to include data from static ESS sensors as well as mobile sensors. The first issue that will need to be investigated will be how we might adjust the cross-sectional depths of the various forms of moisture present on the road, when all we have is a single friction value to work with. There are likely an infinite number of ways these cross-sectional moisture depth profiles could lead to the same overall friction value, so it is not a straightforward conversion. If a potentially viable approach can be identified, DTN will build the software necessary to acquire and assimilate the friction data into the model, and then evaluate that approach using the modeling changes that were implemented in Phase XII to accommodate small-segment routes. Since these small-segment routes generally have coincident routes with more 'normal' segment lengths, this should permit an exploration of the viability of applying friction data both with and without the implementation of much shorter route segments that are better aligned with the spatial and temporal resolution of the data.

FISCAL YEAR 2024 PROPOSED ACTIVITIES

Tasks assigned for FY24

- Assessment of Recommendations (continued)
- Automated Spreader Control
- Automated WMRI Reports
- Deicer Demand Forecasts
- Forecast Verification Tools
- Heatmap Generation of Trouble Spots
- Integrating Crowdsourced Data
- Integrating Probe/OEM Data
- Integration of Dash Cam Imagery
- Integration of Friction/ Grip Sensors
- Integration of Real Time Traffic Data
- Level of Service Definition
- Liquid Deicers
- Monitor Research Relevant to MDSS
- Predicting Impact of Weather on Traffic
- Return on Investment Analysis
- Road Conditions using pictures
- Small Segment Analysis
- State Weight Restrictions
- Training Curriculum
- Truck Specific Material Recommendations

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

Phase 3 under solicitation (1562):

The Michigan Department of Transportation's (MDOT's) original funding commitment was allocated over FYs 2012, 2013, and 2015-2017 under TPF-5(054). However, the lead agency requested all partner states to transfer future funds beyond FY 2016 to TPF-5(347), which is a new continuation study with an effective start in FY 2017.

TAC members assess future research needs on an annual basis. New projects identified/approved are incorporated in the annual work plan, which may extend the overall study an additional year. The new TPF-5(347) pooled fund study's duration must not exceed five years (FYs 2017- 2021). As such, MDOT has posted its FY 2021 pledge amount to the TPF website, [which includes the additional \$5,000 in contributions for FYs 2019- 2021.

This TPF project has been extended and MDOT will continue as a state partner until all project deliverables are completed. The solicitation 1562 fiscal year 2022 pledge commitment was transferred to TPF-5(347) in 2022.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Project expected completion FY 2024.

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2023**

STUDY TITLE: Clear Roads Winter Highway Operations Pooled Fund (Phase II)

FUNDING SOURCE: FHWA OTHER (PLEASE EXPLAIN)

TPF NO.	TPF-5(353)	MDOT START DATE	10/1/2016
PROJECT NO.		MDOT COMPLETION DATE (Original)	12/30/2021
OR NO.	OR13-015	COMPLETION DATE (Revised)	6/30/2023
MDOT TECHNICAL CONTACT	Justin Droste, 517-636-0518 DrosteJ@michigan.gov		
LEAD AGENCY	Minnesota Department of Transportation		
PROJECT MANAGER	Debbie Sinclair, 651-366-3746 debbie.sinclair@state.mn.us		
CONTRACTOR			

BUDGET STATUS

FY 2023 MDOT Budget			MDOT Total Budget		
FY FUNDS	(Original)	\$0.00	TOTAL BUDGET	(Original)	\$125,000.00
	(Revised)			(Revised)	
TOTAL FY 2023 EXPENDITURES			TOTAL COMMITTED FUNDS AVAILABLE		
		\$0.00			\$0.00

PARTICIPATING STATES

AK, AZ, CA, CO, CT, DE, IA, ID, IL, IN, KS, MA, MDOT SHA, ME, MI, MN, MO, MT, ND, NE, NH, NV, NY, OH, OR, PA, RI, SD, TX, UT, VA, VT, WA, WI, WV, WY.

PURPOSE AND SCOPE

This pooled fund project will maintain its focus on advancing winter highway operations nationally, but it will include a more pronounced emphasis on state agency needs, technology transfer, and implementation. State departments of transportation are aggressively pursuing new technologies, practices, tools, and programs to improve winter highway operations and safety while maintaining fiscal responsibility. This pooled fund is needed to evaluate these new tools and practices in both lab and field settings, to develop industry standards and performance measures, to provide technology transfer and cost benefit analysis, and to support winter highway safety. This project responds to research and technology transfer needs not currently met by other pooled fund projects. Existing partners make every effort to coordinate with other agencies to avoid duplication of efforts and to encourage implementation of results.

Objectives of this ongoing pooled fund project will include:

- Conducting structured field testing and evaluation across a range of winter conditions and different highway maintenance organizational structures to assess the practical effectiveness, ease of use, optimum application rates, barriers to use, durability, safety, environmental impact and cost-effectiveness of innovative materials, equipment, and methods for improved winter highway maintenance.
- Establishing industry standards and developing performance measures for evaluating and utilizing new materials and technologies.
- Supporting technology transfer by developing practical field guides and a training curriculum that will promote the results of research projects.
- Conducting cost-benefit analysis to ensure that new technologies, materials, or methods contribute to operational efficiency.
- Supporting the exchange of information and ideas via peer exchanges and collaborative research efforts that provide opportunities for maintenance specialists to share experiences related to winter maintenance.
- Promoting public education and outreach related to winter maintenance and winter driving safety.
- Conducting state of the practice surveys to share best practices on current operational issues. (For example: Salt shortages, level of service requirements, or other hot button issues).
- Included in the Scope of work: Research reports, technical briefs, synthesis reports, field guides, specifications, PowerPoint presentations, video documentation, training materials, public safety messages, and software programs.

FISCAL YEAR 2017 ACCOMPLISHMENTS

The Clear Roads pooled fund study completed five research projects and several other projects commenced during the 2017 FY.

- 12-04 Snowplow Operator and Supervisor Training.
- 14-04 Plug and Play, Phase 2.
- 14-05 Snow Removal Performance Metrics – Phase I: Synthesis.
- 14-07 Snowplow Route Optimization.
- 15-03 North American Study on Contracting Snow and Ice Response.

Two of the five completed projects and their respective deliverables are described below.

2- 2017 Completed Projects/Respective Deliverables:

- 12-04 Snowplow Operator and Supervisor Training
- The key outcomes of the project are presentations, course guides, exams, and other training support materials for winter maintenance operations. MDOT can use the information to help train staff during winter operations schools, region trainings, and other training events.

14-04 Plug and Play, Phase 2

- Clear Roads has been leading a collaborative effort called the Plug-and-Play Initiative to develop a universal bi-directional
- communications protocol for in-cab electronics, regardless of the manufacturer or service provider. This project identified the most
- appropriate standard protocols and made recommendations regarding the method of transmission. MDOT will use this research to assist
- with the development of an RFP for our automated vehicle location and maintenance decision support system.
- Five new research projects and five new synthesis projects were also authorized for solicitation.

FISCAL YEAR 2018 ACCOMPLISHMENTS

The Clear Roads pooled fund study completed five research projects, two synthesis projects and several other projects commenced during the 2018 FY.

- 14-02: Quantifying the Impact That New Capital Projects Will Have on Roadway Snow and Ice Control Operations (November 2017)
- 15-02: Identification and Recommendations for Correction of Equipment Factors Causing Fatigue in Snowplow Operators (November 2017)
- 12-03: Understanding the Chemical and Mechanical Performance of Snow and Ice Control Agents on Porous or Permeable Pavements (January 2018)
- 16-04: Emergency Operations Methodology for Extreme Winter Storm Events (May 2018)
- 16-06: Training Video for the Implementation of Liquid-Only Plow Routes (June 2018)
- 16-S3: Maintenance Vehicle Conspicuity (February 2018)
- 17-S1: Accuracy of Deicer and Abrasive Material Application Equipment (September 2018)

Two of the five completed projects and their respective deliverables are described below.

12-03 Understanding the Chemical and Mechanical Performance of S&I Control Agents on Porous or Permeable Pavements

This project provided better information and guidelines to help determine the optimum maintenance strategies for porous or permeable asphalt pavements, including:

- Dense graded pavements.
- Open graded pavements.
- Ultrathin Friction Course.

14-02 Quantifying the Impact that New Capital Projects Will Have on Roadway Snow and Ice Control (RSIC) Operations

The project developed an automated method of quantifying the anticipated impact that new capital projects will have on costs for RSIC. This method could be used in the early stages of project development to determine if an agency will need additional resources, such as trucks, salt, fuel, and manpower, to accomplish winter maintenance tasks after the project is completed. This methodology could also be used by maintenance managers to justify requests for additional resources after projects are complete.

Eight new research projects were also authorized for solicitation. Clear Roads also elected to form a subcommittee to manage the Clear Roads QPL (formally known as Pacific Northwest Snow fighters QPL).

FISCAL YEAR 2019 ACCOMPLISHMENTS

The Clear Roads pooled fund study completed six research projects and continued several other projects during the 2019 FY. These projects and their respective deliverables are described below.

13-05 Developing Test Bed Software to Qualify Plug and Play Technology

The goal of this project is to develop a software suite that will be used to validate and certify candidate spreader controllers and AVL equipment for compliance with the current Clear Roads Universal In-Cab Performance Specification and Communications Protocol.

14-03 Developing a Training Video and Manual for Best Practices and Techniques in Clearing Different Interchange Configurations and Other Geometric Layouts

This project was extended into FY 18. It will be a 15-20-minute video that showcases the most efficient pass sequences to properly clear various interchange and intersection layouts. MDOT plans to use this to instruct operators on the best way(s) to safely clear various intersection geometries.

15-01 Synthesis of Material Application Methodologies for Winter Operations

The goal of this project is to create a synthesis of best management practices for application rates, material application methodologies and material usage, including chloride brines applied directly or as additives to abrasives and rock salts.

16-01 Utilization of AVL/GPS Technology: Case Studies

The goal of this project is to help state DOTs make more informed decisions with respect to implementation of winter maintenance AVL/GPS. MDOT was one of the case studies highlighted in this report.

16-02 AWSSI Enhancements in Support of Winter Road Maintenance

The objective of this project is to expand on the current AWSSI Tool to add more stations and provide features to allow for winter severity projections and connect winter severity to winter maintenance costs.

16-05 Weather Event Reconstruction and Analysis Tool

The goal of this project is to allow transportation agencies to reconstruct winter weather events quickly and easily, with a focus on drawing from data sources that cover the entire United States or large regions.

16-03: Standards and Guidance for Using Mobile Sensor Technology to Access Winter Road Conditions

Through rigorous testing of sensor equipment, development of standardized scales, and creation of guidance for using an array of Measurements in concert for decision-making, Clear Roads will make better use of road sensor data than is now currently available.

FISCAL YEAR 2020 ACCOMPLISHMENTS

The Clear Roads pooled fund study completed five research projects and continued several other projects during the 2020 FY. Completed projects and their respective deliverables are listed below.

- 18-S1: Mechanic/Operator Training and Training Needs for Winter Maintenance Equipment
- 18-01: Defensive Driving for Snowplow Operators
- 18-05: Alternative Methods for Deicing
- 17-02: Standard Specifications for Plow Blades with Carbide Inserts
- 16-05: Weather Event Reconstruction Analysis Tool

FISCAL YEAR 2021 ACCOMPLISHMENTS

The Clear Roads pooled fund study plans to commence and continue several projects during the 2021 FY. These projects are listed below.

- 21-01 Grip Sensor Technology and Salt Application
- 21-02 Update to CR 13-04 Best Practices for Protecting DOT Equipment from Corrosive Effect of Chemical Deicers
- 21-03 The Efficacy and Environmental Impact of Non-Chloride Deicers
- 21-04 Training Module Development for CR 18-03 Evaluation of SSI/WSI Variables
- 21-05 Synthesis Evaluation of Electric Vehicle Technologies and Alternate Fuels for Winter Operations
- 21-06 Calculated Plow Cycle Times from AVL Data
- 21-07 Determining the Migration of Chloride-based Deicers through Different Soil Types Adjacent to Chloride-treated Roadways
- 20-06 Salt Shed Design Template
- 20-05 Using GIS to Highlight Highway Segments Sensitive to Deicing Materials
- 20-04 Expanded Use of AVL/GPS Technology
- 20-03 Evaluation of Indoor Automated Stockpile Measurement Systems
- 20-02 Understanding the NaCl Phase Diagram
- 20-01 Entry-Level Driver Training (CDL) for Maintenance Equipment Operators
- 19-04 Synthesis of Technical Requirements and Considerations for an Automated Snowplow Route Optimization RFP Template
- 19-03 Measuring the Efficiencies of Tow Plows and Wing Plows
- 19-01 Expanding Application Rate Guidance for Salt Brine Blends for Direct Liquid Application and Anti-icing
- 18-06 Standard Test Procedures for Ice Melting Capacity of Deicers
- 18-02 High Performance Blade Evaluation

FISCAL YEAR 2022 ACCOMPLISHMENTS

Project selected for FY2022

- 22-01 Comprehensive Guide to Prewet [A comprehensive guide that will provide optimal application rates for meeting pre-wetting goals and will quantify the benefits of different rates, speeds, and other delivery factors. The guide will also present the findings of using two to four salt spreader configurations and delivery systems (e.g., auger, Monroe hopper, zero-velocity spreader). The evaluation will include a discussion of the advantages and disadvantages of each in meeting pre-wetting goals.]
 - 22-02 Liquid Chloride Storage and Pump System Best Management Practices [This project will develop a guidance manual that explores the issues transportation agencies should consider when choosing or replacing deicing liquid storage systems. There are several areas of interest associated with operating a reliable system including safety, environment, and cost-effectiveness. A review of the systems different agencies use, including system benefits and challenges, will help agencies better understand their options when procuring a new system or updating an existing one.]
 - 22-03 Effects of Additives in Lowering the Freezing Point [While manufacturers of deicing salt products claim that additives enhance product performance, there is no definitive evidence to substantiate these claims. Evaluating these products in the lab and in the field will establish the effectiveness of additives to lower eutectic temperatures and will indicate whether additives increase the performance of deicing salts. Research recommendations can be used to inform the decision-making of state departments of transportation (DOTs), municipalities and other winter maintenance practitioners when choosing a deicing salt for winter maintenance operations.]
 - 22-04 Evaluation of DLA of Salt Brine vs Granular Salt as Measured through Various Performance and Safety Metrics [Many of the studies conducted to date focus on cost savings and environmental impacts of the DLA of salt brine while not addressing the efficacy and safety impacts of its use. Without performance comparison data to support DLA practices, the traveling public
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may conclude that while the advantages of DLA in cost savings and environmental impacts are clear, granular salt treatments are still the more effective way to treat winter roadways. This study aims to provide DOTs with the information they need to defend the use of DLA treatments where appropriate.]

- 22-05 Synthesis: Use of Dashboards for Winter Operations [Advances in information technology offer agencies the capability to capture and track data obtained from winter maintenance equipment. A review of which agencies are using dashboards in winter maintenance operations, including necessary resources and best practices for developing and implementing this tool, will give Clear Roads an understanding of how this data is obtained and displayed through these dashboards. Then, how is the information displayed used to gain efficiencies related to Level of Service, material use, resource allocation, and the cost of winter maintenance operations.]
- 22-S1 Synthesis: Corrosion and Connectors Don't Mix [The goal of this synthesis is to identify the various setups / connectors used by Clear Roads members. Determine if anyone is experiencing success in keeping the lights operating for an entire winter season. Identify a setup / connector that is most likely to operate for an entire snow season.]
- Project completed in FY 2022
- 19-02 Recruitment and Retention of Highway Maintenance Workers [This project developed a concise guide of innovative but practical ways for DOTs to recruit and retain a highly proficient, productive, versatile, and committed roadway maintenance workforce. The final report includes case studies in several categories, including recruitment programs, retention strategies, recruitment and retention for underserved communities, recruitment, and retention of the next generation, and capturing information to inform program improvements.]
- 20-07 AWSSI Enhancements, Phase 2 [This project continued the process of improving the tool developed by the MRCC. This iteration added additional locations to the AWSSI tool; updated the average AWSSI seasonal total map through the 2019-2020 season; added the ability to download the daily seasonal data for any given station during the current season; and provided the user with the ability to add up to five specific historical seasons to be included in any station's current year chart.]
- 20-01: Entry-Level Driver Training (CDL) for Maintenance Equipment Operators [This project developed the following materials: (1) complete curriculum to meet the FMCSA requirements for the instructor-led classroom and behind-the-wheel components of the entry-level driver training rule, focusing on obtaining an initial Class B CDL, upgrading from a Class B CDL to a Class A CDL, and obtaining the hazardous materials endorsement for the first time; (2) all training materials and resources necessary for states to execute the training program; (3) train-the-trainer materials to assist agencies in implementing the training program; and (4) fact sheet and timeline to help agencies ensure that all of their training locations are added to the TPR before February 7, 2022. To date, there have been 750 requests for this material from agencies all over the U.S.]
- 19-04 Synthesis of Technical Requirements and Considerations for Automated Snowplow Route Optimization [Through a survey and follow-up interviews with agencies and vendors, this project captured the technical requirements and considerations involved in selecting an automated snowplow route optimization program. The project produced two complementary documents as appendices to the final report: 1) Decision Support Guidance: An accessible and in-depth discussion of the technical requirements for route optimization and the key decisions DOTs should consider when developing the project scope and managing a provider. 2) Contracting Language Template: A flexible template to assist DOTs with developing a scope of work for an RFP for automated snowplow route optimization services. The language in the template is intended to ensure that DOTs and service providers have a shared understanding of the scope of work that the DOT requires and to maximize the likelihood that the project will result in safe, feasible, implementation-ready routes.]
- 19-01 Expanding Application Rate Guidance for Salt Brine Blends for Direct Liquid Application and Anti-icing [Through a survey of practice and subsequent field testing, researchers gathered a robust set of data on how agencies apply various liquid deicers across a broad range of field conditions, particularly at lower temperatures. The test results, along with the survey results and information gathered through a literature review, were used to create a set of application rate tables for brine and brine blend usage for DLA and anti-icing.]
- 19-03 Measuring the Efficiencies of Tow Plows and Wing Plows [Through a practitioner survey, testing/simulation, and analysis, this project created a spreadsheet-based Decision Support Tool to help agencies more accurately assess the efficiencies, costs of ownership, and return on investment for tow plows and wing plows and determine the best locations to deploy it. A companion Best Practices Guide will help agencies understand the considerations for purchasing, deploying, and operating specific plow types.]
- 20-02 Understanding the NaCl Phase Diagram [Project deliverables include the development of training materials (a fact sheet and a video) to help provide winter maintenance practitioners with a better understanding of the phase diagram for sodium chloride and how to apply it to yield the best results in roadway deicing. This knowledge will help winter maintenance agencies apply salt and salt brines effectively for the best performance on winter roadways.]

Ongoing Projects for FY 2023

- 18-02 High Performance Blade Evaluation
 - 18-06 Standard Test Procedures for Ice Melting Capacity of Deicers
 - 20-03 Evaluation of Indoor Automated Stockpile Measurement Systems
 - 20-04 Expanded Use of AVL/GPS Technology
 - 20-05 Using GIS to Highlight Highway Segments Sensitive to Deicing Materials
 - 20-06 Salt Shed Design Template
 - 21-01 Grip Sensor Technology and Salt Applications
 - 21-02 Update to CR 13-04: Best Practices for Protecting DOT Equipment from the Corrosion Effect of Chemical Deicers
 - 21-03 Efficacy, Cost, and Impacts of Non-Chloride Deicers
 - 21-04 Training Module Development for Evaluation of Storm Severity Index and Winter Severity Index Variables
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- 21-05 Evaluation of Electric Vehicle Technologies and Alternative Fuels for Winter Operations
- 21-06 Calculating Plow Cycle Times from AVL Data
- 21-07 Determining the Migration of Chloride-based Deicers through Different Soil Types

FISCAL YEAR 2023 ACCOMPLISHMENTS

Completed Projects

- 20-02 Understanding the NaCl Phase Diagram (June 2022)
- 20-03 Evaluation of Indoor Automated Stockpile Measurement Systems (December 2022)
- 20-04 Expanded Use of AVL / GPS Technology (January 2023)
- 18-02 High Performance Blade Evaluation
- 21-05 Evaluation of Electric Vehicle Technologies and Alternative Fuels for Winter Operations
- 21-03 Efficacy, Cost, and Impacts of Non-Chloride Deicers
- TPF-5(353): all contract tasks were completed by June 30, 2023. No additional projects will be programmed on this TPF pooled fund project phase II.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

This continuation project will maintain its focus on advancing winter highway operations nationally through practical, practice-ready research related to materials, equipment, and methods. State departments of transportation are aggressively pursuing new technologies, practices, tools, and programs to improve winter highway operations and safety while maintaining fiscal responsibility. Project will continue with existing funds to complete all tasks/deliverables.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Thirty-Six (36) state partner's leveraged funds provide support for investigator work on research projects, implementation and technology transfer activities, administrative management of the pooled fund, and travel expenses for member representatives to attend 2 Technical Advisory Committee meetings per year.

As a participating state MDOT can:

- Inform the research agenda for Clear Roads by proposing topics for future projects.
- Help prioritize and select projects for funding.
- Evaluate technical proposals to conduct the research from academic and private-sector investigators.
- Serve on subcommittees that oversee research projects.
- Meet with experts from around the country on winter maintenance issues.
- Travel to TAC meetings with expenses paid by the pooled fund.

One of the most important aspects of Clear Roads membership is access to the Clear Roads members themselves and their expertise. Members often send inquiries to their member peers for quick turnaround information. They can then report back to their management within days and provide information based on actual experiences of member states. Those inquiries and the summary of the information they receive back from the states is posted on a members-only page on the Clear Roads website.

Regarding the above list of projects 21-05 was proposed by MDOT and the project-subcommittee formed was championed by a Michigan Rep. Also, a Michigan Rep serve on several other project subcommittees, including 21-01 and 21-04.

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2023**

STUDY TITLE: Building Information Modeling (BIM) for Bridges and Structures

FUNDING SOURCE: FHWA OTHER (PLEASE EXPLAIN)

TPF NO.	TPF-5(372)	MDOT START DATE	10/1/2017
PROJECT NO.		MDOT COMPLETION DATE (Original)*	3/31/2023
OR NO.	OR18-015	COMPLETION DATE (Estimated)	1/31/2024
MDOT TECHNICAL CONTACT	Brad Wagner, 517-256-6451 WagnerB@michigan.gov		
LEAD AGENCY:	Iowa DOT		
PROJECT MANAGER	Khyle Clute, 515-239-1646 Khyle.Clute@iowadot.us		
CONTRACTOR	HDR Engineering Inc.		

BUDGET STATUS

FY 2023 MDOT Budget			Total Budget		
FY FUNDS	(Original)	\$0.00	TOTAL COST	(Original)	\$100,000.00
	(Revised)	\$25,000.00		(Revised)	\$125,000.00
		\$0.00			\$0.00

PARTICIPATING STATES

AL, CA, DE, FHWA, FL, GA, IADOT, IL, IN, KS, MI, MN, MS, NC, NE, NJ, NY, OH, OK, PA, TX, UT, VT, WA, WI.

PURPOSE AND SCOPE

The pooled fund project will provide the primary funding mechanism for AASHTO Subcommittee on Bridges and Structures (SCOBS) T-19 to perform the duties of governance and stewardship of Building Information Modeling (BIM) for Bridges and Structures.

1. Establish standards, guidelines, or manuals for bridge project stakeholders to facilitate the wide use of Industry Foundation Classes (IFC) as an exchange standard in BIM for Bridges and Structures in bridge projects. This would include recommending or mandating the use of common modeling format and IFC submittal.
2. Develop the national standard Model View Definitions (MVD), data definitions, and data requirements for the model life cycle for all data exchanges for transportation bridges and structures. This national standard will use the above governance and stewardship model to facilitate the development and future maintenance.
3. Collaborate with stakeholders to provide timely update of IFC data dictionary for common bridge elements.
4. Collaborate with building SMART and software vendors to design and offer suitable training covering BIM for Bridges and Structures model development, management, and usage.
5. Conduct Return on Investment (ROI) analysis to quantify the benefits of using a common modeling format, BIM for Bridges and Structures, in terms of time and cost savings.
6. Develop a template of BIM for Bridges and Structures-specific contractual provisions for managing, reducing, or eliminating the risks associated with IFC-BIM for Bridges and Structures. Project stakeholders/owners could use the template to conduct a risk evaluation for deploying BIM for Bridges and Structures at a project and organization level.
7. Provide recommendations to T-19 on changing existing workflows to leverage model exchanges for project delivery and asset management for transportation bridges and structures owners.
8. Provide a work plan, progression schedule, and coordination web and face to face meetings with T-19 on the development and implementation of BIM for Bridges and Structures.
9. Establish a forum/expert hub for practitioners in the bridge industry to promote the common modeling formats and share experiences.
10. Provide technical support, organize training workshops, and facilitate pilot/demonstration projects for bridge owners to encourage and accelerate the adoption of BIM for Bridges and Structures.

It is envisioned that the tasks listed above will be contracted to a consultant with proven expertise in this area.

FISCAL YEAR 2018 ACCOMPLISHMENTS

An initiation meeting was held to get input from industry and to refine the project request for proposals. The project was advertised, and a preferred vendor was selected. Currently, the first-year work plan is being negotiated to authorize the consultant. Expected authorization will be October 2018.

FISCAL YEAR 2019 ACCOMPLISHMENTS

The researchers documented existing BIM efforts and formed working groups to carry out various activities associated with the pooled fund. Accomplishments include development of a website to support BIM education and overall engagement, submitted a draft report

documenting existing BIM efforts and common terminology, updated the bridge lifecycle process map to reflect current needs, and developed an overall engagement/outreach plan.

FISCAL YEAR 2020 ACCOMPLISHMENTS

The completed a gap analysis comparing the current MVD for Design to Construction with the international Bridge Design Transfer View MVD. A process map was developed that maps out the full design to construction process and identifies all applicable data exchanges. A focus group, consisting of all applicable software vendors was established. The communication plan was completed, an info graphic/roadmap was developed, and a recommendation for data governance was completed.

FISCAL YEAR 2021 ACCOMPLISHMENTS

An Information Delivery Manual (IDM) was developed and reviewed, and final draft will be submitted in November 2021. Significant coordination with software developers occurred, and a test suite is being developed that will allow software vendors to determine compliance with MVD. Several outreach activities were completed. Will be developed and submitted. Roadmap will be widely distributed, officially kicking off communication plan. Initial data dictionary developed.

FISCAL YEAR 2022 ACCOMPLISHMENTS

The final IDM was delivered, balloted through AASHTO Committee on Bridges and Structures and approved. The bridge data dictionary was completed. A software certification program was initiated. An economic analysis was started, and a literature review was delivered, which focused on the benefits of using IFC. Coordination began on a governance model with AASHTO and FHWA. Several software vendors signed a letter of intent to support IFC development.

FISCAL YEAR 2023 ACCOMPLISHMENTS

During the CY2023 annual meeting, a revision to the scope was made with regards to the economic analysis. This scope item was repurposed into a brief memo that is still forthcoming this year. The governance model discussion has somewhat stalled due to changes in bSI as well as vacancies within the organization structure of AASHTO that will be involved in governing. A governance model recommendation is still forthcoming. The draft unit test suite has been developed, and coordination with vendors to refine and initiate use of test suite continues. In September of 2023, considering reduction in scope of the economic analysis and additional available funds as we wrap up this pooled fund; several items were added to the scope, as such, the project is estimated to be completed by Jan 31, 2024.

Products include a 1-page infographic that summarizes and describes the efforts of the pooled fund and IFC (supported by a brief executive summary), support broader implementation of the unit test suite, and bolster other original scope items (such as the final report).

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

The lead agency updated the TPF website with a revised project completion date of January 31, 2024. MDOT pledged an additional commitment of \$25k for a 6th year of the pooled fund. This will allow for additional tasks to be completed. MDOT remains an active partner until all project objectives have been fulfilled.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Project completion expected FY 2024.

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2023**

STUDY TITLE: National Partnership to Determine the Life Extending Benefit Curves of Pavement Preservation Techniques
(MnROAD/NCAT Joint Study – Phase II)

FUNDING SOURCE: FHWA OTHER (PLEASE EXPLAIN)

TPF NO.	TPF-5(375)	MDOT START DATE	1/2/2019
PROJECT NO.		MDOT COMPLETION DATE (Original)	12/31/2023
OR NO.	OR19-203	COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Kevin Kennedy, 517-749-9067 KennedyK@Michigan.gov		
LEAD AGENCY:	Minnesota Department of Transportation		
PROJECT MANAGER	Ben Worel 763-381-2130 ben.worel@state.mn.us		
CONTRACTOR	University of Minnesota [MnROAD Facility]		

BUDGET STATUS

FY 2023 Budget			Total Budget		
FY FUNDS	(Original)	\$50,000.00	TOTAL COST	(Original)	\$250,000.00
	(Revised)			(Revised)	
		\$50,000.00			\$0.00

PARTICIPATING STATES

AL, AR, CO, FHWA, FP2, GADOT, IL, KS, KY, MDOT SHA, MI, MN, MO, MS, NC, NY, OK, PADOT, SC, TN, TX, WI, WV.

PURPOSE AND SCOPE

Main objectives include:

- Determining the life cycle cost of various pavement preservation alternatives in a highly controlled experiment that will provide state Departments of Transportation (DOTs) with the financial foundation to begin to build a decision tree for their own maintenance program.
- Develop Quality Assurance (QA) field testing protocols to correlate construction practices with long-term performance of pavement preservation techniques.
- Technology transfer - Answering practical questions posed by research sponsors through formal (i.e., reports & technical papers) & informal (e.g., one-on-one responses to sponsor inquiries) technology transfer on how these life extending benefits can be best utilized in each state.

This second phase (2019-2024) will be used to continue to monitor and analyze data from the low and high-volume pavement preservation sections built both in Alabama and Minnesota since many of the test sections were built in 2016 and not had enough time to show what rate of deterioration they will have. MnDOT will lead this portion of the pooled fund study and will again partner with National Center for Asphalt Technology (NCAT) but now they will be the subcontractor doing the data collection in Alabama and most of the data analysis.

Activities that are expected include: Continue Data Collection of each of the test sections both in Alabama and Minnesota utilizing common methods and equipment between all four locations.

FISCAL YEAR 2019 ACCOMPLISHMENTS

PR outreach for new members to join the pooled fund study. Monitoring of various test sections including data collection, analyzation and reporting out of findings. Technical transfer efforts continue with presentations to various DOT's and organizations on current best practices and latest technologies.

FISCAL YEAR 2020 ACCOMPLISHMENTS

Continued Public Relations (PR) outreach and technical transfer of findings and solicitation of national innovations for such technology transfer. Technical Webinar Presentations. Continual efforts of data gathering, analyzation and reporting of findings from the various test sections that have been constructed at the test track and off-site. Initial development of QA protocols to correlate construction practices with actual performance. Data collection and analyzation for life cycle cost analysis purposes.

FISCAL YEAR 2021 ACCOMPLISHMENTS

Joint Activities:

- Test Track Conference held in June 2021
- Article submitted for PP Journal Summer issue
- Presented two papers at 7th Eurasphalt & Eurobitume Congress (virtual)
- Presented findings at National Pavement Preservation Conference (virtual)
- Accepted invitations to present at Public Works Expo (August 2021) and ALDOT Construction Engineers and Materials Engineers Conference (September 2021) NCAT Activities (South)
- Data collection continues on US-280 and Lee Road 159

- Continued development of the process to analyze the data
- Southern section performance data updated on NCAT's website MnDOT Activities (North)
- Field data collection on US-169 and CSAH-8
- Working to develop a process for the Pathways Autocrack to help in the research.

FISCAL YEAR 2022 ACCOMPLISHMENTS

Joint Activities:

- Contract extension through December 2023 at same level of effort has been executed
- Article submitted for PP Journal Spring issue
- Paper presented at APT International Conference in April
- Spring sponsor meeting held in Auburn in May
- Two presentations given at NEPPP annual meeting in May
- Two presentations given at ETF meeting in June
- Schedule developed for bi-monthly online meetings with sponsors/stakeholders
- Fall sponsor meeting in Minnesota in September

NCAT Activities (South):

- Data collection continues on US-280 and Lee Road 159
- Continued development of the process to analyze data
- Southern section performance data updated on NCAT's website

MnDOT Activities (North):

- Field data collection on US-169 and CSAH-8
- Working to develop a process for the Pathways Autocrack to help in the research

FISCAL YEAR 2023 ACCOMPLISHMENTS

Joint Activities:

- Spring sponsor meeting was held in Auburn, Michigan in May
- Article submitted for PP Journal Summer issue
- One bi-monthly online meeting held (UTBWC & OGFC)
- Two presentations given at T&DI Conference

NCAT Activities (South):

- Data collection continues US-280 and Lee Road 159
- Continued development of the process to analyze the data
- Southern section performance data updated on NCAT's website

MnDOT Activities (North):

- Field data collection on US-169 and CSAH-8
- Working to develop a process for the Pathways Autocrack to help in the research

FISCAL YEAR 2024 PROPOSED ACTIVITIES

Prepare end of project report. This pooled fund ends in the first quarter of FY 2024.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Project expected completion FY 2024.

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2023**

STUDY TITLE: Pavement Structural Evaluation with Traffic Speed Deflection Devices (TSDD's)

FUNDING SOURCE: FHWA OTHER (PLEASE EXPLAIN)

TPF NO.	TPF-5(385)	MDOT START DATE	3/1/2019
PROJECT NO.		MDOT COMPLETION DATE (Original)	9/30/2022
OR NO.	OR19-205	COMPLETION DATE (Revised)	10/31/2023
MDOT TECHNICAL CONTACT	Paul Shapter 517-243-7739 ShapterP@michigan.gov		
LEAD AGENCY:	Virginia Department of Transportation		
PROJECT MANAGER	Bill Kelsh Bill.Kelsh@VDOT.Virginia.gov		
CONTRACTOR	Louisiana Transportation Research Center		

BUDGET STATUS

FY 2023 MDOT Budget			Total Budget		
FY FUNDS (SPR)	(Original)	\$45,000.00	TOTAL BUDGET	(Original)	\$135,000.00
Non-SPR Funds	(Revised)			(Revised)	\$260,000.00
		4			\$0.00

PARTICIPATING STATES

LTRC, AR, CA, CO, FHWA, GADOT, ID, IL, IN, KS, KY, LA, MI, MN, MO, MS, MT, NC, NM, NV, OK, PADOT, SC, TN, TX, VA, VT, WI

PURPOSE AND SCOPE

The objective of the proposed pooled-fund project is to establish a research consortium focused on providing participating agencies guidelines on how to specify collection and use data collected with TSDDs for network- and project-level (if feasible) pavement management applications. Specific tasks within this multi-year program will be developed in cooperation with the consortium participants. In addition, the consortium will also provide participating agencies with a mechanism to conduct pilot demonstration testing in their respective networks.

The work plan will be developed based on the priorities indicated by the consortium participants, during the kick-off meeting. It is anticipated that the details and scope of the objectives will be further defined to reflect the concerns of the consortium participants. However, it is proposed that the project will include the following tasks:

- Develop a list of available devices and their characteristics. This will include details about the number of devices currently in operation and what type of data they collect.
- Develop data collection guidelines and specifications for agencies. This will include reviewing best practices from around the world and will be coordinated with service providers to ensure proposed guidelines can be implemented.
- Develop guidelines on how to incorporate pavement structural condition data into agency network-level pavement business processes. This will include defining what structural indices to use and investigating how the structural condition data can complement currently collected surface condition data to make better decisions.
- Demonstrate how structural condition collected from TSDDs can be used for supporting project level decision-making based on case studies.
- Demonstrate the costs effectiveness of collecting structural condition data both, at the network and project levels, through case studies.
- Collect data on at least 100 miles of interstate or primary type pavements for each year of participation with the option to include additional testing at additional commitment levels.
- Organize and deliver workshops and training material for the consortium members.

The pooled-fund project will be led by the Virginia Department of Transportation (VDOT) through its research office, the Virginia Transportation Research Council (VTRC).

FISCAL YEAR 2019 ACCOMPLISHMENTS

- 13 states have collected data.
- Some states had additional testing performed.
- The pool fund held a meeting and conference to go over data and activities.
- Developed route for collection.

FISCAL YEAR 2020 ACCOMPLISHMENTS

- Developed first research statement for developing guidelines and procedures to implement TSDD measurements into pavement management.

- Work on incorporating structural data into network pavement management.
- Developed route for additional collection.
- Attended webinar “demonstration of TSD Data Extraction and Processing tool”.

FISCAL YEAR 2021 ACCOMPLISHMENTS

- Develop route for additional collection.
- Continue to work on research project Guidelines and specification for TSDD data collection.
- Attended remote pool fund annual meeting.
- Formed four subgroups of pooled fund member to conduct outreach and discuss implementation.

FISCAL YEAR 2022 ACCOMPLISHMENTS

- Distribute final version of Guideline for Pavement Management Implementation of TSD
- Attended remote pool fund annual meeting.
- Develop route for additional collection.
- Finalize report summarizing the first 6 organized webinars.

FISCAL YEAR 2023 ACCOMPLISHMENTS

- Attend remote pool fund annual meeting.
- Develop route for additional collection.
- Share for review the document Guidelines and Specifications for TSDD Data Collection.

FISCAL YEAR 2024 PROPOSED ACTIVITIES

Current study is expected to end with a new pool fund to replace it.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

Two (2) additional years needed for more data to be collected. According to the latest quarterly report (First Q1- Calendar) posted on the TPF website the revised project end date is 10/31/2023.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

MDOT selected Option 2a, which include one day of TSDD testing on agency designated routes (approximately 100-200 miles depending on routes selected) = \$45,000 per year. In FY 2022- additional non-SPR funds were provided by Metro Region (\$35,000.00).

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2023**

STUDY TITLE: Mid-America Freight Coalition (MAFC) Phase 3

FUNDING SOURCE: FHWA OTHER (PLEASE EXPLAIN)

TPF NO.	TPF-5(396)	MDOT START DATE	2/1/2019
PROJECT NO.		MDOT COMPLETION DATE (Original)	9/30/2021
OR NO.	OR19-206	COMPLETION DATE (Revised)	3/31/2023
MDOT TECHNICAL CONTACT	Elisha Wulff 517-241-4778 WulffE@michigan.gov		
LEAD AGENCY:	Wisconsin Department of Transportation		
PROJECT MANAGER	Ethan Severson 608-266-1457 ethanp.severson@dot.wi.gov		
CONTRACTOR			

BUDGET STATUS					
FY 2023 MDOT Budget			Total Budget		
FY FUNDS	(Original)	\$0.00	TOTAL COST	(Original)	\$111,000.00
	(Revised)			(Revised)	\$148,000.00
		\$0.00			\$0.00

PARTICIPATING STATES

IA, IL, IN, KS, KY, MI, MN, MO, OH, and WI. Total Commitments Received:

PURPOSE AND SCOPE

The Wisconsin Department of Transportation (WisDOT) is leading a pooled fund that will:

- Produce freight-related research results.
- Improve cross-state freight-related coordination and facility development.
- Increase awareness of the importance of freight transportation for the nation's economy

Ultimately, the results of the Mid-America Freight Coalition (MAFC) activities will support and develop the economic well-being of the industries, businesses, farms, and the people of the ten-state region by keeping their products flowing to markets safely, reliably, and efficiently. Participation in this pooled fund presents an opportunity for agencies to support research on freight and economic development issues specific to the needs of transportation agencies, advance regional freight-related coordination, and ultimately allow for the quick implementation of research and development efforts.

Products of previous iterations of the MAFC pooled fund have included:

- High-quality research reports
- Recently published reports from TPF-5(293) have included an examination of the impact of Upper Mississippi River lock and dam shutdowns on state highway infrastructure, and the development of a potential regional regulatory approach to truck platooning
- Annual freight conferences attended by representatives of the ten states
- Recent conferences have run concurrent with the Ohio Conference on Freight and the Mid America Association of State Transportation Officials (MAASTO) Annual Meeting
- Educational seminars and training sessions conducted for state transportation officers
- Support to MAASTO state Freight Advisory Committees
- Direct support to MAASTO Planning and Motor Carrier Committees

Using the MAFC as a foundation, partner agencies will be able to take advantage of a wide range of expertise in truck, rail, waterway, air, and multimodal freight planning, research, management, and operations to assess and answer their regional freight research needs

The MAFC actively engages and supports freight-related activities of the MAASTO states through research projects and reports, the MAFC annual freight conference and outreach efforts, web applications, and personal communications. While specific research topics remain to be approved by the MAASTO Board of Directors (with one exception), objectives of a third iteration of MAFC efforts will generally:

- Define, conduct, and publish critical freight and economic research in coordination with the states that will support and improve freight-related facility development efforts and the related outcomes.
- Identify, evaluate, and share information, technologies, and best practices between state agencies to increase awareness and speed of implementation of best practices and increase the effectiveness of freight development initiatives. This will include a "Truck Parking Information Management System" data warehousing and performance metrics development effort that was approved, but not contracted, during TPF-5(293)
- Increase the awareness and utilization of the linkages between freight transportation investments and local, regional, and national economic development.
- Continue to advocate and support a regional approach to freight planning, policy, and operations.
- Keep abreast of industry and commodity trends and incorporate this information into MAFC communications and efforts; strive to be a clearinghouse for freight information and research.

- Maintain the MAFC website as an up-to-date resource, a source of innovative freight development ideas, and as an information-sharing hub
- Actively contribute to the development of freight policy and national freight research direction through the American Association of State Highway and Transportation Officials (AASHTO) and the Transportation Research Board (TRB)

FISCAL YEAR 2019 ACCOMPLISHMENTS

Major accomplishments include the following:

1. Completed Identification of Urban Truck Parking Locations in the MAASTO region
2. Completed Quantification of the Value of Multimodal Freight Investments
3. Completed Assessment of Multimodal Bottlenecks in the MAASTO region
4. Completed Freight Data Inventory and Training
5. Completed Truck Parking Information System (TPIMS) Performance Metrics and Data Warehouse Preparation

In addition, the MAFC held several conference calls with its members as needed and completed planning for and held its Annual Meeting in Indianapolis August 13-14, 2019.

FISCAL YEAR 2020 ACCOMPLISHMENTS

Major accomplishments include the following:

1. Review and Assessment of Rail Waybill Data
2. Develop Regional Freight Plan
3. Evaluation of Air Freight Operations in the MAASTO states
4. Region-Wide Freight Survey
5. Benefits of Weigh Station Investments on Pavement Longevity and Expense
6. Update of Freight Plan Alignment Project
7. System Failure with Automated Vehicles and Truck Platooning: What is Safe?
8. Literature Review and Bibliography of Ports and Waterway Studies

Of the studies included in the 2020 MAFC Work Program, the Review and Assessment of Rail Waybill Data is completed. The Update of Freight Plan Alignment Project is underway and has a completion date of 2/28/21. The Evaluation of Air Freight Operations in the MAASTO states is also underway with a completion date of 08/01/2021. Work continues on data management and performance reporting for Truck Parking Information Management System Performance Metrics and Data Warehousing project. Coordination and development of TPIMS web-based data repository is continuing. Dr. Perry also participated in monthly MAASTO Planning Committee and MAASTO Motor Carrier teleconferences to support upcoming projects and track other freight-related work within the agencies.

The MAFC conducted its annual meeting virtually in FY 2020. The event was broken-up into three sessions which included business meetings and virtual presentations by MAFC staff/members, industry experts and federal agencies.

FISCAL YEAR 2021 ACCOMPLISHMENTS

The current MAFC research program was planned for FY 2020-2021. The above eight research studies were continued and/or finalized in FY 2021 with cooperation of the member states. The MAFC again conducted its annual meeting virtually in FY 2021 with presentations by member states, external partners and federal agencies.

FISCAL YEAR 2022 ACCOMPLISHMENTS

The following projects have been completed in calendar year 2022 or are nearly completed.

1. Truck Parking Information Management Systems (TPIMS). MAFC manages the TPIMS data warehouse.
2. COVID-19 Disruptions: Freight System and Agency Operational Changes Affecting Freight Planning.
3. Characteristics and Importance of Freight Aviation in the MAASTO Region.
4. Establishing MAASTO Emergency Divisible Load Management.
5. MAASTO Regional Freight Alignment: Regional Assets for Freight Movement and Economic Development.

FISCAL YEAR 2023 ACCOMPLISHMENTS

The MAFC will be completing the following project throughout the remainder of calendar year 2023-2024.

1. Emergency Service Access along Class I Rail Routes
2. Construction Impacts to Multistate OSOW and Major Freight Corridors
3. Maximizing State Marine Freight Planning: Collaborative Freight Planning and Economic Development
4. Marine Geoeconomics Project

JUSTIFICATION(S) FOR REVISION (S (List the approval date for the revision(s)))

Per second quarter the MAFC has been approved for extension in funding and time for 1 year beginning March 31, 2022, through March 31, 2023. TPF website last updated August 28, 2023. Pending project closeout.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

MAFC and its member states continue to share results of the MAFC research.

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2023**

STUDY TITLE: National Cooperative Highway Research Program (NCHRP)

FUNDING SOURCE: FHWA OTHER (PLEASE EXPLAIN)

TPF NO.	TPF-5(423)	MDOT START DATE	10/01/2022
PROJECT NO.	Not applicable	MDOT COMPLETION DATE (Original)	09/30/2023
OR NO.	OR22-201	COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Andre' Clover, 517-749-9001 CloverA@michigan.gov		
LEAD AGENCY:	Federal Highway Administration (FHWA)		
PROJECT MANAGER	Jean Landolt, 202-493-3146 Jean.Landolt@dot.gov		
CONTRACTOR	Not applicable		

BUDGET STATUS

FY 2023 MDOT Budget			Total Budget		
FY FUNDS	(Original)	\$1,463,324.00	BUDGETED AMT.	(Original)	\$1,500,000.00
	(Revised)*			(Revised)	\$1,463,324.00
		\$1,463,324.00			\$0.00

PARTICIPATING STATES

The NCHRP 5-1/2% total for FY 2023 (50 states plus DC)

PURPOSE AND SCOPE

Every federal fiscal year, State Departments of Transportation are solicited to contribute 5.5 percent of their State Planning and Research (SP&R) Program federal funds to the National Cooperative Highway Research Program (NCHRP) to ensure its continued successful operation. The NCHRP is a federal program in place to develop and fund national transportation research in acute problem areas that affect highway planning, design, construction, operation, and maintenance nationwide. The NCHRP disseminates information throughout the transportation community and conducts independent research that benefits various transportation agencies throughout the country.

FISCAL YEAR 2022 ACCOMPLISHMENTS

Published Materials:

NCHRP reports are often written as guidebooks or manuals. However, supplemental research project material—such as appendixes, describe technical details, information-gathering activities, or survey instruments; glossaries; and bibliographies. These are disseminated online as web-only documents.

Published syntheses report on the state of the practice based on literature reviews and surveys of recent activities in critical areas.

Other types of published works are Research Results Digests (RRDs); Legal Digests (LRDs); Web-Only searchable documents and Selected Studies in Transportation Law.

FISCAL YEAR 2023 ACCOMPLISHMENTS

All approved active NCHRP projects were continued, and new projects were initiated and placed under contract.

FISCAL YEAR 2024 PROPOSED ACTIVITIES

The NCHRP will continue to disseminate information throughout the transportation community and conduct independent research that benefits various transportation agencies throughout the country.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

MDOT's NCHRP annual contribution is funded through its SPR Part B Program utilizing 100% federal funds.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Research findings are published in the NCHRP Reports series and the NCHRP Syntheses of Highway Practices series. MDOT technical experts have access to all NCHRP productions and continually review, share, and incorporate NCHRP research findings and recommendations into its business operations as appropriate.

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2023**

STUDY TITLE: Behavior of Reinforced and Unreinforced Lightweight Cellular Concrete for Retaining Walls

FUNDING SOURCE: FHWA OTHER (PLEASE EXPLAIN)

TPF NO.	TPF-5(433)	MDOT START DATE	10/1/2019
PROJECT NO.	OR20-206	MDOT COMPLETION DATE (Original)	9/30/2022
		COMPLETION DATE (Revised)	03/31/2024
MDOT TECHNICAL CONTACT	Joel Tichenor 517-636-4933 TichenorJ@michigan.gov		
LEAD AGENCY	Utah DOT		
PROJECT MANAGER	David Stevens 801-589-8340 davidstevens@utah.gov		
CONTRACTOR	Brigham Young University		

BUDGET STATUS

FY 2023 MDOT Budget			MDOT Total Budget		
FY FUNDS	(Original)	\$0.00	TOTAL BUDGET	(Original) FY 2020	\$30,000.00
	(Revised)			(Revised)	
TOTAL FY 2023 EXPENDITURES			TOTAL COMMITTED FUNDS AVAILABLE		
		\$0.00			\$0.00

PARTICIPATING STATES

CA, FHWA, KS, LA, MI, NY, OR, UT, and WA

PURPOSE AND SCOPE

The overall objective of this study is to measure engineering design parameters and failure mechanisms for unreinforced and reinforced LCC backfills based on large-scale laboratory tests.

Funded tasks for this study include the following:

1. Perform literature review and survey to determine methods currently used in design of MSE walls with LCC backfill, and review performance of these walls since construction (where possible).
2. Conduct Unconfined Compressive Strength (UCS), triaxial shear, direct shear, unit weight, and other laboratory tests to define basic material properties of LCC backfill (Caltrans Class II) that is used during each of the five large-scale laboratory tests.
3. Perform a large-scale test on unreinforced LCC using a reinforced concrete, cantilever retaining wall on the open side of an existing BYU test box. Measure pressures on wall, wall deformations, and eventual failure planes during fill placement, curing, and after application of a surcharge load at the top of the cured fill surface. (This test will be performed after reviewing results of a similar test previously performed on a separate UDOT research project.)
4. Within the BYU test box, perform the following four large-scale tests using MSE wall panels with various arrangements of LCC fill reinforced with inextensible ribbed strip reinforcements:
 - > Reinforced LCC Test 1 – MSE wall with LCC backfill,
 - > Reinforced LCC Test 2 – MSE wall with LCC backfill against soil slope,
 - > Reinforced LCC Test 3 – MSE walls on both sides of LCC and overlapping reinforcements, and
 - > Reinforced LCC Test 4 – Pull-out tests on MSE wall.

In these MSE reinforced LCC backfill tests, measure pressures on wall panels, wall deformations, force in reinforcements, and internal failure planes during fill placement and after application of a surcharge load at the cured fill surface. In the final test, the pull-out tests of reinforcements will be performed at a variety of vertical effective stress levels with and without surcharge.
5. Compare results with design methods. Define earth pressure coefficients, wall displacement, and failure surface geometry for the unreinforced LCC backfill test and the reinforced MSE wall LCC backfill tests. Define reinforcement pull-out resistance as a function of vertical stress and LCC strength. Compare measured earth pressure, tensile force, and pull-out resistance with available design methods.
6. Prepare two Final Reports that describe the test setup, test results, and provides comparisons with existing design procedures for (a) the unreinforced LCC test and (b) the reinforced LCC tests. The reports will also provide recommendations for design procedures based on test results and analyses of data relative to existing procedures.
7. Disseminate study results in periodic TAC update meetings and in other venues as funding allows.

FISCAL YEAR 2020 ACCOMPLISHMENTS

Tasks 1, 2, 3, and 4 listed above have been completed. Data analysis and final reports have not been completed and disseminated.

FISCAL YEAR 2021 ACCOMPLISHMENTS

Two additional tests were performed to acquire additional data related to MSE wall reinforcement in LCC Backfill. This brought the total number of tests to 6 (including the 4 tests originally listed in task 4 above). The first additional test involved MSE wall panels and LCC backfill with welded-wire reinforcements. The second additional test involved additional reinforcement pull-out tests. Data related to these additional tests was provided to the research team.

Task 5 started but has not been completed and disseminated.
Task 6 is in progress but has not been completed and disseminated.

FISCAL YEAR 2022 ACCOMPLISHMENTS

Task 5 completion pending.
Task 6 reports have been provided to the team for review and comment but have not been completed and disseminated.
Task 7 to be completed after review and comment of the reports.

FISCAL YEAR 2023 ACCOMPLISHMENTS

Status of each task at FYE is as follows:
Task 1- 70%
Tasks 2, 3, 4, and 5- 100%
Tasks 6* and 7- 50% [*Additional Task 6 reports were generated and disseminated to the group for review and comment]

Reports:

- 6- Short Interim Reports
- 6- Detailed Interim Reports
- 1- Short Report
- 2- Final Reports (to post on TPF website)

FISCAL YEAR 2024 PROPOSED ACTIVITIES

Final reports will be completed after review and comment from the group. After completion, the reports and study results will be disseminated to the group.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

No cost time extension required to complete final report.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Project expected completion FY 2024.

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2023**

STUDY TITLE: Aurora Program (FY20-24)

FUNDING SOURCE: FHWA OTHER (PLEASE EXPLAIN)

TPF NO.	TPF- 5(435)	MDOT START DATE	10/01/2019
PROJECT NO.		MDOT COMPLETION DATE (Original)	09/30/2024
OR No.	OR20-212	COMPLETION DATE (Revised)	12/31/2024
MDOT TECHNICAL CONTACT	James Roath, 517-230-5361 RoathJ1@michigan.gov		
LEAD AGENCY:	Iowa DOT		
PROJECT MANAGER	Khyle Clute, 515-239-1646 Khyle.Clute@iowadot.us		
CONTRACTOR			

BUDGET STATUS

FY 2023 MDOT Budget			MDOT Total Budget		
FY FUNDS	(Original)	\$25,000.00	TOTAL BUDGET	(Original)	\$125,000.00
	(Revised)			(Revised)	
		\$25,000.00			\$25,000.00

PARTICIPATING STATES

AK, AZ, CA, CO, DE, IL, IA, KS, ME, MI, MN, MO, ND, OH, PA, UT, VA, WA, and WI.

PURPOSE AND SCOPE

The Aurora program is a partnership of highway agencies that began in 1996 to collaborate on research, development, and the deployment of Road Weather Information Systems (RWIS) to improve the efficiency, safety, and reliability of surface transportation. It is managed by the Center for Weather Impacts on Mobility and Safety (CWIMS) which is housed under InTrans at Iowa State University.

Aurora's initiatives are funded by member agencies to conduct research that services the needs of its members. The board meets twice each year to set the agenda for RWIS research, keep informed about progress on program initiatives, and discuss solutions for common in the field problems. Newly selected initiatives are led by "champion" member agencies, managed by committees of Aurora members.

Aurora works closely with the Federal Highway Administration (FHWA), having been approved for federal-aid research and development funds without state match using 100% SPR funding. Aurora also has a strong relationship with the American Association of State Highway Transportation Officials (AASHTO) and its Snow and Ice Pooled Fund Cooperative Program (SICOP). In addition, Aurora coordinates with the American Meteorological Society (AMS), the National Severe Storm Laboratory, ITS America, Clear Roads, and the National Center for Atmospheric Research (NCAR). Aurora also works closely with industry as initiated by each participating entity.

FISCAL YEAR 2020 ACCOMPLISHMENTS

Administrative:

- Coordinated with states regarding new (or interim) Board representatives.
- Managed Aurora email list. In some cases, states requested multiple individuals be included in Aurora related correspondence.
- Provided program management in terms of projects and program budgets.
- Participated in planning call (July 10) for the 2020 International Road Weather and Winter Maintenance Conference.
- Prepared presentations about Aurora for members to discuss at the following meetings.
- Coordinated with SICOP.
- FHWA Road Weather Stakeholder Meeting held.
- Updated Aurora website content.

FISCAL YEAR 2021 ACCOMPLISHMENTS

Administrative:

- Aurora website updates.
- Ontario membership follow up.
- Manage budget.
- Track new solicitation contributions.
- Update the Aurora Charter, Work Plan and Associate Members.

Project-Specific Activities:

- Tracked project status and prepared a summary for recently completed and active projects.

- Distributed quarterly reports and invoices for project team approval.
- Upon approval, submitted invoices to the Iowa DOT for payment.
- 2020-02 "Roadway Ice/snow Detection using a Novel Infrared Thermography Technology".
- Distributed quarterly report to project team.
- Had project update presentation during the spring meeting.
- 2020-03 Roadway Friction Modeling
- Facilitated sharing of some sensors in support of the project.
- Collaborated in project re-scoping.
- Distributed quarterly reports and invoices.

Meetings and Conferences:

Board member monthly conference calls were held on the following dates.

April 8, 2021

- Financials
- Membership
- Submitted ideas
- Additional solicitation

May 2021 meeting was held in conjunction with the Aurora Spring meeting.

2021 Aurora Spring Meeting

- Coordinated presentations from FHWA, SICOP and researchers.
- Prepared financial details, including commitment, encumbrances, and available funds.
- Solicited project ideas for the 2021 Aurora Spring Meeting. A total of 14 ideas were received.
- Prepared spreadsheet for project voting.
- Organized and distributed project ideas and voting spreadsheet to Aurora Board.
- Obtained and integrated voting results for discussion during the spring meeting.
- Prepared and distributed questions to the proposers of the five highest rated project ideas.

Conference calls were held with two of the proposers

June 10, 2021

- Project idea update
- Project update
- Other action items – equipment compatibility, data logger use

FISCAL YEAR 2022 ACCOMPLISHMENTS

Project- Non-Invasive Sensor Deployment in Aurora Member States

Continue monthly Board meeting calls.

Continue to communicate with new Aurora representatives.

Seek additional project ideas from members.

Gather and distribute project ideas to members.

Continue to hold project-related meetings.

Collaborate and facilitate addressing project needs, relating to scope and/or budget changes, that may arise.

Meetings and Conferences:

Board member monthly conference calls

- Financials
- Membership
- Submitted ideas
- Additional solicitation

May 2022 meeting was held in Portland, OR.

2022 Aurora Spring Meeting

- Coordinated presentations from FHWA, SICOP and researchers.
- Prepared financial details, including commitment, encumbrances, and available funds.
- Solicited project ideas for the 2022 Aurora Spring Meeting. A total of 19 ideas were received.
- Prepared spreadsheet for project voting.
- Organized and distributed project ideas and voting spreadsheet to Aurora Board.
- Obtained and integrated voting results for discussion during the spring meeting.
- Prepared and distributed questions to the proposers of the five highest rated project ideas.

October 2022 Meeting Held in Minneapolis, MN

- Friends of Aurora Presentations
 - Final Project decisions
 - Projects and Invoices
 - State Commitments
-

- Management and Board Meeting Costs
- Overall Funds Available for Projects
- Discussion regarding 2023 Spring Meeting

FISCAL YEAR 2023 ACCOMPLISHMENTS

Automated Extraction of weather Variables from Imagery
 Roadway Friction Modeling: Improving the Use of Friction Measurements in State DOTs

Continue monthly Board meeting calls.
 Continue to communicate with new Aurora representatives.
 Seek additional project ideas from members.
 Gather and distribute project ideas to members.
 Continue to hold project-related meetings.
 Collaborate and facilitate addressing project needs, relating to scope and/or budget changes, that may arise.

Meetings and Conferences:

Board member monthly conference calls

- Financials
- Membership
- Submitted ideas
- Additional solicitation

May 2023 meeting was held in San Diego, CA.

2023 Aurora Spring Meeting

- Coordinated presentations from FHWA, SICOP and researchers.
- Prepared financial details, including commitment, encumbrances, and available funds.
- Solicited project ideas for the 2023 Aurora Spring Meeting.
- Prepared spreadsheet for project voting.
- Organized and distributed project ideas and voting spreadsheet to Aurora Board.
- Obtained and integrated voting results for discussion during the spring meeting.
- Prepared and distributed questions to the proposers of the five highest rated project ideas.

October 2023 Meeting Held in Portland, MA

- Several project kickoff presentations and project final presentations
- Final Project decisions
- Projects and Invoices
- State Commitments
- Management and Board Meeting Costs
- Overall Funds Available for Projects

Discussion regarding 2024 Spring Meeting, looking at scheduling it to be in Colorado.

FISCAL YEAR 2024 PROPOSED ACTIVITIES

Spring and fall in person meetings.
 Evaluation of Spring Load Restriction Removal Protocols
 Road Weather Management using Connected Vehicle Technology
 Optimal RWIS Sensor Density and Location – Phase 4
 Real User Friction for Winter Maintenance Operation and Evaluation

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

The project start date was delayed due to budget needs not being met; thus, delaying the contract execution. The delay required moving project end date back to complete the work.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Project expected completion FY 2024.

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2023**

STUDY TITLE: Development of Criteria to Assess the Effects of Pack-out Corrosion in Built-up Steel Members

FUNDING SOURCE: FHWA OTHER (PLEASE EXPLAIN)

TPF NO.	TPF-5(436)	MDOT START DATE	10/1/2019
PROJECT NO.	OR20-201	MDOT COMPLETION DATE (Original)	9/30/2022
		COMPLETION DATE (Revised)	9/30/2024
MDOT TECHNICAL CONTACT	Allie Nadjarian 517-331-6602 NadarianA@michigan.gov		
LEAD AGENCY:	Indiana DOT		
PROJECT MANAGER	Tommy Nantung tnantung@indot.in.gov		
CONTRACTOR			

BUDGET STATUS

FY 2023 MDOT Budget			MDOT Total Budget		
FY FUNDS	(Original)	\$0.00	TOTAL BUDGET	(Original)	\$120,000.00
	(Revised)			(Revised)	
		\$0.00			\$0.00

PARTICIPATING STATES

IN, IL, KS, MI, MN, PA, and TX.

PURPOSE AND SCOPE

The objectives of the proposed pooled-fund study are as follows:

- 1) To develop AASHTO ready specifications for the evaluation of the effects of pack-out corrosion in built-up steel tension, compression, and flexural members.
- 2) Provide guidance on the need for repairs and corrosion rates that can be expected in various environments to assist owners in programming when repairs may need to be made.
- 3) Identify the most effective methods of repairs and provide suggesting verbiage that could be used when preparing special provisions for repairs.
- 4) Develop several case-study examples, including calculations that will be used for training users on the methodologies to be developed. It is anticipated that the research team will host several webinars or on-site training sessions to ensure technology transfer and implementation.
- 5) The impact of this study is obvious considering there is no such quantitative guidance available at present. The results of the work will allow owners to accurately assess the effects of this form of corrosion on various limits states (e.g., strength, fatigue, buckling, etc.) in built-up steel members. Both flexural and truss-type members will be studied. The ability to program repairs based on data-driven models allows for the best possible use of limited maintenance funds and safely extend the life of the existing inventory.

Research Tasks:

To achieve the proposed objectives, the following tasks are proposed:

Task I – Perform a thorough literature review of both domestic and international research on pack-out corrosion, how various owners have addressed this problem, repair strategies, and collect data on corrosion processes and rates.

Task II – Develop a laboratory experimental program that will include large-scale testing of members which contain damage due to pack-out. At present, the research team will explore the use of both simulated pack-out (i.e., newly fabricated components with induced local distortions that simulate pack-out) and “natural” pack-out by obtaining members from various bridge being removed from service. The effects of temperature on the performance of damaged members will also be included in the laboratory testing as the fracture toughness of some older steels is minimal at low temperatures. In this regard, testing of tension and flexural members will be completed at cold temperatures. The benefits of internal redundancy will also be examined. Finally, various mitigation strategies will also be investigated. While there are some anti-corrosion products currently available on the market, it is not clear how to evaluate the effectiveness of these products. Therefore, a portion of the work will focus on the evaluation of such products and to subsequently develop methods to assess the short- and long-term effectiveness of such products.

Task III – As data become available from Task II, the research team will conduct numerical (FEA) parametric studies to allow a wider range of damage to be evaluated under various geometries and loading conditions which are not possible to include in the laboratory studies. It is noted the research team at Purdue University has gained extensive experience in the laboratory testing and calibrated

non-linear FEA of built-up steel members during the development of the recently published AASHTO Guide Specifications for Internal Redundancy of Mechanically fastened Built-up Steel Members.

Task IV – Based on the results of Tasks I through III, proposed guide specifications for the evaluation of the effects of pack-out corrosion will be developed for consideration by AASHTO COBS. The research team has considerable experience in the development of AASHTO Specifications and has worked very closely with various AASHTO subcommittees to ensure all stakeholders, including FHWA, are involved and have input.

Task V - In addition to developing the Guide Specifications, a methodology to estimate the interval from when “non-critical” pack-out becomes “critical” pack-out corrosion will be developed. This information will be particularly useful to owners when programing funding for future repairs. Finally, guidance on the best practices for the repair of pack-out corrosion, when deemed required, will also be compiled.

Task VI – Develop training materials to ensure the results are disseminated and the research is moved into practice.

Task VII – Summarize the results of the research in a detailed Final Project Report.

FISCAL YEAR 2020 ACCOMPLISHMENTS

- Despite the challenges with Purdue being shut down from approximately mid-March through the end of June due to COVID-19, reasonable progress has been made regarding the finite element studies to evaluate the effects of pack-out on the strength of compression members. Analysis have begun to consider the effects of pack-out in flexural members considering fastener pitch, cover plate thickness, flange thickness, and degree of pack-out distortion on the strength of the member. The studies will be used to develop the details associated with the experimental portion of the research.

FISCAL YEAR 2021 ACCOMPLISHMENTS

- Prototype testing focusing on the compression flange of a beam was completed. Three tests in total were performed. A W24x68 with top and bottom cover plates was tested to focus on pack-out in a compression flange. Tests included zero distortion of the cover plate as well as various levels of distortion due to simulate pack out. For this test, no section loss was introduced to isolate the effect of the pack-out. The test yielded valuable data regarding the effect of distortion on fastener forces, local stresses, and stiffness. The second test included a girder with simulated section loss and no simulated distortion and a third specimen which included a cover plate having simulated section loss and with simulated pack out distortion. The section loss was simulated by machining material away in a profile like what has been measured from real specimens.
- The data from the two additional prototype tests were used to further calibrated the FEA studies. As with the other tests, excellent agreement between the laboratory measured data and the FEA results have been observed.
- An entire truss has been obtained from INDOT which included members with moderate to severe pack-out that has been taken out of service. Work is underway to develop tests which will utilize these members to evaluate the strength as well as fatigue/fracture performance.

FISCAL YEAR 2022 ACCOMPLISHMENTS

- The tests on small portions of members with real pack out corrosion was completed, and data was reviewed and used to calibrated FEA simulations. These specimens were subjected to compression loading to evaluate the effect of section loss and distortion on local buckling. These data will be used along with the data from the compression flange girder tests to begin to develop strategies to evaluate the effects of pack-out on the capacity of compression members.
- The large-scale fatigue specimens have been fabricated and shipped to the lab.
- Continued calibrating FEA models based on the experimental data. 3D mapping of the distortion from pack-out and section loss is being incorporated into the girder FEA models to identified regions of amplified local stresses.
- Continue to calibrate FEA models of compression flanges and axial members using the large-and small-scale test date. These data will be used along with the data from the compression flange girder tests to begin to develop strategies to evaluate the effects of pack-out on the capacity of compression members. FEA parametric studies are underway for these compression members.
- Began fatigue testing the large-scale girders. The testing began later than anticipated due to equipment issues. The tests are being run at low stress ranges (7 ksi) to obtain data at stress range levels representative of in-service bridges. Hence, they will take a very long time to complete. There are 4 girders in total that will be fatigue tested.
- Continued calibrating FEA models based on the experimental data.

FISCAL YEAR 2023 ACCOMPLISHMENTS

- FEA parametric studies continued on flexural and axial members to evaluate the effect of pack-out corrosion on the strength and fatigue performance of such members.
- Work on parametric studies focused on compression members was intimated for a range of flexural members.
- Conclusions and AASHTO-ready evaluation procedures should be forthcoming.

FISCAL YEAR 2024 PROPOSED ACTIVITIES

- Continue with the finite element parametric studies and based on the results of the prototype test, develop the detailed experimental program for compression flanges.
 - Continue analytical and experimental studies on tension flanges with pack-out corrosion.
 - Continue evaluating the strength and fatigue data.
 - Begin to craft AASHTO-ready code and commentary for evaluation of members with pack-out corrosion for consideration by AASHTO COBS, T-18 and T-14.
 - Obtain additional members with pack-out corrossions.
-

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

The project will require a 12-18 month no cost extension. While the “official project start date on the TPF website was effectively September 2019, commitments did not arrive until spring of 2020. This was documented in the earlier QPRs from 2019 and 2020. COVID 19 then shut the university down in Spring of 2020 and no work could be performed and no students were hired out of caution. To perform all the long-life fatigue and strength testing, finish all FEA studies, compile all project results, etc. a no-cost extension will be requested through FY24.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Project expected completion FY 2024.

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2023**

STUDY TITLE: Technology Transfer Concrete Consortium (FY20-FY24)

FUNDING SOURCE: FHWA OTHER (PLEASE EXPLAIN)

TPF NO.	TPF-5(437)	MDOT START DATE	10/01/2019
PROJECT NO.	OR20-207	MDOT COMPLETION DATE (Original)	12/31/2025
		COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Kevin Kennedy 517-749-9067 KennedyK@Michigan.gov		
LEAD AGENCY:	Iowa DOT		
PROJECT MANAGER	Khyle Clute Khyle.Clute@iowadot.us		
CONTRACTOR	Iowa State University		

BUDGET STATUS

FY 2023 MDOT Budget			MDOT Total Budget		
FY FUNDS	(Original)	\$12,000.00	TOTAL BUDGET	(Original)	\$80,000.00
	(Revised)			(Revised)	\$60,000.00
		\$12,000.00			\$12,000.00

PARTICIPATING STATES

AL, AR, CA, CO, FL, GA, IA, ID, IL, IN, KS, KY, MA, MI, MN, MO, MT, NC, ND, NE, NV, NY, OH, OK, OR, PA, SC, SD, TN, TX, UT, WA, WI, WV, and WY.

PURPOSE AND SCOPE

The goals of the Technology Transfer Concrete Consortium (TTCC) are to:

- Identify needed research priorities by region
- Provide a forum for technology exchange between participants
- Develop and fund technology transfer materials
- Provide on-going communication of research needs faced by state agencies to the Federal Highway Administration (FHWA), industry, and the National Concrete Pavement Technology Center (CP Tech Center)
- Provide technical leadership for concrete related national initiatives to advance state-of-the-art construction and material practices

It is anticipated that this consortium would become the national forum for state involvement in the technical exchange needed for collaboration and new initiatives and provide tactical strategies and solutions to issues identified by the member states.

This pooled fund project allows for state representatives to continue the collaborative efforts of TPF-5(313) that originally began in TPF-5(066) Materials and Construction Optimization. The TTCC is open to any state agency desiring to be a part of new developments in concrete. TTCC will meet in conjunction with the National Concrete Consortium (NCC), twice a year. NCC Bylaws and the Executive Committee membership can be found at <http://www.cptechcenter.org/ncc/TTCC-NCCMeetings.cfm>.

TTCC Project Activities and Deliverables:

- Identify and guide the development and funding of technology transfer materials such as tech brief summaries, web-based courses, and training materials from research activities
- Publish Moving Advancements into Practice (MAP) Briefs on a quarterly basis
- Provide research ideas to funding agencies
- Identify and instigate needed research projects
- Include current activities and deliverables of the pooled fund on the CP Tech Center website
- Maintain the pooled fund project website with current activities and deliverables
- Maintain the TTCC pooled fund listserv; a forum for state reps to post questions to the other state reps and hear how similar problems or situations have been mitigated.
- Track TTCC listserv posted problems and discussions and categorize them for inclusion in a library on the project website
- Develop research problems statements for possible pooled fund projects to address research needs identified by member state reps
- Act as a technology exchange forum for the participating entities
- Contribute to a technology transfer newsletter on concrete pavement research activities every six months
- Submit electronic quarterly reports following lead state guidelines

Pooled fund activities and budgets are discussed at the semi-annual meetings. Proposals for minor research, synthesis studies, and/or training are often presented by partners and then discussed and voted on at the semi-annual meetings. NCC members may propose needed research and/or training, however they may not vote on how to utilize the federal pooled funds. Selection of needed work by partners does not guarantee work can be conducted under this pooled fund project since the Iowa DOT and FHWA must ensure the work will fit within the funding guidelines and scope of the project. Occasionally e-mail discussions and votes are warranted.

FISCAL YEAR 2020 ACCOMPLISHMENTS

The spring meeting, which was scheduled for April 2020 in Nashville, TN, was postponed due to COVID-19. The fall face to face meeting scheduled for Minneapolis, MN was postponed due to COVID-19. The fall “virtual” meeting was held September 1-3, 2020. The agenda was comprised of the following:

- FHWA Alkali-Silica Reactivity (ASR) Update
- Managing ASR for the Future
- Post-treating for ASR
- Lightweight Cellular Concrete
- Performance Engineered Mixture (PEM) Testing Experiences
- Dowel/Tie Bars
- National Transportation Product Evaluation Program (NTPEP) Update
- Pumping Concrete
- National Road Research Alliance (NRRRA) Update

FISCAL YEAR 2021 ACCOMPLISHMENTS

This pooled fund project, TPF-5-(437), is a continuation/reauthorization of TPF-5(313). The Spring 2021 meeting for TPF-5(437) was tentatively scheduled to be held in Nashville, TN on April 13-15. However, it was, again, switched to a virtual web meeting. The fall 2021 meeting was replaced by registration and attendance to the International Conference on Concrete Pavements. Several MDOT CFS staff attended this weeklong virtual web-based conference, which showcased many very informative topics relative to concrete pavements, presented by experts throughout the world.

FISCAL YEAR 2022 ACCOMPLISHMENTS

Held NCC Spring 2022 at the Embassy Suites in Nashville on April 4-6. Attendees included 197 in-person and 75 virtual from 39 states, District of Columbia, Puerto Rico, and Canada. Information and PowerPoints from the presentations are available: <https://intrans.iastate.edu/events/spring>. Spring e-news is available: <https://mailchi.mp/9695b280bd3c/spring-2022-nc2-news>. The Fall 2022 meeting was held in Detroit on September 27-29. E-news and MAP Brief were published.

FISCAL YEAR 2023 ACCOMPLISHMENTS

Spring (Savannah, Georgia) and Fall (Portland, Oregon) Conferences were held. Information and PowerPoints from the Spring 2023 meeting held April 11-13 are available: <https://cptechcenter.org/nc2-meetings>. Technology transfer and exchanges remained a major focus. Identified and facilitated research activities. Maintained and updated pooled fund website.

FISCAL YEAR 2024 PROPOSED ACTIVITIES

Spring and Fall Conferences will be held. Technology transfer and exchanges will remain a major focus. Plans to identify and facilitate research activities. Maintain and update pooled fund website.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

MDOT Research Advisory Committee- Chair approved 2 MDOT representatives.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Expected project completion FY 2026.

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2023**

STUDY TITLE: Smart Work Zone Deployment Initiative (FY20-FY24)

FUNDING SOURCE: FHWA OTHER (PLEASE EXPLAIN)

TPF NO.	TPF-5(438)	MDOT START DATE	10/1/2019
PROJECT NO.	OR20-200	MDOT COMPLETION DATE (Original)	12/31/2024
		COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Chris Brookes BrookesC@michigan.gov 517-242-6486		
LEAD AGENCY:	Iowa DOT		
PROJECT MANAGER	Khyle Clute Khyle.Clute@iowadot.us		
CONTRACTOR	Iowa State University		

BUDGET STATUS

FY 2023 MDOT Budget			MDOT Total Budget		
FY FUNDS	(Original)	\$25,000.00	TOTAL BUDGET	(Original)	\$125,000.00
	(Revised)			(Revised)	
		\$25,000.00			\$25,000.00

PARTICIPATING STATES

IA, IL, KS, MI, Mn, MO, NE, TX, and WI.

PURPOSE AND SCOPE

This program represents an on-going effort among cooperating states' Departments of Transportation (DOTs), the Federal Highway Administration (FHWA), universities, and industry to evaluate new products and conduct related research focused on the enhancement of safety and mobility in highway work zones. Over 100 studies and evaluations have been completed since the inception of the SWZDI and final reports are posted in the Smart Work Zone Deployment Initiative (SWZDI) web site at <https://swzdi.intrans.iastate.edu/>.

Procedures for Project Selection, Award, Implementation

1. Board of Director (BOD) members solicit and develop problem statements.
2. BOD prioritizes problem statements.
3. Program administrator prepares Request for Proposals and collects proposals from researchers in partnering states.
4. BOD prioritizes proposal topics.
5. BOD reviews, discusses, and prioritizes submitted proposals.
6. Proposal are scored and ordered based on priorities collected in item 5 and weighted values that are based on state partner commitments that year.
7. Annual work plan is prepared by the program administrator who also facilitates contracts between the selected researcher(s) and the Iowa DOT.
8. State DOTs form and lead the individual project Technical Advisory Committees (TACs) for projects awarded to a university or entity in their state (other members can request to serve on the TAC).
9. Projects are tracked quarterly.
10. Draft final reports are reviewed by the home state as well as by the BOD.
11. Final reports are posted to the program webpage and sent to national research report repositories.
12. Implementation and technical transfer opportunities are discussed by the BOD.

Research Implementation and Technology Transfer Benefits: The benefits from the SWZDI pooled fund include a wide variety of products including completed research reports, technical transfer documents, potential presentations and training, safety equipment evaluations, support toward other research, as well as development and/or implementation of research results in areas of mutual interest and benefit to pooled fund members and others in the industry.

FISCAL YEAR 2020 ACCOMPLISHMENTS

For the 2020 program, 30 problem statements were developed; the BOD decided that 10 problem statements should be included in the annual Request for Proposals (RFP). The RFP was distributed to potential researchers at research institutions in contributing states on October 25, 2019.

The three top ranked proposals could be funded and were selected for the 2020 program year and are expected to total \$200,000.

List of Approved projects:

1. Temporary Traffic Control Devices at Driveways within a One-Lane, Two-Way Section
2. Using Smart Work Zone Trailer Data to Evaluate and Predict Lane Closure Impacts with a Consideration of Work Intensity
3. Work Zone Activity Data Logging – Phase II

Project 3a is with Michigan State University and is taking place on MDOT project sites. This data collection would have been completed in house but was able to be performed by MSU instead due to the selection of the project. The voting influence gained by MDOT being an active member played a large role in this project being selected.

FISCAL YEAR 2021 ACCOMPLISHMENTS

The Reports completed during the 2021 fiscal year are as follows:

4. Using Smart Work Zone Trailer Data to Evaluate and Predict Lane Closure Impacts with a Consideration of Work Intensity
This report describes the implementation of machine learning (ML) models to the prediction of work-zone traffic impacts including local speed and traffic volume changes and corridor-level travel time increases. It also summarizes efforts to refine an existing tool that estimates work-zone-related delays and costs by providing consistent estimates of typical travel times that consider variations across days of the week and months of the year.
5. Work Zone Data Management Applications and Opportunities
This project reviewed various stakeholders' current needs for pre-construction, real-time, and post-construction work zone information and compared these needs to the available work zone data sources and standards. The analysis identified a substantial mismatch between the roadway and lane closure data currently available and the data required to manage work zone traffic impacts effectively. To address this gap, the project developed a conceptual prototype for a tool that would facilitate self-reporting of closure details by contractors and maintenance crews.

FISCAL YEAR 2022 ACCOMPLISHMENTS

The Reports completed during the 2021 fiscal year are as follows:

1. Investigation of Autonomous/Connected Vehicles in Work Zones
This study is the first research project that examined truck platooning in work zones. A networked or federated simulator was used in which a vehicle driven by a human subject encountered a truck platoon with the lead truck driven by a human driver. The experiment involved 10 scenarios composed of differences in education, truck signage, and number of trucks in the platoon. The results point to the importance of education as the post-education vehicle speeds increased between 8.6% and 12.9% across scenarios, and the distance headways decreased between 28.8% and 30%. The vehicles increased in efficiency while still staying under the work zone speed limit.
2. Effective Signing Strategies and Signal Displays for Work Zone Driveway Assistance Devices (DADs)
Work zones that include a single lane closure on a two-lane, two-way roadway present unique traffic control challenges. In these situations, traffic regulators (i.e., flaggers or temporary traffic signals) are often utilized to regulate traffic such that only a single direction utilizes the open travel lane at any time. Recently, an experimental traffic control treatment, referred to as the driveway assistance device (DAD), was developed to help drivers safely enter a one-lane, bi-directional work zone from a driveway or minor side street by using alternating left and right flashing arrows along with a steady red indication. As the DAD is a relatively new and under-researched treatment, much is still unknown about the optimal designs of the signal display and auxiliary signage to provide the highest comprehension and compliance.

FISCAL YEAR 2023 ACCOMPLISHMENTS

The Reports completed during the 2022 fiscal year are as follows:

1. Work Zone Activity Data Logging – Phase II
In the Work Zone Activity Data Logging Phase I project, state transportation agencies in the SWZDI states and beyond expressed a strong need for better information about the location, extent, and timing of lane closures. More than a dozen use cases for detailed lane closure data were identified and prioritized, such as helping first-responders avoid closures, providing more accurate public information about closure locations and timing, and more efficiently conducting post-construction work zone traffic management effectiveness reviews. Phase I affirmed that most state DOTs currently lack the ability to track lane closures at the level of temporal and spatial detail required for these uses. Among the very few agencies that have the technical ability to record this information, the data lacks reliability. Closures on county and municipal routes were seldom, if ever, tracked.
2. Work Zone Speed Limits and Motorist Compliance:
This study sought to identify best practices for setting work zone speed limits by state departments of transportation (DOTs) and to evaluate select strategies for improving compliance with work zone speed limits. This was achieved by synthesizing information from a literature review, a state DOT survey, and field evaluations of select speed management strategies.
3. Evaluation of Messaging Techniques to Increase Vehicle Spacing at Work Zones
Rear-end collisions in work zones, induced primarily by speeding and tailgating, are a predominant concern for roadway safety. Although considerable research has shed light on the dangers and implications of speeding within these zones, there exists a conspicuous research gap on tailgating behaviors.

As of June 30, 2023, work completed was approximately 50%.

Per the TPF website the estimated project completion date is December 31, 2024.

FISCAL YEAR 2024 PROPOSED ACTIVITIES

The 2024 problem statements RFP have been sent out and are as follows:

Subject 1: Work Zone Performance

Subject 2: Accommodation of Vulnerable Road Users

Subject 3: Artificial Intelligence and its Uses for Work Zone Management

Once all RFPs are submitted the board will review and determine which will be funded for the fiscal year 2024.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Expected project completion FY 2025.

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2023**

STUDY TITLE: No Boundaries Transportation Maintenance Innovations

FUNDING SOURCE: FHWA OTHER (PLEASE EXPLAIN)

TPF NO.	TPF-5(441)	MDOT START DATE	10/1/2019
PROJECT NO.	OR20-208	MDOT COMPLETION DATE (Original)	9/30/2024
		COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Todd Rowley 517-322-3311 RowleyT@michigan.gov		
LEAD AGENCY:	Colorado DOT		
PROJECT MANAGER	David Reeves 303-757-9518 david.reeves@state.co.us		
CONTRACTOR			

BUDGET STATUS

FY 2023 MDOT Budget			MDOT Total Budget		
FY FUNDS	(Original)	\$10,000.00	TOTAL BUDGET	(Original)	\$50,000.00
	(Revised)			(Revised)	
TOTAL FY 2023 EXPENDITURES			TOTAL COMMITTED FUNDS AVAILABLE		
			\$10,000.00		

PARTICIPATING STATES

CA, CO, CT, FL, ID, IL, IN, LA, MDOT SHA, ME, MI, MN, MO, MS, ND, NY, OH, SC, TX, UT, VA, WA, and WI.

PURPOSE AND SCOPE

Through this pooled fund project, the Colorado Department of Transportation (CDOT) will work with other State Departments of Transportation (DOTs) to facilitate the transfer of knowledge of promising non-snow and ice maintenance innovations and technologies. This project provides a forum for State DOTs to share their maintenance innovations with each other, support technology transfer activities and develop marketing and deployment plans for selected innovations through bi-annual 2–3-day peer exchange meetings at various locations selected by participating members. Resources will be provided for the transfer of knowledge and experience of various innovations that includes travel, training, and other technology transfer activities.

It is anticipated that this consortium will become the national forum for state involvement in the technical exchange needed for collaboration and new initiatives and be a forum for advancing the application and benefit of research technologies. In addition, the project will create a searchable database or warehouse where innovations and research done relating to highway maintenance can be found and showcased. State participation in this process will be through the pooled fund. FHWA, industry and others will be invited to participate in the project discussions and activities.

Workshops will continue to be provided for the states participating in the pooled fund project. This project will help DOTs to save time and money by not investing in the same research that has already been performed by other state DOTs. Rather than having each DOT identify and conduct research separately, DOTs can work collectively through this pooled fund project.

The Colorado DOT will serve as the lead state for the execution of the pooled fund project described in this proposal. The Colorado DOT will handle all administrative duties associated with the project.

- 1) Identify promising innovations and technologies ready to be deployed within Maintenance activities, developed by the participating State DOTs, non-participating DOTs, and outside entities.
- 2) Develop marketing plans for selected ready to deploy innovations and technologies
- 3) Organize training classes about specific research topics for member State DOTs.
- 4) Develop searchable database where innovations and research projects developed across the country can be identified and accessed.
- 5) Maintain a web site along with content management: <http://maintainroads.org>
- 6) (Optional depending on amount and interest level) Creation of synthesis (practice or literature) like reports that will dig deeper into "like issues" facing State DOT operations of maintenance. Topics might include, although not limited to (based on current hot topics):
 - a. Employ recruitment & retention including maintenance degree like opportunities.
 - b. Asset Management
 - c. Emergency and Resiliency Management
 - d. Roadside Maintenance such as pollinators
 - e. Increased communication opportunities between No-Boundaries and related FHWA-AASHTO-MAC committees/and or groups
 - f. New product innovations or best practices specific to operations of maintenance
- 7) Considering results of #6 above
 - a. Develop appropriate workshops
 - b. Peer Exchanges
 - c. Webinars
 - d. Website enhancements (<http://maintainroads.org/>)
 - e. Best practice or manual development

8) Also considering results of #6 - Scope research necessary for funding/management, by others, that will vary dependent upon the nature and scope of the topic.

FISCAL YEAR 2020 ACCOMPLISHMENTS

FY 2020 has accomplished establishing the transition to No Boundaries Phase III from Ohio's lead in Phase II. No Boundaries transition team completed the Request for Proposals (RFPs) and consultant selection to manage the pool fund. Setting up the next phase included a series of monthly transition meetings, scope of work development, fund transfers, CDOT contracting process and consultant selection to manage the pool fund. Consultant contract was signed on Sept 1, 2020, and task order 1 signed in late Oct. Pool fund activities should resume with contracts and task order in place.

FISCAL YEAR 2021 ACCOMPLISHMENTS

FY 2021 will move forward with the above-mentioned activities using web-based format to replace travel requirements. Because of COVID-19 pandemic from early 2020 and ongoing, our group has not had a "face to face" meeting since May of 2019 in Denver CO. Also, a factor for 2020 was the expiration of the managing contract for No Boundaries. As of 10/01/2020, Colorado has accepted the role as lead state and CTC & Associates LLC as the managing source with future virtual training session planned but not scheduled as of 10/2020. Update: No Boundaries did have a "face to Face" meeting in Denver on September 14th and 15th. Michigan attended virtually because of the short notice and lack of out of state travel approval.

FISCAL YEAR 2022 ACCOMPLISHMENTS

No Boundaries is continuing to improve on our on-line database of innovations. The group had its most recent "face to face" meeting in May 2022 at CALTRANS Sacramento CA facility which MDOT attended. Also planned for 2022 is a "face to face" meeting in Indianapolis IN in October of 2022 which will be attended by an MDOT representative. MDOT benefited from the Sacramento CA "face to face" by learning of a new QR code process of providing safety and training videos on demand for equipment operations and safety. Process is ongoing and planned to be rolled out in 2023.

FISCAL YEAR 2023 ACCOMPLISHMENTS

No Boundaries added entries to the on-line maintenance innovations database, as well as updates to the No Boundaries website. The group held two "face to face" meetings, the first in October 2022 in Indianapolis, IN and the second in Missouri in April 2023. The group also held two TAC teleconferences in March and August 2023. An MDOT representative attended all meetings.

FISCAL YEAR 2024 PROPOSED ACTIVITIES

No Boundaries will continue to add entries to the on-line maintenance innovations database, along with updates to the No Boundaries website. Two in-person meeting will be held, the first in October in Virginia and the second in the spring of 2024 in Louisiana. Two TAC teleconferences will be held in the spring and summer of 2024. Several syntheses efforts will be completed in 2024 on topics including equipment acquisition and management, reducing backing accidents, virtual reality for maintenance training and getting technology to field staff). The group will also work on the solicitation for the next phase of the pooled fund.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Project expected completion FY 2024.

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2023**

STUDY TITLE: Traffic Safety Culture - Phase 2

FUNDING SOURCE: FHWA OTHER (PLEASE EXPLAIN)

TPF NO.	TPF-5(444)	MDOT START DATE	10/1/2019
PROJECT NO.	OR20-211	MDOT COMPLETION DATE (Original)	9/30/2024
		COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Mark Bott 517-335-2625 BottM@michigan.gov		
LEAD AGENCY:	Montana DOT		
PROJECT MANAGER	Susan Sillick ssillick@mt.gov		
CONTRACTOR	Montana State University- Western Transportation Institute/Center for Health and Safety Culture (CHSC)		

BUDGET STATUS

FY 2023 MDOT Budget			MDOT Total Budget		
FY FUNDS	(Original)	\$10,000.00	TOTAL BUDGET	(Original)	\$50,000.00
	(Revised)			(Revised)	
		\$10,000.00			\$10,000.00

PARTICIPATING STATES

KY, CA, CT, GA, IA, ID, IL, IN, KS, KY, LA, MI, MN, MS, MT, NV, TX, UT, VT, WA.

PURPOSE AND SCOPE

Only through the growth of a positive safety culture can significant and sustainable reductions in crash fatalities and serious injuries be achieved. Towards that end, this pooled fund program will:

- (1) Conduct research to identify solutions to specific culture-based traffic safety problems, taking advantage of the implementation opportunities to improve traffic safety.
- (2) Develop resources to enhance understanding and application of traffic safety culture strategies; and
- (3) Provide technology transfer of best practices in traffic safety culture strategies.

This program will support integrated and multiyear research to guide the transformation of local, state, and national traffic safety culture. Funding partners determine the priority issues each year, and work plans are developed for the selected issues.

Three types of effort are expected in this pooled-fund program:

- Could propose culture-based research directed to specific traffic safety problems. For example, there are common behavioral risk factors amongst most state Strategic Highway Safety Plans (SHSP) such as impaired or distracted driving that can be influenced by culture.
- May generate ideas for general “services and tools” to support the understanding and application of traffic safety culture in the safety plans of project partners. For example, online courses on traffic safety culture for workforce development or a repository of relevant literature and case studies of best practice relevant to addressing the cultural factors of a risky behavior could be created.
- Can be used to implement a limited number of demonstration projects to evaluate specific strategies to transform traffic safety culture in select communities, which could then be applied elsewhere.

FISCAL YEAR 2020 ACCOMPLISHMENTS

Guidance for Evaluating Traffic Safety Culture Strategies - The completion of this project is key to all future activities for the pooled fund study as it will lay out the basis for how research will be conducted. We have learned to change the culture we need to change people’s beliefs to change their behavior, which in turn will move the safety culture needle. In a safety effort, we need to convince people that a change in the bad behavior will have minimal impacts on them.

FISCAL YEAR 2021 ACCOMPLISHMENTS

- Guidance on Messaging to Avoid Reactance and Address Moral Disengagement – project is complete with webinar and poster given in addition to final report. In addition, information sheets were developed for aggressive driving and seat belt use.
- Guidance to Promote Workplace Policies and Family Rules to Reduce Cell Phone Use While Driving and Promote Engaged Driving - project is complete with webinar and poster given in addition to final report.

FISCAL YEAR 2022 ACCOMPLISHMENTS

- A Review of Methods to Change Beliefs – project is completed with the following deliverables: PowerPoint slides, webinar, poster, and the final report

- Resources and Tools to Reduce Multi-Risk Driving Behaviors – Task 1 Literature Review and Task 2 Content Development of Brief Intervention are completed. Expected completion is October 2023.
- Resources and Tools to Improve Pedestrian Safety – Task 1 Literature review is 40% completed. Expected completion is October 2025.

FISCAL YEAR 2023 ACCOMPLISHMENTS

- 2023 Annual Meeting held in person in Bozeman, MT on June 6-7th.
- Resources and Tools to Reduce Multi-Risk Driving Behaviors – Task 3: Test Brief Intervention and Task 4: Create Resources and Complete Final Report. Amendment to Task 3 to add more study subjects. Expected completion for Task 3 is December 31, 2023, and Task 4 is June 30, 2024. Final expected September 30, 2024.
- Resources and Tools to Improve Pedestrian Safety – Task 1 report completed ([Resources and Tools to Improve Pedestrian Safety](#)) Task 2: Understand the Culture of Pedestrian Safety. Expected completion is October 2025.
- Understanding Aggressive Driving Phase 1 report completed ([Understanding Aggressive Driving and Ways to Reduce It – Phase 1](#)).
- Evaluating proposals for Resources and Tools to Improve Occupant Protection and Phase 2 of the Aggressive Driving project currently underway

FISCAL YEAR 2024 PROPOSED ACTIVITIES

- Resources and Tools to Reduce Multi-Risk Driving Behaviors –Task 4: Create Resources and Complete Final Report. Expected completion for Task 4 is June 30, 2024. Final expected September 30, 2024.
- Resources and Tools to Improve Pedestrian Safety – Task 3; Create tool, Task 4 Work on Final Report
- Planning and holding annual meeting.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Project expected completion FY 2024.

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2023**

STUDY TITLE: High Performance Computational Fluid Dynamics (CFD) Modeling Services for Highway Hydraulics

FUNDING SOURCE: FHWA OTHER (PLEASE EXPLAIN)

TPF NO.	TPF-5(446)	MDOT START DATE	9/30/2022
PROJECT NO.	OR23-208	COMPLETION DATE (Original)	9/30/2025
		COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Erik Calson 517-230-8180 Email: CarlsonE2@michigan.gov		
LEAD AGENCY:	FHWA		
PROJECT MANAGER	Kornel Kerenyi 202-493-3142 Email: kornel.kerenyi@dot.gov		
CONTRACTOR			

BUDGET STATUS					
FY 2023 MDOT Budget			MDOT Total Budget		
FY FUNDS	(Original)	\$80,000.00	TOTAL BUDGET	(Original)	\$80,000.00
	(Revised)			(Revised)	
		\$80,000.00			\$0.00

PARTICIPATING STATES

ABBREVIATE THE PARTICIPATING STATES. IF MDOT IS THE LEAD AGENCY, ALSO LIST THE CONTRIBUTION PERCENTAGE PER STATE.

MI, OH, SC, TX

PURPOSE AND SCOPE

The objective of these pooled funds is to provide research and analysis for a variety of highway hydraulics projects managed or coordinated by State DOTs; to provide and maintain a high-performance Computational Fluid Dynamics (CFD) computing environment for application to highway hydraulics infrastructure and related projects; and to support and seek to broaden the use of CFD among State Department of Transportation employees.

Task 1: Computational Mechanics Research on a Variety of Projects: The TRACC scientific staff in the computational mechanics focus area will perform research, analysis, and parametric computations as required for projects managed or coordinated by State DOTs. Task 2: Computational Mechanics Research Support: The TRACC support team consisting of highly qualified engineers in the CFD focus areas will provide guidance to users of CFD software on an as needed or periodic basis determined by the State DOTs. Task 3: Computing Support: The TRACC team will use the TRACC clusters for work done on projects; The TRACC system administrator will maintain the clusters and work closely with the Argonne system administrator's community; The TRACC system administrator will also install the latest versions of the STAR-CCM+ and OpenFOAM CFD software and other software that may be required for accomplishing projects.

FISCAL YEAR 2023 ACCOMPLISHMENTS

Initial CFD modeling of a C type grate for on-grade and sump locations have been started. The initial modeling assumed the following variables:

- Gutter Manning's n of 0.016
- Longitudinal slopes of 0.5% to 5%
- Gutter cross sectional slopes of 2 and 4%
- Discharge (Q) from 0 – 2.5 cfs
- Impacts of debris clogging on inlet capture efficiency

FISCAL YEAR 2024 PROPOSED ACTIVITIES

The work in FY 2024 will include modeling of additional scenarios, as noted from comments in update meetings throughout FY2023, and a finalized report and deliverables. The final deliverables will include updating FHWA's Hydraulic Toolbox software to include our C grates for inlet capture efficiency.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

We are still waiting on final deliverables, but they will include a report on the analysis and a capture efficiency curve that will be utilized in FHWA's Hydraulic Toolbox. Designers will then be able to utilize these efficiency curves as a check for inlet spread calculations.

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2023**

STUDY TITLE: Traffic Control Device (TCD) Consortium (3)

FUNDING SOURCE: FHWA OTHER (PLEASE EXPLAIN)

TPF NO.	TPF-5(447)	MDOT START DATE	1/1/2021
PROJECT NO.		MDOT COMPLETION DATE (Original)	2/12/2025
OR NO.	OR21-207	COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Mark Bott 517-335-2625 BottM@michigan.gov		
LEAD AGENCY	FHWA		
PROJECT MANAGER	Laura Mero, 202-493-3377 Laura.Mero@got.gov		
CONTRACTOR			

BUDGET STATUS				
FY 2023 MDOT Budget			MDOT Total Budget	
FY FUNDS	(Original)	\$20,000.00	TOTAL BUDGET	(Original) \$100,000.00
	(Revised)			(Revised)
TOTAL FY 2023 EXPENDITURES		\$20,000.00	TOTAL COMMITTED FUNDS AVAILABLE	\$40,000.00

PARTICIPATING STATES

NJ, NM, AL, AZ, CO, CT, DE, FHWA, FL, GA, IA, ID, IL, KS, KY, MA, MDOT SHA, MI, MO, MS, MT, NC, NE, NH, NJ, NM, NY, OR, PA, SC, TN, TX, WI

PURPOSE AND SCOPE

This project is being created to re-new the contract for Pooled Fund Project TPF-5(316). All new Funding Commitments will need to be made on the Pooled Fund Website to this new project and all new funds will be transferred to the Lead State/Agency by the partners. The Lead State/Agency will have the responsibility for Receiving, Obligating, Expending, and Balancing the funding for this project.

To assemble a consortium composed of regional, State, local entities, appropriate organizations and the FHWA to 1) establish a systematic procedure to select, test, and evaluate approaches to novel TCD concepts as well as incorporation of results into the MUTCD; 2) select novel TCD approaches to test and evaluate; 3) determine methods of evaluation for novel TCD approaches; 4) initiate and monitor projects intended to address evaluation of the novel TCDs; 5) disseminate results; and 6) assist MUTCD incorporation and implementation of results.

The TCD Consortium will focus on systematic evaluation of novel TCDs, employing a consistent process that addresses human factors and operations issues for each TCD idea. Providing local and state agencies responses to their needs and to new technologies with the right assessment skills and tools will enable consistent TCD idea identification and evaluation. TCD Consortium efforts will address TCD issues identified by local and state jurisdictions, industry, and organizations and aid in the compliance to the MUTCD rule-making process and incorporation of novel TCDs into the MUTCD.

FISCAL YEAR 2021 ACCOMPLISHMENTS

Work continues in FY 2021 on the following topics.

- Evaluation of Additional Alternatives of and Arrow Sizes for Overhead Arrow per Lane Guide Signs
- Enhancing Conspicuity for Standard Signs and retro reflectivity Strips on Posts
- Sign Guidance for Zipper Merge

While no products have been delivered to date the outcomes will shape the standards and guidance in the Manual on Uniform Traffic Control Devices and thus impact MDOT operating practices for each of these areas.

FISCAL YEAR 2022 ACCOMPLISHMENTS

Held the Annual meeting in person in August in San Diego

Progress has been made on the following:

- Advisory Speed Signs on Ramps: 1) Had kick-off meeting; 2) Currently processing information from most participating states; 3) A work-plan will be presented in October 2022
- Sign Guidance for Zipper Merge: 1) The research team completed data collection in New Hampshire and most of the data collection in North Carolina and Maryland. 2) In addition, the team has analyzed data collected from the three locations. 3) They are looking to finalize the research and host a final meeting
- Enhancing Conspicuity for Standard Signs and retro reflectivity Strips on Posts: The research team has provided edits to the FHWA publications team, and the final version has been developed for publication.

-
- Evaluation of Additional Alternatives of and Arrow Sizes for Overhead Arrow-per-Lane Guide Signs: 1) Finished data collection, 2) Began data analysis.
 - [Comprehension and Legibility of Selected Symbol Signs Phase IV](#)
 - [Countdown Pedestrian Signals \(CPS\) Legibility and Comprehension without Flashing Hand: Phase I and II Final Report](#)
 - [Signing, in Combination with Lane Markings, in Advance of Lane-Reduction Transitions](#)
-

FISCAL YEAR 2023 ACCOMPLISHMENTS

- Completed [Evaluation of Lane Reduction and Late Merge Signing](#) (formerly called Zipper Merge)
 - Advisory Speed Signs on Ramps: 1) Field Review of selected sites and 2) Analysis data from field review.
 - Completed [Evaluation of Additional Alternatives of and Arrow Sizes for Overhead Arrow-per-Lane \(OAPL\) Guide Signs](#)
 - Pedestrian Signing at Unsignalized Crossings - preparation for computer-based testing have been completed and now search for on road field locations.
 - 2023 Annual meeting held in person in Albuquerque, NM on September 13-15th. Call for proposals was held. Voting held on top priorities.
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FISCAL YEAR 2024 PROPOSED ACTIVITIES

- Completion of Advisory Speed Signs on Ramps.
 - Kick of research on top 3-4 priorities as identified in 2023.
 - Plan and hold 2024 Annual meeting.
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JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Project expected completion FY 2025.

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2023**

STUDY TITLE: Automated Vehicle Pooled Fund Study

FUNDING SOURCE: FHWA OTHER (PLEASE EXPLAIN)

TPF NO.	TPF-5(453)	MDOT START DATE	10/1/2020
PROJECT NO.		MDOT COMPLETION DATE (Original)	9/30/2025
OR NO.	OR21-203	COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Elise Feldpausch, 517-388-2371 FeldpauschE1@michigan.gov		
LEAD AGENCY	Ohio DOT		
PROJECT MANAGER	Jill Martindale, 614-644-8172 jacquelin.martindale@dot.ohio.gov		
CONTRACTOR			

BUDGET STATUS

FY 2023 MDOT Budget			MDOT Total Budget		
FY FUNDS	(Original)	\$50,000.00	TOTAL BUDGET	(Original)	\$250,000.00
	(Revised)			(Revised)	
TOTAL FY 2023 EXPENDITURES			TOTAL COMMITTED FUNDS AVAILABLE		
		\$50,000.00			\$100,000.00

PARTICIPATING STATES

CT, MDOT SHA, MI, MN, OH, PA, TX

PURPOSE AND SCOPE

Through this pooled fund, the Ohio Department of Transportation (ODOT) will work with federal and state departments of transportation to establish multiple projects to research vehicle-roadway interaction including data failures and mitigation methods, identify and define standards, and encourage interoperability across state borders.

The pooled fund study will focus on the following:

- Independently research and address issues that will affect the deployment of Automated Vehicle systems by state transportation agencies.
- Support AASHTO's Strategic and Deployment Plans
- Support USDOT's Automated Vehicle Policy

FISCAL YEAR 2021 ACCOMPLISHMENTS

Worked with PFS members to decide on initial projects and study scope.

Selected consultant and started project entitled Infrastructure Owner Operator Strategic Roadmap for Accelerated Adoption of Automated Vehicles

FISCAL YEAR 2022 ACCOMPLISHMENTS

- Completed Infrastructure Owner Operator Strategic Roadmap project.
- Select consultant and begin research on Automated vehicle industry forum project

FISCAL YEAR 2023 ACCOMPLISHMENTS

Pooled fund study overall

Monthly meetings

Third project RFP has been posted, Guidance for Sustainable Integration of Automated Transportation Technologies to focus on researching best practices for successfully integrating and sustaining AV technologies into the transportation infrastructure. The goal of this project is to determine what infrastructure modifications should be performed to adapt to the integration of AV transportation technologies.

Second project developed a Stakeholder engagement plan and website to promote collaboration between academic, industry and government partners around AV development and deployment. This is still supported throughout the life of the AV PFS.

Launched the AV Industry Forum and published an AV Pooled Fund Forum - Final Report, dated June 2023.

FISCAL YEAR 2024 PROPOSED ACTIVITIES

Third Project should start January/February 2024.

Fourth project concept being developed and is anticipated to be advertised in January of 2024.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Project expected completion FY 2025.

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2023**

STUDY TITLE: Flood-Frequency Analysis in the Midwest: Addressing Potential Nonstationary Annual Peak-Flow Records

FUNDING SOURCE: FHWA OTHER (PLEASE EXPLAIN)

TPF NO.	TPF-5(460)	MDOT START DATE	10/1/2021
PROJECT NO.	OR22-208	MDOT COMPLETION DATE (Original)	9/30/2024
		COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Erik Carlson, 517-230-8180 Carlson.E2@michigan.gov		
LEAD AGENCY:	South Dakota DOT		
PROJECT MANAGER	David Huft dave.huft@state.sd.us		
CONTRACTOR			

FY 2023 MDOT Budget			MDOT Total Budget		
FY FUNDS	(Original)	\$55,600.00	TOTAL BUDGET	(Original)	\$166,800.00
	(Revised)			(Revised)	
		\$55,600.00			\$55,600.00

PARTICIPATING STATES

IA, IL, MI, MN, MO, Montana DNRC, SD, WI

PURPOSE AND SCOPE

The overall goal of this study is to evaluate the combined effects of multidecadal climatic persistence (including hydroclimatic shifts), gradual climate change, and land-use change on peak-flow frequency analyses in the multi-state region in the Midwest. This study is intended to provide a framework for addressing potential nonstationary issues in statewide flood-frequency updates that commonly are conducted by the USGS in cooperation with state DOTs throughout the nation on an ongoing basis. This will be achieved through the following primary objectives: 1. Define spatial and temporal characteristics of climatic persistence/change affecting annual peak flows in the multi-state region. 2. Develop and apply a statistical methodology for estimating changes in peak-flow frequency distributions in the multi-state region in relation to climatic persistence/change and urbanization; the effects of rural and land-use change will only be investigated in an exploratory manner. 3. Investigate methods for addressing regional climatic persistence/change and land-use change in peak-flow frequency analysis. To the extent possible, estimates of trend-adjusted flood magnitudes for various exceedance levels (such as the 10-percent or 1-percent annual exceedance probability) will be provided for comparison to previously published estimates.

The results of the proposed investigation will be presented in two peer reviewed USGS Data Releases, two Scientific Investigations Reports (SIR; online only), two journal articles and a USGS Fact Sheet. Tasks include efforts to: (1) Publicly release watershed-based climate data (metrics of precipitation and temperature) on a monthly time scale and summed to annual seasonal and annual total values. These data will also contain trend results for trends in climate metrics in annual peak streamflow and climate variables (Years 1 and 2); (2) Characterize the effects of natural hydroclimatic shifts and potential climate change on annual peak flows in Midwest: Illinois, Iowa, Minnesota, North Dakota and South Dakota (Years 1 and 2); (3) Analyze the seasonality of flood peaks in the region and their trends and implications for trend attribution (Years 1 and 2); (4) Evaluate the effect of urbanization on flood-peaks in major metropolitan areas in the study region (Years 2 and 3); (5) Publicly release data that compares adjustment methods at individual sites, such as multiple flood-frequency analysis results (Years 3 and 4); (6) Summarize methods for addressing regional hydroclimatic shifts, climate change, and land-use change in peak-flow frequency analyses in the Midwest (Years 3 and 4); (7) Succinctly summarize the above work in a short fact sheet that provides links to project products to make it easy to find data and results. This summarization is intended to be handed out at future meetings, sent to managers for an overview, etc. (Year 4).

FISCAL YEAR 2022 ACCOMPLISHMENTS

USGS is wrapping up Tasks 1, 2, and 3, as noted above. They have provided preliminary findings in climate trends of gages, including seasonality of peak flow values, for participating Midwest states at quarterly Teams meetings.

FISCAL YEAR 2023 ACCOMPLISHMENTS

Finalized Tasks 1, 2, and 3 and transitioning to Tasks 4, 5, and 6, as noted above.

FISCAL YEAR 2024 PROPOSED ACTIVITIES

Working on Tasks 4, 5 and 6 and starting to summarize work, as noted in Task 7, as noted above.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Project expected completion FY 2024.

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2023**

STUDY TITLE: Consortium for Asphalt Pavement Research and Implementation (CAPRI)

FUNDING SOURCE: FHWA OTHER (PLEASE EXPLAIN)

TPF NO.	TPF-5(465)	MDOT START DATE	9/30/2022
PROJECT NO.	OR23-205	MDOT COMPLETION DATE (Original)	
		COMPLETION DATE (Revised)	9/30/2025
MDOT TECHNICAL CONTACT	Kevin Kennedy 517-749-9067 Email: KennedyK@Michigan.gov		
LEAD AGENCY:	Alabama DOT		
PROJECT MANAGER	Kidada Dixon 334-353-6940 Email: dixonk@dot.state.al.us		
CONTRACTOR			

BUDGET STATUS

FY 2023 MDOT Budget			MDOT Total Budget		
FY FUNDS	(Original)	\$10,000.00	TOTAL BUDGET	(Original)	\$30,000.00
	(Revised)			(Revised)	
		\$10,000.00			\$20,000.00

PARTICIPATING STATES

ABBREVIATE THE PARTICIPATING STATES. IF MDOT IS THE LEAD AGENCY, ALSO LIST THE CONTRIBUTION PERCENTAGE PER STATE.

AL, CO, FHWA, FL, GA, HI, ID, IN, KY, MI, MO, MS, NC, ND, NE, NM, NY, OH, OK, PA, PR, SC, TN, TX, VA, VIDPW, WA, WI.

PURPOSE AND SCOPE

The goals of CAPRI are to: • Provide technical guidance on current and evolving specifications for asphalt materials. • Develop asphalt pavement research needs. • Conduct small-scale studies to address knowledge gaps or explore new topics. • Foster the implementation of practical research findings to help improve the performance, sustainability, value, and safety of asphalt pavements. As a consortium of all asphalt pavement stakeholders, CAPRI will be a key resource to the AASHTO Committee on Materials and Pavements, state DOTs, FHWA, and industry.

Activities related to the above goals will be developed through semi-annual meetings rotated among participating organizations. CAPRI meetings will serve as a forum to facilitate knowledge sharing among participants. Outcomes of CAPRI meetings will include technical guidance articles on high profile issues, and research need statements (RNSs) organized into a new National Asphalt Research Roadmap (NARR) that will be made public through a website managed and maintained by NCAT. Recognizing the existence of specialized topics within asphalt pavement engineering and the range of expertise that CAPRI participants will bring to the forum, CAPRI meetings will be organized into topics led by committees that focus on asphalt binders, asphalt mixtures, pavement design, construction, maintenance/rehabilitation, pavement-vehicle interaction, and other committees as the need arises in the future. More details about the CAPRI operation are provided in the full announcement. The activities and deliverables of CAPRI are as follows: • Organize semi-annual meetings that include presentations on research of national significance, discussions on implementation and technology transfer, and activities organized by the committees. • Identify issues with current asphalt-related standards and share potential solutions to help move standards forward to ultimately improve pavement performance. • Identify short-term and long-term research needs and strategically prioritize the needs so the most urgent and impactful opportunities are addressed first. • Develop research need statements (RNSs) and identify the appropriate source(s) of funding for each project. Organized RNS into the National Asphalt Research Roadmap and publish it on the website. • Select and prioritize small-scale, exploratory, kick-off studies that can be funded directly by CAPRI to address gaps in the path to implementation, gather additional information to assess the magnitude of perceived problems, and/or explore new technologies. • Assist in the deployment of research findings by selecting and prioritizing activities such as conducting workshops, refining and shepherding of standards, demonstration project assistance, which can be funded through CAPRI or from other sources. • Publish progress reports that document the results of the entire project

FISCAL YEAR 2023 ACCOMPLISHMENTS

The CAPRI Executive Director continued to recruit additional member organizations to join the consortium. CAPRI subcommittees and task forces continued to work on their respective roles and initiated work to fill gaps in research of high priority need, advocated for funding for other priority needs in other research funding programs, and supported the development of tech transfer for proven technologies. A Fall meeting is scheduled.

FISCAL YEAR 2024 PROPOSED ACTIVITIES

Spring and Fall meetings will be held. Plans to provide technical guidance on current and evolving specifications for asphalt materials. Develop asphalt pavement research needs. Conduct small-scale studies to address knowledge gaps or explore new topics. Foster the implementation of practical research findings to help improve the performance, sustainability, value, and safety of asphalt pavements.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Project expected completion FY 2025.

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2023**

STUDY TITLE: National Road Research Alliance - NRRRA (Phase-II)

FUNDING SOURCE: FHWA OTHER (PLEASE EXPLAIN)

TPF NO.	TPF-5(466)	MDOT START DATE	10/01/2020
PROJECT NO.		MDOT COMPLETION DATE (Original)	12/31/2025
OR NO.	OR21-209	COMPLETION DATE (Revised)	01/31/2026
MDOT TECHNICAL CONTACT	Kevin Kennedy, 517-749-9067 KennedyK@Michigan.gov		
LEAD AGENCY:	Minnesota DOT		
PROJECT MANAGER	Glenn Engston, 651-366-5531 glenn.engstrom@state.mn.us		
CONTRACTOR			

BUDGET STATUS

FY 2023 MDOT Budget			MDOT Total Budget		
FY FUNDS	(Original)	\$150,000.00	TOTAL BUDGET	(Original)	\$750,000.00
	(Revised)			(Revised)	
		\$150,000.00			\$300,000.00

PARTICIPATING STATES

CA, FHWA, GA, IA, IL, Local Road Research Board (LRRB), MI, MN, MO, MS, MT, ND, NE, NY, and WI.

PURPOSE AND SCOPE

Primary objectives of the National Road Research Alliance (NRRRA Phase-II) are:

- Implementation and technology transfer of NRRRA Phase-I research efforts and other common interests.
- Continue to fund and support research and implementation efforts of common interest.
- Continue the communication with both its government agencies along with its associate members (industry, associations, consultants, academia).
- Continued utilization of MNROAD to conduct structured construction, field testing and evaluation of pavement materials, equipment, and methods under real-world conditions.
- Establish industry standards and develop performance measure for improving pavement performance.
- Develop and/or revise specifications and recommendations.
- Studying and promoting innovative techniques and technologies that will save agencies money, improve safety, and increase efficiency.
- Supporting technology transfer by developing practical field guides, best practices, and training curriculum to promote the results of research projects.
- Conduct cost-benefit analysis to ensure that new technologies, materials, or methods contribute to operational efficiencies.
- Support the exchange of information and ideas through collaborative research efforts that provide opportunities for public agencies to share experiences.
- Identify and prioritize common road related research needs to address regional and national issues that are built on existing efforts such as FHWA's PCC and HMA Roadmaps as well as the Foundation for Pavement Preservation Roadmap.
- Fund high priority, readily implementable research projects through research contracts and university partnerships.
- Leverage knowledge, skills, and resources from participating partners to advances pavement research and implementation efforts while developing the workforce of the future.
- Support technology transfer that highlights the implementation of research results and the associated benefits.

The scope of work for this pooled fund project is:

- Members provide the prioritized research needs, project development and design by way of the research project teams.
- Members provide funding for high priority, readily implementable research projects.
- Members receive timely results on NRRRA research projects through communication products that emphasize lessons learned and implementation.
- Assistance in putting research results into practice through technology transfer events.
- NRRRA members support committees that meet periodically throughout the year to determine priorities, develop strategies to address the priorities, and execute action plans.

FISCAL YEAR 2021 ACCOMPLISHMENTS

To date ten (10) government agencies and over fifty-five (65+) industry, associations, consultants, and academic institutions have become NRRRA members to share their expertise and are learning about new tools and methods to improve and expand upon transportation systems nationally.

Phase-I Projects:

- Tech Transfer - 100% of the 13/13 projects complete.
- 2017 Long Term Research – 50% of the 4/8 projects complete.
- 2019 Long Term Research – 8% of the 1/11 projects complete.
- 2019 Call for Innovation Research – 0% of the 0/5 projects complete.
- 2020 Call for Innovation Research – 0% of the 0/7 projects complete.

Phase-2 Projects:

- 2021 Long Term Research – 0% of the 0/13 projects complete.

General:

- NRRRA members/Teams have met monthly again this quarter which also acts as TAP meetings for each team’s short- and long-term research efforts also focusing on development of 2021 projects with inputs on MnROAD 2022 construction.
- Executive Committee meetings: Two meetings held this quarter and one expected in the next quarter to help establish Phase-II efforts in February 2021.
- Call for Construction sent out and ideas are being submitted – one formal idea so far and other potential ideas – Construction in 2022.
- Monthly Research pays off webinars have been completed and a plan for end of 2021 topics are developed.

FISCAL YEAR 2022 ACCOMPLISHMENTS

Working on two RFPs fall/winter of 2022. NRRRA members/Teams have met monthly again this year which also acts as TAP meetings for each team’s short and long-term research efforts also focusing on development of 2021 projects with inputs on MnROAD 2022 construction/sensors. Monthly Research pays off webinars have been completed and a plan for 2022 topics are developed. See the NRRRA website for details on all the teams’ updated activities. Technical teams TAPS developing construction designs, layers, sensor requirements, and ICT related construction activities to include in the 2022 MnROAD construction. Completed partnerships with FHWA for veta and carboncure related research efforts. Finalizing partnerships with a local HMA plant to furnish HMA surface mix for the reflective cracking group study. Finalizing partnerships with a local PCC plant to furnish PCC mix need for the 2022 construction. Finalized partnerships with Missouri and the funding received for reflective cracking challenge. Successful 2022 Minnesota Transportation Conference & Expo in St. Paul, Minnesota on May 17-19 and the NRRRA tracks for each technical team.

FISCAL YEAR 2023 ACCOMPLISHMENTS

NRRRA members/teams continued to meet monthly, which also acts as TAP meetings for each team’s short and long-term research efforts. Monthly research pays off webinars continued. Technology transfer has remained a focus of the pooled fund. Continued to plan and schedule conferences. Call for innovation added approximately \$1.8 million of new research to program. NRRRA had a technical track at the Minnesota Transportation Conference and Expo on May 15-17, 2023.

FISCAL YEAR 2024 PROPOSED ACTIVITIES

Technology transfer will remain a focus of the pooled fund. Continue to plan and schedule conferences. NRRRA members/teams continue to meet monthly, which will also act as TAP meetings for each team’s short and long-term research efforts. Monthly research pays off webinars will continue. A conference will be scheduled for spring 2024.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Project expected completion FY 2026.

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2023**

STUDY TITLE: Structural Behavior of Ultra- High-Performance Concrete

FUNDING SOURCE: FHWA OTHER (PLEASE EXPLAIN)

TPF NO.	TPF-5(468)	MDOT START DATE	2/1/2021
PROJECT NO.	[Sol. #1510]	MDOT COMPLETION DATE (Original)	9/30/2025
OR NO.	OR20-214	COMPLETION DATE (Revised)	12/31/2025
MDOT TECHNICAL CONTACT	Bradley Wagner, 517-256-6451 WagnerB@michigan.gov		
LEAD AGENCY:	FHWA		
PROJECT MANAGER	Benjamin Graybeal, 202-493-3122 Benjamin.graybeal@dot.gov		
CONTRACTOR			

BUDGET STATUS

FY 2023 MDOT Budget			MDOT Total Budget		
FY FUNDS	(Original)	\$10,000.00	TOTAL BUDGET	(Original)	\$50,000.00
	(Revised)			(Revised)	
		\$10,000.00			\$10,000.00

PARTICIPATING STATES

FL, G , MI, MN, MS, NJ, NY, PA, TX.

PURPOSE AND SCOPE

The objective of the proposed project is to develop knowledge pertinent to the structural performance of ultra-high-performance concrete (UHPC). This knowledge will be of significant value as the AASHTO Committee on Bridges and Structures considers the use of UHPC-class materials in highway bridges and structures.

The proposed project is focused on the design, fabrication, performance, and analysis of UHPC components. It is anticipated that various UHPC components will be designed, fabricated, and tested. The test results will be analyzed and used to inform proposed structural design guidance for UHPC components. Results will also be used to support usage of UHPC by interested departments of transportation. It is anticipated that bridge superstructure components (e.g., pretensioned girders) will be a significant part of this study, with behaviors related to flexure, shear, and end zones being investigated. Other components may be investigated based on available resources and the interest of participating partners.

FISCAL YEAR 2021 ACCOMPLISHMENTS

This Pooled Fund Study held its project kicked off meeting in February of 2021.

The Principal Investigator discussed with each partner representative present their respective input on priorities regarding UHPC. Two (2) initial priorities identified were:

- Development of guidelines for the design of UHPC. A draft "AASHTO LRFD Guide Specifications for Structural Design with UHPC" was developed and reviewed by the pooled fund members. Member's comments were provided.
- Develop design examples for UHPC members. This initiative is just now getting underway and will be further developed/delivered in FY 2022.

FISCAL YEAR 2022 ACCOMPLISHMENTS

- Worked on finalization of LRFD Guide Specifications
- Developed two UHPC Design Examples and submitted to AASHTO for review
- MDOT selected a UHPC beam end repair project in Grand Region and will be let and constructed FY23
- Developed visual aids to support testing methods for UHPC.
- Published AASHTO T397 "Standard Method of Test for Uniaxial Tensile Response of Ultra-High-Performance Concrete".
- Initiated a task for full scale testing of UHCP girders.

FISCAL YEAR 2023 ACCOMPLISHMENTS

- The guide specification was published. The research team is developing a "Materials Conformance Guidance" that parallels this guide spec.
- Fabricated girders for full scale testing.
- Tensile testing was completed.
- Fatigue testing is in progress on large scale UHPC girders.
- Testing performed to determine development length for prestressed strands in UHPC beams
- Work 50% completed as of Sept 30, 2023.

FISCAL YEAR 2024 PROPOSED ACTIVITIES

- Continue to support AASHTO Committee on Bridges and Structures (CBS) subcommittee T-10 on Structural Concrete to evaluate FHWA proposed draft UHPC Materials Conformance Guidance that has been requested by T-10.
- Continue work on a journal paper draft detailing the results of the experimental investigation utilizing servo-hydraulic and non-servo hydraulic loading frames in performing direct tension tests of UHPC specimens in accordance with AASHTO T 397.
- Work towards publishing an FHWA report on UHPC design recommendations and examples highlighting the analysis of a rectangular mild steel reinforced UHPC beam and a pretensioned UHPC I-Beam with a conventional concrete deck. This report is complete and undergoing a final review by the FHWA Public Affairs office. Publication is anticipated during in 2023Q4.
- Continue work on the UHPC tensile fatigue behavior project: continue cycling second girder.
- Continue testing of 12 pretensioned beams that were designed to investigate the development length of prestressing strands.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

This is a rather loosely structured Pooled Fund with high level initiatives that are continually developing.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Project expected completion FY 2026.

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2023**

STUDY TITLE: Clear Roads Winter Highway Operations Pooled Fund – Phase III

FUNDING SOURCE: FHWA OTHER (PLEASE EXPLAIN)

TPF NO.	TPF-5(479)	MDOT START DATE	5/1/2022
PROJECT NO.		MDOT COMPLETION DATE (Est. Original)	9/30/2026
OR NO.	OR22-206	COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Justin Droste, 517-636-0518 DrosteJ@michigan.gov		
LEAD AGENCY:	Minnesota Department of Transportation		
PROJECT MANAGER	Nicole Westadt, 651-366-4270 Nicole.Westadt@state.mn.us		
CONTRACTOR			

BUDGET STATUS

FY 2023 MDOT Budget			MDOT Total Budget		
FY FUNDS	(Original)	\$25,000.00	TOTAL BUDGET	(Original)	\$125,000.00
	(Revised)			(Revised)	
		\$25,000.00			\$75,000.00

PARTICIPATING STATES

AK, AZ, CA, CO, CT, DE, IA, ID, IL, IN, KS, KY, MA, MDOT SHA, ME, MI, MN, MO, MT, ND, NE, NH, NJ, NV, NY, OH, OK, OR, PA, RI, SD, TX, UT, VA, VT, WA, WI, WV, WY.

PURPOSE AND SCOPE

This pooled fund project will maintain its focus on advancing winter highway operations nationally, but it will include a more pronounced emphasis on state agency needs, technology transfer, and implementation. State departments of transportation are aggressively pursuing new technologies, practices, tools, and programs to improve winter highway operations and safety while maintaining fiscal responsibility. This pooled fund is needed to evaluate these new tools and practices in both lab and field settings, to develop industry standards and performance measures, to provide technology transfer and cost benefit analysis, and to support winter highway safety. This project responds to research and technology transfer needs not currently met by other pooled fund projects. Existing partners make every effort to coordinate with other agencies to avoid duplication of efforts and to encourage implementation of results.

Objectives of this ongoing pooled fund project will include:

- Conducting structured field testing and evaluation across a range of winter conditions and different highway maintenance organizational structures to assess the practical effectiveness, ease of use, optimum application rates, barriers to use, durability, safety, environmental impact and cost-effectiveness of innovative materials, equipment, and methods for improved winter highway maintenance.
- Establishing industry standards and developing performance measures for evaluating and utilizing new materials and technologies.
- Supporting technology transfer by developing practical field guides and a training curriculum that will promote the results of research projects.
- Conducting cost-benefit analysis to ensure that new technologies, materials, or methods contribute to operational efficiency.
- Supporting the exchange of information and ideas via peer exchanges and collaborative research efforts that provide opportunities for maintenance specialists to share experiences related to winter maintenance.
- Promoting public education and outreach related to winter maintenance and winter driving safety.
- Conducting state of the practice surveys to share best practices on current operational issues. (For example: Salt shortages, level of service requirements, or other hot button issues).

Included in the Scope of work: Research reports, technical briefs, synthesis reports, field guides, specifications, PowerPoint presentations, video documentation, training materials, public safety messages, and software programs.

FISCAL YEAR 2021 ACCOMPLISHMENTS

The Clear Roads pooled fund study plans to commence and continue several projects during the 2021 FY. These projects are listed below.

- 21-01 Grip Sensor Technology and Salt Application
- 21-02 Update to CR 13-04 Best Practices for Protecting DOT Equipment from Corrosive Effect of Chemical Deicers
- 21-03 The Efficacy and Environmental Impact of Non-Chloride Deicers
- 21-04 Training Module Development for CR 18-03 Evaluation of SSI/WSI Variables
- 21-05 Synthesis Evaluation of Electric Vehicle Technologies and Alternate Fuels for Winter Operations

- 21-06 Calculated Plow Cycle Times from AVL Data
- 21-07 Determining the Migration of Chloride-based Deicers through Different Soil Types Adjacent to Chloride-treated Roadways
- 20-06 Salt Shed Design Template
- 20-05 Using GIS to Highlight Highway Segments Sensitive to Deicing Materials
- 20-04 Expanded Use of AVL/GPS Technology
- 20-03 Evaluation of Indoor Automated Stockpile Measurement Systems
- 20-02 Understanding the NaCl Phase Diagram
- 20-01 Entry-Level Driver Training (CDL) for Maintenance Equipment Operators
- 19-04 Synthesis of Technical Requirements and Considerations for an Automated Snowplow Route Optimization RFP Template
- 19-03 Measuring the Efficiencies of Tow Plows and Wing Plows
- 19-01 Expanding Application Rate Guidance for Salt Brine Blends for Direct Liquid Application and Anti-icing
- 18-06 Standard Test Procedures for Ice Melting Capacity of Deicers
- 18-02 High Performance Blade Evaluation

FISCAL YEAR 2022 ACCOMPLISHMENTS

Projects selected for FY 2022:

- **22-01 Comprehensive Guide to Prewet** [A comprehensive guide that will provide optimal application rates for meeting pre-wetting goals and will quantify the benefits of different rates, speeds, and other delivery factors. The guide will also present the findings of using two to four salt spreader configurations and delivery systems (e.g., auger, Monroe hopper, zero-velocity spreader). The evaluation will include a discussion of the advantages and disadvantages of each in meeting pre-wetting goals.]
 - **22-02 Liquid Chloride Storage and Pump System Best Management Practices** [This project will develop a guidance manual that explores the issues transportation agencies should consider when choosing or replacing deicing liquid storage systems. There are several areas of interest associated with operating a reliable system including safety, environment, and cost-effectiveness. A review of the systems different agencies uses, including system benefits and challenges, will help agencies better understand their options when procuring a new system or updating an existing one.]
 - **22-03 Effects of Additives in Lowering the Freezing Point** [While manufacturers of deicing salt products claim that additives enhance product performance, there is no definitive evidence to substantiate these claims. Evaluating these products in the lab and in the field will establish the effectiveness of additives to lower eutectic temperatures and will indicate whether additives increase the performance of deicing salts. Research recommendations can be used to inform the decision-making of state departments of transportation (DOTs), municipalities and other winter maintenance practitioners when choosing a deicing salt for winter maintenance operations.]
 - **22-04 Evaluation of DLA of Salt Brine vs Granular Salt as Measured through Various Performance and Safety Metrics** [Many of the studies conducted to date focus on cost savings and environmental impacts of the DLA of salt brine while not addressing the efficacy and safety impacts of its use. Without performance comparison data to support DLA practices, the traveling public may conclude that while the advantages of DLA in cost savings and environmental impacts are clear, granular salt treatments are still the more effective way to treat winter roadways. This study aims to provide DOTs with the information they need to defend the use of DLA treatments where appropriate.]
 - **22-05 Synthesis: Use of Dashboards for Winter Operations** [Advances in information technology offer agencies the capability to capture and track data obtained from winter maintenance equipment. A review of which agencies are using dashboards in winter maintenance operations, including necessary resources and best practices for developing and implementing this tool, will give Clear Roads an understanding of how this data is obtained and displayed through these dashboards. Then, how is the information displayed used to gain efficiencies related to Level of Service, material use, resource allocation, and the cost of winter maintenance operations.]
 - **22-S1 Synthesis: Corrosion and Connectors Don't Mix** [The goal of this synthesis is to identify the various setups / connectors used by Clear Roads members. Determine if anyone is experiencing success in keeping the lights operating for an entire winter season. Identify a setup / connector that is most likely to operate for an entire snow season.] Project completed in FY 2022
 - **19-02 Recruitment and Retention of Highway Maintenance Workers** [This project developed a concise guide of innovative but practical ways for DOTs to recruit and retain a highly proficient, productive, versatile, and committed roadway maintenance workforce. The final report includes case studies in several categories, including recruitment programs, retention strategies, recruitment and retention for underserved communities, recruitment, and retention of the next generation, and capturing information to inform program improvements.]
 - **20-07 AWSSI Enhancements, Phase 2** [This project continued the process of improving the tool developed by the MRCC. This iteration added additional locations to the AWSSI tool; updated the average AWSSI seasonal total map through the 2019-2020 season; added the ability to download the daily seasonal data for any given station during the current season; and provided the user with the ability to add up to five specific historical seasons to be included in any station's current year chart.]
 - **20-01: Entry-Level Driver Training (CDL) for Maintenance Equipment Operators** [This project developed the following materials: (1) complete curriculum to meet the FMCSA requirements for the instructor-led classroom and behind-the-wheel components of the entry-level driver training rule, focusing on obtaining an initial Class B CDL, upgrading from a Class B CDL to a Class A CDL, and obtaining the hazardous materials endorsement for the first time; (2) all training materials and resources necessary for states to execute the training program; (3) train-the-trainer materials to assist agencies in implementing the training program; and (4) fact sheet and timeline to help agencies ensure that all of their training locations are added to the TPR before February 7, 2022. To date, there have been 750 requests for this material from agencies all over the U.S.]
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- **19-04 Synthesis of Technical Requirements and Considerations for Automated Snowplow Route Optimization** [Through a survey and follow-up interviews with agencies and vendors, this project captured the technical requirements and considerations involved in selecting an automated snowplow route optimization program. The project produced two complementary documents as appendices to the final report: 1) Decision Support Guidance: An accessible and in-depth discussion of the technical requirements for route optimization and the key decisions DOTs should consider when developing the project scope and managing a provider. 2) Contracting Language Template: A flexible template to assist DOTs with developing a scope of work for an RFP for automated snowplow route optimization services. The language in the template is intended to ensure that DOTs and service providers have a shared understanding of the scope of work that the DOT requires and to maximize the likelihood that the project will result in safe, feasible, implementation-ready routes.]
- **19-01 Expanding Application Rate Guidance for Salt Brine Blends for Direct Liquid Application and Anti-icing** [Through a survey of practice and subsequent field testing, researchers gathered a robust set of data on how agencies apply various liquid deicers across a broad range of field conditions, particularly at lower temperatures. The test results, along with the survey results and information gathered through a literature review, were used to create a set of application rate tables for brine and brine blend usage for DLA and anti-icing.]
- **19-03 Measuring the Efficiencies of Tow Plows and Wing Plows** [Through a practitioner survey, testing/simulation, and analysis, this project created a spreadsheet-based Decision Support Tool to help agencies more accurately assess the efficiencies, costs of ownership, and return on investment for tow plows and wing plows and determine the best locations to deploy it. A companion Best Practices Guide will help agencies understand the considerations for purchasing, deploying, and operating specific plow types.]
- **20-02 Understanding the NaCl Phase Diagram** [Project deliverables include the development of training materials (a fact sheet and a video) to help provide winter maintenance practitioners with a better understanding of the phase diagram for sodium chloride and how to apply it to yield the best results in roadway deicing. This knowledge will help winter maintenance agencies apply salt and salt brines effectively for the best performance on winter roadways.]

Ongoing Projects

- 18-02 High Performance Blade Evaluation
- 18-06 Standard Test Procedures for Ice Melting Capacity of Deicers
- 20-03 Evaluation of Indoor Automated Stockpile Measurement Systems
- 20-04 Expanded Use of AVL/GPS Technology
- 20-05 Using GIS to Highlight Highway Segments Sensitive to Deicing Materials
- 20-06 Salt Shed Design Template
- 21-01 Grip Sensor Technology and Salt Applications
- 21-02 Update to CR 13-04: Best Practices for Protecting DOT Equipment from the Corrosion Effect of Chemical Deicers
- 21-03 Efficacy, Cost, and Impacts of Non-Chloride Deicers
- 21-04 Training Module Development for Evaluation of Storm Severity Index and Winter Severity Index Variables
- 21-05 Evaluation of Electric Vehicle Technologies and Alternative Fuels for Winter Operations
- 21-06 Calculating Plow Cycle Times from AVL Data
- 21-07 Determining the Migration of Chloride-based Deicers through Different Soil Types

FISCAL YEAR 2023 ACCOMPLISHMENTS

Completed Projects

- 22-S1 Corrosion and Connectors Don't Mix

Funded Projects

- 23-01 Development of a Public Service Announcement Library
- 23-02 Quantifying the Economic Value of Snow and Ice Operational Success
- 23-03 Updating the Impact of Capital Projects Decision Support Tool
- 23-04 Solar Radiation Benefits / Chloride Reduction Potential Associated with the Use of Vegetation Management Practices Near Roads

Ongoing Projects

- Comprehensive Guide to Pre-wetting Application Rates and Methods (CR 22-01)
- Best Management Practices for Liquid Chloride Storage and Pumping Systems (CR 22-02)
- Effects of Additives in Deicing Salts at Lower Temperatures (CR 22-03)
- Evaluation of Direct Liquid Application of Salt Brine Versus Granular Salt as Measured Through Various Performance and Safety Metrics (CR 22-04)
- Use of Dashboards for Winter Operations (CR 22-05)
- pH Waiver for Deicing Products and the Qualified Products List (CR 22-06)

In-Person Meetings

- 2022 Fall Meeting (Indianapolis, IN)
- 2023 Spring Meeting (Austin, TX)
- 2023 Fall Meeting (Salt Lake City, UT)

Feature Articles

- The August issue of APWA Reporter covers the project, Entry-Level Driver Training (CDL) for Maintenance Equipment Operators.
- The Winter issue (October) of APWA Reporter addressed recently completed Clear Roads projects that advance winter maintenance decision-making / efficiency. Those projects include:
 - Measuring the Efficiencies of Tow Plows and Wing Plows.
 - Synthesis of Technical Requirements and Considerations for Automated Snowplow Route Optimization.
 - Training Module Development for Evaluation of Storm Severity Index and Winter Severity Index Variables.

State Winter Maintenance Data Survey

Published the 2021-2022 survey results.

Qualified Products List

Upgraded the vendor submission form and back- end management system / database.

Research Implementation Survey

Completed the 2023 edition of the Clear Roads Research Implementation Survey.

FISCAL YEAR 2024 PROPOSED ACTIVITIES

- Fund a new set of projects during the spring 2024 meeting.
- Commence the 2023 funded projects.
- Complete the following projects:
 - Standard Test Procedures for Ice Melting Capacity (CR 18-06)
 - Using GIS to Highlight Highway Segments Sensitive to Deicing Materials (CR 20-05)
 - Salt Shed Design Template (CR 20-06)
 - Grip Sensor Technology and Salt Applications (CR 21-01)
 - Update to CR 13-04: Best Practices for Protecting DOT Equipment from the Corrosion Effect of Chemical Deicers (CR 21-02)
 - Training Module Development for Evaluation of Storm Severity Index and Winter Severity Index Variables (CR 21-04)
 - Calculating Plow Cycle Times from AVL Data (CR 21-06)
 - Determining the Migration of Chloride-based Deicers through Different Soil Types (CR 21-07)
Current Status: A Test Plan was approved in May 2023. Testing is on-going and should conclude in the fall of 2023.
- Conduct in-person meetings in Annapolis, MD and Kalispell, MT.
- Publish a feature article.
- Publish the 2022-2023 State Winter Maintenance Data Survey results.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

This continuation project (formally TPF-5(353)) will maintain its focus on advancing winter highway operations nationally through practical, practice-ready research related to materials, equipment, and methods. State departments of transportation are aggressively pursuing new technologies, practices, tools, and programs to improve winter highway operations and safety while maintaining fiscal responsibility.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Project expected completion FY 2026.

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2023**

STUDY TITLE: Building Information Modeling (BIM) for Infrastructure

FUNDING SOURCE: FHWA OTHER (PLEASE EXPLAIN)

TPF NO.	TPF-5(480)	MDOT START DATE	7/1/2021
PROJECT NO.		MDOT COMPLETION DATE (Original)	9/30/2025
OR NO.	OR21-210	COMPLETION DATE (Revised)	12/31/2027
MDOT TECHNICAL CONTACT	Luke Arnold, 517- 243-8313 ArnoldL1@michigan.gov		
LEAD AGENCY:	Iowa DOT		
PROJECT MANAGER	Khyle Clute, 515-239-1646 Khyle.Clute@iowadot.us		
CONTRACTOR			

BUDGET STATUS

FY 2023 MDOT Budget			MDOT Total Budget		
FY FUNDS	(Original)	\$30,000.00	TOTAL BUDGET	(Original)	\$150,000.00
	(Revised)			(Revised)	
		\$30,000.00			\$60,000.00

PARTICIPATING STATES

AZ, FL, IA, IN, KY, MI, MT, NE, NY, PA, SC, TX, UT

PURPOSE AND SCOPE

The pooled fund serves as the mechanism for stakeholders to work collaboratively to advance BIM for Infrastructure. This will involve building off the foundational work that was charted out in the BIM National Strategic Work Plan, with emphasis on increasing coordination and awareness of BIM technologies and activities. Activities that advance the short- and medium-term goals of the BIM National Strategic Work Plan will be prioritized and carried out by the pooled fund participants. Meetings will serve as a forum to facilitate knowledge sharing among participants. Proposed activities include:

- Develop BIM foundational use cases and workflows. Highlight more effective digital exchange of information (e.g., survey to design, design to construction, construction to asset management, etc.). This kind of exchange will increase collaboration and automation, reduce duplication of effort, and avoid errors.
- Establish BIM Processes (e.g., Develop contract model language to guide BIM procurements.)
- Identify and Execute Capacity-Building Activities (e.g., Establish project selection criteria for BIM implementation; Identify project types and use cases for early pilot projects phase).
- Enhance Skills and Collaboration (e.g., Establish workforce training curriculum to set expectations about required BIM qualifications. Understand organizational roles and responsibilities to connect data silos).
- Deploy Standards-Based Data Management Tools and Techniques (e.g., Develop catalog of information model requirements to define what data should be created and why. Develop standard information delivery specifications for data exchange between systems).
- Lessons Learned - Identify issues with current implementation efforts and share potential solutions to help move toward to greater BIM maturity.
- Research Priorities - Identify short-term and long-term research needs and strategically prioritize the needs so the most urgent and impactful opportunities are addressed first.
- Information Exchange - Establish a forum/expert hub for practitioners in the highway industry to understand the various tools and technologies being used, promote the common modeling formats, and share experiences.

FISCAL YEAR 2021 ACCOMPLISHMENTS

What products or services were delivered from study activities performed in 2021? The project was approved by FHWA and assigned federal project number TPF-5(480) in August 2021. The lead agency's current activities include identifying participants to serve on the Technical Advisory Committee (TAC).

FISCAL YEAR 2022 ACCOMPLISHMENTS

The TAC met virtually several times throughout FY 2022 to discuss the key objectives of TPF-5(480), along with drafting and finalizing the RFP for this project. The RFP was posted in September 2022 with proposals due on November 1, 2022. Current activities underway include scheduling of the first TAC meeting in 2022.

FISCAL YEAR 2023 ACCOMPLISHMENTS

Proposals due: Tuesday, November 1, 2022.
Notification of virtual interview: Friday, November 11, 2022
Virtual interviews: Friday, November 18, 2022
Notification of proposal selection: Tuesday, November 22, 2022
Virtual kick-off meeting to discuss Year 1 Scope of Work: Friday, December 16, 2022
Year 1 Scope of Work approval and contract negotiation: End of January
Project start date: February 1, 2023.

In addition, the TAC intends on meeting in-person for two days per year of the project.

2023 Accomplishments

Provided detailed 5-year plan for this project.
Created "Digital Workflow Graphic" to describe the data flow through road projects.
Developed best practice document for signing and sealing models.
Developed best practice document for "Model as a Legal Document".
Started work on a digital clearinghouse website to create a searchable database for BIM topics / research.
Documented "state of the practice" for BIM at the DOT level.

FISCAL YEAR 2024 PROPOSED ACTIVITIES

Creation of a "BIM Guidebook" for states to leverage. This will include short guides and best practices for all state DOT's and how they can leverage BIM at their state. This guidebook will be evaluated and updated every year.

Create a data dictionary for road objects and their attributes or property sets.

Creation of an "Information Delivery Manual" for the digital workflows. This document will describe what properties objects must have to digital handoff to downstream customers.

Identify field tools (software) and resources that state DOTs are currently using.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Project expected completion FY 2027.

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2023

STUDY TITLE: Center for the Aging Infrastructure: Steel Bridge Research, Inspection, Training and Education Engineering Center - SBRITE (Continuation)

FUNDING SOURCE: FHWA OTHER (PLEASE EXPLAIN)

TPF NO.	TPF-5(486)	MDOT START DATE	10/1/2021
PROJECT NO.	OR22-205	MDOT COMPLETION DATE (Original)	9/30/2026
		COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Rebecca Curtis, 517-449-5243 CurtisR4@michigan.gov		
LEAD AGENCY:	Indiana DOT		
PROJECT MANAGER	Anne Rearick, 317-232-5152 arearick@indot.in.gov		
CONTRACTOR			

BUDGET STATUS

FY 2023 MDOT Budget			MDOT Total Budget		
FY FUNDS	(Original)	\$30,000.00	TOTAL BUDGET	(Original)	\$60,000.00
	(Revised)			(Revised)	\$210,000.00
		\$30,000.00			\$90,000.00

PARTICIPATING STATES

AK, AR, FHWA, IADOT, ID, IL, KS, MI, MN, MT, NC, NY, SD, TX, WI

PURPOSE AND SCOPE

This is a continuation of SPR-5(281) for the Steel Bridge Research, Inspection, Training, and Education (S-BRITE) Engineering Center focused on existing steel highway bridges. Initially proposed in 2013, this has become a national center leading education, training, research, and engineering that benefits the existing aging steel bridge and structure inventory. Over the life of the project, ten states, the US Army Corps, and FHWA have provided support. Current funding is very strong and partner states continue to be added. Although the Center has been focused on highway bridges, it will also support stakeholders of steel railroad bridges and steel ancillary structures, such as lighting towers and sign supports. As a result, in-kind support from the railway industry has been strong as well. The Center has contributed to improved asset management decisions for DOTs, FHWA, and other partners relative to existing steel bridge inventory.

A long-term goal of the S-BRITE Center has been to create the next generation of bridge engineers and inspectors who are properly educated to be effective stewards of the existing aging steel bridge inventory. At the university level, the development of a new "minor" or certificate within Civil Engineering is proposed that will prepare engineering students for a career in transportation structures. At the professional level, high-quality, specialized short courses will be developed targeting individuals currently responsible for the existing infrastructure. The courses will go beyond the current National Highway Institute (NHI) course level. Although training, education, and research are the overall focus of the Center, the cornerstone will be a multi-acre Bridge Component Gallery that will include full-scale bridge structures, portions of complete structures, and individual components with a host of common and uncommon details used in steel bridges. The gallery has provided a unique hands-on experience for education of individuals of all levels regarding steel fabrication, deterioration, inspection techniques, etc. An S-BRITE flyover video highlighting the scale of the bridge component gallery can be found at: <https://engineering.purdue.edu/CAI/SBRITE/Facilities>. Since the bridge components are not actually in service and are in more accessible conditions, costly traffic control and extensive fall-protection will not be required during training. Conveniently, they have been situated so that real-world conditions exist to truly simulate in-situ inspection conditions. The S-BRITE "living laboratory" has become incredibly useful for research tools being developed for inspection, durability modeling, and performance testing of inspectors. To help fill the technical voids found at most DOTs, a unique team of experts have been assembled through the S-BRITE Center to create a Distributed Expertise Network (DEN). Some of these individuals are local to Purdue at the Center while others are located at their respective institution. The DEN serves the role that no longer exists in many individual state DOTs today, specifically the existence of a group of highly specialized technical experts that are "on-call" to assist as issues arise. These experts have been able to travel to the participant's location if required as funding levels provide. There is no need for special subcontracts between the individual state and the expert since the agreements are already in place as participants of the Center. As states have different needs and resources, three different levels or "tiers" of contributions were developed with each tier receiving defined benefits. Participants will be stakeholders in the direction of the Center, research program directions, and coursework development. Tier 1A and Tier 1B come at a cost of \$30,000 per year for two years, making the total commitment \$60,000. This level provides support for the administration and policy development for center operations and strategic plan along with course development, traditional research and gallery development and maintenance. Specific deliverables will include one training course at the stakeholder's facility for up to 30 people and one training course for up to two people, including travel to Purdue University for specialized training.

FISCAL YEAR 2022 ACCOMPLISHMENTS

- MDOT 125869 CAH S13 Beam E Pier 2 Pin Hole Corrective Action Stress Analysis & Repair Plan - Provided some guidance on this issue. Turned out it got replaced.
- Parish Road's span bridge with damage flanges that were weld repaired. Girders lifted off supports. Provided FEA analysis on estimated locked in stresses due to the many CJP welds added to the flanges. provided in put on heat straightening etc. should the contract elect to go that route
- M-55 Colleyu Bridge over Pine Creek (Cooley Bridge) plug weld questions. Provided suggested strategies moving forward and retrofit suggestions.

FISCAL YEAR 2023 ACCOMPLISHMENTS

- 35022-B01: Dr. Connor provided recommendations for analyzing link plates with out of plane distortion due to pack rust.
- B01-11101: US-12 over St. Joseph River
- Dr. Connor provided recommendations regarding plug weld removals using hand drilling adjacent to the defects.
- B03-51021: M-55 over Pine River (Cooley Bridge)
- Dr. Connor provided recommendations regarding plug weld removals identified in the North Truss U8'-U9' tension chord.
- B01-41027-4: I-196 WB over Grand River
- S-BRITE provided recommendations regarding analyzing web distortion of the beams and the load rating analysis.
- STR 2134: Route 537 over Ford River (Delta County)
- Dr. Connor provided recommendations regarding pin and hangers with welded washers.
- MDOT hosted S-BRITE to teach the following classes:
 - Inspector Awareness (October 6 and Oct 27)
 - Inspecting Steel Bridges for Fatigue (Nov 2-3)
- SBRITE provided feedback on a structural steel detail at B05-2 of 25132 (I-475/Flint River). It is a highly skewed bridge with long spans, and SBRITE was asked to comment on the proposed cross frame details and connections to the bottom flange of the girder.
- SBRITE provided CIF detail risk assessment guidance to help us assess whether we needed to retrofit existing structures.
- US-2 over Cut River – they provided guidance for instrumenting the hold down link plates to assess the remaining fatigue life. They gave us a diagram for where to instrument, they gave us recommendations for how to set a threshold and how to pare down the strain data and gave a path forward in terms of how to use the data to assess fatigue life.
- S05 of 63103 – They gave us guidance for how to assess and retrofit a bridge that has experienced cracks in the juncture between the longitudinal beams and a transverse steel box girder.

FISCAL YEAR 2024 PROPOSED ACTIVITIES

Provided training and miscellaneous support as needed

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

MDOT plans to increase its pledge commitment by \$50,000 each year in FY 2024-2026 for a total commitment of \$150,000.00.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Project expected completion FY 2026.

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2023**

STUDY TITLE: Transportation Management Centers Pooled Fund Study Phase II

FUNDING SOURCE: FHWA OTHER (PLEASE EXPLAIN)

TPF NO.	TPF-5(487)	MDOT START DATE	9/30/2023
PROJECT NO.	OR22-211	MDOT COMPLETION DATE (Original)	9/30/2027
		COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Suzette Peplinski 616-451-3091 Email: PeplinskiS@michigan.gov		
LEAD AGENCY:	FHWA		
PROJECT MANAGER	Jon Obenberger 202-493-3265 Email: Jon.Obenberger@dot.gov		
CONTRACTOR			

BUDGET STATUS

FY 2023 MDOT Budget			MDOT Total Budget		
FY FUNDS	(Original)	\$25,000.00	TOTAL BUDGET	(Original)	\$125,000.00
	(Revised)			(Revised)	
		\$25,000.00			\$100,000.00

PARTICIPATING STATES

AL, AZ, CA, FL, GA, IA, IL, KS, MDOT SHA, MI, MN, MO, NJ, NV, NY, OH, PA, TN, TX, UT, VA, WA, WI.

PURPOSE AND SCOPE

The objectives of the Traffic Management Centers (TMC) Pooled Fund Study (PFS) is to assemble regional, state, and local transportation management agencies and FHWA to: (1) identify key issues and challenges agencies are facing with their traffic management systems (TMSs) or centers (TMCs); (2) suggest approaches to addressing identified issues; (3) initiate and monitor projects intended to address identified issues; (4) develop technical resources and disseminate results; (5) provide leadership and coordinate with others on TMC interests; and (6) promote and facilitate sharing information on TMC issues nationally.

The TMC Pooled PFS involves a group of public agencies and organizations who voluntarily pool funds each year to address the key challenges and issues they are facing in support of improving performance, capabilities, and how they manage and operate their TMSs. TMC PFS members collaborate by using funds they contribute for the pursuit of projects they agree to pursue and develop technical resources and advance activities to address the key challenges and issues they are collectively facing. This project is being created to establish a new number (Phase II of TPF-5(319)) and allow for 5 additional years (April 17, 2022, to April 16, 2027) beyond the existing study (TPF-5(319)). Agencies can join and add their commitments to the TMC PFS at any time during each year the TMC PFS, which is approved through April 16, 2027.

The Chair of the TMC Pooled Fund Study is Alex Wassman from the Missouri Department of Transportation. The Co-chairs are Josh Brown from the Tennessee Department of Transportation and Ryan McNary from the Pennsylvania Department of Transportation.

The TMC PFS is a group of public agencies and organizations who voluntarily pool funds each year to address the key challenges and issues they are facing in support of improving the performance, capabilities, and how they manage and operate their TMSs. TMC PFS members collaborate by using funds they contribute for the pursuit of projects they agree to pursue and develop technical resources and advance activities to address the key challenges and issues they are collectively facing. FHWA provides the staff and resources (e.g., administrative, technical, project management) to facilitate all the activities and develop the technical resources for each initiated project.

TMC PFS members have identified the need to develop resources to assist with evaluating and benchmarking the capabilities, and desired levels of performance for the existing and the next generation of their TMS. The need for technical resources were also identified to assist with planning, designing, procuring, developing, implementing, testing, operating, and evaluating possible improvements to these systems. TMC PFS members have identified over 15 ideas for possible future projects to pursue within the following four technical areas identified where work needs to be pursued over the next five years: 1) assessing and reporting on TMS capabilities and performance; 2) planning, designing, and procuring TMSs; 3) managing and operating TMSs; and 4) staffing, support resources, and capacity building.

FISCAL YEAR 2023 ACCOMPLISHMENTS

Completed reports include the Analysis of TMC Staff and Staffing Contracts, TMS Asset Management Planning for TMSs and LCCA, Inventorying, Documenting, and Configuring TMS Assets and Resources.

The annual meeting was held in May 2023 to select new projects, provide presentations on current projects, hear member state initiatives, and tour the Tennessee DOT facilities.

Multiple webinars and virtual technical exchanges were held for all TMC PFS members.

Webinars are usually hosted by NOCOE and are available to the national transportation community.

FISCAL YEAR 2024 PROPOSED ACTIVITIES

Current and upcoming projects for the PFS include: Sharing and Using Different Types of Data in Transportation Management Systems (TMS), Planning TMS Strategic Direction and Future Investment, Using Social media to Improve the Management and Operation of TMSs, Methods to Identify Staffing Needs and Developing or Updating Staffing Plans for TMS, Enabling the Sharing and Use of Open-Source or Agency Owned Software and APIs, Designing, Procuring, and Managing a Data Subsystem for TMSs and Data Management Plans for TMS, Locating and Placing TMS Field Devices, and Classifying, Measuring, Collecting, and Using Information on the Conditions of TMS Assets.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

This PFS Phase 2 is active and running concurrent w/ TPF-5(319) Phase 1.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Project expected completion FY 2026.

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2023**

STUDY TITLE: Safety Service Patrol Standardization and Management Practices

FUNDING SOURCE: FHWA OTHER (PLEASE EXPLAIN)

TPF NO.	TPF-5(489)	MDOT START DATE	10/1/2021	
PROJECT NO.	OR22-209		MDOT COMPLETION DATE (Original)	9/30/2025
			COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Sarah Gill, 248-867-6841 GillS@michigan.gov			
LEAD AGENCY:	Minnesota DOT			
PROJECT MANAGER	Paul Jodoin, 202-366-5465 paul.jodoin@dot.gov			
CONTRACTOR				

BUDGET STATUS

FY 2023 MDOT Budget			MDOT Total Budget		
FY FUNDS	(Original)	\$25,000.00	TOTAL BUDGET	(Original)	\$100,000.00
	(Revised)			(Revised)	
		\$25,000.00			\$50,000.00

PARTICIPATING STATES

LTRC, CA, FHWA, FL, GA, IN, LA, MDOT SHA, MI, MN, MO, NC, NJ, NY, PA, TN, TX, UT, WA.

PURPOSE AND SCOPE

The primary objective of this PFS study will be to gain technical information related to SSP program management, standards associated with SSP response protocol and the implementation of traffic control, and references and guidance related to staffing, training, and resource allocations within SSP programs. The goals include: 1. Assemble best practices and lessons learned from existing programs 2. Develop guidance documents based on lessons learned from existing programs 3. Reference or create tools that will help agencies make informed program decisions such as route selection, staffing levels, and resource allocation.

The work plan is described in three primary phases. Phase 1 is best practices research effort on the deployment of emergency traffic control (ETC) and potential SSP vehicle configurations used by agencies across the country. Phase 2 is focused on the staffing resources with a research effort focused on Staffing strategies, training programs, and the use of associated certifications. Phase 3 includes a focus on the strategic level of managing an SSP program and will focus on funding strategies and budgets, and resource management (route selection, number and type of vehicles, lengths of patrol routes, time of day, etc.) Phase 1 Best Practices in ETC and Vehicle Configurations (est. \$250,000) Phase 1 includes an assessment in standards for both SSP vehicle and emergency traffic control implementation. SSP programs can range widely in the types of services provided to the motorists and it is paramount that responders can safely manage the on-scene response. This requires the appropriate type of vehicle, communications, technology, and resources to be contained within a single vehicle. This phase will look at emergency traffic control layouts that optimize the safety of all responders and the public and balance with the available storage capacity of an SSP vehicle. This will include the color and visibility of the vehicles, traffic control devices and placement, lighting systems and other emerging technologies (beacons, tethered drones, etc.) that add value to the response and safety. In addition, it will look at additional technologies and equipment contained on an SSP vehicle and the effectiveness of those tools in supporting a response. Tasks: 1. Multi-state Program and Literature Review 2. Focused research and outreach to agencies on ETC layouts, vehicle equipment, and use of emerging technologies 3. Technical guide for best practices in ETC implementation, including device requirements and schematics of actual layout 4. Technical guide for potential vehicle configurations (chassis, 4x4 etc.), equipment needs, and emerging technology applications Phase 2 Staffing, Training, and Certification (\$275,000) Phase 2 is focused on how agencies are staffing their SSP program. Programs can use in-house, contracted staff, or even a hybrid structure to provide the necessary staffing levels and oversight of the day-to-day operations. Additionally, SSP staff are required to perform independently every day and must have a broad technical skill set to respond to a variety of issues while on duty. This phase will include research on the structure and content of existing training programs as well as identifying lessons learned or the future direction of established programs. This research also should capture the integration of certification within agencies' training curriculum and how that certification is used to support the staffing, hiring, and promotion structure. Tasks: 1. Multi-state Program and Literature Review 2. Focused research and outreach to agencies on staffing structure including policies or legislation that may steer the decisions around the staffing structure 3. Focused research and outreach to agencies on training and certification programs and how they are integrated into the resource management and staffing strategy 4. Technical guide for best practices in staffing structures including job descriptions, qualifications job postings, policies, and legislation that drive staffing decisions 5. Technical guide for developing, implementing, and maintaining a training and certification program Phase 3 Program Management (\$225,000) Phase 3 is focused on an assessment of existing programs and their program management strategies. This includes a look at tools used for route selection, asset management, staffing levels, and budgeting purposes. All public agencies are required to commit to a budget and that is no exception for an SSP. This research will focus on how SSP programs are determining and managing budgets.

FISCAL YEAR 2022 ACCOMPLISHMENTS

We have formed our technical group and meet regularly. Share information and have started to collect and compare documentation.

FISCAL YEAR 2023 ACCOMPLISHMENTS

We held our first in person SSP Pooled Fund Study meeting in North Carolina in May. The SSP Pooled Fund study has focused on Phase 1 – Information gathering and classifying information to document all service patrol nationally and classify them based on the size and responsibility of the program. Documentation and information were provided on a SharePoint site. A master excel file was updated with the information to compare programs. Interviews were held to get remaining information.

FISCAL YEAR 2024 PROPOSED ACTIVITIES

Phase 1 report will be published in March/April of 2024. The next in person meeting will be May 1st and 2nd in Cambridge, MA. We will be starting Phase 2 with a focus on 2-3 research topics in our 4-hour quarterly calls.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Project expected completion FY 2025.

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2023**

STUDY TITLE: Evaluating New Technologies for Roads Program Initiatives in Safety and Efficiency (ENTERPRISE- Phase III)

FUNDING SOURCE: FHWA OTHER (PLEASE EXPLAIN)

TPF SOLICITATION NO.	TPF-5(490)	MDOT START DATE	10/25/2022
PROJECT NO.		MDOT COMPLETION DATE (Original)	09/30/2027
		COMPLETION DATE (Estimated Revised)	09/30/2028
MDOT TECHNICAL CONTACT	Elise Feldpausch		
LEAD AGENCY	Michigan Department of Transportation		
PROJECT MANAGER	Elise Feldpausch		
CONTRACTOR			

BUDGET STATUS

FY 2023 MDOT Budget			MDOT Total Budget		
FY FUNDS	(Original)	\$35,000.00	SPR Budget	(Original)	\$175,000.00
	(Revised)		Non-SPR Budget	(Original)	\$240,980.00
		\$35,000.00			\$415,980.00

Year	Total MDOT Contributions	Project Total Expenditures
2022	See TPF-5(359)	*\$15,352.95
2023	\$35,000.00	\$163,651.81

*CTC and Associates expenditure for assistance with Phase III preparation and transition from Phase II

PARTICIPATING STATES

IA, IL, KS, MI, MN, TX, and WI

PURPOSE AND SCOPE

This study is a continuation of TPF-5(359) Phase II to enhance innovation in highway operations and Intelligent Transportation Systems (ITS) through research and technology transfer. Another purpose of this study is to continue the assessment of transformational technologies and their impact on the transportation industry.

FISCAL YEAR 2021 ACCOMPLISHMENTS

This proposed study was approved for solicitation by FHWA Michigan Division and is included on the FY 2021 annual work plan. Current state partners pledge commitments total is \$450,000.00.

FISCAL YEAR 2022 ACCOMPLISHMENTS

Full waiver was approved; MDOT obtained FHWA final approval of the proposed study, and a federal project number was assigned. MDOT requested all state partners transfer their FY 2022 pledge commitment amounts.

FISCAL YEAR 2023 ACCOMPLISHMENTS

Secured state partner's fund transfers for FY 2022 and 2023.

Project 1: State of the Art Roadway Sensors – Phase 1

- Task 1: Literature Search, Survey, and/or Interviews – Completed Task 1 by compiling and organizing findings from the literature search and survey.
- Task 2: Roadway Sensor Analysis – Conducted a webinar with interested ENTERPRISE Board members to prioritize use case areas and specific sensors to focus in-depth analysis on items of interest for Task 2 and 3 activities.
- Task 3: Use Cases – Began documenting use cases that were identified in Tasks 1 and 2.
- Task 4: Draft Final Report – Began development of the report based on findings from Tasks 1 and 2.

Project 2: New Methods of Traffic Data Collection

- Task 1: Literature Search, Survey, and or/Interviews – Continued online search to identify traditional and emerging data collection methodologies. Began to analyze survey results that focused on identifying state DOTs that have used or are using emerging methodologies for collecting traffic data.
- Task 2: Industry Scan – Continued online search of vendors that provide data collection methodologies.

Project 3: Potential Approaches for Wrong Way Driving Applications – Phase 2

- Task 1: Synthesis of Current WWD In-Vehicle or Mobile Applications – Completed Task 1 by completing the online search to identify WWD in-vehicle and mobile applications and prepared the draft synthesis. Presented a project update at the September ENTERPRISE Board meeting.
- Task 2: Industry Outreach - Automobile Manufacturers and Application Providers – Began discussing an outreach strategy.
- Task 3: Industry Outreach – Enhance Phase 1 White Paper – Completed engagement with USDOT/FHWA, received input and insights to continue to pursue inclusion of WWD events in national data exchanges.

Project 4: Procurement Specification for Physical Security of ITS

- Task 1: Investigate Best Practices for Security of ITS Field Devices – Completed the literature review. Created a one- page project summary document. Defined “ITS cabinets, shelters/huts, and boxes” for the purpose of this project. Recruited agencies to participate in interviews through outreach to the AASHTO Committee on Transportation System Operations (CTSO). Developed an interview guide. Completed 6 interviews with State DOTs to gather physical security practices and specifications. Began creating interview summaries. Presented a project update at the September ENTERPRISE Board Meeting.
- Task 2: Best Practices Checklist: Began reviewing practices noted by State DOTs, for consideration for inclusion in the best practices checklist.

Project 5: Novel Uses of Unmanned Aerial Systems (UAS) in ITS

- Task 1: Literature Search, Survey, and/or Interviews – Completed the literature search. Began developing survey questions. Provided a project update at the September ENTERPRISE Board meeting.
- Task 2: Use Cases and Applications: Began compiling UAS use cases from the literature.

Project 6: State of the Art of Roadway Sensors – Phase 2

- Conducted project kickoff during September ENTERPRISE Board meeting.

FISCAL YEAR 2024 PROPOSED ACTIVITIES

Initiate Phase III research projects:

- Project 7: Administration of Communications – Phase 1
- Project 8: Something Old, Something New – New Applications of Old Technologies
- Project 9: Uncontrolled Pedestrian Crossing ITS Countermeasures
- Project 10: Communication Future – Phase 1
- Project 11: Quick Connect DMS Replacement
- Project 12: Administration of Communications – Phase 2
- Project 13: Analysis and Benefits of Connected Street Lighting

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

A no cost time extension was granted to CTC and Associates under the administrative contract to allow additional time for their assistance with transition into Phase III of this pooled fund project.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Project estimated completion FY 2028.

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2023**

STUDY TITLE: 2023 Technology Exchange on Low Volume Road Design, Construction and Maintenance

FUNDING SOURCE: FHWA OTHER (PLEASE EXPLAIN)

TPF NO.	TPF-5(495)	MDOT START DATE	9/1/2021
PROJECT NO.	OR22-207	MDOT COMPLETION DATE (Original)	9/30/2023
		COMPLETION DATE (Revised)	12/31/2023
MDOT TECHNICAL CONTACT	Tracie Leix LeixT@michigan.gov		
LEAD AGENCY:	Iowa DOT		
PROJECT MANAGER	Khyle Clute Khyle.Clute@iowadot.us		
CONTRACTOR	Iowa State University		

BUDGET STATUS					
FY 2023 MDOT Budget			MDOT Total Budget		
FY FUNDS	(Original)	\$0.00	TOTAL BUDGET	(Original)	\$12,000.00
	(Revised)			(Revised)	
		\$0.00			\$0.00

PARTICIPATING STATES

IA, ID, KS, LA, MI, MO, OH, TX, VA

PURPOSE AND SCOPE

The primary activities of this pooled fund project are technology exchange, information sharing, and the facilitation of partnering relationships among state agencies and participating members with FHWA, Local Public Agencies and other appropriate agencies and associations. Technology exchange activities in conjunction with the 13th International Conference on Low Volume Roads will be advantageous to participating members. Specifically, this pooled fund will: 1. Provide communication and information sharing among member participants: Discuss research, development, and technology transfer needs in the areas of design, construction, maintenance, and safety on low volume roads and provide research ideas to the Transportation Research Board (TRB) in the areas of Low Volume Roads. 2. Member workshop at the 13th International Conference on Low Volume Roads: Provide a technology and knowledge exchange forum to enhance the practical knowledge of pooled fund participants concerning low volume road management with a focus on encouraging State DOT and other agency participation in the pooled fund. 3. Pooled Fund Member Meeting on Low Volume Road Issues: Provide a technology and knowledge exchange forum focused on Low Volume Road issues. Topics may include agency collaboration, funding, asset management, shared ROW/utilities, safety programs, emergency response, training and certifications, maintenance of traffic, federal oversight, standards, and specifications, contracting methods, environmental issues, energy development, maintenance, material sources and quality, and bonding. 4. Technology Transfer through paper publication, webinars, technology field demonstrations, and expanding access to solutions on issues selected by pooled fund member in areas of Low Volume Road Design, Construction and Management.

The principal tasks are: 1. TRB will organize arrangements for the Low Volume Road pooled fund member agencies for the technology exchange on best practices in management of Low Volume Roads. The pooled fund will help support the travel and per diem expenses of pooled fund members associated with the technology exchange. This will include expenses to attend the 13th International Conference on Low Volume Roads. It is anticipated that individuals from pooled fund partner members may be invited to participate on the Conference Planning Committee calls to coordinate technology exchange events with the conference. These calls will help in coordinating the activities during the conference as determined by participating member agencies. 2. TRB will provide for a learning session and technology exchange forum to be held during the conference at the same venue as the conference. The intent will be for pooled fund partners and other invited agencies plus invited speakers to discuss member agency issues related to Low Volume Roads. This is an opportunity for the pooled fund partners to collaborate and share best practices and strategies for overcoming certain challenges. The exchange forum will be held during the conference due to the anticipated opportunity to interact with experts and other technical professionals at the conference. The Iowa DOT will coordinate the learning session with other pooled fund partners. The Conference Planning Committee will not be involved in planning the pooled fund partner session, though collaboration is expected on venue accommodations and conference program planning. TRB will synchronize the conference and pooled fund member activities to allow pooled fund members to accomplish its business and technology deployment goals while also providing opportunity to participate in key components of the international conference. 3. If funds allow, follow-up post conference webinars will be organized by pooled fund partners and led by TRB for dissemination and execution. The webinars will share highlights from activities and include an open forum question/answer discussion or it may be to highlight the best papers of presentation that pooled fund members find of interest from the conference. In addition, pooled fund member agencies will review topics and projects through a selection process and select those worthy of dissemination through publications. In addition, pooled fund partners will identify technologies for field demonstration as part of technology exchange and outline activities to increase outreach to low volume road agencies for technology transfer efforts.

FISCAL YEAR 2022 ACCOMPLISHMENTS

Participation in Low Volume Roads conference planning.

FISCAL YEAR 2023 ACCOMPLISHMENTS

Actively participated in the 2023 Low Volume Road conference by presenting at the conference. Attendance at Low Volume Roads Conference in Iowa included two members of MDOT's Local Agency Program (LAP) Section. MDOT's contribution was paid early during FY 2022.

FISCAL YEAR 2024 PROPOSED ACTIVITIES

Continued participation in the TRB Low-Volume Road Pooled Committee.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Project expected completion FY 2024.

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2023**

STUDY TITLE: Roadside Safety Pooled Fund – Phase 3

FUNDING SOURCE: FHWA OTHER (PLEASE EXPLAIN)

TPF NO.	TPF-5(501)	MDOT START DATE	9/30/2023
PROJECT NO.	OR23-204	MDOT COMPLETION DATE (Original)	9/30/2025
		COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Carlos Torres 517-335-2852 Email: TorresC@michigan.gov		
LEAD AGENCY:	Washington State DOT		
PROJECT MANAGER	Mustafa Mohamedali 360-704-6307 Email: MohameM@wsdot.wa.gov		
CONTRACTOR			

BUDGET STATUS

FY 2023- MDOT Budget			MDOT Total Budget		
FY FUNDS	(Original)	\$65,000.00	TOTAL BUDGET	(Original)	\$195,000.00
	(Revised)			(Revised)	
		\$65,000.00			\$130,000.00

PARTICIPATING STATES

AK, AL, CA, CO, CT, DE, FL, IA, ID, IL, LA, MA, MDOT SHA, MI, MN, MO, NM, OH, Ontario MOT, OR, PA, RI, TN, TX, UT, WA, WI, WV.

PURPOSE AND SCOPE

The objective of this Pooled Fund is to assist transportation agencies in achieving their Roadway Departure (RwD) related all state Strategic Highway Safety Plans (SHSPs) goals through development, evaluation and deployment of life-saving roadside safety devices and countermeasures in accordance with AASHTO and Federal Highway Administration (FHWA) adopted standards such as the Manual for Assessing Safety Hardware (MASH). It will also support continuation of MASH implementation in roadside hardware categories that have lagged in achieving MASH compliance (special barrier applications, sign supports, work zone traffic control devices, luminaire poles, etc.) due to various design and performance challenges and other related factors. These activities will directly support and impact state efforts to achieve Target Zero by helping reduce the frequency and severity of roadway departure crashes.

TPF-5(501) is intended to replace the current Roadside Safety Research for MASH Implementation pooled fund study, TPF-5(343), which expires in December 2023.

Given their common interest in SHSP implementation, all states would benefit from participation in this Pooled Fund program. However, the FHWA Roadway Departure Focus States may particularly benefit from the roadside safety research, collaboration, and information sharing that will constitute the framework of the program.

Representatives of participating states will be convened as a technical committee to identify common research needs, select and prioritize projects for funding, and oversee research and testing. Specific activities include the design, analysis, testing, and evaluation of crashworthy roadside safety devices, and the development of guidelines for the use, selection, and placement of these devices. Devices to be considered for research include bridge rails, guardrails, transitions, median barriers, portable concrete barriers, end treatments, crash cushions, culverts, breakaway support structures (e.g., sign supports, luminaire supports, mailboxes), and work zone traffic control devices. Research will also address the influence of roadside features such as driveways, slopes, ditches, shoulders, medians, and curbs on vehicle collision performance. Computer simulation, full-scale crash testing, analysis of real-world crash data, and cost effectiveness analysis are the primary tools that will be employed in these investigations. The identification, description, selection, and prioritization of research issues will be made by the technical committee on an annual basis, unless emerging issues require committee decisions in the interim.

FISCAL YEAR 2023 ACCOMPLISHMENTS

This is a new pooled fund group that officially started on 9/9/22. Once sufficient funds were obligated to the pooled fund by member states, beginning in May 2023, the lead agency was able to start executing task orders to initiate some of the priorities member states had identified at the fall 2022 annual meeting.

After a significant deal of work, collaboration and negotiations between all parties and legal counsel, the master agreement with the research institution (Texas Transportation Institute) was finally concluded. This led to TTI being able to submit proposals for individual tasks and projects that had been identified at the 2022 annual meeting.

The following projects and tasks were initiated between 4/1/23 and 6/30/23:

1. T1969-AA: 2023 Program Development & Coordination Effort
2. T1969-AB: Optimized Guardrail Blockouts
3. T1969-AC: W-Beam Guardrail in Front of Retaining Wall or Rip Rap
4. T1969-AD: Barrier Deflections at Lower Impact Severities
5. T1969-AE: Phase II Thrie Beam Retrofit – Application of New Design without a Curb for MASH TL-3 and Performance and Improvements for MASH TL-4
6. T1969-AF: MASH TL-3 Evaluation of Sign Posts with Flashing Beacon Equipment
7. T1969-AG: MASH TL-3 Transition Design with a Storm Drain Inlet: Phase II

FISCAL YEAR 2024 PROPOSED ACTIVITIES

Continued work on projects initiated in FY 2023. Also, additional projects will be selected for initiation at the upcoming annual pooled fund meeting in October 2023.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Project expected completion FY 2025.

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2023**

STUDY TITLE: Concrete Bridge Engineering Institute (CBEI)

FUNDING SOURCE: FHWA OTHER (PLEASE EXPLAIN)

TPF NO.	TPF-5(508)	MDOT START DATE	9/30/2023
PROJECT NO.	OR23-206	MDOT COMPLETION DATE (Original)	9/30/2026
		COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Bradley Wagner WagnerB@michigan.gov		
LEAD AGENCY:	Texas DOT		
PROJECT MANAGER	Joanne Steele Email: Joanne.Steele@txdot.gov		
CONTRACTOR			

BUDGET STATUS					
FY 2023 MDOT Budget			MDOT Total Budget		
FY FUNDS	(Original)	\$50,000.00	TOTAL BUDGET	(Original)	\$200,000.00
	(Revised)			(Revised)	
		\$50,000.00			\$150,000.00

PARTICIPATING STATES

CO, FHWA, FL, GA, IA, MI, MN, PA, TN, TX, UT.

PURPOSE AND SCOPE

The overall objective of this pooled fund is to implement specific programs within the Concrete Bridge Engineering Institute (CBEI) that address national workforce training needs through research, development, and technology transfer activities.

The specific objectives are to develop and implement the following programs with coordinated input of members of the pooled fund: Three initial specific training programs, a Concrete Solutions Center, and a Bridge Component Collection. The scope of each is further defined below.

The technology transfer through training programs will draw on the latest technologies and provide an innovative approach by utilizing a hands-on intensive curriculum. The training programs will draw from the best, and most current, state of the art methods. CBEI will serve to continually gather emerging or underutilized technologies such as those above, and provide research, development, and technology transfer activities in partnership with the originators of the technology. This will result in training curricula and technology transfer documents for the concrete bridge workforce. Non-destructive Evaluation (NDE) techniques will be an overarching component included in each of the programs.

This solicitation will create a consortium of states that fund the Concrete Bridge Engineering Institute (CBEI). The scope within this pooled fund includes the resources to create and operate the components of CBEI and member benefits listed below:

- Training Seats:
 - o Deck Construction Inspection Program to meet the need of ensuring proper initial construction of concrete bridge decks utilizing full-scale hands-on components. Bridge deck construction techniques utilizing precast deck panels and associated technologies will be included in this program.
 - o Concrete Materials for Bridges Program to provide guidance on the proper selection and use of constituent materials to improve the service life of concrete bridges, sustainability of concrete construction, and provide hands-on examples of what happens when these are not considered.
 - o Post-tensioning (PT) Laboratory (aka PT Academy) to provide hands-on training for inspectors and field installers as well as test and evaluate promising post-tensioning technologies.
- Concrete Solutions Center: Members are provided support through the CBEI Concrete Solutions Center including direct technical support, webinars, and custom workshops. Identified emerging technologies will be further evaluated through this program and new training programs and draft documentation developed to foster successful implementation.
- Bridge Component Collection: Member support will help fund the growth and development of the full-scale Bridge Component Collection. The Concrete Bridge Component Collection at CBEI contains full scale specimens from decommissioned bridges as well as from previous research projects. The components include segmental bridge components, precast girders, bent caps, and specimens exhibiting concrete deficiencies such as alkali-silica reaction (ASR). This resource will be used for training and technology testing and can serve specific needs of a member with consensus of the Technical Advisory Committee.

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- CBEI will engage partners such as industry groups and will seek to complement existing training and resources. CBEI will draw on existing resources at the University, such as other Centers and departments and will also engage other subject matter experts and resources outside of the University.

FISCAL YEAR 2023 ACCOMPLISHMENTS

The project agreement for this pooled fund was issued on June 21, 2023, and the kickoff meeting was held with the TAC on 6/22/23. An overview of the pooled fund was described. The majority of the pooled fund efforts officially begin in January of 2024. However, technical support capacity is now available, and MDOT has utilized this for several current issues as noted below:

- Assessment of beam end flange cracking on several new structures. CBEI has met with us, proposed a plan, and will perform analysis.
- Assessment of beam end web cracking – CBEI met with us, gave recommendations, and shared research information.
- Assessment of fabrication issues on an active construction project – Had a call with the PI and received recommendations for how to proceed.

FISCAL YEAR 2024 PROPOSED ACTIVITIES

- Complete beam end cracking assessment and issue a report.
- Begin developing a bridge deck construction class. MDOT will propose a SME to participate in this effort.
- Site development of CBEI's Austin Texas training facility.
- Continued technical support for MDOT.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Project expected completion FY 2026.

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2023**

STUDY TITLE: TRB Core Program Activities FFY 2023 (TRB FY 2024)
 FUNDING SOURCE: FHWA OTHER (PLEASE EXPLAIN)

TPF NO.	TPF-5(511)	MDOT START DATE	10/01/2022
PROJECT NO.	Not applicable	MDOT COMPLETION DATE (Original)	09/30/2023
OR NO.	OR23-200	PROJECT COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	André Clover, 517-749-9001 CloverA@michigan.gov		
LEAD AGENCY:	Federal Highway Administration (FHWA)		
PROJECT MANAGER	Jean Landolt, 202-493-3146 Jean.Landolt@dot.gov		
CONTRACTOR	Not applicable		

BUDGET STATUS					
FY 2023 MDOT Budget			Total Budget		
FY FUNDS	(Original)	\$194,189.00	BUDGETED AMT.	(Original)	\$194,189.00
			ACTUAL COST		\$226,874.00
TOTAL FY 2023 EXPENDITURES		\$226,874.00			\$0.00

PARTICIPATING STATES

AR, CA, CT, DC, DE, FL, IA, ID, KY, MA, MDOT SHA, MI, MN, MO, MS, NC, ND, NH, NV, NY, OH, OK, OR, SC, TN, TX, UT, and WA.

PURPOSE AND SCOPE

The Michigan Department of Transportation (MDOT) provides annual financial support for the Transportation Research Board's (TRB's) Core Program technical activities. This support helps to operate TRB annual meetings, the committee structure, state visits by TRB, and the TRB publication program. This pooled fund study permits states to make their contributions to the TRB Core Program instead of sending their contributions to the TRB directly. TRB FY 2024 covers the period from July 1, 2023- June 30, 2024

FISCAL YEAR 2023 ACCOMPLISHMENTS

Funds used to support the TRB's core program and services.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

The TRB Executive Committee recommend annual contributions from each state be based on the most current SP&R funding tables available. MDOT elected to transfer its federal fund contribution for FY 2023 through the TPF-5(511) pooled fund study. MDOT fiscal year commitment level per the SPR funding tables was paid in full.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

MDOT technical experts have access to all TRB publications to review and share internally as appropriate.

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2023**

STUDY TITLE: Highway Safety Manual 2nd Edition (HSM2) Implementation

FUNDING SOURCE: FHWA OTHER (PLEASE EXPLAIN)

TPF NO.	TPF-5(516)	MDOT START DATE**	5/22/2023
PROJECT NO.	OR23-203	COMPLETION DATE (Original)	9/30/2027
		COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Mark Bott 517-335-2625 Email: BottM@michigan.gov		
LEAD AGENCY:	FHWA		
PROJECT MANAGER	Matthew Hinshaw matthew.hinshaw@dot.gov		
CONTRACTOR			

BUDGET STATUS

FY 2023 MDOT Budget			MDOT Total Budget		
FY FUNDS	(Original)	\$16,000.00	TOTAL BUDGET	(Original)	\$80,000.00
	(Revised)			(Revised)	
		\$16,000.00			\$64,000.00

PARTICIPATING STATES

AR, FL, IA, ID, KS, KY, LA, MA, MI, MO, MS, NV, OH, PA, TX, UT, WA

PURPOSE AND SCOPE

Accelerate implementation of HSM2 and related analytical tools to assess current and future safety performance of existing roadways and alternative designs, and help practitioners make more informed decisions, better target investments, and reduce fatalities and serious injuries on the nation's roadways. This includes activities before and after publication of HSM2 (anticipated 2025).

This study will conduct research and develop products to enable States to accelerate their implementation of HSM2. A Technical Working Group consisting of one representative from each participating agency will help identify and prioritize the specific tasks and products.

FISCAL YEAR 2023 ACCOMPLISHMENTS

- The solicitation for the HSM2 pooled fund has cleared and the process to transfer funds completed.
- Planning started for 2024 Peer Exchange in support of HSM 2nd Edition implementation.
- Activities being coordinated with Highway Safety Manual Implementation TPF-5(255)

** TPF-5(516) FHWA Acceptance Memo Dated: May 22, 2023.

FISCAL YEAR 2024 PROPOSED ACTIVITIES

The fund is considering a peer exchange in Michigan for 2024 during the balloting period of the Second Edition of the Highway Safety Manual. This will allow pooled fund study members to discuss changes and identify implementation needs prior to the final publication of the manual. Each PFS member state could send up to 2 participants. The maximum length would be 3 total days.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Project expected completion FY 2027.

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2023**

STUDY TITLE: Sustainable Performance Engineered Concrete

FUNDING SOURCE: FHWA OTHER (PLEASE EXPLAIN)

TPF NO.	TPF-5(517)	MDOT START DATE	5/30/2023
PROJECT NO.	OR23-207	COMPLETION DATE (Original)	9/30/2027
		COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Ethan Bahmer 517-636-4919 Email: BahmerT1@michigan.gov		
LEAD AGENCY	Iowa DOT		
PROJECT MANAGER	Khyle Clute 515-239-1646 Email: Khyle.Clute@iowadot.us		
CONTRACTOR			

BUDGET STATUS				
FY 2023 MDOT Budget			MDOT Total Budget	
FY FUNDS	(Original)	\$0.00	TOTAL BUDGET	(Original) \$100,000.00
	(Revised)	*\$0.00		(Revised)
TOTAL FY 2023 EXPENDITURES		\$0.00	TOTAL COMMITTED FUNDS AVAILABLE	\$100,000.00

PARTICIPATING STATES

CO, IA, ID, KS, MI, MO, ND, PA, WI

PURPOSE AND SCOPE

Surveys conducted for the past 5 years indicate that several states have changed or are in the process of changing their specifications in response to the PEM initiative. It is time to consider "what's next?" The intent of this proposed work is to answer that question.

The fundamental philosophy is unchanged; the ability to specify, measure, and deliver concrete paving mixtures that perform as intended for their design lifetime and beyond. Having the capability to consistently prepare reliable, high-performing mixtures at the batch plant naturally leads to the need to evaluate what happens to the concrete through the stages of transportation, placement, finishing and sawing. Actions between the batch plant and the grade that potentially influence the longevity of a mixture include:

- Transport
- Handling
- Water / admixture addition
- Vibration
- Finishing / texturing
- Curing
- Sawing
- Opening to traffic

Properties that may be affected by these actions include:

- Uniformity
- Consolidation
- Air void system stability
- Durability and strength
- Segregation
- Smoothness
- Cracking

It is intended to follow the previous PEM model to:

- Establish a sound understanding of these properties and how they are affected by workmanship
- Develop / select appropriate test methods for evaluation at or behind the paver
- Select pass / fail criteria
- Provide tools for contractors to ensure that compliance is practical
- Provide documentation and training resources to encourage agencies and contractors to adopt performance-based specifications reflecting PEM and related construction practices.
- The first action will be a brainstorming session with stakeholders, including those engaged in construction and inspection on the grade. The objective will be to review what actions can be taken on the grade that affect sustainable pavement performance, and what data is needed to guide these actions. Tools needed to provide a feedback loop between the batch plant and the paver operator will be

discussed, along with tools that can be used to assure that the finished concrete will perform satisfactorily with a focus on sustainability, for the design life of the pavement. The work plan will be refined following the brainstorming session.

FISCAL YEAR 2023 ACCOMPLISHMENTS

The kickoff meeting was held August 14, 2023. The meeting started with a review of the previous PEM study. Then an open discussion was held with all members of the study.

Based on this discussion and the survey results, the group identified five primary priorities and one secondary priority for P3C:

- Primary
 - o Curing
 - o Consolidation
 - o Finishing
 - o W/cm
 - o Air
- Secondary
 - o Smoothness

If any and/or all these goals are meet/improved it would increase the ride quality, durability, and life of MDOT's concrete pavements. Thus, improving MDOT's transportation system.

FISCAL YEAR 2024 PROPOSED ACTIVITIES

The lead researcher will develop a scope and budget for the pooled fund study and circulate it to the TAC for their review. After the review, the team will submit the scope and budget to Iowa DOT (pooled fund lead state) to get the project under contract. After completion of this task literature review will begin and start of the project will commence.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

*MDOT's fund transfer of its original pledge commitment for FY 2023 did not occur, thus, the amount was added to the FY 2024 pledge amount.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Project expected completion FY 2027.

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APPENDIX

FISCAL YEAR 2022 REPORT UPDATES

The following update notes a change to the MDOT *State Planning and Research Part II Program Fiscal Year 2022 Annual Report*:

Table 1 – 80% Federally Funded Projects (Pg. 6-7):

- \$93,237.66 in costs were reported for project number 201393, “Effects of Concrete Cure Time on Epoxy Overlay and Sealant Performance,” under contract with Western Michigan University (WMU) number 2016-0069 Authorization 6. Expenses should have been reported as \$83,525.97 with total cost to date through fiscal year-end of \$477,338.33. The cost reported on the project form should also be revised (Pg. 17).
- \$25,935.38 in costs were reported for project number 208774, “Safety Enhancements at Short-Storage-Space Railroad Crossings,” under contract with Texas A&M University Transportation Institute number 2019-1033. Expenses should have been reported as \$6,934.28 with total cost to date through fiscal year-end of \$68,871.25. The cost reported on the project form should also be revised (Pg. 41).
- \$76,462.94 in costs were reported for project number 209437, “Research Administration Section Planning and Communication,” under contract with CTC and Associates number 2020-0776. Expenses should have been reported as \$717,05.16 in SPR-II funds with total cost to date through fiscal year-end of \$201,187.00. The cost reported on the project form should also be revised (Pg. 54).
- \$109,568.23 in costs were reported for project number 210791, “Assessing System Performance of the Michigan Trunkline: Measures and Analytical Procedures for Planning and Operations,” under contract with Michigan State University (MSU) number 2020-0783. Expenses should have been reported as \$99,001.03 with total cost to date through fiscal year-end of \$136,679.15. The cost reported on the project form should also be revised (Pg. 57).
- \$23,943.48 in costs were reported for project number 211058, “Effective Bridge Deck Weather Earning Technologies,” under contract with MSU number 2021-0412. Expenses for the year, as well as costs to date (Pg. 65), should have been reported as \$27,509.53.
- \$75,849.48 in costs were reported for project number 213313, “Establish Policies and Procedures for Use of Subgrade Stabilization in Michigan,” under contract with Lawrence Technological University (LTU) number 2019-0309 Authorization 4. Expenses for the year, as well as costs to date (Pg. 79), should have been reported as \$45,713.90.
- \$159,496.92 in costs were reported for project number 213316, “Michigan Hydrologic Calculation Procedures,” under contract with MTU number 2019-0311 Z3. Expenses for the year, as well as costs to date should also be revised (Pg. 82).

100% Federally Funded Projects:

- \$119,824.35 in total project expenditures were reported for TPF-5(359), “Evaluating New Technologies for Roads Program Initiatives in Safety and Efficiency (ENTERPRISE) - Phase II,” under contracts with CTC and Associates number 2018-0172 and Athey Creek number 2019-0045. Expenses should have been reported as \$104,471.40 with total cost to date through fiscal year-end of \$1,043,234.35. The cost reported on the project form should be revised (Pg. 145).

