Michigan Department of Transportation

RESEARCH Administration

STATE PLANNING & RESEARCH PART II PROGRAM

FISCAL YEAR 2024

ANNUAL REPORT

OCTOBER 1, 2023 — SEPTEMBER 30, 2024

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Fiscal Year 2024 Annual Report

STATE PLANNING AND RESEARCH, PART II PROGRAM
2024 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 (RAd) 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 fiscal year (FY), 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 for the FY 2024 on July 12, 2023. This annual report covers the MDOT SPR Part II Program from Oct. 1, 2023, through Sept. 30, 2024.

Summary

FY 2024 research was conducted in the following focus areas, representing several modes of transportation and MDOT's diverse business functions:

Highways Development
- Environment and Water Resources
- 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
- Nonmotorized Planning and Development
- Program Development
- Travel Demand Forecasting

Multimodal Transportation and Finance
- Aviation
- Local Transit
- Finance

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

The FY 2024 SPR, Part II, Program consisted of 90 projects; 42 were 80 percent federally funded and 48 were 100 percent federally funded. The FY 2024 approved budget was $9,597,071.00 and expenditures totaled $6,315,398.77. Table 1 summarizes 80 percent federally funded projects that were funded in FY 2024 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 RAd.

Program and Administrative Milestones

RAd staff continued a primarily remote work schedule. The research program was delivered successfully and included the following FY 2024 milestones:

- A new position was developed in the research section to assist with the 100 percent federally funded projects. Sarah Rottiers was hired as the pooled fund analyst to fulfill this role for the first time.

- MDOT received an AASHTO Research Advisory Committee (RAC) High Value Research (HVR) supplemental maintenance category award given to the top research projects in the nation for *Repair of Bridge Deck Fascias.*

- Two RAd staff members attended the TRB Annual Meeting in January 2024 and coordinated the attendance of other MDOT employees. Research staff presented information at a poster session on the 2023 HVR award winning research project, *Evaluating Safety and Traffic Improvements Along Michigan's First Flex Route.*

- Completed 11 projects that were 80 percent federally funded.

- Initiated contracts for 17 new 80 percent federally funded projects in FY 2024, with total budgets of approximately $4.3 million.

- Research staff participated in the Region 4 AASHTO RAC Peer Exchange in Madison, Wisconsin. This event contributed to RAd's knowledge and sharing of best practices for developing a great research program. State Departments of Transportation were represented along with universities and FHWA.

- Published documents to transfer the results of research and innovation to practitioners, including the following Research Spotlights, highlighting the value of individual research projects:

    - Improving road safety with video analytics technology
    - Best practices and specifications for stabilizing pavement subgrades
    - Transportation agencies pool ideas and resources for technology-enabled solutions
    - Alerting drivers to unsafe winter conditions on Michigan bridges
    - New methods for preventing and repairing bridge deck fascia damage
    - Refining data and tools to design cost-effective, sustainable pavement
    - Making high-speed corridors safer for pedestrians and cyclists
    - Modernizing right of way maps with geographic information technology

- RAd updated MDOT's High Value Research StoryMap: The StoryMap highlights several MDOT projects that were selected through AASHTO over the last six years as high value or special category.

- The Implementation Spotlight, a new one-page document, was developed to help with implementation by sharing successful steps taken to implement innovations. The first Implementation Spotlight was titled Green Strobes Added to MDOT Winter Maintenance Vehicles Increases Visibility.

- A Technology Transfer document was created to explain that SPR, Part II funds can be used to bring new innovations to practical application.

- RAd contracted 10 research projects 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 led 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 has provided project selection and project management support. An additional four research projects have been identified for contracting in the future.

- RAd met with FHWA Michigan Division Officer Jenny Staroska to assess progress on addressing the risks of the research program and met with FHWA Michigan Division staff and MDOT staff on April 23, 2024, for the risk assessment workshop.

- Completed the FY 2025, 2026, and 2027 research program planning process.
    - In fall 2023, Research Administration requested research ideas addressing MDOT's priorities. All stakeholders were contacted. RAd received approximately 100 ideas.
    - In February 2024, meetings were held with each MDOT Research Advisory Committee to identify and prioritize the ideas that were recommended and eventually approved by the Research Executive Committee (REC) in March 2024.
    - In May 2024, virtual program development meetings were held with subject matter experts and stakeholders to obtain input and further refine these previously REC approved research ideas.
    - Twenty-six problem statements were developed by project managers and recommended by the RAC members for REC approval in July 2024, to be included as future projects for FYs 2025, 2026, and 2027.
    - Approved problem statements for FY 2025 were submitted to FHWA Michigan Division in the FY 2025 SPR Part II program on July 30, 2024.

- RAd prepared the FY 2025 SPR II program and received FHWA approval on Aug. 21, 2024.

- 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.

- MDOT continues to partner with 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 ($125,000) to the Michigan County Road Association in cooperation with the Bay County Road Commission, Michigan Technological University, and the Michigan Department of Environment, Great Lakes, and Energy, for the development of construction specifications for rubber modified asphalt mixtures and chip seals for local and state-owned roadways.
  - Held monthly meetings to discuss transportation innovations with MDOT, Local Agency and Industry representatives. Held two virtual STIC highlights meetings featuring a total of 13 Michigan transportation industry innovations, with a combined attendance of more than 200 people.

- During winter and spring 2024, 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 attended AASHTO RAC meetings throughout the year to understand the national research agenda and processes. These meetings have included periodic AASHTO RAC discussions, Region 3 Collaboration and Business meetings, and two RAd staff members attended the national meeting in Columbus, Ohio.

- We completed our fiscal year with a Project Manager (PM) Appreciation event held in September 2024. We honored more than 50 research project managers. The following awards were presented, along with an opportunity to walk the "RAd Carpet":

  - **Best Research:**
    - John Belcher - *Effects of Concrete Cure Time on Epoxy Overlay and Sealant Performance*
    - Justin Schenkel - *Testing Protocol, Data Storage and Recalibration for Pavement-ME Design*
    - Dave Smith - *Effective Bridge Deck Weather Warning Technologies*
  - **People's Choice:**
    - Michele Mueller - *Utilizing Video Analytics with Connected Vehicles for Improved Safety*
  - **RAd Champion:**
    - Steve Kahl - *Influence of Revising CFCC Guaranteed Strength on Performance of CFCC Prestressed Highway Bridge Beams Subjected to Various Environmental Conditions*
  - **AASHTO High Value Research:**
    - Matthew Beatty - *Repair of Bridge Deck Fascias*
    - Jason Firman - *Evaluating Safety and Traffic Improvements Along Michigan's First Flex Route*

TABLE 1 - 80% FEDERALLY FUNDED

Job No.	FY 2024 Expenditures	Expenditures to Date	Total Budget	Project Manager	Agency	Principal Investigator	Title	Start Date	End Date	Page No.
128602	$110,909.25	$832,544.80	$1,167,711.17	Kahl, Steve	LTU	Grace	Statewide Overall Carbon Fiber Composite Cable Bridge Monitoring	12/17/2013	9/30/2025	11
132231	$23,445.17	$489,804.04	$528,322.24	Qu, Yige	MSU	Cregg	Slope Restoration on Urban Freeways	4/1/2017	12/31/2025	13
208773	$2,068.49	$295,015.05	$359,310.57	Grabarkiewicz, Jeff	MSU	Roloff	Eastern Massasauga (Sisturus catenatus) Road Ecology and Population Dynamics in Michigan	11/25/2019	2/29/2024	15
209437	$59,107.26	$306,973.51	$492,314.72	Hoffmeyer, Mary	CTC & Associates	Casey	Research Administration Section Planning and Communications	10/1/2020	9/30/2025	17
211053	$64,161.13	$440,290.51	$442,505.15	Zwolinski, Andrew	UM	Kerkez	Electronic Water Level Sensors for Monitoring Scour Critical Structures	4/1/2021	6/30/2024	19
211056	$83,796.07	$327,080.62	$359,823.08	Mueller, Michele	Kimley-Horne	Good	Utilizing Video Analytics w/Connected Vehicles for Improved Safety	2/15/2021	1/31/2024	21
211058	$48,596.59	$351,167.11	$351,167.11	Smith, Dave	MSU	Gates	Effective Bridge Deck Weather Warning Technologies	2/15/2021	12/31/2023	23
211061	$55,563.55	$567,657.03	$713,839.88	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	5/31/2025	25
211063	$10,410.73	$245,202.67	$246,705.08	Miller, Nathan	WSP	Wendling	Corridor and Systemwide Application of Performance Based Practical Design	2/1/2021	1/31/2024	27
213122	$122,792.88	$258,988.78	$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	9/30/2025	28
*213313	-$605.00	$187,514.11	$190,866.05	Eacker, Michael	LTU	Bandara	Establish Policies and Procedures for Use of Subgrade Stabilization in Michigan	10/1/2021	9/30/2023	31
213316	$177,380.47	$506,411.65	$596,462.57	Carlson, Erik	MTU	Watkins	Michigan Hydrologic Calculation Procedures	11/1/2021	12/31/2024	33
213318	$215,329.75	$354,589.50	$509,167.20	Snook, Ryan	UM	Hryciw	Michigan Cone Penetrometer Test Calibration	1/1/2022	9/30/2026	36
213321	$48,664.05	$215,436.66	$269,685.92	Pakala, Parush	WMU	Attanayake	Operational Baseline for the 2nd Avenue Network Arch Bridge	1/1/2022	11/30/2024	38
217331	$127,245.69	$132,229.67	$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	8/31/2024	40
217419	$157,303.21	$236,531.42	$380,430.69	Tempinson, Don	WMU	Attanayake	Capacity Prediction of Repaired and Unrepaired Bridge Beams with Deteriorated Ends	10/1/2022	9/30/2024	41
217421	$48,933.13	$195,114.46	$195,114.46	Bowerman, Glenda	CRAFT	Ketterl	Construction Digital Delivery Technology Scan	12/9/2022	6/30/2024	42
217455	$16,799.34	$175,665.00	$175,665.00	Davis, Kelly	WSU	Eamon	Enhanced Bridge Cost Estimating	10/26/2022	1/30/2024	44
217934	$91,814.62	$103,416.57	$255,632.95	Uzcategui, Alonso	MSU	Gates	Efficacy of Speed Warning Technologies	1/23/2023	2/15/2025	46
217937	$110,483.82	$154,020.16	$196,250.61	Roath, James	MSU	Zockaie	Winter Severity Index with Winter Maintenance Expenses and Material Usage	2/6/2023	2/6/2025	47
218359	$89,854.75	$89,854.75	$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	49

Job No.	FY 2024 Expenditures	Expenditures to Date	Total Budget	Project Manager	Agency	Principal Investigator	Title	Start Date	End Date	Page No.
218361	$150,909.47	$204,625.24	$230,389.86	Sevigny, Diane	Hatch	Bodarya	MDOT Fleet Electrification Strategies	6/21/2023	2/28/2025	50
218362	$104,167.84	$144,898.70	$177,614.99	Smerdon, Tim	WMU	Van Houten	Examination of Lighting Practices at Crosswalks	4/24/2023	1/31/2025	52
218364	$103,004.93	$175,396.93	$416,541.31	Hoffman, Sarah Krom, Ben	WMU	Oh	Evaluation of MDOT's Methodology for Estimating Work Zone User Delay Times	5/3/2023	2/28/2026	53
218367	$67,776.86	$114,723.86	$359,434.06	Halloran, Mike	HDR	Longfield	Improving MDOT’s Movable Bridge Reliability and Operations	3/17/2023	5/30/2025	54
218391	$43,394.27	$43,394.27	$356,884.59	Martin, John	MSU	Savolainen	Socio Economic Impacts of Technology Based Stakeholder Engagement Platforms	8/21/2023	8/21/2026	56
218392	$133,151.14	$214,404.20	$214,404.20	Smith, Linn	C&S	Trendowski	Multimodal Aircraft Charging Station Deployment	4/3/2023	8/31/2024	58
218394	$35,171.66	$35,171.66	$415,990.45	Kahl, Steve	LTU	Grace	Design Guidance Development for Continuous Prestressed CFCC Strand Beams	10/1/2024	9/30/2026	60
218396	$179,614.81	$184,808.61	$308,350.01	Firman, Jason	MSU	Savolainen	Identify Best Locations for New Flex-Route Projects Throughout the State of Michigan	6/14/2023	6/14/2025	62
**218397	$0.00	$0.00	$459,886.00	Gorman, Joseph	KPMG	To Be Determined	Revenue Opportunities from MDOT Fiber Infrastructure and Other Utility Types	To Be Determined	To Be Determined	64
218398	$170,546.07	$211,734.57	$458,047.93	Schenkel, Justin	MSU	Haider	Pavement ME Rehabilitation Design Protocols for MDOT Implementation	7/13/2023	7/13/2025	65
218401	$65,337.48	$116,283.71	$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	68
218402	$53,094.40	$53,094.40	$160,069.82	Adams, Kelsey	TX A&M	Glover	Bonding vs. Pay-Go	10/30/2023	2/28/2025	69
218403	$57,163.40	$57,163.40	$301,903.93	Kent, Ellen	CRAFT	Ketterl	Marketing and Education Budget for Implementation of New Transit Technology	11/27/2023	8/31/2025	70
218404	$101,724.60	$109,848.21	$211,977.94	Brink, Steve Miller, Dawn	MSU	Gates	Optimizing Work Zone Conditions to Maximize Safety and Mobility	6/27/2023	6/27/2025	72
219527	$200,084.95	$200,084.95	$717,907.42	Smith, Linn	WSP	Wheeler	Unmanned Aircraft System Communications Mesh Test Deployment	1/9/2024	6/30/2025	73
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	75
219734	$55,219.70	$55,219.70	$257,066.97	Case, Michael	Spy Pond Partners	Robert	Multi-Objective Decision Analysis and Optimization Model for Transportation Investment Decision-Making at MDOT	1/30/2024	1/30/2026	76
**219736	$0.00	$0.00	$367,367.00	Douglas, Scott	To Be Determined	To Be Determined	Digital Process Methods and Implementations for Field Applications	To Be Determined	To Be Determined	78
219771	$0.00	$0.00	$176,540.77	Armour, Jacob	WMU	Attanayake	Enhance Bridge Image Attribution Through Automated Post Image Processing	9/1/2024	2/28/2026	79
220847	$5,503.82	$5,503.82	$292,358.15	Bramble, Mary	MSU	Gates	Safety Effectiveness of Non-Freeway Sinusoidal Shoulder Corrugations	4/24/2024	4/24/2026	80
220848	$9,664.92	$9,664.92	$315,200.83	McQuiston, Carissa	MSU	Savolainen	Covid and Traffic Crashes/Impact on Safety Targets	6/17/2024	7/17/2026	81
	$3,224,585.27	**$8,426,529.22**	**$14,648,028.23**	**TOTAL 80% FEDERALLY FUNDED PROJECTS**						

*Project was not in the annual program but a payment or adjustment was made in FY 2024. Negative numbers indicate a credit.
**Project start was delayed from FY 2024 into FY 2025.

TABLE 2 - 100% FEDERALLY FUNDED PROJECTS

Project No.	FY 2024 Expenditures	Expenditures to Date	Total Budget	Agency	Project Manager	Title	Start Date	End Date	Page No.
219547	$16,150.43	$16,150.43	$88,090.00	MSU	Renner, Lindsey	Michigan (One Point) Cone Test Evaluation - University Transportation Center (UTC)	12/17/2013	9/30/2025	83
219737	$18,455.97	$18,455.97	$96,799.99	MSU	Arnold, Luke	Digital Collaboration using Industry Foundation Classes (IFC) and Building Information Model (BIM) Technology – UTC	6/3/2024	6/3/2025	85
219864	$27,399.95	$27,399.95	$176,667.80	UM	Mueller, Michele	Effectiveness of Inductive Vehicle Charging to Alleviate EV Range Anxiety - UTC	3/1/2024	2/28/2026	87
220837	$0.00	$0.00	$137,600.00	MSU	Byrum, Chris	Finite Element Method (FEM) Matrix Study for Rapid Travel Profiler Curl/Wrap Correlations - UTC	8/1/2024	8/31/2025	89
221109	$37,233.79	$37,233.79	$126,504.00	UM	Bayus, Richard Dell, James	Research and Development of a 3-Item Transportation Security Index Mobility Measurement Tool - UTC	5/22/2024	6/5/2025	91
221177	$47,197.35	$47,197.35	$199,999.99	UM	Seeger, William	Automatic Signal Retiming Using Vehicular Trajectory Data - UTC	5/22/2024	5/22/2025	93
221183	$26,853.01	$26,853.01	$124,849.33	UM	Maffeo, Robert	End-to-End Learning Framework for Transportation Network Equilibrium Modeling - UTC	5/28/2024	10/25/2026	95
221872	$0.00	$0.00	$246,946.60	To Be Determined	Zweng, Harold	Flood Fragility of Roads and Railroads - UTC	To Be Determined	To Be Determined	97
*Sol. 1562	$0.00	$0.00	$0.00	South Dakota DOT	Roath, James	Development of a Winter Maintenance Decision Support System (Phase 3)	1/2/2022	9/30/2025	98
SPR1801(179)	$180,000.00	$180,000.00	$180,000.00	AASHTO/ FHWA	Clover, Andre	AASHTO Engineering Technical Service Programs	10/1/2023	9/30/2024	99
TPF-5(255)	$0.00	$100,000.00	$100,000.00	FHWA	Dawe, Garrett	Highway Safety Manual Implementation	11/9/2015	12/31/2025	100
TPF-5(317)	$0.00	$90,000.00	$90,000.00	FHWA	Dawe, Garrett	Evaluation of Low-Cost Safety Improvements	10/1/2019	9/30/2024	103
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	105
TPF-5(347)	$60,000.00	$230,000.00	$260,000.00	South Dakota DOT	Roath, James	Development of Maintenance Decision Support System	10/1/2016	9/30/2025	110
TPF-5(375)	$0.00	$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	113
TPF-5(424)	$1,492,511.00	$1,492,511.00	$1,500,000.00	FHWA	Clover, Andre	National Cooperative Highway Research Program (NCHRP) for FY 2024	10/1/2023	9/30/2024	115

Project No.	FY 2024 Expenditures	Expenditures to Date	Total Budget	Agency	Project Manager	Title	Start Date	End Date	Page No.
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	1/31/2025	116
TPF-5(435)	$25,000.00	$125,000.00	$125,000.00	Iowa DOT	Roath, James	Aurora Program (FY20-FY24)	10/1/2019	9/30/2026	118
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	8/31/2025	122
TPF-5(437)	$12,000.00	$60,000.00	$60,000.00	Iowa DOT	Byrum, Chris	Technology Transfer Concrete Consortium (FY20-FY24)	10/1/2019	12/31/2025	125
TPF-5(438)	$25,000.00	$125,000.00	$125,000.00	Iowa DOT	Brookes, Chris	Smart Work Zone Deployment Initiative	10/1/2019	12/31/2027	127
TPF-5(441)	$10,000.00	$50,000.00	$50,000.00	Colorado DOT	Pratt, Matt	No Boundaries Transportation Maintenance Innovations	10/1/2019	12/30/2025	130
TPF-5(444)	$10,000.00	$50,000.00	$50,000.00	Montana DOT	Powell, Linda	Traffic Safety Culture - Phase 2	10/1/2019	9/30/2024	132
TPF-5(446)	$0.00	$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	134
TPF-5(447)	$20,000.00	$80,000.00	$100,000.00	FHWA	Dawe, Garrett	Traffic Control Device (TCD) Consortium (3)	1/1/2021	2/12/2025	136
TPF-5(453)	$50,000.00	$200,000.00	$250,000.00	Ohio DOT	Feldpausch, Elise	Automated Vehicle Pooled Fund Study	10/1/2020	9/30/2025	138
TPF-5(460)	$55,600.00	$166,800.00	$222,400.00	South Dakota DOT	Carlson, Erik	Flood-Frequency Analysis in the Midwest: Addressing Potential Nonstationary Annual Peak-Flow Records	10/1/2021	9/30/2025	140
TPF-5(465)	$10,000.00	$20,000.00	$30,000.00	Alabama DOT	Miller, Michelle	Consortium for Asphalt Pavement Research and Implementation (CAPRI)	10/1/2022	12/31/2027	142
TPF-5(466)	$150,000.00	$500,000.00	$750,000.00	Minnesota DOT	Kennedy, Kevin	National Road Research Alliance - NRRA (Phase-II)	10/1/2020	1/31/2026	144
TPF-5(468)	$10,000.00	$50,000.00	$50,000.00	FHWA	Wagner, Brad	Structural Behavior of Ultra-High-Performance Concrete	2/1/2021	12/31/2025	146
TPF-5(479)	$25,000.00	$75,000.00	$125,000.00	Minnesota DOT	Feddars, Carl	Clear Roads Winter Highway Operations Pooled Fund (Phase III)	5/1/2022	9/30/2026	148
TPF-5(480)	$30,000.00	$120,000.00	$150,000.00	Iowa DOT	Arnold, Luke	Building Information Modeling (BIM) for Infrastructure	7/1/2021	12/31/2027	153
TPF-5(486)	$50,000.00	$110,000.00	$210,000.00	Indiana DOT	Curtis, Rebecca	Center for the Aging Infrastructure: Steel Bridge Research, Inspection, Training and Education Engineering Center - SBRITE (Continuation)	10/1/2021	9/30/2026	155
TPF-5(487)	$25,000.00	$50,000.00	$125,000.00	FHWA	Peplinski, Suzette	Transportation Management Centers Pooled Fund Study Phase II	4/17/2022	4/16/2027	157

Project No.	FY 2024 Expenditures	Expenditures to Date	Total Budget	Agency	Project Manager	Title	Start Date	End Date	Page No.
TPF-5(489)	$25,000.00	$75,000.00	$100,000.00	FHWA	Gill, Sarah	Safety Service Patrol Standardization and Management Practices	10/1/2021	9/30/2025	159
TPF-5(490)	$35,000.00	$105,000.00	$175,000.00	MDOT	Spinks, Marlon	Evaluating New Technologies for Roads Program Initiatives in Safety and Efficiency (ENTERPRISE) - Phase III	10/25/2022	10/21/2028	161
TPF-5(501)	$65,000.00	$130,000.00	$195,000.00	Washington DOT	Torres, Carlos	Roadside Safety Pooled Fund – Phase 3	1/1/2023	12/31/2027	163
TPF-5(508)	$50,000.00	$100,000.00	$200,000.00	Texas DOT	Wagner, Brad	Concrete Bridge Engineering Institute (CBEI)	10/1/2022	9/30/2026	165
TPF-5(514)	$30,000.00	$30,000.00	$90,000.00	Indiana DOT	Brookes, Chris	Work Zone Analytics	10/1/2023	9/30/2026	167
TPF-5(515)	$15,000.00	$15,000.00	$75,000.00	FHWA	Dawe, Garrett	Evaluation of Low-Cost Safety Improvements	10/1/2023	9/30/2028	169
TPF-5(516)	$16,000.00	$32,000.00	$80,000.00	FHWA	Garcia, Daniel	Highway Safety Manual Implementation (HSM2) 2nd Edition	10/1/2022	9/30/2027	170
TPF-5(517)	$40,000.00	$40,000.00	$100,000.00	Iowa DOT	Bahmer, Ethan	Sustainable Performance Engineered Concrete	10/1/2022	12/31/2029	171
TPF-5(518)	$55,000.00	$55,000.00	$220,000.00	Virginia DOT	Shapter, Paul	Implementation of Structural Data from Traffic Speed Deflection Devices (Continuation)	10/1/2023	9/30/2027	173
TPF-5(522)	$50,000.00	$50,000.00	$200,000.00	Minnesota DOT	Hunt, Tyler	National Partnership to Improve the Quality of Preventive Maintenance Treatment Construction & Data Collection Practices (PG Phase III)	10/1/2023	12/31/2029	175
TPF-5(523)	$25,000.00	$25,000.00	$100,000.00	Iowa DOT	Wagner, Brad	Building Information Modeling (BIM) for Bridges and Structures – Phase II	12/1/2023	1/31/2029	177
TPF-5(525)	$10,000.00	$10,000.00	$10,000.00	Florida DOT	Schuster, Kristin	2nd International Roadside Safety Conference and Peer Exchange	10/1/2023	9/30/2024	179
TPF-5(530)	$231,412.00	$231,412.00	$231,412.00	AASHTO/ FHWA	Clover, Andre	TRB Core Program Activities FFY 2024 (TRB FY 2025)	10/1/2023	9/30/2024	180
TPF-5(532)	$30,000.00	$30,000.00	$150,000.00	MDOT	Feldpausch, Elise	Mid-America Association of State Transportation Officials Connected Automated Vehicle - Steering Committee	6/3/2024	9/30/2028	181
	$3,090,813.50	**$5,726,013.50**	**$8,426,269.71**	**TOTAL 100% FEDERALLY FUNDED PROJECTS**					

*Solicitation was canceled.

80% FEDERALLY FUNDED PROJECTS

Sequentially Listed by Job Number

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2024

PROJECT TITLE: Statewide Overall Carbon Fiber Composite Cable Bridge Monitoring

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

PROJECT MANAGER: Kahl, Steve

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	Grace, Nabil		

BUDGET STATUS

FY 2024 Budget		Total Budget	
Vendor Budget FY 2024	$125,188.37	Total Vendor Budget	$1,166,711.17
MDOT Budget FY 2024	$1,000.00	Total MDOT Budget	$1,000.00
Vendor FY 2024 Expenditures	$110,909.25	Total Budget	$1,167,711.17
MDOT FY 2024 Expenditures	$0.00	Total Expenditures	$832,544.80
		Total Amount Available	$335,166.37

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 previously constructed bridges will provide information on 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 later corrected. The system then worked properly for both bridges and the readings conformed to the theoretical calculations. At the close of the Fiscal Year (FY), work continued connecting the M-102 bridge to the website and made 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 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 the current inventory of bridges continues. The I-75 SB over Sexton Kilfoil Drain construction was completed, and load tests were performed. This bridge was added to the overall monitoring contract, and monitoring activities will continue until project completion, expected in 2020.

FISCAL YEAR 2018 ACCOMPLISHMENTS

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

Data was reported to the Research Advisory Panel (RAP) with meetings for the other research project (OR14-024), 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 continued 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. The 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 ACCOMPLISHMENTS

During the last fiscal year (2024), 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 research team continues to download the data and perform the necessary analysis and watch for any faulty readings. The team is working closely with the subcontractor to assess the readings from the sensors and address any maintenance issues. The research team is also working on the final report that summarizes the monitoring data.
The decision to repair the hardware components of Bridge-St-Bridge is still pending MDOT review and availability of funds.

FISCAL YEAR 2025 PROPOSED ACTIVITIES

The research team will continue monitoring instrumented bridges on M-39, M-50, M-102, Bridge Street (pending approval of maintenance and repairs) 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 2025 and anticipate 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 in 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.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2024

PROJECT TITLE: Slope Restoration on Urban Freeways

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

PROJECT MANAGER: Qu, Yige

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	Cregg, Bert		

BUDGET STATUS

FY 2024 Budget		Total Budget	
Vendor Budget FY 2024	$25,564.93	Total Vendor Budget	$476,941.06
MDOT Budget FY 2024	$8,590.00	Total MDOT Budget	$51,381.18
Vendor FY 2024 Expenditures	$23,445.17	Total Budget	$528,322.24
MDOT FY 2024 Expenditures	$0.00	Total Expenditures	$489,804.04
		Total Amount Available	$38,518.20

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:

1. Analyze existing research regarding erosion control, restoration, and maintenance on steep slopes adjacent to freeways.
2. Identify field research plot location(s) in the I-696 corridor.
3. Provide MDOT with research work plan.
4. Partner with MDOT and vendor installation contractor to provide oversight on installation.
5. Perform subsequent maintenance of research plots.
6. Collect data.
7. Review and analyze data collected to determine best practices and cost-benefit ratios.
8. Identify best practices for site preparation.
9. 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
10. 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 construction 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 at 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 GREEEN, 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 improved 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 highlights 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, like 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 the establishment of urban highway plantings. Urban Forestry & Urban Greening, 75, 127688) based on plant growth and soil 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 ACCOMPLISHMENTS

Performed regular data downloads and maintenance on weather stations. Analyzed plant cover data across all plots. Removed weed barriers and applied pre-emergence herbicide. Provided project updates to the MDOT team.

FISCAL YEAR 2025 PROPOSED ACTIVITIES

Conduct regular weather data downloads and data analysis.

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 addition to the scope is 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.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2024

PROJECT TITLE: Eastern Massasauga (Sistrurus Catenatus) Road Ecology and Population Dynamics in Michigan

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

PROJECT MANAGER: Grabarkiewicz, Jeff

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	Roloff, Gary		

BUDGET STATUS

FY 2024 Budget		Total Budget	
Vendor Budget FY 2024	$0.00	Total Vendor Budget	$358,958.81
MDOT Budget FY 2024	$7,558.00	Total MDOT Budget	$351.76
Vendor FY 2024 Expenditures	$2,068.49	Total Budget	$359,310.57
MDOT FY 2024 Expenditures	$0.00	Total Expenditures	$295,015.05
		Total Amount Available	$64,295.52

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 ACCOMPLISHMENTS

- Multiple report drafts were submitted and reviewed by research advisory committee members. Two internal meetings were held to consolidate advisory committee member comments. One meeting was held with MSU over Teams to review and discuss comments.
- A final report was submitted and accepted in 2024. All close-out activities were completed.
- One manuscript was submitted for publication to the Wildlife Society Bulletin on 9/21/24.
- A second manuscript is in preparation for a different piece of the research.

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)

The implementation phase of this project is broken down to two parts. The first part is integrating new information into MDOTs internal strategies to protect EMR during maintenance and construction activities. The MDOT Threatened and Endangered Species team has been working on a new programmatic agreement (PA) with FHWA, FWS, and MDOT for 17 federal species; EMR is a component of this agreement. The PA will incorporate the research results which will likely, and substantially, change our mowing regime statewide. There is also discussion about how this research will affect our construction project review and best management practices for the species.

The second part is developing a protocol that can be used by transportation agencies to determine if EMR is present on a project site. This element is more complicated because any survey protocol for a federal species must be created by the regulatory agency. While MDOT can provide a draft approach to a survey protocol this second part of the implementation requires additional approvals and interaction with an external regulatory agency.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2024

PROJECT TITLE: Research Administration Section Planning and Communications

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

PROJECT MANAGER: Hoffmeyer, Mary

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	Casey, Patrick		

BUDGET STATUS

FY 2024 Budget		Total Budget	
Vendor Budget FY 2024	$98,462.94	Total Vendor Budget	$492,314.72
MDOT Budget FY 2024	$0.00	Total MDOT Budget	$0.00
Vendor FY 2024 Expenditures	$59,107.26	Total Budget	$492,314.72
MDOT FY 2024 Expenditures	$0.00	Total Expenditures	$306,973.51
		Total Amount Available	$185,341.21

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

	Budget	Expenditures by Fiscal Year			
		FY 2021	FY 2022	FY 2023	FY 2024
SPR-II	$492,314.72	$129,481.84	$ 71,705.16	$ 46,679.25	$ 59,107.26
Additional State Funds	$ 33,074.14	$ 0.00	$ 2,200.76	$ 779.93	$ 7,492.97
Total	**$525,388.86**	**$129,481.84**	**$ 73,905.92**	**$ 47,459.18**	**$ 66,600.23**

PURPOSE AND SCOPE

MDOT works diligently to deliver innovative research projects that improve operations and services. Research Administration (RAd) works to effectively communicate these research findings clearly and in platforms for wider public reach. This project works with RAd 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 RAd'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 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 highlights MDOT's collaboration with other states on research projects. Developed 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 ACCOMPLISHMENTS

Completed the At-A-Glance report summary of funding statistics and project progress for FY 2023. Developed a new series of publications that focus on successful implementation of research findings; the first completed Implementation Publication covered *SPR-1692: Effectiveness of Green Strobes on Winter Maintenance*. Provided technical editing assistance to MDOT's Transportation Systems Management and Operations (TSMO) on a report for the State of Michigan Senate and House of Representatives entitled *Assessment of Agricultural Byproducts (ABPs) in Direct Liquid Application (DLA) for Road Maintenance*. This report addresses Michigan Public Act 310 of 2020, mandating the MDOT to conduct a pilot study to evaluate the effectiveness of ABPs used in DLA for winter plow routes in the state with the intention of identifying best practices for winter road maintenance with less environmental impact than traditional rock salt application, as well as less corrosive damage to road surfaces. Completed spotlight newsletters including, but not limited to, ***SPR-1705****: Evaluating New Technologies for Roads Program Initiatives in Safety and Efficiency (ENTERPRISE) PHASE II*, ***SPR-1723****: Testing Protocol, Data Storage, and Recalibration for Pavement-ME Design*, ***SPR-1726****: Eastern Massasauga Rattlesnake (Sistrurus catenatus) Detection and Space Use Near Roads in the Southern Lower Peninsula of Michigan*, ***SPR-1728****: Evaluation of Bridge Deck Winter Weather Warning Systems*, ***SPR-1730****: Repair of Bridge Deck Fascias*, ***SPR-1733****: Establish Policies and Procedures for Use of Subgrade Stabilization in Michigan*, ***SPR-1734****: Effective Pedestrian/Nonmotorized Crossing Enhancements Along Higher-Speed Corridors,* ***SPR-1736****: Corridor and Systemwide Application of Performance-Based Practical Design*, and ***SPR-1738****: Utilizing Video Analytics with Connected Vehicles for Improved Safety*. Updated the promotional video with commentary from a new Project Manager (PM) on the benefits of research. The video is intended to highlight the roles of RAd's PMs that lead innovative research efforts and promote participation in the Research Program Development Cycle to build RAd's fiscal year program. Developed communication distribution strategies for spotlight newsletters and videos.

FISCAL YEAR 2025 PROPOSED ACTIVITIES

Expect completion of additional research and implementation spotlight newsletters, production of additional video spotlights, continued development of distribution strategies for communicating innovative research findings and continue providing technical/editing writing services. CTC will also 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 MDOT PM 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.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2024

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)	6/30/2024
RESEARCH AGENCY	University of Michigan (UM)		
PRINCIPAL INVESTIGATOR	Kerkez, Branko		

BUDGET STATUS

FY 2024 Budget		Total Budget	
Vendor Budget FY 2024	$66,375.77	Total Vendor Budget	$442,505.15
MDOT Budget FY 2024	$16,800.00	Total MDOT Budget	$0.00
Vendor FY 2024 Expenditures	$64,161.13	Total Budget	$442,505.15
MDOT FY 2024 Expenditures	$0.00	Total Expenditures	$440,290.51
*15% of contract costs incurred are on hold pending receipt of deliverables.		**Total Amount Available**	$2,214.64

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, modifications will be performed 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 for sensor installation 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 the 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 ACCOMPLISHMENTS

The no-cost time extension allowed the team to maintain the system into fall of 2024 allowing MDOT to closely monitor scour critical bridges around the state, in the Regions, and in Transportation Service Centers (TSC). This project was submitted to the 2024 Information Technology Call for Projects (IT CFP) to create an internal dashboard for continued monitoring of these structures. Available resources did not allow this project to move forward with the IT process. It did however provide a view of what a dashboard could appear as and what would be required to develop and maintain one. The research team provided

alternate options for continued monitoring after the project is complete. Each region was provided with the resources for purchase to continue remotely monitoring scour critical bridges.

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)

Currently, implementation of the dashboard is limited due to the resource limitations in the IT CFP. The project scored the highest ever, but there were no remaining resources to implement a dashboard. When a bridge asset and condition dashboard is potentially created in the future, it is expected that the sensors or a version of them will be able to be utilized along with similarities in the interface. Sensors were shown to withstand the Michigan elements with limited issues. It is expected when these would go into service that this research will provide the framework for mounting, repair, and replacement.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2024

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 2024 Budget		***Total Budget**	
Vendor Budget FY 2024	$119,016.88	Total Vendor Budget	$349,662.20
MDOT Budget FY 2024	$91,868.12	Total MDOT Budget	$10,160.88
Vendor FY 2024 Expenditures	$83,796.07	Total Budget	$359,823.08
MDOT FY 2024 Expenditures	$0.00	Total Expenditures	$327,080.62
		Total Amount Available	$32,742.46

* Strategic Highway Research Program (SHRP2) funding - $25,000.00

FY 2021	FY 2022	FY 2023	FY 2024	Total
$0.00	$3,220.34	$19,344.12	$0.00	$22,546.46

TOTAL PROJECT EXPENDITURES: $349,645.08

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 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; 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 vendors to implement their system at those locations. Began initial analysis of the data and performance.

FISCAL YEAR 2024 ACCOMPLISHMENTS

The pilot demonstration was deployed and completed. Data was collected and validated upon the completion of the pilot demonstration. The results were documented, and a draft Analytic Report and Research report were submitted to MDOT and the RAP board. The reports were revised and submitted to MDOT. Follow-up meetings were scheduled and facilitated with the participating vendors to debrief them on the research results.

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)
The recommendation by the research team is to conduct additional research and utilize the implementation toolbox provided for further video analytics deployments. The implementation toolbox outlines 7 steps for a successful project which include: 1. Define goals and objectives 2. Schedule milestones 3. Allocate resources 4. Designate team responsibilities 5. Define metrics of success 6. Define how to adapt 7. Evaluate success.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2024

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	Gates, Tim		

BUDGET STATUS

FY 2024 Budget		Total Budget	
Vendor Budget FY 2024	$0.00	Total Vendor Budget	$351,167.11
MDOT Budget FY 2024	$4,000.00	Total MDOT Budget	$0.00
Vendor FY 2024 Expenditures	$48,596.59	Total Budget	$351,167.11
MDOT FY 2024 Expenditures	$0.00	Total Expenditures	$351,167.11
		Total Amount Available	$0.00

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 reducing the number of these types of crashes.

FISCAL YEAR 2021 ACCOMPLISHMENTS

- Worked to determine guidelines for weather related DMS and 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 percent 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 ACCOMPLISHMENTS

The draft project report was submitted for review. An accessibility review was done and MDOT provided comments at the final RAP meeting held on November 30, 2023. The report was revised based on comments received, alt-text was provided for all tables and figures, and the final report was submitted in Word and searchable PDF formats, along with the completed spotlight template.

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

A no cost time extension was granted in FY 2023 to allow more time for winter data collection activities that were delayed due to weather. This also provided additional time for data analysis, guidance development, and review of the final project report.

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

The Implementation Action Plan in section 7.3 of the final project report outlines recommendations, split into near-term and long-term action items to guide MDOT with implementation.

- Near-Term Action Items (i.e., within the first year):
  - o For all existing flashing LED border BDWS sign installations, if an auto-dimming sensor is not available, calibrate the LED brightness to achieve optimal brightness during daylight conditions.
  - o Continue to post winter weather warning messages on existing full-sized DMS located around the state, particularly those positioned near bridges. DMS messaging for winter driving conditions should use “SLIPPERY ROAD CONDITIONS / REDUCE SPEEDS” on a single frame.
- Long-Term Action Items (i.e., within four years):
  - o Implement future BDWS with MUTCD W8-13 sign that includes either a flashing LED border, dual top flashing amber beacons, or single top flashing beacons on both sides of the road (for freeways or other divided highways). Other types of signs may be implemented at MDOT’s discretion.
  - o If a flashing LED border is to be used for the BDWS, the LEDs should:
    - Be durable enough to withstand snow from passing plows and
    - Include an auto-dimming sensor to ensure that optimal brightness is achieved during both day and night. If such a sensor is not available, then the LED brightness should be set to achieve optimal brightness during daylight conditions.
  - o For all existing BDWS sign installations on a freeway or divided highway that are only installed on one side of the roadway and only include a single flashing top beacon, implement either:
    - Dual top flashing amber beacons or
    - Add a second BDWS on the other side of the roadway, directly across from the existing BDWS sign.
  - o For all existing or future BDWS, to improve driver response, consider adding a radar-activated dynamic speed feedback sign (DSFS) panel beneath the BDWS signoras a standalone BDWS treatment beneath standard W8-13 warning signs.
  - o Perform a detailed engineering study to determine suitability for implementation of future BDWS at candidate locations, considering factors that include traffic volume, structure length, frequency of winter-season precipitation, horizontal curvature, type of intersecting feature, geographic region, and presence of existing ESS systems near the bridge. Complete details of 100 candidate bridge locations along the trunkline NHS network are provided within Appendix B of the final project report.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2024

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 (Extension)	5/31/2025
RESEARCH AGENCY	Michigan State University (MSU)			
PRINCIPAL INVESTIGATOR	Kutay, M. Emin			

BUDGET STATUS

FY 2024 Budget			Total Budget	
Vendor Budget FY 2024	$128,189.74		Total Vendor Budget	$671,221.53
MDOT Budget FY 2024	$22,859.55		Total MDOT Budget	$42,618.35
Vendor FY 2024 Expenditures	$49,446.78		Total Budget	$713,839.88
MDOT FY 2024 Expenditures	$6,116.77		Total Expenditures	$567,657.03
			Total Amount Available	$146,182.85

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 a 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 out 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 were 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 began. 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 was 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 the 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 ACCOMPLISHMENTS

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 ACCOMPLISHMENTS

Service life modeling of the various pavement rehabilitation and reconstruction fix types using IRI, faulting, and rutting was completed. Transition matrices were developed to facilitate network modeling of IRI, % cracking, rutting, and faulting. This will allow for the prediction of future condition of the MDOT network, based on these metrics, which is required by federal rules every four years. Drafts of the final report for all tasks except the network modeling were delivered and reviewed by MDOT.

FISCAL YEAR 2025 PROPOSED ACTIVITIES

For FY 2025, the research team will be working on the new tasks set forth in the 2024 contract extension.

- Pavement metric (IRI, % cracking, etc.) deterioration models for various pavement types.
- Quantification of the improvements in condition due to different fix types.
- Literature search results on what other states are using utility scoring and their methodology for setting the values.
- Quantification of the ranges of pavement metric values at the time of construction for various fix types.

A tool will be developed that allows MDOT to calculate the above information at the statewide or region levels, with the ability to combine fix types into fix categories. This will allow MDOT to tailor the inputs in the Project Identification Tool for the level of analysis desired by the user.

Lastly, two final reports will be delivered. One report will cover the work tasks under the original contract. The second report will cover the separate set of tasks under contract extension.

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. A 12-month extension that added additional tasks and $45,832.57 in cost was granted in June 2024. The tasks for the extension will provide key input values MDOT can use within the Project Identification Tool (PIT) when it goes live. PIT is a new IT application being developed for MDOT to help with identification of the most cost beneficial pavement projects.

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

Project expected completion FY 2025.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2024

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, Matt D.		

BUDGET STATUS

FY 2024 Budget		Total Budget	
Vendor Budget FY 2024	$0.00	Total Vendor Budget	$246,705.08
MDOT Budget FY 2024	$23,040.00	Total MDOT Budget	$0.00
Vendor FY 2024 Expenditures	$10,410.73	Total Budget	$246,705.08
MDOT FY 2024 Expenditures	$0.00	Total Expenditures	$245,202.67
		Total Amount Available	$1,502.41

PURPOSE AND SCOPE

Performance Based Practical Design (PBPD) represents a change in mindset from traditional design techniques that mainly focus on meeting specific standards. PBPD places an emphasis on planning-level corridors 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 for 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 Research Advisory Panel (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 topics of discussion both internally and with the research team on how to implement.

FISCAL YEAR 2024 ACCOMPLISHMENTS

The summary of findings project report was finalized and submitted. Work on implementation has begun.

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)

Revised Road Design Manual drafts are circulating with stakeholder groups. Working with JobNet production teams on revising the Job Objective field to support Performance-Based Practical Design initiatives.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2024

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: Kahl, Steve

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)	9/30/2025
RESEARCH AGENCY	Lawrence Technological University (LTU)		
PRINCIPAL INVESTIGATOR	Grace, Nabil		

BUDGET STATUS

*FY 2024 Budget		Total Budget	
Vendor Budget FY 2024	$164,011.30	Total Vendor Budget	$481,165.90
MDOT Budget FY 2024	$3,333.33	Total MDOT Budget	$3,333.33
Vendor FY 2024 Expenditures	$122,792.88	Total Budget	$484,499.23
MDOT FY 2024 Expenditures	$0.00	Total Expenditures	$258,988.78
		Total Amount Available	$225,510.45

*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
2024	$32,040.72	$24,649.04	$51,988.56	$42,507.84

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 ACTIVITIES

During fiscal year 2024, the research team worked on Tasks 2, 5, 6, 8, 9 and 10 of the research project.
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. Creep specimens from 2013 were released due to bending of the steel anchors of one of the strands, which resulted in shifting of the steel spring and the end plate.
Task 5: Fire Testing: The research team has resumed the fire testing and continued to evaluate the performance of AASHTO beam segments prestressed with 0.7 in. CFCC strands under fire event according to ASTM E119. The research team completed the fire testing segments and is currently comparing the test results to the control specimens. The research team also evaluated the residual flexural resistance of one segment after it was exposed to fire/loading scenario for one hour
Task 6: Freeze-thaw test: Testing resumed, and the freeze-thaw specimens underwent 300 cycles, after which they were removed from the environmental chamber and were tested under a three-point-loading setup to evaluate the residual bond strength and flexural capacity. In addition, the research team is preparing three additional freeze-thaw specimens prestressed with steel strands to go for 300 freeze-thaw cycles. The new group of specimens will serve as a bench mark for the CFCC prestressed specimens.
Task 7: Full-scale precast beams: The research team completed the testing of AASHTO I beams including one beam prestressed with stainless steel strands. The team shared the test results with MDOT engineers
Task 8: Design concepts: The research team continues to gather 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
Task 9: Products and implementation: The research team is in contact with MDOT engineers to discuss the test results and their impact on the design of CFCC prestressed beams in upcoming bridge projects.
Task 10: Reporting: The research team continued to report on the development of the test program and working on a draft report for findings of the research project

FISCAL YEAR 2025 PROPOSED ACTIVITIES

The research team will continue to work on different research items according to the proposed work schedule. During the next quarter, it is expected that the research team will work on Tasks 2, 5, 6, 8, 9 and 10 and will continue to share and discuss the test results with MDOT Engineers.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))
A time extension was necessary due to the breakdown and repair of freeze thaw chamber. Lead time for parts necessitated a time extension such that complete cycles could be ran to the full 300 cycles.
SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)
Project expected completion FY 2025.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2024

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)	3/07/2024
RESEARCH AGENCY	Lawrence Technological University (LTU)		
PRINCIPAL INVESTIGATOR	Bandara, Nishanta		

BUDGET STATUS

FY 2024 Budget		Total Budget	
Vendor Budget FY 2024	$0.00	Total Vendor Budget	$164,918.18
MDOT Budget FY 2024	$0.00	Total MDOT Budget	$25,947.87
Vendor FY 2024 Expenditures	$0.00	Total Budget	$190,866.05
MDOT FY 2024 Expenditures	-$605.00	Total Expenditures	$187,514.11
		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.

FISCAL YEAR 2024 ACCOMPLISHMENTS

The initial contract end date was in FY 2023 and the final project report was received and all deliverables were approved by MDOT in March 2024. There was also an adjustment to correct MDOT employee time records for FY 2023 that resulted in a $605.00 credit reported in FY 2024. All project accounting has now been finalized and the correct total costs are as reported above.

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

An initial contract revision was approved during FY 2022 to correct the vendor's Indirect Cost Rate. In early FY 2023, the project end date was extended to allow additional time for refining guidance documents, specifications, and pavement design inputs. MDOT also approved a budget shift in university labor costs to move unused supply, travel, and student assistant costs to cover additional work by primary researchers.

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

Recommended pavement design inputs are available for immediate adoption and use. Guidance documents and a newly developed special provision will be provided to region personnel for use in selecting and administering future projects, utilizing subgrade stabilization.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2024

PROJECT TITLE: Michigan Hydrologic Calculation Procedures

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

PROJECT MANAGER: Carlson, Erik

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)	6/30/2025
RESEARCH AGENCY	Michigan Technological University (MTU)		
PRINCIPAL INVESTIGATOR	Watkins, David W.		

BUDGET STATUS

FY 2024 Budget		Total Budget	
Vendor Budget FY 2024	$188,607.00	Total Vendor Budget	$556,935.71
MDOT Budget FY 2024	$23,000.00	Total MDOT Budget	$39,526.86
Vendor FY 2024 Expenditures	$154,380.47	Total Budget	$596,462.57
MDOT FY 2024 Expenditures	$23,000.00	Total Expenditures	$506,411.65
		Total Amount Available	$90,050.92

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 ungagged 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.

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.

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. 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 ungagged 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 ACCOMPLISHMENTS

The following activities were completed.

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. 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. Determined potential precipitation climate zones.
    c. Performed a comparison analysis for multiple sites against statistical gauge data.
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. Conducted a parametric data analysis using gage data on new identified parameters to find the parameters of statistical significance.
    c. Tested the regression equation to evaluate meaningful variables within the equations.
5. Task 5: Investigated alternative hydrologic techniques to calculate recurrence interval peak discharges at ungagged sites will explore the following techniques:
    a. Rain on grid
        i. Performed literature search.
        ii. Investigated potential watersheds.
        iii. Noted that this topic was an NCHRP synthesis topic which has spawned into a full NCHRP research project.
    b. Non-stationarity
        i. Evaluated FHWA’s CMIP tool for two locations within the state (Ann Arbor and Houghton).

FISCAL YEAR 2025 PROPOSED ACTIVITIES

The following activities are proposed.

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.
    f. Develop guidance documents for EGLE and MDOT.
    g. Provide training to EGLE and MDOT staff.
3. Task 3: Is essentially complete with support being provided to MDOT and EGLE staff.
    a. Continue to work with MDOT and EGLE staff with any performance issues with the tools.
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. Compare outcomes for the regression equations for watersheds under 20 sq. miles against outcomes from SCS and statistical gauge analysis.
    b. Provide recommendations on the maximum drainage area thresholds for the SCS method and minimum drainage area thresholds for the regression analysis.
    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.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2024

PROJECT TITLE: Michigan Cone Penetrometer Test Calibration

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

PROJECT MANAGER: Snook, Ryan

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)	9/30/2026
RESEARCH AGENCY	University of Michigan (UM)		
PRINCIPAL INVESTIGATOR	Hryciw, Roman / Garcia, Estefan		

BUDGET STATUS

FY 2024 Budget		Total Budget	
Vendor Budget FY 2024	$223,922.36	Total Vendor Budget	$503,426.52
MDOT Budget FY 2024	$4,800.00	Total MDOT Budget	$5,740.68
Vendor FY 2024 Expenditures	$214,731.12	Total Budget	$509,167.20
MDOT FY 2024 Expenditures	$598.63	Total Expenditures	$354,589.50
		Total Amount Available	$154,577.70

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.

- 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 ACCOMPLISHMENTS

- Finished developing a software tool to characterize soil type. This tool provides information on soil behavior type, yield stress, and other CPT parameters. It will provide an important visual of CPT test results that will aid in foundation design.
- Completed a procedure for identifying organic soils in Michigan by comparing how soils identified as organics within the MDOT dataset compare with existing correlations for organic soil types.
- Developed guidance for identifying organic soil layers and estimating unit weights based on CPT data.
- Developed a screening tool for identifying organics using statistical sensitivity and specificity to quantify the rate of false positives, false negative, true positives, and true negatives.

FISCAL YEAR 2025 PROPOSED ACTIVITIES

- Research Report Summarizing the outcomes from Phase I including: literature search survey summary, dataset summary, data correlations, and recommendations on how to apply published correlations to Michigan soils.
- Develop a MDOT CPT procedures manual for bridge foundation design application
- Develop a Data forensics / DIGGS data system.

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

Additional data was provided to U of M in January 2024, which took more time to incorporate into the analysis.

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

Project expected completion FY 2026.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2024

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

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

PROJECT MANAGER: Pakala, Purush

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)	12/31/2025
RESEARCH AGENCY	Western Michigan University (WMU)		
PRINCIPAL INVESTIGATOR	Attanayake, Upul B.		

BUDGET STATUS

FY 2024 Budget		Total Budget	
Vendor Budget FY 2024	$95,244.82	Total Vendor Budget	$258,887.71
MDOT Budget FY 2024	$4,620.00	Total MDOT Budget	$10,798.21
Vendor FY 2024 Expenditures	$45,615.56	Total Budget	$269,685.92
MDOT FY 2024 Expenditures	$3,048.49	Total Expenditures	$215,436.66
		Total Amount Available	$54,249.26

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 a 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 were 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 operating 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.

- 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 ACCOMPLISHMENTS

- Evaluate the performance of instrumentation: This is an ongoing process to collect data from instruments and WMU is regularly collecting data from the instruments.
- Collect data from instruments as well as evaluate seasonal trends in the data: WMU has been collecting data for 2 years. Bridge construction was completed in late summer of 2023 and declared open on 10/27/23. Due to this, 2 years of data from the completed bridge is not available. With the data collected, strain plots are updated every 3 days to review and identify any trends in data. Data collected from completed bridge to date is inadequate to evaluate seasonal trends.
- Conduct load testing to establish an operational baseline for the structure: Load testing was conducted on 7th August 2024.
- 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: Detailed LARSA model was developed to represent the as-built geometry. Stresses from the output of this model were used to compare it against the results from the Engineer of Record (EOR) and other models. Further, load configurations for load testing were developed using this model.
- Develop a long-term data acquisition plan and transfer responsibility and training to MDOT for long-term monitoring of the structure: This is an ongoing task. A draft training manual was developed but requires including output enveloped to develop guidelines for long-term monitoring and managing the structure. PI is working with MDOT PM to get a project extension till 12/31/2025.

FISCAL YEAR 2025 PROPOSED ACTIVITIES

*A contract revision will be requested to extend time for data collection and analysis and increase the scope by including an additional task for developing a web dashboard.

- Collect data from instruments and provide quarterly updates to MDOT.
- Store and evaluate seasonal trends in data.
- 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.
- Identify output envelopes from the measured data within which the structure can be maintained.
- Develop a long-term data acquisition plan and transfer responsibility and training to MDOT for long-term monitoring of the structure
- Web dashboard development

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

A no cost time extension was approved in FY 2024 because additional time was necessary for data analysis of bridge monitoring data to complete tasks 5, 7, 8, and 9 related to refining the element model and developing the data acquisition plan.

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

*Project expected completion FY 2026.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2024

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.	2023-0106	PROJECT START DATE	6/21/2023
PROJECT NO.	217331NI	COMPLETION DATE (Original)	5/31/2024
OR NO.	OR22-006	COMPLETION DATE (Revised)	8/31/2024
RESEARCH AGENCY	University of Colorado (UC Denver) – Formerly University of Michigan (UM)		
PRINCIPAL INVESTIGATOR	Misra, Aditi		

BUDGET STATUS

FY 2024 Budget		Total Budget	
Vendor Budget FY 2024	$165,898.36	Total Vendor Budget	$170,882.34
MDOT Budget FY 2024	$0.00	Total MDOT Budget	$0.00
Vendor FY 2024 Expenditures	$127,245.69	Total Budget	$170,882.34
MDOT FY 2024 Expenditures	$0.00	Total Expenditures	$132,229.67
		Total Amount Available	$38,652.67

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

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

FISCAL YEAR 2024 ACCOMPLISHMENTS

Accomplishments include collecting and analyzing Strava data for the study years and assessing and refining the different models the research team felt were the best fit for subsequent research project tasks. Once models were selected, frameworks and methodologies were developed. The project report was drafted, comments were incorporated, and the final report was submitted.

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 the remaining contract balance and establish a new contract with UC-Denver to complete remaining tasks/deliverables. The original contract end date with UC Denver was extended from 5/31/24 to 8/31/24 due to unforeseen delays at project start with contracting. The UC Denver research team updated data analysis to include summer 2022 data and were involved in several discussions with Streetlight to obtain additional data. This extension also provided time for the research team to finalize the project report resulting in higher quality deliverables for MDOT.

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

The research project set out to assess if crowdsourced data could be used as a surrogate for, or supplement to, actual data for people walking or bicycling; or to develop adjustment factors sufficient to extrapolate and apply to other areas of the state. The research findings note that crowdsourced data wasn't sufficient for these purposes with the few and largely dispersed actual counts across the state. Take aways from the research indicate that for crowdsourced data to be useful, more actual counts are needed. Moving forward, efforts will be made to work with the necessary MDOT staff to collect more data and partner with external partners for the collection, storage and analysis of the collected data.

Michigan Department
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5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2024

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

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

PROJECT MANAGER: Tempinson, Don

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)	4/30/2025
RESEARCH AGENCY	Western Michigan University (WMU)		
PRINCIPAL INVESTIGATOR	Attanayake, Upul B.		

BUDGET STATUS

FY 2024 Budget		Total Budget	
Vendor Budget FY 2024	$218,356.17	Total Vendor Budget	$355,930.69
MDOT Budget FY 2024	$25,400.00	Total MDOT Budget	$24,500.00
Vendor FY 2024 Expenditures	$157,303.21	Total Budget	$380,430.69
MDOT FY 2024 Expenditures	$0.00	Total Expenditures	$236,531.42
		Total Amount Available	$143,899.27

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 ACCOMPLISHMENTS

- Additional data was collected for further analysis.
- End deterioration and repair types were identified from photos and documents received.
- Developed and distributed surveys to determine MDOT experiences and policies regarding beam ends.
- Multiple visits were made to bridges with deterioration and repairs to collect field data.
- Conducted further review and refinement of end capacity calculation methods.

FISCAL YEAR 2025 PROPOSED ACTIVITES

- Complete final site visits to collect data on concrete beam repair conditions.
- Conduct laboratory testing of steel beam repair samples with pack rust.
- Receive and review final sets of survey results.
- Create final documents and submittals.

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

During FY 2024, a time extension was required to give WMU more time to obtain field data during construction season and analyze it. During the project, it was found there weren't any field samples available for testing where pack rust is a concern. WMU will have to create samples and trigger pack rust to adequately determine the deterioration's effect on capacity. This was not included in the original scope of work and included a small increase in cost.

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

Project expected completion FY 2025.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2024

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, Mona		

BUDGET STATUS

FY 2024 Budget		Total Budget	
Vendor Budget FY 2024	$48,933.13	Total Vendor Budget	$195,114.46
MDOT Budget FY 2024	$24,500.00	Total MDOT Budget	$0.00
Vendor FY 2024 Expenditures	$48,933.13	Total Budget	$195,114.46
MDOT FY 2024 Expenditures	$0.00	Total Expenditures	$195,114.46
		Total Amount Available	$0.00

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 the project did not begin this FY.

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.

- 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 ACCOMPLISHMENTS

Finished the stakeholder engagement meetings.
Developed, reviewed and submitted the final research report.
Presented the research report to the research advisory panel and to several others who participated in the research.
Presentations were given at I-Heep regarding the results of this research.

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)

Several implementation recommendations were made regarding Policies and Processes, Tools and Technology, People and Skills and Data and Standards. There is a diverse group of MDOT staff that are currently working on forming a committee to address several of these needs including requesting funding for construction survey equipment.

Michigan Department
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5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2024

PROJECT TITLE: Enhanced Bridge Cost Estimating

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

PROJECT MANAGER: Davis, Kelly

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	Eamon, Chris		

BUDGET STATUS

FY 2024 Budget		Total Budget	
Vendor Budget FY 2024	$16,799.34	Total Vendor Budget	$175,665.00
MDOT Budget FY 2024	$16,800.00	Total MDOT Budget	$0.00
Vendor FY 2024 Expenditures	$16,799.34	Total Budget	$175,665.00
MDOT FY 2024 Expenditures	$0.00	Total Expenditures	$175,665.00
		Total Amount Available	$0.00

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 for the coming year's pay item prices and appropriately handle 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 costs. 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 type of work 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 ACCOMPLISHMENTS

- Finalized the interactive computer-based worksheet. This allows the user to input data and generate rehabilitation or replacement scenarios.
- Provided a guidance document for performing annual updates to the cost estimation spreadsheet and instructions for use.
- Provided final report and documents

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)

The cost estimation spreadsheet developed during this project was evaluated by MDOT staff and modified based on suggestions to further meet MDOTs needs. It is expected to be released in January or February 2025. The guidance document from the research team is being updated to allow a better understanding of use. Minimal training is expected with this tool as the updated format is like the previous bridge cost estimate spreadsheets. MDOT Big Bridge Management and Scoping Engineer is available to answer questions regarding use of the cost estimate spreadsheet.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2024

PROJECT TITLE: Efficacy of Speed Warning Technologies

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

PROJECT MANAGER: Uzcategui, Alonso

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	Gates, Timothy J.		

BUDGET STATUS

FY 2024 Budget		Total Budget	
Vendor Budget FY 2024	$126,912.64	Total Vendor Budget	$234,139.79
MDOT Budget FY 2024	$21,493.16	Total MDOT Budget	$21,493.16
Vendor FY 2024 Expenditures	$91,814.62	Total Budget	$255,632.95
MDOT FY 2024 Expenditures	$0.00	Total Expenditures	$103,416.57
		Total Amount Available	$152,216.38

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 ACCOMPLISHMENTS

Continued data collection and began writing project reports and recommendations. Also continued task 4 and began tasks 5 through 8, along with starting to draft the final project report.

FISCAL YEAR 2025 PROPOSED ACTIVITES

Complete data collection and complete the final report and recommendations.

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

A time extension is in progress to allow suitable weather for the university to complete collection and analysis of data for remaining location sites.

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

Project expected completion FY 2025.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2024

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

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

PROJECT MANAGER: Roath, James

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)	7/5/2025
RESEARCH AGENCY	Michigan State University (MSU)		
PRINCIPAL INVESTIGATOR	Zockaie, Ali		

BUDGET STATUS

FY 2024 Budget		Total Budget	
Vendor Budget FY 2024	$136,464.27	Total Vendor Budget	$190,000.61
MDOT Budget FY 2024	$30,000.00	Total MDOT Budget	$6,250.00
Vendor FY 2024 Expenditures	$110,553.79	Total Budget	$196,250.61
MDOT FY 2024 Expenditures	$0.00	Total Expenditures	$154,090.13
		Total Amount Available	$42,160.48

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 ACCOMPLISHMENTS

- 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.
- Started 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.

FISCAL YEAR 2025 PROPOSED ACTIVITES

- Completing 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.
- Pilot Phase for modified WSI Validation and Verification
- Final Recommendation for WSI Improvements
- Develop and Deliver Draft and Final Reports

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.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2024

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: Ahlschwede, Carla

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	Dobson, Richard		

BUDGET STATUS

FY 2024 Budget		Total Budget	
Vendor Budget FY 2024	$181,525.86	Total Vendor Budget	$212,451.62
MDOT Budget FY 2024	$5,416.67	Total MDOT Budget	$10,000.00
Vendor FY 2024 Expenditures	$89,854.75	Total Budget	$222,451.62
MDOT FY 2024 Expenditures	$0.00	Total Expenditures	$89,854.75
*Project start was delayed		**Total Amount Available**	$132,596.87

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 ACCOMPLISHMENTS

Conducted and completed most field work. The literature review was completed and submitted. Presented preliminary field results at the September quarterly meeting.

FISCAL YEAR 2025 PROPOSED ACTIVITES

Continue field work for data collection and analysis (tasks 5 and 6) and begin reporting findings (task 7).

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.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2024

PROJECT TITLE: MDOT Fleet Electrification Strategies

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

PROJECT MANAGER: Sevigny, Diane

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	Bodarya, Mihir		

BUDGET STATUS

FY 2024 Budget		Total Budget	
Vendor Budget FY 2024	$121,608.22	Total Vendor Budget	$226,889.86
MDOT Budget FY 2024	$11,581.82	Total MDOT Budget	$3,500.00
Vendor FY 2024 Expenditures	$150,909.47	Total Budget	$230,389.86
MDOT FY 2024 Expenditures	$0.00	Total Expenditures	$204,625.24
		Total Amount Available	$25,764.62

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 electric and alternative fuels 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 of 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 ACCOMPLISHMENTS

The research team completed all necessary data gathering, developed minimum MDOT operating requirements for categorical fleet units, completed an analysis of available zero-emission equipment currently available in the industry that meets MDOT's minimum operating requirements, and performed additional research on transition planning initiatives by other state DOTs and municipalities. The feasibility analysis got underway. The researcher also began work to document and finalize findings. This project is ahead of schedule.

FISCAL YEAR 2025 PROPOSED ACTIVITES
Complete feasibility analysis and cost/benefit determination for categorical zero emission fleet conversion candidates. Complete the final report and submit all research project deliverables to MDOT by the project completion 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 expected completion FY 2025.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2024

PROJECT TITLE: Examination of Lighting Practices at Crosswalks

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

PROJECT MANAGER: Smerdon, Tim

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	Van Houten, Ron		

BUDGET STATUS

FY 2024 Budget		Total Budget	
Vendor Budget FY 2024	$111,662.81	Total Vendor Budget	$170,638.15
MDOT Budget FY 2024	$9,600.00	Total MDOT Budget	$6,976.84
Vendor FY 2024 Expenditures	$104,167.84	Total Budget	$177,614.99
MDOT FY 2024 Expenditures	$0.00	Total Expenditures	$144,898.70
		Total Amount Available	$32,716.29

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 ACCOMPLISHMENTS

Two progress meetings were held (fall/winter of 2023 and spring 2024). The research team completed tasks 2 and 3 (determine whether crashes during lighted conditions occur during said conditions) and began work on tasks 4 and 5 (prepare technical report and strategic plan). Field observations, testing, and data collection also occurred in the Spring/Summer. Data collection for unlighted conditions is nearly complete. Progress has been made in determining whether bright LED lighting at crash sites was installed before or after the crash. Data has been added from Ann Arbor, Detroit, Warren, Royal Oak, and Southfield. We have before and after lighting data for I8 crosswalks at two locations. Tapco, one of the vendors of smart lighting, has agreed to send us a system of four smart lights and movable posts, which can be moved between crosswalks. We have received the units and will be able to obtain data at two of the Rectangular Rapid-Flashing Beacon (RRFB) sites we have been working with. Sufficient data will be available early next fiscal year.

FISCAL YEAR 2025 PROPOSED ACTIVITES

Review, comment and edit the final deliverables.

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

The contract has not been revised; however, MDOT did approve a shift in budgeted funds from equipment to student hours for data collection. (The city of Kalamazoo purchased the Smart Lighting Systems equipment that was included in the project budget.) This change will not alter the overall project budget and will result in better deliverables for MDOT.

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

Expected project completion FY 2025.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2024

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: Krom, Ben / Hoffman, Sarah

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	Oh, Jun-Seok		

BUDGET STATUS

FY 2024 Budget		Total Budget	
Vendor Budget FY 2024	$126,372.77	Total Vendor Budget	$347,947.58
MDOT Budget FY 2024	$52,941.18	Total MDOT Budget	$68,593.73
Vendor FY 2024 Expenditures	$96,175.91	Total Budget	$416,541.31
MDOT FY 2024 Expenditures	$6,829.02	Total Expenditures	$175,396.93
		Total Amount Available	$241,144.38

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 ACCOMPLISHMENTS

The WMU research team concluded the work zone survey, conducted one focus group meeting with a select group of survey participants and gathered their feedback on the needs for a software tool. One Research Advisory Panel (RAP) meeting occurred in November 2023, where the results of the survey and focus group were presented and discussed. Working with MDOT, work zone data collection activities were completed. Their analysis of various work zone scenarios using several existing software tools was also substantially completed, with an upcoming RAP meeting scheduled to discuss the results.

FISCAL YEAR 2025 PROPOSED ACTIVITES

The WMU research team plans on completing the analysis of the various work zone scenarios using several software tools and will present the results to MDOT in early FY 2025. Next, summarizing those results in an interim report, they will make recommendations on how to proceed. Based on MDOT's review, the Research Advisory Panel will decide on whether the project continues with Phase 2 (developing a tool to meet MDOT's business needs) or end. If this research project continues with Phase 2, WMU will begin development of the new work zone evaluation tool.

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.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2024

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

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

PROJECT MANAGER: Halloran, Mike

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)	5/30/2025
RESEARCH AGENCY	HDR Michigan, Inc.		
PRINCIPAL INVESTIGATOR	Longfield, Matt		

BUDGET STATUS

FY 2024 Budget		Total Budget	
Vendor Budget FY 2024	$221,006.77	Total Vendor Budget	$349,434.06
MDOT Budget FY 2024	$10,000.00	Total MDOT Budget	$10,000.00
Vendor FY 2024 Expenditures	$67,776.86	Total Budget	$359,434.06
MDOT FY 2024 Expenditures	$0.00	Total Expenditures	$114,723.86
		Total Amount Available	$244,710.20

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, distributed them to several bridge owners throughout the nation, and began reviewing survey results. A literature review was also completed along with developing a list of questions for MDOT staff and vendors to use in troubleshooting bridges.

FISCAL YEAR 2023 PROPOSED ACTIVITES

Interviews with MDOT staff and vendors were scheduled and held to help the research team understand 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 also identify vulnerabilities in the network, make recommendations to MDOT, and update existing maintenance procedures and recommendations. The initial draft of the final report will also be developed.

FISCAL YEAR 2024 ACCOMPLISHMENTS

The research team continued reviewing survey responses and results were synthesized for their applicability in Michigan. Several MDOT staff as well as others involved in operating, troubleshooting, and repairing the movable bridges were interviewed and the results synthesized. The team researched previously identified topics such as remote monitoring, I/O link protocol, and operator training, as well as information on limit switches. They have also been reviewing previous malfunctions at bridges and looking at protocols for dealing with them, including detour route activation.

FISCAL YEAR 2025 PROPOSED ACTIVITES

Complete tasks 003 to 007. The draft and final report will be completed and submitted along with a presentation of findings. Implementation plan will be developed.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))
A no cost time extension of one year was granted in FY 2024 because the contract start was delayed and MDOT found challenges in providing MiBridge data to the vendor. Survey responses also took more time than expected and additional time was incorporated to allow for an adequate review of data to be incorporated into final deliverables.
SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)
Expected project completion FY 2025.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2024

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

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

PROJECT MANAGER: Martin, John

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	Savolainen, Peter T.		

BUDGET STATUS

FY 2024 Budget		Total Budget	
Vendor Budget FY 2024	$163,194.82	Total Vendor Budget	$353,967.92
MDOT Budget FY 2024	$1,666.67	Total MDOT Budget	$2,916.67
Vendor FY 2024 Expenditures	$43,394.27	Total Budget	$356,884.59
MDOT FY 2024 Expenditures	$0.00	Total Expenditures	$43,394.27
		Total Amount Available	$313,490.32

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 inequality? 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 ACCOMPLISHMENTS

- 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.

FISCAL YEAR 2025 PROPOSED ACTIVITES

- Attend additional community engagement events (continued)
- Send out target and random survey cards w/ incentives to selected bodies across the regions
- Develop and deploy a survey on other virtual and digital platforms to increase the sample size
- Utilize virtual and digital survey formats to bolster technique / response ratio
- Begin assessment of technique / response ratio
- Preliminary report table contents
- Preliminary assessments across study for additional points of contact

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.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2024

PROJECT TITLE:	Multimodal Airport Charging Station Deployment – Phase I			
FUNDING SOURCE:	☒ SPR, Part II ☐ OTHER (*PLEASE EXPLAIN)*			
PROJECT MANAGER:	Smith, Linn			
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	Trendowski, John			

BUDGET STATUS

FY 2024 Budget			Total Budget	
Vendor Budget FY 2024	$133,151.14		Total Vendor Budget	$214,404.20
MDOT Budget FY 2024	$7,433.68		Total MDOT Budget	$0.00
Vendor FY 2024 Expenditures	$133,151.14		Total Budget	$214,404.20
MDOT FY 2024 Expenditures	$0.00		Total Expenditures	$214,404.20
			Total Amount Available	$0.00

PURPOSE AND SCOPE

Newly emerging aircraft 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 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 an opportunity for the Research Advisory Panel (RAP) and C&S Engineers research team to:
  - Made introductions
  - Reviewed the research plan, deliverables, and timeline for activities
  - Established communication protocols
  - Clarified team roles/responsibilities
  - Confirmed 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)
  - Established communication protocols
  - 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 with 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
  - Reviewed the Airport Layout Plan (ALP)

- A detailed electrical analysis
- An infrastructure analysis
- Discussed 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.

FISCAL YEAR 2024 ACCOMPLISHMENTS

- 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 with a memo documenting the findings.
  - Discussed and agreed upon 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.
- On December 12, 2023, C&S provided a summary of the airport site visits they conducted between October and November.
  - The evaluations accounted for electrical capacity, redundancy, environmental justice, economic impact, equity analysis, and other factors that may affect a multimodal charging station.
  - Prepared a scoring matrix for selection and recommended airport(s) for the multi-modal facility.
- January 24, 2024, C&S and MDOT completed a review of airport locations identified.
  - The Lansing Capital Region International Airport (LAN) was selected, and a meeting was held with LAN representatives.
- May 13, 2024, C&S provided a preliminary design, cost estimate, and draft report for MDOT review.
- August 8, 2024, C&S met with MDOT and discussed final comments for the final report.
- August 30, 2024, C&S submitted the 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)

With the results of this research project MDOT Aeronautics has been able to leverage funding ($2.6 million) for a larger scale deployment of electric charging stations that will not only include (LAN), but also Cherry Capital Airport (TVC), West Michigan Regional Airport (BIV) and Willow Run Airport (YIP). As of October 2024, a notice to proceed was given to BETA Technologies to perform the installation. With the installation of these electric charging stations MDOT is create a foundational intrastate charging network to support operations of next generation aircrafts and drive down costs for regional transportation operators.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2024

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

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

PROJECT MANAGER: Kahl, Steve

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

BUDGET STATUS

*FY 2024 Budget		Total Budget	
Vendor Budget FY 2024	$147,059.34	Total Vendor Budget	$399,990.45
MDOT Budget FY 2024	$8,000.00	Total MDOT Budget	$16,000.00
Vendor FY 2024 Expenditures	$35,171.66	Total Budget	$415,990.45
MDOT FY 2024 Expenditures	$0.00	Total Expenditures	$35,171.66
* Project start was delayed		**Total Amount Available**	$380,818.79

This project includes $83,750.00 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**
2024	$27,800.00	$9,279.05	$9,279.05	$74,470.95

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 ACCOMPLISHMENTS

For the 2024 fiscal year, the research team worked on Tasks # 2, 3, 4, 8 and 10.

Task # 2: Draped CFCC Testing: The research team completed the building of the steel frames to evaluate the strength and prestress loss of CFCC strands with different draping angles. The team is also designing multiple beams with straight and draped strands to evaluate the proposed continuity techniques. The first round of draped strand testing with 4” dimeter rollers was completed for different angles of draping. The team will continue the
testing using different diameter rollers and different draping angles.

Task # 3: Post-tensioned CFCC Strands: The research team is evaluating different methods to apply post-tensioning in the field without the need for large conduits and large anchorage devices. The team is evaluating new anchor grout materials that are readily available and do not require special heat curing. In addition, the team is evaluating different types of conduit grouts to be applied after post-tensioning. The intension of grouting the conduit is to create a load transfer mechanism independent of the anchorage device, thereby minimizing the possibility of anchor failure. The team successfully post-tensioned a deck slab using sleeve anchorage that was attached to the strands in on-site simulation and the conduits were grouted with ultra-high-performance concrete in select locations. After grout curing, the anchorage devices were released, and the force transfer took place through the grout only.

Task # 4: Pretensioned bulb T Beams for Flexure: The research team completed the construction of a two-span 50-ft-long bulb T beam that is pretensioned with straight strands and support a deck slab that is post-tensioned over the intermediate support. The team completed the construction of the slab and is currently conducting a load test over the two spans.

Task # 8: Analysis and Design Concepts: The research team performed preliminary analysis aiming at establishing the general design procedure for continuous beams prestressed with CFCC strands. The procedure of the analysis will involve both flexural and shear design.

Task # 10: The team continues to report and share the test results with MDOT engineers.

FISCAL YEAR 2025 PROPOSED ACTIVITES

The research team will continue to work on different research items according to the proposed work schedule. During the next Fiscal year, it is expected that the research team will work on Tasks 2, 3, 4, 8 and 10. Progress meetings each quarter to update 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 2026.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2024

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: Firman, Jason

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	Savolainen, Peter T.		

BUDGET STATUS

FY 2024 Budget		Total Budget	
Vendor Budget FY 2024	$204,520.39	Total Vendor Budget	$300,000.01
MDOT Budget FY 2024	$16,700.00	Total MDOT Budget	$8,350.00
Vendor FY 2024 Expenditures	$179,614.81	Total Budget	$308,350.01
MDOT FY 2024 Expenditures	$0.00	Total Expenditures	$184,808.61
		Total Amount Available	$123,541.40

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 ACCOMPLISHMENTS

- State DOT Survey - The research team has prepared a summary of the state agency survey, which was presented at a series of regional workshops. Follow-up has been conducted with a small number of non-responding agencies and incomplete responses. The results have been incorporated into the project report.
- Safety Analysis – The team has finished assembling crash data on the corridors that have been identified as candidate locations in consultation with MDOT. These analyses focus on crashes that were congestion-related based upon information form the UD-10 crash report forms.
- Additional Analysis – Preparation for additional analyses began, which will consider potential impacts on the other factors, such as the environment as well as potential cost implications of corridor conversions. MSU has also requested details from MDOT on prior studies conducted based on potential flex routes or related strategies.
- Final Report – The team has begun to work on the draft project report.

FISCAL YEAR 2025 PROPOSED ACTIVITES

Finish analyses, complete draft report for review, and submit the final report and presentation to MDOT.

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.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2024

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

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

PROJECT MANAGER: Gorman, Joe

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

BUDGET STATUS

*FY 2024 Budget		Total Budget	
Vendor Budget FY 2024	$312,000.00	Total Vendor Budget	$449,886.00
MDOT Budget FY 2024	$10,000.00	Total MDOT Budget	$10,000.00
Vendor FY 2024 Expenditures	$0.00	Total Budget	$459,866.00
MDOT FY 2024 Expenditures	$0.00	Total Expenditures	$0.00
* Project start was delayed		**Total Amount Available**	$459,886.00

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 Intelligent Transportation Systems (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

Contracting for this project was delayed pushing the date to begin work into FY 2025.

FISCAL YEAR 2025 PROPOSED ACTIVITES

MDOT anticipates execution and completion of a current state assessment and alternative revenue opportunities assessment for this 6-month project.

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.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2024

PROJECT TITLE: Pavement ME Rehabilitation Design Protocols for MDOT Implementation

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

PROJECT MANAGER: Schenkel, Justin

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	Haider, Sayed Waqar		

BUDGET STATUS

FY 2024 Budget		Total Budget	
Vendor Budget FY 2024	$292,646.35	Total Vendor Budget	$402,903.80
MDOT Budget FY 2024	$49,500.00	Total MDOT Budget	$55,144.13
Vendor FY 2024 Expenditures	$137,598.96	Total Budget	$458,047.93
MDOT FY 2024 Expenditures	$32,947.11	Total Expenditures	$211,734.57
		Total Amount Available	$246,313.36

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 include 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 rubblizing 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 ACCOMPLISHMENTS

The team worked on Tasks 2 through 5 and accomplished the following:

- Comprehensive review of project records in extracting inputs, including cross-section details, average daily traffic (ADT) counts, and a year of construction for the projects sampled/tested in 2023 and 2024.
- Back calculation of layer moduli based on Falling Weight Deflectometer (FWD) deflection data for sampled/tested projects.
    - Reviewed the back calculation methodologies (based on FWD deflections) to estimate the layers moduli of existing flexible and composite pavements.
    - Back calculated layer moduli for flexible and composite pavements using three and four-layered pavement structures for all sampled/tested rehab projects.
    - Back calculated layer moduli using the outer area method for composite pavements.
    - The results were compared and verified with pre-construction back calculated layer moduli for unbound layers to compare moduli (lab vs. field).
- Tested the asphalt pavement field cores to obtain damaged modulus master ($|E^*|_{damaged})_{lab}$ curves for existing layers. The undamaged modulus master curve for the projects was also obtained using PMED v3.0 and the Witczack equation.
    - Comparison of the laboratory-measured damaged modulus master ($|E^*|_{damaged})_{lab}$ curves with the calculated damaged modulus master ($|E^*|_{damaged})_{PMED}$ curve based on back-calculated FWD modulus.
    - Comparison of the undamaged modulus and PMED-predicted damaged modulus master curves at three rehabilitation levels.
    - The laboratory-measured damage modulus for wheel path (WP) and non-wheel path (NWP) cores were compared.
    - Manually calculated damaged modulus master curve using Excel.
    - Compared the laboratory-measured damaged modulus master ($|E^*|_{damaged})_{lab}$ curve with the PMED calculated damaged modulus master ($|E^*|_{damaged})_{PMED}$ curve based on back-calculated FWD moduli values (rehabilitation Level 1).
- Using the triaxial lab test, crushed asphalt base material was characterized to estimate its resilient modulus (M_R).
- Tested the compressive strength of PCC cores from the sampled composite pavements.
- Evaluation of existing unbound base/subbase material ME inputs for rehabilitation design of existing pavements.
- Evaluation of the impact of HMA mechanical properties input levels for HMA overlay over fractured JPCP in Pavement ME.
- Sampled materials (and associated findings) were organized and cataloged.
- Assessed the performance prediction of HMA overlay over HMA pavements using ME rehabilitations Levels 2 and 3.
- HMA overlay over crushed asphalt was analyzed in Pavement ME by modeling the crushed asphalt as a pulverized in place recycled asphalt layer and alternatively, as an unbound aggregate base layer.
- Pavement sections with TSD deflection data were selected and in process of review to assess its use/application for pavement design/analysis.
- Analyzed the responses from the MDOT online survey to better understand existing practices and MDOT expectations for rehab design.

FISCAL YEAR 2025 PROPOSED ACTIVITES

The research team will continue to work on Tasks 3 through 8, to include the following items:

- Provide final recommendations for Pavement ME inputs of crushed asphalt base, ASCRL, and existing unbound base/subbase materials.
- Based on non-destructive testing, compare the performance prediction for laboratory-measured damaged dynamic modulus and PMED-predicted damaged dynamic modulus.
- Recalibration of the PMED performance models for rehabilitation options.
- A detailed TSD data analysis for the selected sections will be conducted to determine:
    - Subgrade modulus variations with project length.
    - Layer modulus (back calculate using Evercalc for asphalt pavements and the area method for concrete and composite pavements).
    - Effective and required structural number, remaining service life, and recommended overlay thickness (based on AASHTO 1993).
    - JPCP load transfer evaluation for JPCP.
- Investigate and analyze the results of the TSD and 3DGPR data to identify additional pavement performance information (e.g., areas of localized distress).
- 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.
- Verify if rehab recalibration is warranted and provide updated calibration if so.
- Work on the design matrix to identify essential variables for potential catalog design using the PMED and compare with AASHTO 1993 designs.
- Compare the outputs of AASHTO 1993 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.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2024

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: Kirkpatrick, Kristi

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	Liu, Hexu		

BUDGET STATUS

FY 2024 Budget		Total Budget	
Vendor Budget FY 2024	$65,338.13	Total Vendor Budget	$116,284.36
MDOT Budget FY 2024	$0.00	Total MDOT Budget	$0.00
Vendor FY 2024 Expenditures	$65,337.48	Total Budget	$116,284.36
MDOT FY 2024 Expenditures	$0.00	Total Expenditures	$116,283.71
		Total Amount Available	$0.65

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 ACCOMPLISHMENTS

Accomplishments include obtaining a fully executed data sharing agreement and successful data collection. From this data, a project and pay item cost index was developed that can take into consideration economic factors based on cost index predictions. Other accomplishments include the development of an index-based estimation method for budget planning purposes while completing a state and regional cost index comparison. An updated tool for cost index calculation and price analysis was created, with new features for MHCCI predictions and new index calculations. The final report was completed and submitted to the Research Advisory Panel (RAP) for review.

FISCAL YEAR 2025 PROPOSED ACTIVITES

Proposed activities include presenting the improved MHCCI tool, findings, and recommendations to the RAP. Review, and revise the final report as needed. Any other work based on feedback from the RAP on the 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.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2024

PROJECT TITLE: Bonding Vs. Pay as You Go

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

PROJECT MANAGER: Adams, Kelsey

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)	7/31/2025
RESEARCH AGENCY	Texas A&M University Transportation Institute (TTI)		
PRINCIPAL INVESTIGATOR	Glover, Brianne		

BUDGET STATUS

FY 2024 Budget		Total Budget	
Vendor Budget FY 2024	$92,563.50	Total Vendor Budget	$160,069.82
MDOT Budget FY 2024	$0.00	Total MDOT Budget	$0.00
Vendor FY 2024 Expenditures	$53,094.40	Total Budget	$160,069.82
MDOT FY 2024 Expenditures	$0.00	Total Expenditures	$53,094.40
		Total Amount Available	$106,975.42

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 ACCOMPLISHMENTS

- TTI conducted a literature review and provided MDOT with a report summarizing their findings in May 2024. The literature review examined: 1) the true cost of bonding; 2) the impacts of inflation on transportation projects; 3) costs related to construction delay; and 4) costs related to increasing user delay.
- As part of the literature review, the team conducted a review of best practices with ten states similar to Michigan that explored: 1) obligations issued or assumed; 2) change in indebtedness; and 3) receipts and disbursements for debt service. Findings were included in the May 2024 report.
- The research team also conducted a deeper dive with Michigan and three peer states (Ohio, Indiana, and Wisconsin) to compare: 1) the amount obligated; 2) interest rates; 3) timing; 4) debt coverage ratios; and 5) revenue versus general obligation bonds.
- TTI is currently working on comparing debt service costs associated with bonding against 1) increased costs related to delayed construction, including additional maintenance and deterioration (review of typical life cycle costs); 2) user delay costs due to increased congestion over time; and 3) increased cost of inflation (sourcing the Michigan Transportation Construction Price Index and the National Highway Construction Cost Index).

FISCAL YEAR 2025 PROPOSD ACTIVITES

- As part of their comparison study on debt service costs, TTI will perform a case analysis to examine increased costs related to delayed construction by 1) selecting three projects (small, medium, and large) that were paid for using bond proceeds; 2) apply a range of delay scenarios that could have occurred due to pay-go funding; and 3) perform calculations that will include the costs of deferred maintenance.
- The research team will complete their analysis of the costs and benefits of the applicable funding mechanism.
- TTI will also submit the draft final report for MDOT review, update the report based on questions/comments from MDOT, and submit the completed final report by the contract end date.

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

There was a change in the MODT Project Manager in the middle of fiscal year 2024. A no-cost-time extension was granted due to delays in the contract award that provides the vendor with the original 21-month project schedule noted in the original project workplan, which provided the time necessary for quality data and analysis that will result in higher quality deliverables for MDOT.

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

Project expected completion FY 2025.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2024

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

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

PROJECT MANAGER: Kent, Ellen

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	Ketterl, Mona		

BUDGET STATUS

*FY 2024 Budget		Total Budget	
Vendor Budget FY 2024	$140,770.60	Total Vendor Budget	$295,618.22
MDOT Budget FY 2024	$5,714.29	Total MDOT Budget	$6,285.71
Vendor FY 2024 Expenditures	$57,238.59	Total Budget	$301,903.93
MDOT FY 2024 Expenditures	$0.00	Total Expenditures	$57,238.59
* Project start was delayed		**Total Amount Available**	$244,665.34

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 a 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 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 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 ACCOMPLISHMENTS

Completed CRAFT project activities for FY24 include:

- Presented on OR23-021 at the Rural Transit Workshop in April 2024. The presentation covered overview of project, preliminary market research, work plan overview, and vision/goals of the project.
- Conducted a literature review of the best practices for budgeting and marketing for public transit. They examined what research exists today, both locally and nationally, to identify top use cases which they could use to evaluate and benchmark. They examined the current state with transit authorities and key barriers to successful adoption, marketing and in consideration of budgeting.
- Conducted workshops between June and July with transit stakeholders to fully investigate current state challenges, opportunities, planning recommendations and validation process for the introduction of new transit technology. Additionally, through the workshops CRAFT was able to develop personas of the agencies (size, location, scope, staffing, budget, current use of tech, etc.), identify the current rider profile, and build persona and user profiles.
- Developed a survey that was distributed through the Office of Passenger Transportation “OPT Weekly” newsletter that is sent out to all transit agencies to identify needs/solutions, transit methods, etc. Received 50 survey responses.
- Presented on OR233-021 at the MPTA Annual Conference in August 2024. Provided sessions on technology, budgeting, and community and partnerships. Also, roundtable discussions were conducted to solicit more formal feedback from rural and urban transit agency stakeholders on challenges with tech adoption.

FISCAL YEAR 2025 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.
- Conduct an in-Person development workshop in February 2025 for MDOT, MBI, and UDM representation, Transit Riders United (Tru), and some selected transit agencies. Potentially ahead of workshops, have transit agencies host webinars on use cases. Day 1 will have vendor demos and a begin solution design with attendees. Day 2 design solution with consultant team facilitating.
- Attend and present project information at the Rural Transit Workshop in April 2025.
- Attend and present project information at the MPTA Annual Conference in August 2025.
- Draft the research report outline and framework for MDOT review. The report will serve as a strategic guidebook/manual which will inform transit agencies on how to successfully implement and deploy transit technology, including budget optimization for marketing and education. CRAFT will update the report based on MDOT feedback and submit the final report to MDOT by the contract 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 expected completion FY 2025.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2024

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

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

PROJECT MANAGER: Brink, Steve / Miller, Dawn

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	Gates, Timothy J.		

BUDGET STATUS

FY 2024 Budget		Total Budget	
Vendor Budget FY 2024	$130,008.72	Total Vendor Budget	$196,477.94
MDOT Budget FY 2024	$15,500.00	Total MDOT Budget	$15,500.00
Vendor FY 2024 Expenditures	$101,724.60	Total Budget	$211,977.94
MDOT FY 2024 Expenditures	$0.00	Total Expenditures	$109,848.21
		Total Amount Available	$102,129.73

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 ACCOMPLISHMENTS

Task 1a: Completed literature review. Research Advisory Panel members and PM's feedback ongoing.
Task 1b: Completed and distributed a survey to other states for best practices for work zone safety and mobility. Compiling responses to provide to MDOT for review.
Task 2: National fatal crash data collected and analyzed and provided for MDOT review, awaiting feedback. Analyzed Michigan work zone data and compared it to FARS database. Analysis written and provided to MDOT for review, awaiting feedback. Selected MDOT work zones for review. Reviewed configurations and work zone data. Completing analysis of safety performance within 25 selected MDOT work zones, performing extensive analysis of each.
Task 3: Collected and continue to analyze work zone driver behavioral and operational data for two 'zipper merge' sites. Collected data with and without law enforcement presence. Data is being analyzed.
Task 4: No work performed in FY 2024
Task 5: No work performed in FY 2024

FISCAL YEAR 2025 PROPOSED ACTIVITES

Task 1a: Finalize synthesis based on feedback.
Task 1b: Finalize data and analysis from other states' agencies. Provide analysis for review then finalize documentation.
Task 2a: Finalize National WZ synthesis based on feedback.
Task 2b: Finalize Michigan WZ synthesis based on feedback.
Task 2c: Complete detailed crash analyses of 25 MDOT work zones and provide report for review; finalize based on comments.
Task 3: Finalize review of driver behavior. Provide driver behavior data for review.
Task 4: Begin and complete findings and cost-effectiveness evaluation.
Task 5: Complete final project report and provide for review. Finalize based on comments.

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.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2024

PROJECT TITLE: Unmanned Aircraft Systems Communications Mesh Test Deployment

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

PROJECT MANAGER: Smith, Linn

CONTRACT/AUTHORIZATION NO.	2023-0679	PROJECT START DATE	1/9/2024
PROJECT NO.	219527	COMPLETION DATE (Original)	6/30/2025
OR NO.	OR24-012	COMPLETION DATE (Revised)	
RESEARCH AGENCY	WSP of Michigan		
PRINCIPAL INVESTIGATOR	Wheeler, Paul		

BUDGET STATUS

*FY 2024 Budget		Total Budget	
Vendor Budget FY 2024	$611,522.06	Total Vendor Budget	$717,907.42
MDOT Budget FY 2024	$0.00	Total MDOT Budget	$0.00
Vendor FY 2024 Expenditures	$200,084.95	Total Budget	$717,907.42
MDOT FY 2024 Expenditures	$0.00	Total Expenditures	$200,084.95
* Project start was delayed		**Total Amount Available**	$517,822.47

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 benefits 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 ACCOMPLISHMENTS

The research team coordinated the needed Right of Way (ROW) licensing with MDOT experimental license from the Federal Communications Commission (FCC), and prepared a waiver for the Federal Aviation Administration (FAA) which will allow drone pilots to deviate from certain rules under part 107 by demonstrating they can still fly safely using alternative methods beyond the visual line of sight (BVLOS). The research team performed an extensive investigation of potential test site locations, analyzing the strengths, weaknesses, opportunities, and threats (SWOT) of each candidate site. Upon selection of the Lansing location near Canal and Ricks Roads they examined flyable paths in the area which included 21 different criteria (i.e., population, zoning, roadways and traffic monitoring, obstructions, railway, bodies of water, etc.). The research team designed, purchased, and fabricated the needed equipment and modifications for flight testing and installed two roadside units for radio performance trials.

FISCAL YEAR 2025 PROPOSED ACTIVITES

Further confirmation testing
Expand RF Performance testing to include altitudes below and above 400’ AGL, evaluate combination vertical/horizontal polarization to expand coverage skyward, COTS collision avoidance capability, COTS authentication, COTS tracking.

Lansing Radio Testing & Development
Select BVLOS CONOP and appropriate platform to perform “real world” job to be done, apply for FAA waiver, Ground equipment installation, Aerial RF Testing, Authentication of RSU and OBU equipment.

Data Analysis Development
Test operations log files have been identified. A criterion for evaluating the effectiveness of the communication network needs to be developed and agreed upon with the client.

Demonstrations
The research team will discuss specifics with MDOT for flight demonstrations based on the Lansing location.

Helicopter Test
Trials and radio performance testing using conventional aircraft and ground vehicles.

Multi-modal Traffic Management Demonstration
- Integrate OBUs with up to 50 UAS aircraft to demonstrate authentication and tracking.
- Operate 1 vehicle BVLOS with continuous connectivity and route planning.
- Deploy OBU on ground, marine and rail platforms for tracking.

Final report
Upon completion of the demonstration, it is anticipated that the final draft report will be submitted 90 days before the contract end date and an updated final report with MDOT feedback by June 30, 2025.

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.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2024

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: Clover, Andre

CONTRACT/AUTHORIZATION NO.	N/A	PROJECT START DATE	10/1/2022
PROJECT NO.	219532NI	COMPLETION DATE (Original)	09/30/2023
OR NO.	OR23-025	COMPLETION DATE (Revised)	
RESEARCH AGENCY	National Academies of Sciences		
PRINCIPAL INVESTIGATOR	Director Brad Wieferich		

BUDGET STATUS

***FY 2024 Budget**		**Total Budget**	
Vendor Budget FY 2024	$0.00	Total Vendor Budget	$25,000.00
MDOT Budget FY 2024	$0.00	Total MDOT Budget	$0.00
Vendor FY 2024 Expenditures	$0.00	Total Budget	$25,000.00
MDOT FY 2024 Expenditures	$0.00	Total Expenditures	$25,000.00
*Project ended FY 2023		**Total Amount Available**	$0.00

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

FISCAL YEAR 2024 PROPOSED ACTIVITES

This TRB forum was included in MDOT's FY 2024 program; however, it ended in FY 2023. The associated membership cost for FY 2023 was paid using FY 2024 funds.

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)

Several resources, publications, and additional information on related projects is available on the TRB Forum website at Forum on Preparing for Automated Vehicles and Shared Mobility Services | National Academies.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2024

PROJECT TITLE: Multi-Objective Decision Analysis and Optimization Model for Transportation Investment Decision-Making at MDOT

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

PROJECT MANAGER: Case, Michael

CONTRACT/AUTHORIZATION NO.	2024-0192	PROJECT START DATE	1/30/2024
PROJECT NO.	219734	COMPLETION DATE (Original)	1/30/2026
OR NO.	OR24-004	COMPLETION DATE (Revised)	
RESEARCH AGENCY	Spy Pond Partners, LLC		
PRINCIPAL INVESTIGATOR	Robert, William		

BUDGET STATUS

FY 2024 Budget		Total Budget	
Vendor Budget FY 2024	$93,460.11	Total Vendor Budget	$249,226.97
MDOT Budget FY 2024	$4,704.00	Total MDOT Budget	$7,840.00
Vendor FY 2024 Expenditures	$49,208.60	Total Budget	$257,066.97
MDOT FY 2024 Expenditures	$6,011.10	Total Expenditures	$55,219.70
		Total Amount Available	$201,847.27

PURPOSE AND SCOPE

Fair and objective resource allocation is key to effective transportation asset management. Despite resource constraints, MDOT must invest in projects that simultaneously improve asset conditions, safety, accessibility, and mobility. To optimize decision-making, it is critical to forecast the short and long-term impacts of these projects on system performance, as well as the trade-offs of deferring investments in other competing areas to a later time. This research project is intended to develop a Multiple Objective Decision Making (MODA) approach and model to advise decision-making for the highway capital program, where available data can be analyzed to prioritize projects by considering multiple agency objectives and trade-offs. Public and private market software that utilize this approach is available and used in a variety of business settings, including by transportation agencies, but vary widely in method. Therefore, it is vital to first understand how these methods differ in their benefits and drawbacks, and how they could improve and integrate with decision-making processes at MDOT. Once a core approach has been established that is consistent with needs and MDOT's mission, a broader decision-making model that addresses the issues outlined above will be developed and tested for potential implementation in the process for prioritizing pavement rehabilitation projects and potentially other asset areas, pending available data and need.

FISCAL YEAR 2024 ACCOMPLISHMENTS

Spy Pond has performed the following activities:

- Project management (Task 1) which included:
  - Attended March 13, 2024, a kickoff meeting with the MDOT Research Advisory Panel (RAP). Meeting activities included the review of projects tasks, schedule, milestones, deliverables, and reporting requirements.
  - Attended update meetings on June 17, 2024, and August 12, 2024, with the MDOT RAP to review progress on project tasks and project timeline.
  - Complete quarterly progress reports for research administration.
- Submitted to MDOT a Technical Memo 1 on best practices/applications of MODA based on research in the field as well as interviews with agencies that have implemented a similar process (Task 2). The memo examined what similarities and differences with the approach between five agencies (Caltrans, North Carolina DOT, Texas DOT, Vermont DOT, and Pennsylvania DOT). including asset types, it applies to, goals and objectives, and analytical approaches. The findings were summarized and compared against MDOT's existing project identification process to identify a recommendation for an initial approach to MODA that will best fit the readiness to apply it.
- Began coordinating MDOT working groups (Task 3) to identify the objectives and goals needed to guide the development of subobjectives and measures for prioritizing MDOT's Transportation Asset Management (TAM) using MODA. The working groups will work to define goals and objectives, select performance measures and evaluate criteria, assess data and analytical capabilities and evaluate existing solutions.

FISCAL YEAR 2025 PROPOSED ACTIVITES

Spy Pond anticipates performing the following activities:

- Project management (Task 1) which included:
  - Attended quarterly update meetings with the MDOT RAP to review progress on project tasks and project timeline.
  - Submit quarterly progress reports for research administration.
- Complete the MDOT working groups (Task 3) to identify the requirements needed to develop an approach for prioritizing MDOT's Transportation Asset Management (TAM) using MODA.
  - Tuesday, October 8, 1-2 (Pavement)
  - Wednesday, October 23, 9-10 (Mobility)

- Thursday, October 24, 11-12 (Safety)

The results of these working groups will be provided in a Technical Memo 2 for MDOT RAP review.

- Using the approach detailed in the previous task a requirements summary for the prototype model will be developed (Task 4) and sample data will be obtained from MDOT for testing. The results of the data used, and the priorities generated through the process will be documented in a “State of Practice” report.
- Begin documentation on a base model (Task 5) that will incorporate the results from the prototyping, extend to the full prioritization process, and include a sensitivity analysis.

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.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2024

PROJECT TITLE: Digital Process Methods and Implementations for Field Applications

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

PROJECT MANAGER: Douglas, Scott

CONTRACT/AUTHORIZATION NO.	To be determined	PROJECT START DATE	To be determined
PROJECT NO.	219736	COMPLETION DATE (Original)	To be determined
OR NO.	OR24-009	COMPLETION DATE (Revised)	
RESEARCH AGENCY	To be determined		
PRINCIPAL INVESTIGATOR	To be determined		

BUDGET STATUS

FY 2024 Budget		Total Budget	
Vendor Budget FY 2024	$298,707.00	Total Vendor Budget	$298,707.00
MDOT Budget FY 2024	$68,660.00	Total MDOT Budget	$68,660.00
Vendor FY 2024 Expenditures	$0.00	Total Budget	$367,367.00
MDOT FY 2024 Expenditures	$0.00	Total Expenditures	$0.00
		Total Amount Available	$367,367.00

PURPOSE AND SCOPE

Static information created by siloed production methods can lead to duplication of effort and lack of connectivity between phases as information is passed between survey, design, construction, and asset management. In addition, not utilizing effective change management strategies to update processes and train staff can slow progress in adoption of new digital processes and approaches. This research will build on previously completed research to investigate and provide actionable methods and change management strategies for utilizing digital processes and technology for construction field applications. This research will identify and present strategies for streamlining processes for construction including but not limited to, equipment procurement, staff training, integration of tools, and digital inspection methods.

FISCAL YEAR 2024 ACCOMPLISHMENTS

Contracting for the project was delayed into the next fiscal year (FY).

FISCAL YEAR 2025 PROPOSED ACTIVITES

Finalize selection of the vendor or university and initiate contracting. Host the kick off meeting and initiate the stakeholder engagement meetings and begin the risk assessment report and matrix, and data map. Host multiple update meetings throughout the FY.

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.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2024

PROJECT TITLE: Enhance Bridge Image Attribution Through Automated Post Image Processing

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

PROJECT MANAGER: Armour, Jacob

CONTRACT/AUTHORIZATION NO.	2022-0434 Z7	PROJECT START DATE	9/1/2024
PROJECT NO.	219771	COMPLETION DATE (Original)	2/28/2026
OR NO.	OR24-008	COMPLETION DATE (Revised)	
RESEARCH AGENCY	Western Michigan University (WMU)		
PRINCIPAL INVESTIGATOR	Attanayake, Upul B.		

BUDGET STATUS

FY 2024 Budget		Total Budget	
Vendor Budget FY 2024	$8,068.23	Total Vendor Budget	$140,900.77
MDOT Budget FY 2024	$1,980.00	Total MDOT Budget	$35,640.00
Vendor FY 2024 Expenditures	$0.00	Total Budget	$176,540.77
MDOT FY 2024 Expenditures	$0.00	Total Expenditures	$0.00
		Total Amount Available	$176,540.77

PURPOSE AND SCOPE

MDOT currently captures images with every bridge inspection. These images contain bridge components including decks, barrier walls and piers or they could contain defects and other areas of interest on the bridge. They may also contain load posting signs or traffic control devices. These images are only able to have one attribute indicating what the image contains. This one image description limits the rich data potential these images may truly contain. With more meaningful information on each image, MDOT has an opportunity to utilize more imagery in a more efficient manner to make asset management decisions on our network.

FISCAL YEAR 2024 ACCOMPLISHMENTS

The kickoff meeting was held, and the research team began reviewing available tools that could be used to analyze MDOT's bridge images. The capabilities and limitations of several tools including Bentley's Blyncsy and YOLOv8 were reviewed. The Port Authority of New York and New Jersey, City of Plano, Alaska DOT, Hawaii DOT, and New York City DOT have completed or have on-going projects utilizing Bentley's Blyncsy. We will continue to follow up with such projects to learn from their experience. Data sharing agreements were started and are set to be finalized before MDOT data is shared. WMU confirmed no costs hit their accounting before the fiscal year end deadline.

FISCAL YEAR 2025 PROPOSED ACTIVITES

Researcher will begin analyzing the bridge inspection imagery MDOT has collected and apply attribution as necessary. They will analyze the imagery using their preconfigured tool and then use that analysis to compare against other commercially available tools.

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.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2024

PROJECT TITLE: Safety Effectiveness of Non-Freeway Sinusoidal Shoulder Corrugations

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

PROJECT MANAGER: Bramble, Mary

CONTRACT/AUTHORIZATION NO.	2024-0232	PROJECT START DATE	4/24/2024
PROJECT NO.	220847	COMPLETION DATE (Original)	4/24/2026
OR NO.	OR24-006	COMPLETION DATE (Revised)	
RESEARCH AGENCY	Michigan State University (MSU)		
PRINCIPAL INVESTIGATOR	Gates, Tim		

BUDGET STATUS

FY 2024 Budget		Total Budget	
Vendor Budget FY 2024	$75,621.47	Total Vendor Budget	$264,706.18
MDOT Budget FY 2024	6,875.00	Total MDOT Budget	$27,651.97
Vendor FY 2024 Expenditures	$3,976.85	Total Budget	$292,358.15
MDOT FY 2024 Expenditures	$1,526.97	Total Expenditures	$5,503.82
		Total Amount Available	$286,854.33

PURPOSE AND SCOPE

MDOT needs to determine the safety effectiveness of a newer design of rumble strips (called sinusoidal or "mumble" strips). To date no crash modification factors (CMFs) have been developed for mumble strips, and there have been no safety or vibration and limited noise comparisons done between traditional rumble strips and the mumble strips for motorized or nonmotorized travelers (bicyclists). Most installations of mumble strips are not at new locations, but rather traditional rumble strips have been in place and are being replaced with mumble strips. However, we have an opportunity in Michigan as we have several hundred miles of mumble strips placed where there were no previous strips.

FISCAL YEAR 2024 ACCOMPLISHMENTS

The research team started their Literature Review. The team also began collecting and analyzing historical data. MSU settled on locations and obtained the necessary equipment for noise and vibration field data collection and were able to collect data utilizing both a minivan and an MDOT snowplow truck. The team also worked with MDOT to recruit motorcyclists and bicyclists for future participation.

FISCAL YEAR 2025 PROPOSED ACTIVITES

Motorcyclist vibration data collection is planned for spring of 2025. The bicyclist stability and comfort study is proposed for May 2025.The research team will also analyze data from noise and vibration field evaluation to present to the MDOT RAP, and continue to assemble database of MDOT sinusoidal rumble strip locations, roadway inventory data, traffic volume data, and traffic crash data.

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

While the contract did not require modification, MDOT approved a shift in budget during FY 2024 to correct MSU's Indirect Cost Rate and shift the overage from that to cover additional costs on equipment beyond what was originally expected.

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

Project expected completion FY 2026.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2024

PROJECT TITLE: Covid and Traffic Crashes/Impact on Safety Targets

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

PROJECT MANAGER: McQuiston, Carissa

CONTRACT/AUTHORIZATION NO.	2024-0558	PROJECT START DATE	6/17/2024
PROJECT NO.	220848	COMPLETION DATE (Original)	7/17/2026
OR NO.	OR24-007	COMPLETION DATE (Revised)	
RESEARCH AGENCY	Michigan State University (MSU)		
PRINCIPAL INVESTIGATOR	Savolainen, Peter T.		

BUDGET STATUS

FY 2024 Budget		Total Budget	
Vendor Budget FY 2024	$107,476.00	Total Vendor Budget	$310,589.63
MDOT Budget FY 2024	$628.80	Total MDOT Budget	$4,611.20
Vendor FY 2024 Expenditures	$9,664.92	Total Budget	$315,200.83
MDOT FY 2024 Expenditures	$0.00	Total Expenditures	$9,664.92
		Total Amount Available	$305,535.91

PURPOSE AND SCOPE

This project will conduct a comprehensive before-after safety analysis to better understand what factors may have driven the increase in fatalities and serious injuries since the COVID-19 pandemic. The researcher will assist MDOT in determining suitable strategies and countermeasures to revert the negative safety-trends and set future safety performance targets.

FISCAL YEAR 2024 ACCOMPLISHMENTS

The researcher has completed a draft Literature Review related to COVID-19 and its impact on crashes, injuries, and fatalities. Collected data relating to state DOT targets/goals, and how these goals were impacted by the pandemic.

Developed a draft set of questions for the State of the State Survey. These questions will be sent to the RAP members for review. Data collection activity is underway. The research team is assembling an extensive state and county level dataset for the purpose of a state-by-state comparison of travel and fatality trends, as well as for Michigan at the roadway and crash level.

FISCAL YEAR 2025 PROPOSED ACTIVITES

Data and safety analysis activities will continue. Countermeasures and strategies will be identified, and project meetings/updates will be held with the RAP.

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.

100% FEDERALLY FUNDED PROJECTS

Sequentially Listed by TPF Number

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2024

PROJECT TITLE: Michigan (One Point) Cone Test Evaluation – University Transportation Center (UTC)

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

PROJECT MANAGER: Linsey Renner

CONTRACT/AUTHORIZATION NO.	2024-0433	PROJECT START DATE	5/16/2024
PROJECT NO.	219547NI	COMPLETION DATE (Original)	9/30/2025
OR NO.	OR24-014	COMPLETION DATE (Revised)	
RESEARCH AGENCY	Michigan State University (MSU)		
PRINCIPAL INVESTIGATOR	Surya S. C. Congress, Ph.D.		

BUDGET STATUS

*FY 2024 Budget		*Total Budget	
Vendor Budget FY 2024	$46,675.62	Total Vendor Budget	$88,090.00
MDOT Budget FY 2024	$0.00	Total MDOT Budget	$0.00
Vendor FY 2024 Expenditures	$16,150.43	Total Budget	$88,090.00
MDOT FY 2024 Expenditures	$0.00	Total Expenditures	$16,150.43
		Total Amount Available	$71,939.57

***This is a University Transportation Center (UTC) project.**

	Total Contract Budget	FY 2024 Expenditures
MDOT SPRII Funding (~71.81%)	$90,465.63	$16,150.43
University Match (~28.19%)	$35,506.95	$ 6,338.90

PURPOSE AND SCOPE

Recent use of Open Graded Drainage Course (OGDC) has drawn the attention of MDOT to our current practice of using One-Point Michigan Cone tests to determine the Maximum Density for such soils. The material is relatively new to MDOT, and we desire to discover if current field tests involving the Michigan cone correlate with other industry standard tests. Studies from the 1960's, 70's and early 2000's indicate that for many applications, Michigan Cone Maximum density values exceed those garnered by other acceptable testing methods. The department would like to explore if Michigan Cone testing practices as written are an effective determination of Maximum density for OGDC, or if modifications to this current process are more appropriate for determining this maximum density. MDOT would prefer to keep our current equipment for field testing without investing in ovens for oven dry moisture, generators, new volumetric molds or hammers, so a preference exists to manipulate our current processes to give a representative sample of the maximum density.

FISCAL YEAR 2024 ACCOMPLISHMENTS

MSU has performed the following activities:

- Attend July 23, 2024, a kickoff meeting with the MDOT RAP. Meeting activities included the review of projects tasks, schedule, milestones, deliverables, and reporting requirements.
- Attend monthly check-in meetings with PM and MDOT RAP on project progress.
- Conducted a comprehensive literature review of testing practices, related to the American Society for Testing and Materials (ASTM), followed by MDOT and various State Departments of Transportation (DOTs) in the US (Task 1). Compiled a detailed table outlining each state's testing methods. Created a comparative table to depict modifications from each state for each test and method. Identified key differences in testing protocols and highlighted innovative practices adopted by certain states.
- Contacted vendors and collected 4G materials from various sources (i.e., Stone, Great Lakes, LaFarge, etc.) (Task 2).
- Characterized the material collected from vendors and conducted material testing using various methods for identifying density (Task 3) which included but was not limited to the proctor test and vibratory table test.
- The repeatability and reliability of the Michigan cone test will be evaluated by conducting several tests over the range of OGDC materials selected. For this task a compact accelerometer to be attached to the MDOT cone was purchased and two graduate students that are working on this project were provided with safety training certification to execute test methods. They were trained by MDOT personnel on the MDOT Cone test to execute it and evaluate the repeatability and reliability of the density values (Task 4).

FISCAL YEAR 2025 PROPOSED ACTIVITES

MSU anticipates performing the following activities:

- Attending monthly progress updates with the MDOT RAP.
- Continue to contact vendors to collect more 4G materials from different sources (Task 2).
- Complete the testing of the materials using various density tests (Task 3).
- Both graduate students will complete the MDOT cone and speedy test to identify the density values of all 4G material samples (Task 4).

- Produce a final report for the project and provide recommendations for MDOT on future use 90 days before the contract end date (Task 5). Update as needed based on MDOT RAP comments and submit a completed final report by contract end date.
- New text will be drafted for the Density Testing and Inspection Method Manual based on the project findings (Task 6).

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

There was a small increase in cost authorized in FY 2024 to cover additional travel necessary once final sampling locations were identified.

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

Project expected completion FY 2025.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2024

PROJECT TITLE: Digital Collaboration using Industry Foundation Classes (IFC) and Building Information Model (BIM) Technology – University Transportation Center (UTC)

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

PROJECT MANAGER: Luke Arnold

CONTRACT/AUTHORIZATION NO.	2024-0580	PROJECT START DATE	6/3/2024
PROJECT NO.	219737	COMPLETION DATE (Original)	6/3/2025
OR NO.	OR24-010	COMPLETION DATE (Revised)	
RESEARCH AGENCY	Michigan State University (MSU)		
PRINCIPAL INVESTIGATOR	Cetin, Kristen		

BUDGET STATUS

*FY 2024 Budget		*Total Budget	
Vendor Budget FY 2024	$45,679.88	Total Vendor Budget	$96,799.99
MDOT Budget FY 2024	$0.00	Total MDOT Budget	$0.00
Vendor FY 2024 Expenditures	$0.00	Total Budget	$96,799.99
MDOT FY 2024 Expenditures	$45,679.88	Total Expenditures	$45,679.88
		Total Amount Available	$78,344.02

***This is a University Transportation Center (UTC) project.**

	Total Contract Budget	FY 2024 Expenditures
MDOT SPRII Funding (80%)	$ 96,799.99	$18,455.97
University Match (20%)	$ 24,200.00	$ 4,613.99

PURPOSE AND SCOPE

Traditional project delivery includes the development of information rich 2D and 3D models which are then printed to PDF files for construction purposes. Printing a model to a PDF causes the loss of important data that can be embedded in the design objects such as pay items, specifications, material requirements and asset data. This data must be recreated in other parts of the plans in a fashion that is not connected to the original design object. In addition, asset information is not collected until after the completion of the project. This is an inefficient process which could be optimized to produce considerable cost and time savings. The use of BIM technology should allow for users of the data to have the data that they need within the model of the project.

In 2019, AASHTO adopted Industry Foundation Classes (IFC) as the national standard for AASHTO states to exchange digital information. In theory, this should provide a mechanism for the seamless transfer of data throughout the lifecycle of an asset. Adopting the use of IFC models should allow for a collaborative environment where data about MDOT's assets can be housed, tracked, and transferred to other databases.

The purpose of this research is to document current MDOT dataflows for MDOT design objects and to understand how IFC or other technologies will allow for the transfer of relevant business data at specific data handoff points.

FISCAL YEAR 2024 ACCOMPLISHMENTS

MSU has performed the following activities:

- Attend July 1, 2024, a kickoff meeting with the MDOT RAP. Meeting activities included the review of projects tasks, schedule, milestones, deliverables, and reporting requirements.
- Attend monthly check-in meetings with PM and MDOT RAP on project progress.
- Conducted a literature review (Task 1) of manuals, guidelines, research and technical reports, handbooks, and research articles that have been conducted in the past 10-15 years focusing on the (1) current and future use of digital data asset management both within and outside of transportation applications; (2) available technologies, methods, and software packages for digital asset management and data handover; (3) advantages and disadvantages of different methods used for digital asset management and data handover; and (4) case studies showing the results of real-world implementation.
- Developed a survey (Task 1) to distribute to DOTs to look at questions 1) what kind of data is generated/used to represent a transportation asset; 2) how is data transferred between DOT & contractors; 3) are there certain data requirements; 4) what is the current version of IFC used and how does schema map to the transportation assets we are focused on; and 5) how compatible are currently utilized software packages with IFC. What other software package options are there?
- Coordinate interviews with the asset groups within MDOT for pavements, drainage structures, storm sewer systems, culverts, guardrails, signs, and pavement markings, to understand how each of the different assets flows from start to finish, how things are exchanged between the different groups, with the contractors (Task 2).
- Create maps of the data structure and workflow of each studied transportation asset thus far, including data handoffs between asset stages (Task 3).

- Begin to identify points within the data workflows of each asset where there is a possibility of data loss (Task 4).

FISCAL YEAR 2025 PROPOSED ACTIVITES

MSU anticipates performing the following activities:

- Attend monthly check-in meetings with PM and MDOT RAP on project progress.
- Distribute the survey on assets to the DOTs and collect/analyze results (Task 1).
- Complete the interviews with the MDOT asset groups (Task 2).
- Complete the interviews with the contractors (Task 2).
- Complete the data workflow maps for the assets studied (Task 3) and identify where there is data loss (Task 4).
- Formulate recommendations for reducing data loss and improving data management efficiencies within MDOT's data workflows and handovers (Task 5). These recommendations will encompass a range of strategies, including the adoption of specific software tools (i.e. BIM) and/or file formats (i.e. IFC).
- Demonstrate the use of the proposed improvements to the transportation assets data workflow using MDOT data (Task 6).
- Produce a final report for the project and provide recommendations for MDOT for future use, due 90 days before the close of the contract (Task 7). Update as needed based on MDOT RAP comments and submit a completed final report by contract 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 expected completion FY 2025.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2024

PROJECT TITLE: Effectiveness of Inductive Vehicle Charging to Alleviate EV Range Anxiety – University Transportation Center (UTC)

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

PROJECT MANAGER: Michelle Mueller

CONTRACT/AUTHORIZATION NO.	2022-0433 Z4	PROJECT START DATE	3/1/2024
PROJECT NO.	219864NI	COMPLETION DATE (Original)	2/28/2026
OR NO.	OR24-003	COMPLETION DATE (Revised)	
RESEARCH AGENCY	University of Michigan (UM)		
PRINCIPAL INVESTIGATOR	Yin, Yafeng		

BUDGET STATUS

FY 2024 Budget		Total Budget	
Vendor Budget FY 2024	$52,507.37	Total Vendor Budget	$176,667.80
MDOT Budget FY 2024	$0.00	Total MDOT Budget	$0.00
Vendor FY 2024 Expenditures	$27,399.95	Total Budget	$176,667.80
MDOT FY 2024 Expenditures	$0.00	Total Expenditures	$27,399.95
		Total Amount Available	$149,267.85

***This is a University Transportation Center (UTC) project.**

	Total Contract Budget	FY 2024 Expenditures
MDOT SPRII Funding (80%)	$176,667.80	$27,399.95
University Match (20%)	$ 44,166.95	$ 6,849.99

PURPOSE AND SCOPE

The Infrastructure Investment and Jobs Act (IIJA) has made the transition from fossil fuel-powered vehicles to electric vehicles (EVs) a priority in the United States, and as a state transportation agency with one of the nation's mobility hubs, the Michigan Department of Transportation (MDOT) is tasked with making EVs more accessible to the public. One major challenge for EVs' broad acceptance is "range anxiety," which describes an EV user's worry that the car battery will run out before they can reach a charging point. MDOT is aiming to be the first in the nation to ease range anxiety with a new innovative solution: inductive vehicle charging. This technology allows EVs to wirelessly charge in motion while driving over a road with embedded charging coils. The proposed research will evaluate, analyze, and validate the effectiveness of this technology and identify ideal locations for implementation. Researching this system in Michigan allows this technology to be tested in a variety of weather conditions and potentially proves its usefulness to the public. If proven effective, this technology could be expanded across the country for the benefit of the public

FISCAL YEAR 2024 ACCOMPLISHMENTS

UM has performed the following activities:

- Attend July 8, 2024, kickoff meeting (Task 1) with the MDOT RAP. Meeting activities included the review of projects tasks, schedule, milestones, deliverables, and reporting requirements.
- Attend monthly check-in meetings with Co-PM Caitlin Day on project progress.
- Attend October 17, 2024, an update meeting with the MDOT RAP to review progress on project tasks and project timeline.
- Identify different IVC use cases targeting various types of EV users, specify scenarios under which IVC technology can effectively overcome users' range anxiety or will be favored over charging stations, and assess the potential benefits of IVC technology for each use case (Task 2). These have included:
  - Intercity highways which serve private vehicles and long-haul trucks,
  - Central business district serving private vehicles, ride-sourcing vehicles and delivery trucks,
  - Border crossings serving private vehicles and long-haul trucks,
  - Transit routes serving transit buses, and
  - Pick up/drop off areas of points of interest such as airport or central station serving ride sourcing vehicles.

FISCAL YEAR 2025 PROPOSED ACTIVITES

UM anticipates performing the following activities:

- Attend monthly check-in meetings with the PM and quarterly progress updates with the MDOT RAP.
- Complete the identification and analysis of the IVC use cases (Task 2).
- Begin the investigation of IVC technology (Task 3). This task involves collecting and analyzing data on IVC technology by reviewing the literature, examining the industry, meeting with IVC technology manufacturers, and gathering information from the IVC pilots. Information will be used to develop IVC technology performance metrics, to evaluate the ability of IVC

technology to extend the target user group(s) range and recommend the minimum requirements such as lane length for IVC technology implementation to be successful.
- Begin the research and establish a mathematical model to identify the optimal locations for implementing IVC technology, with the objective of mitigating range anxiety for the selected high impact use case (Task 4). A custom model will be created tailored to meet the requirements of the chosen high impact use case. This model can then act as a decision-support tool for MDOT when selecting optimal locations for IVC technology implementation.
- Begin the conceptual cost-benefit analysis considering the revenue generated based on different technology adoption scenarios by potential user groups for the selected high impact use case to help MDOT in their return-on-investment analysis (Task 5).

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.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2024

PROJECT TITLE: Finite Element Method (FEM) Matrix Study for Rapid Travel Profiler Curl/Warp Correlations – University Transportation Center (UTC)

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

PROJECT MANAGER: Chris Byrum

CONTRACT/AUTHORIZATION NO.	2024-0565	PROJECT START DATE	8/1/2024
PROJECT NO.	220837	COMPLETION DATE (Original)	8/31/2025
OR NO.	OR24-005	COMPLETION DATE (Revised)	
RESEARCH AGENCY	Michigan State University (MSU)		
PRINCIPAL INVESTIGATOR			

BUDGET STATUS

*FY 2024 Budget		*Total Budget	
Vendor Budget FY 2024	$85,023.56	Total Vendor Budget	$137,600.00
MDOT Budget FY 2024	$0.00	Total MDOT Budget	$0.00
Vendor FY 2024 Expenditures	$0.00	Total Budget	$137,600.00
MDOT FY 2024 Expenditures	$0.00	Total Expenditures	$0.00
		Total Amount Available	$137,600.00

***This is a University Transportation Center (UTC) project.**

	Total Contract Budget	FY 2024 Expenditures
MDOT SPRII Funding (80%)	$ 137,600.00	$0.00
University Match (20%)	$ 34,400.00	$0.00

PURPOSE AND SCOPE

It is known from experience over the years that development of unusual large warp curvatures in jointed concrete pavement slabs can cause accelerated or rapid deterioration rates for the pavement and result in poor ride quality. MDOT has experienced occasional events of large upwarp or downwarp; a complex phenomenon not well understood or easily simulated with structural analysis tools. It has also been shown that typical variation in daily slab curvatures caused by morning to afternoon thermal gradient variations (curling) can affect International Roughness Index (IRI) calculations used for initial smoothness specifications control and for pavement management systems.

MDOT's current focus is to undertake studies of how warp and curl related slab curvature affects initial smoothness IRI calculations and long-term pavement management system IRI values. Rapid travel profiling devices can accurately measure average concrete pavement slab curvature and daily curvature changes caused by varying temperature gradients. These profiling devices measure variations in curvature present along the traveled wheel paths in the slabs. Procedures exist for quantifying curvature in slabs from rapid travel profile data.

Thus, the problem to address under this proposed research is to develop a structural back-calculation or matching tool from modern finite element type analysis methods that will match observed slab curvature magnitudes and variations in the wheel path location, to those predicted using FEM models. This tool is to replace existing simplified tools that use Westergaard's equations for "infinite strip" slab shape from the 1920s, with a more realistic tool based on wheel path shapes predicted from a suitable modern FEM structural analysis model.

FISCAL YEAR 2024 ACCOMPLISHMENTS

MSU has performed the following activities:

- Attend August 13, 2024, a kickoff meeting with the MDOT RAP. Meeting activities included the review of projects tasks, schedule, milestones, deliverables, and reporting requirements.
- Attend bi-weekly check-in meetings with PM on project progress.
- Provide the MDOT team with comparison data on the available Finite Element Method (FEM) models and software. The evaluation considered various slab lengths, joint stiffness parameters and thermal gradient variations, ensuring comprehensive analysis capabilities for JCP slabs. This is to ensure the chosen FEM model can properly handle different thermal loading scenarios, boundary conditions, and provide accurate simulation of slab curvatures and related parameters essential for pavement analysis (Task 1).
- Begin developing a test matrix for FEM runs to enable the development of Neural Networks (NNs) for prediction of slab shape profiles (Task 2). The chosen FEM model used should be able to predict slab shape profiles and have the following characteristics: 1) an extended model with at least 3 slabs with two simulated joints. The data from the middle slab will be used for curled slab shape within wheel paths for a 12-ft slab width; 2) the modeled slabs will be placed on a single composite subgrade model (k-values between 150 and 450 psi/inch); 3) Typical MDOT concrete physical properties representing typical

in-service values will be used; 4) slab thickness is between 9 and 15 inches, and joint spacing is between 12 and 24 feet; 5) thermal gradients ranging from -6 degF/in (afternoon) to +8 degF/in (morning); and 6) joint stiffness to vary from low load transfer efficiency (30 to 40 percent for winter/old conditions) to high load transfer efficiency (75 to 85 percent for newer working joints and warm weather).

MSU does not bill until costs hit their accounting and confirmed nothing was billed for FY 2024.

FISCAL YEAR 2025 PROPOSED ACTIVITES

MSU anticipates performing the following activities:

- Attend bi-weekly check-in meetings with PM on project progress.
- Attend quarterly update meetings, including October 29, 2024, with the MDOT RAP to review progress on project tasks and project timeline.
- Complete the development of the test matrix (Task 2).
- Complete the slab shape analysis (Task 3). The NNs developed in the previous task will calculate surface deformation output in the wheel path and diagonal in a similar system. In this task, the deflection prediction tool will be developed and compared with the deflection profile computed using the FEM model.
- Complete the slab stress analysis (Task 4). The NNs developed in the previous task will calculate peak transverse and longitudinal curling stresses in a similar system.
- Complete the slab shape International Roughness Index (IRI) calculations (Task 5) by creating a 500-ft length simulated IRI profile for each slab shape calculated from the FEM runs by repeating the slab shape and will calculate the IRI value for each simulated profile.
- A relational database will be developed based on the results of FEM analyses for input variables considered in the test matrix (Task 6). Also, an artificial neural network (ANN) will be trained as a practical tool to calculate slab shape and stresses. The ANN model can be used to predict slab shapes and stress rapidly without having to set up a new FEM model for each calculation. The team will also develop a separate tool to estimate surface roughness (i.e., IRI) based on the longitudinal profiles in the wheel path from the ANN tool. A graphic interface will be designed to input various parameters and data visualization.
- Produce a final report for the project and provide recommendations for MDOT for future use 90 days before the close of contract (Task 7). Update as needed based on MDOT RAP comments and submit a completed final report by contract 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 expected completion FY 2025.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2024

PROJECT TITLE:	Research and Development of a 3-Item Transportation Security Index Mobility Measurement Tool – University Transportation Center (UTC)
FUNDING SOURCE:	☒ SPR, Part II ☐ OTHER (*PLEASE EXPLAIN)*
PROJECT MANAGER:	Richard Bayus and James Dell

CONTRACT/AUTHORIZATION NO.	2022-0433 Z5	PROJECT START DATE	5/22/2024
PROJECT NO.	221109	COMPLETION DATE (Original)	6/5/2025
OR NO.	OR24-017	COMPLETION DATE (Revised)	
RESEARCH AGENCY	University of Michigan (UM)		
PRINCIPAL INVESTIGATOR	Murphy, Alexandra		

BUDGET STATUS

*FY 2024 Budget		*Total Budget	
Vendor Budget FY 2024	$111,000.00	Total Vendor Budget	$126,504.00
MDOT Budget FY 2024	$0.00	Total MDOT Budget	$0.00
Vendor FY 2024 Expenditures	$37,233.79	Total Budget	$126,504.00
MDOT FY 2024 Expenditures	$0.00	Total Expenditures	$37,233.79
		Total Amount Available	$89,270.21

***This is a University Transportation Center (UTC) project.**

	Total Contract Budget	FY 2024 Expenditures
MDOT SPRII Funding (63%)	$ 126,504.00	$37,233.79
University Match (37%)	$ 74,296.00	$20,072.33

PURPOSE AND SCOPE

Transportation security index mobility measurement tool offers new insights into who is experiencing transportation insecurity and the severity of the experience. The transportation security index is an essential measurement tool the Michigan DOT could utilize to (1) assess populations and geographies where mobility infrastructure investments are needed, (2) evaluate the impact of department investments on mobility approaches, and (3) trace the progress the department is making on transportation equity goals. Therefore, this research project will focus on the research and development of a cost effective, reduced 3-item TSI mobility measurement tool. Once research is complete this tool may be utilized by the department on future mobility infrastructure investments to identify travel behavior trends and patterns to inform future mobility approaches with respect to transportation equity. In this way the problem to address will be limited to the research and development of a data collection tool, and not include the deployment of that tool.

FISCAL YEAR 2024 ACCOMPLISHMENTS

UM has performed the following activities:

- Attend June 18, 2024, kickoff meeting (Task 1) with the MDOT RAP. Meeting activities included the review of projects tasks, schedule, milestones, deliverables, and reporting requirements.
- Attend August 13, 2024, an update meeting with the MDOT RAP to review progress on project tasks and project timeline.
- Began a literature review on approaches that are currently used to assess the mobility needs of a population (Task 2). This review will help detail how the Transportation Security Index (TSI) evolved, including how it is different from other approaches used to assess mobility needs. It will also provide a synapsis of contemporary TSI research that led to the existing approaches available.
- Collect the data on the six-item transportation security index that was part of the survey conducted by the Detroit Metro Area Community Study (DMACS) which was administered to 2,300 City of Detroit residents. Analyze the data from the survey and produce a white paper on Transportation Insecurity in the Motor City and for MDOT review (Task 3).
- Identified a candidate 3-item index using existing nationally representative data (Task 4).
- Conducted a new survey, using the new 3-item index on an independent, nationally representative sample using a split-ballot experiment (Task 5). Each ballot had approximately 2,000 respondents.
- Began analyzing the results of the survey to validate the 3-item index to determine if it is as predictive and the previous TSI-6 (Task 6).
- Completed the 3rd and 4th quarter progress reports (Task 7).

FISCAL YEAR 2025 PROPOSED ACTIVITES

UM anticipates performing the following activities:

- Attend quarterly progress updates with the MDOT RAP.
- Complete the literature review (Task 2) of TSI research.
- Finalize white paper (Task 3).
- Finish validating the TSI-3 index (Task 6).
- Complete quarterly progress reports (Task 7).

Produce a final draft report for the project and provide recommendations for MDOT to utilize the TSI on future mobility projects 90 days before the contract end date (Task 8). Update as needed based on MDOT RAP comments and submit a completed final report by contract 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 expected completion FY 2025.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2024

PROJECT TITLE: Automatic Signal Retiming Using Vehicular Trajectory Data – University Transportation Center (UTC)

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

PROJECT MANAGER: William Seeger

CONTRACT/AUTHORIZATION NO.	2022-0433 Z6	PROJECT START DATE	5/22/2024
PROJECT NO.	221177	COMPLETION DATE (Original)	5/22/2025
OR NO.	OR24-015	COMPLETION DATE (Revised)	
RESEARCH AGENCY	University of Michigan (UM)		
PRINCIPAL INVESTIGATOR	Liu, Henry		

BUDGET STATUS

*FY 2024 Budget		*Total Budget	
Vendor Budget FY 2024	$75,811.44	Total Vendor Budget	$199,999.99
MDOT Budget FY 2024	$0.00	Total MDOT Budget	$0.00
Vendor FY 2024 Expenditures	$47,197.35	Total Budget	$199,999.99
MDOT FY 2024 Expenditures	$0.00	Total Expenditures	$47,197.35
		Total Amount Available	$152,802.64

***This is a University Transportation Center (UTC) project.**

	Total Contract Budget	FY 2024 Expenditures
MDOT SPRII Funding (70%)	$ 199,999.99	$47,197.35
University Match (30%)	$ 98,000.00	$20,227.44

PURPOSE AND SCOPE

Traffic signal optimization is a cost-effective method for reducing congestion and energy consumption in urban areas. However, due to the high cost of manual data collection and the labor-intensive modeling, only minimum amounts of data are typically collected and traffic signals and are not regularly optimized. More cost-effective methods for signal optimization need to be explored, such as the use of vehicle trajectory data that is now available. Research is needed to determine if this process can provide optimized timings at more frequent and regular intervals, yielding better overall signal performance.

FISCAL YEAR 2024 ACCOMPLISHMENTS

UM has performed the following activities:

- Attend July 31, 2024, a kickoff meeting with the MDOT RAP. Meeting activities included the review of projects tasks, schedule, milestones, deliverables, and reporting requirements.
- Attend October 15, 2024, an update meeting with the MDOT RAP to review progress on project tasks and project timeline.
- Developed a network setup procedure by configuring the Optimizing Signals as a Service (OSaaS) platform in preparation for signal retiming activities in the operational network area network of Oakland County (Task 1).
- Acquired trajectory data from General Motors (GM) for the Oakland County operational area and processed it for compatibility with the OSaaS system. To standardize and automate the signal process, this data was matched to the map network stored on the cloud, splitting vehicle trips at the intersection level, performance index calculations, and trajectory aggregation (Task 2).
- Determined traffic flow model calibration (Task 3) by developing methods for automatically extracting model input parameters (i.e., saturation flow rate, free-flow speed, and start-up loss time) from aggregated historical measurements representative of the time of interest for the traffic flow model.
- The traditional method of signal optimization was completed (Task 6).
- Completed the 3rd and 4th quarter progress reports (Task 8).

FISCAL YEAR 2025 PROPOSED ACTIVITES

UoM anticipates performing the following activities:

- Attending quarterly progress updates with the MDOT RAP.
- Diagnosis and optimization (Task 4) by standardizing methods to automatically search for potential performance improvements in the traffic flow model with respect to different signal parameters (i.e., time of day splits, cycle length, green splits, offsets).
- Implement this process with 30 to 40 signals on pilot corridors in Oakland County. (Task 5)
- Compare the effectiveness of the signal timings and the cost for implementation for automatic signal retiming using OSaaS versus the traditional retiming methods to determine the most cost-effective method for signal performance (Task 7).
- Completing quarterly progress reports (Task 8).

- Produce a final report for the project and provide recommendations for MDOT on future use 90 days before the close of contract (Task 9). Update as needed based on MDOT RAP comments and submit a completed final report by contract 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 expected completion FY 2025.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2024

PROJECT TITLE:	End-to-End Learning Framework for Transportation Network Equilibrium Modeling – University Transportation Center (UTC)

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

PROJECT MANAGER: Robert Maffeo

CONTRACT/AUTHORIZATION NO.	2022-0433 Z7	PROJECT START DATE	5/28/2024
PROJECT NO.	221183	COMPLETION DATE (Original)	10/25/2025
OR NO.	OR24-016	COMPLETION DATE (Revised)	
RESEARCH AGENCY	University of Michigan (UM)		
PRINCIPAL INVESTIGATOR	Yafeng Yin, Ph.D.		

BUDGET STATUS

*FY 2024 Budget		*Total Budget	
Vendor Budget FY 2024	$25,950.94	Total Vendor Budget	$124,849.33
MDOT Budget FY 2024	$0.00	Total MDOT Budget	$0.00
Vendor FY 2024 Expenditures	$26.853.01	Total Budget	$124,849.33
MDOT FY 2024 Expenditures	$0.00	Total Expenditures	$26,853.01
		Total Amount Available	$97,996.32

***This is a University Transportation Center (UTC) project.**

	Total Contract Budget	FY24 Expenditures
MDOT SPRII Funding (80%)	$ 124,849.33	$26,853.01
University Match (20%)	$ 31,212.33	$6,713.25

PURPOSE AND SCOPE

Transportation network equilibrium modeling plays a crucial role in the analysis and planning of transportation roadway network systems. However, historically, these modeling systems have relied on costly and time-consuming household surveys to gather data. As a result, planning agencies only update their models every few years, and limited efforts have been made to calibrate the systems due to a lack of empirical traffic data. Consequently, the resulting models often produce inaccurate results.

Moreover, previous models have been constructed using a "bottom-up" assembly approach, where the specification and calibration of individual components, whether on the supply or demand side, are divorced from the goal of the model: prescribing an equilibrium flow distribution that closely matches observations.

Fortunately, with the advent of vehicle connectivity, vehicle trajectory data has become more readily available. Leveraging this dataset and recent advancements in artificial intelligence, our proposed research aims to develop an end-to-end modeling framework. This framework will directly utilize empirical sampled trajectory data as inputs to learn the modeling components for both the supply and demand sides, as well as the equilibrium flow distribution. By doing so, the proposed framework has the potential to transform the way States and Metropolitan Planning Organizations (MPO) analyze and plan their transportation networks.

FISCAL YEAR 2024 ACCOMPLISHMENTS

UM has performed the following activities:

- Project management (Task 1) which included:
  - Attend July 19, 2024, a kickoff meeting with the MDOT RAP. Meeting activities included the review of projects tasks, schedule, milestones, deliverables, and reporting requirements.
  - UofM met with MDOT and the Southeast Michigan Council of Governments (SEMCOG) on August 9, 2024, to collect output information on the trip-based forecast, zone-level data, the auto-trip matrices and the network information from 2020 and 2025.
  - PM Robert Maffeo invited Zhichen Liu to attend the LOCUS Workshop on August 14, 2024.
  - Downloaded the 2022 INRIX data from the RITIS platform for analysis.
  - Attend October 24, 2024, an update meeting with the MDOT RAP to review progress on project tasks and project timeline.
  - Completed the quarter progress reports.
- Began developing a unified framework for end-to-end learning of transportation network equilibrium (Task 2). The required building from existing prototypes to analyze supply/demand components from empirical data and unify the use of model-based and model-free components.

- Acquired and leveraged General Motor's vehicle trajectory data and the proposed end-to-end learning framework from Task 2 to enhance the behavioral realism and prediction accuracy of a planning model maintained by Washtenaw Area Transportation Study to demonstrate the unifying end-to-end framework using Ann Arbor as the case study (Task 3).

FISCAL YEAR 2025 PROPOSED ACTIVITES

UM anticipates performing the following activities:

- Project management (Task 1) which will include:
  - Attending quarterly progress updates with the MDOT RAP.
  - Completing quarterly progress reports.
- Complete the unified framework for end-to-end learning of transportation network equilibrium (Task 2) by conducting theoretical analysis on the feasibility of the proposed framework.
- Complete demonstrating the feasibility of the framework (Task 3) by developing a new trajectory-data driven feasible path set generation algorithm framework to account for unavailable data.
- Using the Ann Arbor case study and the developed framework investigate and prescribe improvement strategies to the framework (Task 4).
- Produce a final draft report for the project and provide recommendations for MDOT on future use 90 days before the contract end date (Task 5). Update as needed based on MDOT RAP comments and submit a completed final report by contract 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 expected completion FY 2027.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2024

PROJECT TITLE: Flood Fragility of Roads and Railroads – University Transportation Center (UTC)

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

PROJECT MANAGER: Harold Zweng

CONTRACT/AUTHORIZATION NO.	To Be Determined	PROJECT START DATE	To Be Determined
PROJECT NO.	221872	COMPLETION DATE (Original)	To Be Determined
OR NO.	OR25-006	COMPLETION DATE (Revised)	
RESEARCH AGENCY	To Be Determined		
PRINCIPAL INVESTIGATOR	To Be Determined		

BUDGET STATUS

FY 2024 Budget		***Total Budget**	
Vendor Budget FY 2024	$174,615.60	Total Vendor Budget	$246,946.60
MDOT Budget FY 2024	$0.00	Total MDOT Budget	$0.00
Vendor FY 2024 Expenditures	$0.00	Total Budget	$246,946.60
MDOT FY 2024 Expenditures	$0.00	Total Expenditures	$0.00
		Total Amount Available	$246,946.60

PURPOSE AND SCOPE

Rising water levels and frequent intense rain events have caused roads and railroads to be inundated in more locations and more frequently. Inundation impacts are unique to the location, road use, soils, pavement design, duration, and other factors, MDOT's approach to inundated roadways has generally been limited to observations and limited adaptation strategies. While pavement and embankments that have been washed out need to be repaired or replaced, roadways that remain visually intact during a flood event or extended high water events are not as well understood. This project will identify countermeasures and study the long-term and short-term effect of these inundation cycles.

FISCAL YEAR 2024 ACCOMPLISHMENTS

Project start was delayed into FY 2025.

FISCAL YEAR 2025 PROPOSED ACTIVITES

Vendor selection and contracting is expected.

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.

Michigan Department
Of Transportation
5307 (11/17)

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2024

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)	9/30/2023
MDOT TECHNICAL CONTACT	James Roath, 517-230-5361 Email: RoathJ1@michigan.gov		
LEAD AGENCY	South Dakota DOT		
PROJECT MANAGER	David Huft, 605-773-3358 Email: dave.huft@state.sd.us		
CONTRACTOR			

BUDGET STATUS

FY 2024 MDOT Budget			MDOT Total Budget		
FY FUNDS	(Original)	$30,000.00	TOTAL BUDGET	(Original)	$90,000.00
	(Revised)	$0.00	FY 2024	(**Revised**)	$0.00
TOTAL FY 2024 EXPENDITURES		$0.00	TOTAL COMMITTED FUNDS AVAILABLE		$0.00

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 ACCOMPLISHMENTS

MDOT discontinued its funding commitment to this solicitation effective FY 2024. MDOT moved its pledge commitments for FY 2023 and 2024 to TPF-5(347) at $30,000.00 each year.

Michigan Department
Of Transportation
5307 (2011)

RESEARCH ADMINISTRATION
TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2024

STUDY TITLE: AASHTO Engineering Technical Service Programs

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.		MDOT START DATE	10/1/2023
FEDERAL PROJECT NO.	SPR1801(179)	MDOT COMPLETION DATE (Original)	9/30/2024
OR NO.	OR24-202	COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Andre Clover, 517-749-9001 Email: CloverA@michigan.gov		
LEAD AGENCY	American Association of State Highway and Transportation Officials (AASHTO)		
PROJECT MANAGER	Various - Based on technical focus matter		
CONTRACTOR			

BUDGET STATUS

FY 2024 MDOT Budget				Total Budget		
FY Budgeted Funds	(Original)	$180,000.00		TOTAL COST	(Original)	$180,000.00
FY Billed Invoices	(Revised)				(Revised)	
*TOTAL FY 2024 EXPENDITURES		$180,000.00		TOTAL COMMITTED FUNDS AVAILABLE		$0.00

PARTICIPATING STATES

Nationwide Departments of Transportation.

PURPOSE AND SCOPE

As a general practice, MDOT technical experts each fiscal year analyze the benefits to MDOT of services and information shared by respective TRB's Technical Service Programs (TSPs). 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 development and continued operation of each of the following critical programs:

- AASHTO Innovation Management (Formerly A.I.I.) - $6,000
- AASHTO Materials Guidelines (Formerly DAMS) - $10,000
- AASHTO Environmental Management (Formerly ETAP) - $10,000
- AASHTO Technical Training Solutions (Formerly TC3) - $20,000
- AASHTO Winter Weather Management (Formerly SICOP) - $4,000.
- AASHTO Preservation Management (Formerly TSP2) - $20,000.
- AASHTO Equipment Management (Formerly EMTSP) – $5,000.
- AASHTO Produce Evaluation and Audit Solutions (Formerly NTPEP) - $25,000.
- AASHTO Safety Management (Formerly SAFETY) - $10,000.
- AASHTO Structures Guidelines (Formerly LRFDSM) - $15,000.
- National Operations Center of Excellence (NOCoE) - $15,000.
- Operations TSP- $15,000.
- AASHTO Design Guidelines (Formerly DPM) - $15,000.
- AASHTO Safety Hardware Management (Formerly MASH) - $10,000.

FISCAL YEAR 2024 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 2024.

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 recommend contributions continue. If no value is realized from a particular program, MDOT may choose to discontinue its contribution.

Michigan Department
Of Transportation
5307 (11/17)

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2024

STUDY TITLE: Highway Safety Manual Implementation

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF-5(255)		MDOT START DATE [FY 2016]	11/9/2015
PROJECT NO.	Not Applicable		MDOT COMPLETION DATE (Original) [FY 2020]	12/31/2019
OR NO.	OR15-527		COMPLETION DATE (Estimated)	12/31/2025
MDOT TECHNICAL CONTACT	Garrett Dawe, 989-289-2388 Email: DaweG@michigan.gov			
LEAD AGENCY	Federal Highway Administration (FHWA)			
PROJECT MANAGER	Matthew Hinshaw, 360-619-7677 Email: matthew.hinshaw@dot.gov			
CONTRACTOR	Louisiana Transportation Research Center			

BUDGET STATUS

FY 2024 MDOT Budget				MDOT Total Budget		
FY FUNDS	(Original)	$0.00		TOTAL BUDGET	(Original)	$100,000.00
	(Revised)				(Revised)	
TOTAL FY 2024 EXPENDITURES		$0.00		TOTAL COMMITTED FUNDS AVAILABLE		$0.00

PARTICIPATING STATES

LA, 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 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 were 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 remains 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 are 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 ACCOMPLISHMENTS

- Completed Task 2 of Advancing Application of DDSA: Explore the Validity of Combining Predictive Methods
- Tasks 3 and 4 of Advancing DDSA kicked off.
- Developed scope and budget for three new projects identified by members as high interest. The projects are: HSM Screening Tool, Open-Source Tools and Processes, and Additional exploration of Empirical-Bayes in Predictive Analysis. Contract actions were prepared.

FISCAL YEAR 2025 PROPOSED ACTIVITIES
• Tasks 3 and 4 of Advancing DDSA will continue. • New projects for HSM Screening Tool, Open-Source Tools and Processes, and Additional exploration of EB in Predictive Analysis will begin.
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
Project expected completion FY 2025.

Michigan Department
Of Transportation
5307 (11/17)

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2024

STUDY TITLE: Evaluation of Low-Cost Safety Improvements

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF-5(317)		MDOT START DATE (Original)	October 2015
PROJECT NO.	OR20-209		MDOT COMPLETION DATE (Original)	9/30/2022
PFS START DATE	FEB 2015		COMPLETION DATE (Revised)	9/30/2024
MDOT TECHNICAL CONTACT	Garrett Dawe, 989-289-2388 Email: DaweG@michigan.gov			
LEAD AGENCY	Nevada DOT			
PROJECT MANAGER	Kim Woon, 202-493-3383 Email: woon.kim@fhwa.dot.gov			
CONTRACTOR				

BUDGET STATUS

FY 2024 MDOT Budget				MDOT Total Budget		
FY FUNDS	(Original)	$0.00		TOTAL BUDGET	(Original)	$40,000.00
	(Revised)			FY 2023 (INCR $50K)	(Revised)	$90,000.00
TOTAL FY 2024 EXPENDITURES		$0.00		TOTAL COMMITTED FUNDS AVAILABLE		$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 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, and 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 where MDOT wants to expand its use and with this information we can make efficient decisions.

FISCAL YEAR 2021 ACCOMPLISHMENTS

The annual meeting was held on 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 email 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)

- Fixed Objects Delineation of (FOD)

This task order's kickoff meeting is on August 17, 2022.
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. Quarterly progress highlights include:

- 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 the publication process has started for the 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 email 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 ACCOMPLISHMENTS

Held an annual meeting in Oklahoma City in June. Top safety needs were discussed, in addition to CMF development ideas and SLCI evaluation suggestions. The meeting also included topics on micromobility, motorcycles, MIRE data elements, and emerging topics.

FISCAL YEAR 2025 PROPOSED ACTIVITIES

New studies will kick off on Curb Extensions, Narrow Width Rumble Strips, and Wide Width Pavement markings.

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.

Michigan Department
Of Transportation
5307 (11/17)

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2024

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 (Revised) *	6/30/2024
MDOT TECHNICAL CONTACT	Carlos Torres, 517-335-2852 Email: TorresC@michigan.gov			
LEAD AGENCY:	Washington DOT			
PROJECT MANAGER	Mustafa Mohamedali, 360-704-6307 Email: Mustafa.Mohamedali@wsdot.wa.gov			
CONTRACTOR				

BUDGET STATUS

FY 2024 MDOT Budget				MDOT Total Budget		
FY FUNDS	(Original)	$0.00		TOTAL BUDGET	(Original)	$220,000.00
	(Revised)	$0.00		FYs 22 $50k	(Revised)	$270,000.00
TOTAL FY 2024 EXPENDITURES		$0.00		TOTAL COMMITTED FUNDS AVAILABLE		$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:

1. 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 into methods to anchor temporary concrete barrier to permanent concrete barrier.
2. 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 into an alternative limited deflection temporary concrete barrier system that meets MASH.
3. 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:

1. 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.
2. 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

1. 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.
2. 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.
3. 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.
4. 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

1. T4541-DA: Administrative Support
2. T4541-DI: Determination of Pedestrian Rail Offset Requirements to Eliminate Vehicle Interaction
3. T4541-DS: 2019 Travel and Meeting Assistance
4. T4541-CU: 2018 MASH Coordination Effort

Ongoing Projects

1. Engineering Support Services and Recommendations for Roadside Safety Issues/Problems for Member States
2. Testing of MGS System with Reduced Post Spacing for MASH Compliance
3. Testing and Evaluation of the MGS System with Maximum Flare at MASH Test
4. Thrie-Beam/W-Beam/Tubular Barrier Gap Rail for MASH TL-3
5. Placement of Guardrail on Slopes Phase IV: MASH TL-3 Testing of Guardrail
6. MASH TL-3 Transition Design with a Storm Drain Inlet
7. MASH Coordination Effort
8. 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 1TO1 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

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 ACCOMPLISHMENTS

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 ACCOMPLISHMENTS

Completed Projects

1. T4541-FB: MASH TL-3 Evaluation of a Median Guide Rail Transition to Median F-Shape Concrete Barrier
2. T4541-FE: MASH Test Level 3 Evaluation of a Shorter Thrie-Beam Approach Transition
3. T4541-FF: Steel-Post W-Beam Guardrail in Asphalt Mow Strip
4. T4541-FG: Evaluation of Open Joints in Concrete Bridge Rail Systems
5. T4541-EM: Multi-Directional Base Design for Steel Beam Non-Proprietary Large Sign Supports: Phase I
6. T4541-ES: MASH 4-12 Evaluation of a Fence Mounted System for Attachments to Concrete Bridge Barrier
7. T4541-EV: MASH Crashworthy Pedestrian and Small Traffic Signals
8. T4541-EX: Buried-in-Backslope Terminal Variations in Foreslope, Backslope, and Ditch Configurations
9. T4541-FC: Evaluation of a Four Bolt Slip Base for Breakaway Luminaire Supports with Various Pole Configurations
10. T4541-FD: Portable Sign Supports for Aluminum Signs with Variations on Mounting Height
11. T4541-ET: MASH Testing of a Guardrail System on 1H:1V Slope
12. T4541-ES: MASH 4-12 Evaluation of a Fence Mounted System for Attachments to Concrete Bridge Barrier

All work was completed in the second quarter of calendar year 2024, and no further activities are expected as part of TPF-5(343).

FISCAL YEAR 2025 PROPOSED ACTIVITIES

Pending Final Report.

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

Reports published by the Texas A&M University Transportation Institute (TTI) as part of the Roadside Safety Pooled Fund will be reviewed by MDOT's Barrier Advisory Committee (BAC). Reports will be reviewed individually by BAC, prioritized based on the relevance of topics contained in each report based on MDOT's roadside safety needs.

BAC will then propose recommendations, as deemed appropriate, concerning the results and recommendations from these reports. BAC recommendations involving the development of new MDOT guidelines, standards, etc. or modifications to existing MDOT guidelines, standards, etc. may need to be submitted to others within MDOT (e.g., MDOT's Engineering Operations Committee (EOC)) for further consideration and approval before implementation. These decisions will be evaluated on a case-by-case basis.

Michigan Department
Of Transportation
5307 (2011)

RESEARCH ADMINISTRATION
TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2024

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)	9/30/2022
OR NO.	OR14-034		COMPLETION DATE (Revised)	9/30/2025
MDOT TECHNICAL CONTACT	James Roath, 517-230-5361 Email: RoathJ1@michigan.gov			
LEAD AGENCY:	South Dakota Department of Transportation			
PROJECT MANAGER	David Huft, 605-773-3358 Email: Dave.huft@state.sd.us			
CONTRACTOR	Iteris, Inc.			

BUDGET STATUS

FY 2024 MDOT Budget				Total Budget		
FY FUNDS	(Original)	$0.00		TOTAL COST	(Original)	$170,000.00
Amendment 3	(Revised)	$60,000.00		FY24 Amendment 3	(Revised)	$260,000.00
TOTAL FY 2024 EXPENDITURES		$60,000.00		Total Committed Funds Available*		$30,000.00

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 ACCOMPLISHMENTS

Tasks assigned for FY24, and many will be continued work beyond 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 the 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) pledge commitment to TPF-5(347) covers FYs 2017-2022 for a combined total amount of $170,000.00

The lead agency requested all partner states to transfer their pledge commitments from Solicitation 1562 to TPF-5(347) for fiscal years 2023 and 2024 @ $30,000.00 each year.

This TPF project has been extended and MDOT will continue as a state partner until all project deliverables are completed. MDOT's Solicitation 1562 pledge commitments were transferred to TPF-5(347) for FYs 2023 and 2024.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

project estimated completion is 9/30/2025. FHWA has approved extending this pooled fund study through fiscal year 2025. However, MDOT has elected to end its funding commitment to this project.

Michigan Department
Of Transportation
5307 (2011)

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2024

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 Email: KennedyK@Michigan.gov			
LEAD AGENCY:	Minnesota Department of Transportation			
PROJECT MANAGER	Ben Worel 763-381-2130 Email: ben.worel@state.mn.us			
CONTRACTOR	University of Minnesota [MnROAD Facility]			

BUDGET STATUS

FY 2024 Budget				Total Budget		
FY FUNDS	(Original)	$0.00		TOTAL COST	(Original)	$250,000.00
	(Revised)				(Revised)	
TOTAL FY 2024 EXPENDITURES		$0.00		TOTAL COMMITTED FUNDS AVAILABLE		$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, and 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 ACCOMPLISHMENTS

- Final report published and NCAT final payment made
- Working with FHWA to close out this pooled fund

FISCAL YEAR 2025 PROPOSED ACTIVITIES

No activities anticipated as pooled fund is pending federal project closure.

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

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

An article is being prepared for the winter Pavement Preservation Journal to report on latest findings of study. Data continues to be collected on test sections and results will factor into future decisions and discussed as part of phase III of this study (TPF-5(522)).

Michigan Department
Of Transportation
5307

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2024

STUDY TITLE: National Cooperative Highway Research Program (NCHRP)

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF-5(424)		MDOT START DATE	10/01/2023
PROJECT NO.	Not applicable		COMPLETION DATE (Original)	9/30/2024
OR NO.	OR24-201		COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Andre Clover, 517-749-9001 Email: CloverA@michigan.gov			
LEAD AGENCY	Federal Highway Administration (FHWA)			
PROJECT MANAGER	Jean Landolt, 202-493-3146 Email: Jean.Landolt@dot.gov			
CONTRACTOR	Not applicable			

BUDGET STATUS

FY 2024 MDOT Budget				Total Budget		
FY FUNDS	(Original)	$1,500,000.00		BUDGETED AMT.	(Original)	$1,500,000.00
	(Revised)			ACTUAL COST	(Revised)	$1,492,511.00
TOTAL FY 2024 EXPENDITURES		$1,492,511.00		Total Committed Funds Available		$7,489.00

PARTICPATING STATES

50 states and DC

PURPOSE AND SCOPE

Every federal fiscal year, state Departments of Transportation asked 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 appendices), 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 ACCOMPLISHMENTS

The NCHRP will continue to disseminate information throughout the transportation community and conduct independent research that benefits various transportation agencies throughout the country.

FISCAL YEAR 2025 PROPOSED ACTIVITIES

Active NCHRP projects will continue, and new projects approved will be initiated and placed under contract.

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

None.

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.

Michigan Department
Of Transportation
5307 (11/17)

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2024

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)	9/30/2024
		COMPLETION DATE (Revised)	1/31/2025
MDOT TECHNICAL CONTACT	Joel Tichenor, 517-636-4933 Email: TichenorJ@michigan.gov		
LEAD AGENCY	Utah DOT		
PROJECT MANAGER	David Stevens, 801-589-8340 Email: davidstevens@utah.gov		
CONTRACTOR	Brigham Young University		

BUDGET STATUS

FY 2024 MDOT Budget			MDOT Total Budget		
FY FUNDS	(Original)	$0.00	TOTAL BUDGET	(Original) FY 2020	$30,000.00
	(Revised)			(Revised)	
TOTAL FY 2024 EXPENDITURES		$0.00	TOTAL COMMITTED FUNDS AVAILABLE		$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 ACCOMPLISHMENTS

Status of each task at FYE is as follows:
Task 1 – 70% complete. Continued the literature review and survey.
Task 2 – 100% complete.
Task 3 – 100% complete.
Task 4 – 100% complete.
Task 5 – 90% complete. Continued work on Detailed Interim Reports including key parameters from the reinforced tests.
Task 6 – 70% complete. Draft Final Report for unreinforced LCC tests sent to TAC and review comments returned to research team. Continued work on the Draft Final Report for the reinforced LCC tests.
Task 7 – 70% complete.

FISCAL YEAR 2025 PROPOSED ACTIVITIES

This pooled fund project is nearly completion (~95% completed). The revised estimated project completion date is January 31, 2025

Draft Final Reports for Tasks 5 and 6 will be disseminated to the TAC and updated based upon review comments. Upon delivery of the Final Reports, they will be disseminated to all partner state members (TAC).

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 2025.

Michigan Department
Of Transportation
5307 (11/17)

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2024

STUDY TITLE: Aurora Program (FY 2020 - 2024)

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF- 5(435)		MDOT START DATE	10/01/2019
PROJECT NO.			MDOT COMPLETION DATE (Original)	9/30/2024
OR No.	OR20-212		COMPLETION DATE (Revised)	9/30/2026
MDOT TECHNICAL CONTACT	James Roath, 517-230-5361 Email: RoathJ1@michigan.gov			
LEAD AGENCY:	Iowa DOT			
PROJECT MANAGER	Khyle Clute, 515-239-1646 Email: Khyle.Clute@iowadot.us			
CONTRACTOR				

BUDGET STATUS

FY 2024 MDOT Budget				MDOT Total Budget		
FY FUNDS	(Original)	$25,000.00		TOTAL BUDGET	(Original)	$125,000.00
	(Revised)				(Revised)	
TOTAL FY 2024 EXPENDITURES		$25,000.00		TOTAL COMMITTED FUNDS AVAILABLE		$0.00

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 a 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.
- 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

The 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 ACCOMPLISHMENTS

Projects Completed:
Evaluation of Spring Load Restriction Removal Protocols
Road Weather Management using Connected Vehicle Technology
Roadway Ice/Snow Detection using a novel infrared thermography technology
Integration of connected vehicle and RWIS technologies
Assessment of connected vehicle friction measurement data on DOT Winter Maintenance use cases

May 2024 Meeting was held in Boulder, Colorado
- Prepared financial details, including commitment, encumbrances, and available funds.
- Solicited project ideas for the 2024 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.
- Discussed new Pooled Fund Solicitation

October 2024 Meeting held in Madison, Wisconsin
- Project updates and Invoices
- State Commitments and moving over to new Pooled Fund # after solicitation
- Management and Board Meeting Costs
- Overall Funds Available for Projects

FISCAL YEAR 2025 PROPOSED ACTIVITIES

Project: Optimal RWIS Sensor Density and Location-Phase 4
Project: Automating Variable Speed Limits Using Weather, Traffic Data
Project: Standardized Framework for Winter Weather Road Condition Indices
Project: An Intelligent Human-Centric Communication System for Adverse Weather and Road Conditions

Project: Roadway Friction Forecasting using Stationary and Mobile Friction Data

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

Spring 2025 Meeting location still to be determined.
Fall 2025 Meeting location is Denver, Colorado and will be a peer exchange between Aurora, Clear Roads, and AASHTO.

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 the project end date back to complete the work.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Project expected completion FY 2026.

Michigan Department
Of Transportation
5307 (11/17)

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2024

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 (On a Revised Schedule)	8/31/2025
MDOT TECHNICAL CONTACT	Allie Nadjarian, 517-331-6602 Email: NadarianA@michigan.gov			
LEAD AGENCY	Indiana DOT			
PROJECT MANAGER	Tommy Nantung, 765-463-1521 ext. 248 Email: tnantung@indot.in.gov			
CONTRACTOR				

BUDGET STATUS

FY 2024 MDOT Budget				MDOT Total Budget		
FY FUNDS	(Original)	$0.00		TOTAL BUDGET	(Original)	$120,000.00
	(Revised)				(Revised)	
TOTAL FY 2024 EXPENDITURES		$0.00		TOTAL COMMITTED FUNDS AVAILABLE		$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 limit 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 extends 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 effectives 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 ACCOMPLISHMENTS

- Continued FEA parametric studies on flexural and axial members to evaluate the effect of pack-out corrosion on the strength and fatigue performance of such members.
- Completed testing of the pull-plate specimens to study ductility in the presence of corrosion. The results are being incorporated into FEA models and are also being evaluated in the context of incorporating the results into the proposed AASHTO-ready guidelines.
- Continued work on parametric studies focused on compression members.
- Results (compression, tension, and fatigue) continue to be synthesized into draft AASHTO ready code and Commentary.

- Created a high-level summary of the portion of the work focused on tension components with results that will be used as the basis for the AASHTO language in preparation.

FISCAL YEAR 2025 PROPOSED ACTIVIITES

- Complete the finite element parametric studies.
- Continue to craft AASHTO-ready code and commentary for evaluation of members with pack-out corrosion for consideration by AASHTO COBS, S&E and S&M committees.

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 FY 2024.

A 12 month no cost extension was approved to:

- Perform additional parametric studies to enhance the work, as related to tension flanges with pack out and truss compression members with pack-out.
- Prepare the ballot language for AASHTO consideration and present at AASHTO committee meetings.
- Prepare and submit a final project report.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Project expected completion FY 2025.

Michigan Department
Of Transportation
5307 (11/17)

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2024

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)	9/30/2026
MDOT TECHNICAL CONTACT	Chris Byrum, 517-285-7085 Email: ByrumC@Michigan.gov			
LEAD AGENCY:	Iowa DOT			
PROJECT MANAGER	Khyle Clute, 515-239-1646 Email: Khyle.Clute@iowadot.us			
CONTRACTOR	Iowa State University			

BUDGET STATUS

FY 2024 MDOT Budget				MDOT Total Budget		
FY FUNDS	(Original)	$12,000.00		TOTAL BUDGET	(Original)	$80,000.00
	(Revised)				(Revised)	$60,000.00
TOTAL FY 2024 EXPENDITURES		$12,000.00		TOTAL COMMITTED FUNDS AVAILABLE		$0.00

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 categorized 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 consisted 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 (NRRA) 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 at 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 ACCOMPLISHMENTS

Information and PowerPoints from the Fall 2023 meeting held September 12-14 were made available at: https://cptechcenter.org/nc2-meetings/ • E-news and MAP Brief was published in Summer: NC² E-News: Summer 2023• MAP Brief on Revisiting Concrete Scaling: cdn-wordpress.webspec.cloud/intrans.iastate.edu/uploads/2023/07/revisiting_concrete_scaling_summer_2023_MB.pdf• News from the field includes; Illinois Center For Transportation: Performance Evaluation of Stabilized Support Layers for Concrete Pavements, MnDOT: Performance of Concrete Overlays over Full Depth Reclamation, ISU: Impact of Curling and Warping on Concrete Pavement: Phase II. One tech brief was published regarding thin concrete overlay behavior research at the following link; Research Solutions: Geotextiles used in road rehab may help extend pavement life. Spring and Fall Conferences were held. Information and PowerPoints from the Spring 2024 meeting held April 9-11 are available: https://cptechcenter.org/nc2-meetings/ The fall conference was a Big Deal and held concurrent with the 13th International Conference for Concrete Pavements in Minneapolis, MN where a full presentation session was held highlighting project research..

FISCAL YEAR 2025 PROPOSED ACTIVITIES

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

Project expected completion FY 2026.

Michigan Department
Of Transportation
5307 (11/17)

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2024

STUDY TITLE: Smart Work Zone Deployment Initiative

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)	12/31/2027
MDOT TECHNICAL CONTACT	Chris Brookes, 517-242-6486 Email: BrookesC@michigan.gov			
LEAD AGENCY	Iowa DOT			
PROJECT MANAGER	Khyle Clute, 515-239-1646 Email: Khyle.Clute@iowadot.us			
CONTRACTOR	Iowa State University			

BUDGET STATUS

FY 2024 MDOT Budget				MDOT Total Budget		
FY FUNDS	(Original)	$25,000.00		TOTAL BUDGET	(Original)	$125,000.00
	(Revised)				(Revised)	
TOTAL FY 2024 EXPENDITURES		$25,000.00		TOTAL COMMITTED FUNDS AVAILABLE		$0.00

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 headway 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 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 conducing 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 in 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 ACCOMPLISHMENTS

Reports completed during the 2024 fiscal year are as follows:

1. *Improving the Effectiveness of Speed Feedback Trailers in Freeway Work Zones*: This study investigated methods for improving the effectiveness of speed feedback trailers (SFTs) when used as a speed management strategy in highway work zones. The research included a literature review, a state department of transportation (DOT) survey, and field evaluations conducted at several freeway work zones. The findings were synthesized to provide recommendations on methods for optimizing the deployment of SFT in freeway work zones.
2. *Mobility and Safety Impacts of Work Zone Lane and Shoulder Widths*: The goal of this project was to quantify the mobility and safety impacts of different combinations of lane width and shy distance to a barrier for a given paved width. The research team developed a device to measure lateral distance and derive speed, vehicle length/type, and headway information under day and night conditions. Data collected at 17 locations in Illinois, Michigan, and Wisconsin were used for the analyses. Lateral distance data of over a quarter of a million vehicles were used for the safety analysis. Extreme value theory (EVT) modeling was conducted to estimate the probabilities of right edge line encroachment and right barrier contact. Wider lanes were found to have decreased edge line encroachment and barrier contact, while wider shy distances were associated with increased edge line encroachment and decreased barrier contact.

FISCAL YEAR 2025 PROPOSED ACTIVITIES

The 2025 problem statements RFP have been sent out and are as follows:

Subject 1: Best Practices and Evaluation of Automated Speed Enforcement in Work Zones
Subject 2: Traffic Control for Work Zones in Alternative Intersections
Subject 3: Identification and Testing of Crashworthy Temporary Sign Stands
Subject 4: Mobility and Safety Impacts of Work Zone Lane and Shoulder Widths- Part 2

Once all RFPs are submitted the board will review and determine which ones will be funded for the fiscal year 2025.

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

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Project expected completion FY 2027.

Michigan Department
Of Transportation
5307 (11/17)

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2024

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)	12/30/2025
MDOT TECHNICAL CONTACT	Matt Pratt, 517-643-5372 Email: PrattM@michigan.gov			
LEAD AGENCY	Colorado DOT			
PROJECT MANAGER	David Reeves, 303-757-9518 Email: david.reeves@state.co.us			
CONTRACTOR				

BUDGET STATUS

FY 2024 MDOT Budget				MDOT Total Budget		
FY FUNDS	(Original)	$10,000.00		TOTAL BUDGET	(Original)	$50,000.00
	(Revised)				(Revised)	
TOTAL FY 2024 EXPENDITURES		$10,000.00		TOTAL COMMITTED FUNDS AVAILABLE		$0.00

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 include 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 a 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 ACCOMPLISHMENTS

No Boundaries continued to add entries to the on-line maintenance innovations database, updated the No Boundaries website and sent weekly news posts to the No Boundaries mailing list. Three in-person meetings were held: October 17-19, 2024, in Virginia, May 10-12, 2024, in Louisiana and September 10-12, 2024, in North Dakota. TAC teleconferences were held on 1/31/24 and 7/31/24. Several syntheses efforts were completed in 2024 on topics including equipment acquisition and management, innovation showcases and virtual reality for maintenance training. The group drafted the solicitation for phase IV of the pooled fund, which CDOT posted on the TPF website.

FISCAL YEAR 2025 PROPOSED ACTIVITIES

The pooled fund administration contract has been extended to 9/30/25 to minimize a gap between Phase III of the pooled fund and upcoming phase IV, which should begin sometime in 2025. No Boundaries will continue to add entries to the on-line maintenance innovations database, update the No Boundaries website and send weekly news posts to the No Boundaries mailing list. One in-person meeting will be held, in spring of 2025 in Maine. A fall 2025 in-person meeting and additional activities may happen depending on available funds and which phase the pooled fund is in.

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

None. Based on the June 2024 quarter ending the project is 87% completed.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Project expected completion FY 2025.

Michigan Department
Of Transportation
5307 (11/17)

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2024

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	Linda Powell (517)331-7880 Email: PowellL2@michigan.gov			
LEAD AGENCY	Montana DOT			
PROJECT MANAGER	Rebecca Ridenour, 406-444-7203 Email: rridenour@mt.gov			
CONTRACTOR	Montana State University- Western Transportation Institute/Center for Health and Safety Culture (CHSC)			

BUDGET STATUS

FY 2024 MDOT Budget				MDOT Total Budget		
FY FUNDS	(Original)	$10,000.00		TOTAL BUDGET	(Original)	$50,000.00
	(Revised)				(Revised)	
TOTAL FY 2024 EXPENDITURES		$10,000.00		TOTAL COMMITTED FUNDS AVAILABLE		$0.00

PARTICIPATING STATES

KY, CA, CT, GADOT, IADOT, 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 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 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 ACCOMPLISHMENTS

- Resources and Tools to Reduce Multi-Risk Driving Behaviors –Task 4: create resources (PowerPoint presentation, poster and final webinar) and complete Final Report.
- Resources and Tools to Improve Pedestrian Safety – finalized Task 2 report; Task 3 developed a toolkit of tools and resources based on Task 1 and Task 2. Draft Task 3 report and toolkit submitted for review; begin Task 4.
- Understanding Aggressive Driving and Ways to Reduce It – Phase 1 finalized all deliverables and completed final webinar. Project complete.
- Understanding Aggressive Driving and Ways to Reduce It – Phase 2: expanded research of Phase 1 by developing and testing one or more strategies to engage bystanders to discourage aggressive driving and develop and test media messaging to reduce aggressive driving behavior. Research will be conducted from May 2024 to March 2026. Continue work on Task 1, complete interviews by the end of the quarter, and begin work on Task 3 to Develop and Test Media Messages.
- Planning Phase 3 kickoff meeting to be held in the spring of 2025.

FISCAL YEAR 2025 PROPOSED ACTIVITIES

- Promote Phase 3 of the TSC Pooled Fund.
- Attend and engage in an in-person kick-off meeting to create a management plan that will identify common research needs, select and prioritize research tasks, and provide oversight of these tasks.

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

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Phase 2 of the TSC Pooled Fund is complete in FY 2024. Pending final report.

Michigan Department
Of Transportation
5307 (11/17)

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2024

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	10/1/2022
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	Argonne National Laboratory			

BUDGET STATUS

FY 2024- MDOT Budget				MDOT Total Budget		
FY FUNDS	(Original)	$0.00		TOTAL BUDGET	(Original)	$80,000.00
	(Revised)				(Revised)	
TOTAL FY 2024 EXPENDITURES		$0.00		TOTAL COMMITTED FUNDS AVAILABLE		$0.00

PARTICIPATING STATES

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 ACCOMPLISHMENTS

Continued computational mechanics research on a variety of projects.
CFD modeling for DI 36x36, DI 112, DI 125, CB 9, and CB 18 Roadway Drainage Inlets.

The final report, "Computational Analysis of Hydraulic Efficiency of Michigan DOT Cover C" was published.
(https://www.anl.gov/argonne-scientific-publications/pub/189529)

The researcher provided capture efficiency curves that can be implemented in a spreadsheet, and we are working to find ways to incorporate in the ORD Drainage and Utilities.

FISCAL YEAR 2025 PROPOSED ACTIVITIES

Task 1: Computational Mechanics Research on a Variety of Projects
• hydraulic analysis of catch basins on grade and in sump
• analysis of water film thickness on pavements (hydroplaning water film thickness and speed)
• infiltration of water from roadside ditches
Task 2: Computational Mechanics Research Support This work will continue.

Task 3: Computing Support This work will continue.
JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))
None.
SUMMARY OF THE IMPLEMENTATION RECOMMENDATION
Project expected completion FY 2025.

Michigan Department
Of Transportation
5307 (11/17)

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	Garrett Dawe, 989-289-2388 Email: DaweG@michigan.gov		
LEAD AGENCY	FHWA		
PROJECT MANAGER	Laura Mero, 202-493-3377 Email: Laura.Mero@got.gov		
CONTRACTOR			

BUDGET STATUS

FY 2024 MDOT Budget			MDOT Total Budget		
FY FUNDS	(Original)	$20,000.00	TOTAL BUDGET	(Original)	$100,000.00
	(Revised)			(Revised)	
TOTAL FY 2024 EXPENDITURES		$20,000.00	TOTAL COMMITTED FUNDS AVAILABLE		$20,000.00

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 compliance with 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 has been completed and is now searching 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.

FISCAL YEAR 2024 ACCOMPLISHMENTS

- Several projects were initiated and are in various phases of progress/completion. They include evaluations of Pedestrian Signing at Unsignalized Crosswalks, Advisory Exit and Ramp Speed Signs, and Comprehension of Legibility of Selected Symbol Signs Phase IV and V.
- Final deliverable received for Advisory Exit and Ramp Speed Signs.

FISCAL YEAR 2025 PROPOSED ACTIVITIES

- Continued evaluation on Pedestrian Signing at Unsignalized Crosswalks.
- Continued evaluation on Comprehension of Legibility of Selected Symbol Signs Phase IV and V.
- Expecting several new efforts to come out of the Annual Meeting being held in October 2024 in Virginia.

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

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Project expected completion FY 2025.

Michigan Department
Of Transportation
5307 (11/17)

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2024

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 Email: FeldpauschE1@michigan.gov			
LEAD AGENCY	Ohio DOT			
PROJECT MANAGER	Jill Martindale, 614-644-8172 Email: jacquelin.martindale@dot.ohio.gov			
CONTRACTOR				

BUDGET STATUS

FY 2024 MDOT Budget				MDOT Total Budget		
FY FUNDS	(Original)	$50,000.00		TOTAL BUDGET	(Original)	$250,000.00
	(Revised)				(Revised)	
TOTAL FY 2024 EXPENDITURES		$50,000.00		TOTAL COMMITTED FUNDS AVAILABLE		$50,000.00

PARTICIPATING STATES

CO, CT, MDOT SHA, MI, MN, OH, PADOT, TX, VA

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.
The 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 ACCOMPLISHMENTS

IOO Strategic Roadmap (Project 1) is being utilized to develop concepts for future RFPs.

AV Industry Forum currently has 104 active users, and the Board plan is to incorporate continued use of the forum for future projects.

Overall study activities:
Monthly meetings
An RFP (Project 1) was posted. Study Title: **Guidance for Sustainable Integration of Automated Transportation Technologies.**
The objective is 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.
Project 2 developed a Stakeholder engagement plan and website to promote collaboration between academic, industry and government partners around the area of AV development and deployment. This will be supported throughout the life of the AV PFS.

FISCAL YEAR 2025 PROPOSED ACTIVITIES

A third project was started in FY 2024 and will continue in FY 2025. A concept for a 4th project is planned for development in FY 2025.

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

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Project expected completion FY 2025.

Michigan Department
Of Transportation
5307 (11/17)

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2024

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)	9/30/2025
			COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Erik Carlson, 517-230-8180 Email: CarlsonE2@michigan.gov			
LEAD AGENCY	South Dakota DOT			
PROJECT MANAGER	David Huft, 605-773-3358 Email: dave.huft@state.sd.us			
CONTRACTOR				

BUDGET STATUS

FY 2024 MDOT Budget				MDOT Total Budget		
FY FUNDS	(Original)	$55,600.00		TOTAL BUDGET	(Original)	$166,800.00
	(Revised)			FY 2025 $55,600 Incr.	(Revised)	$222,400.00
TOTAL FY 2024 EXPENDITURES		$55,600.00		TOTAL COMMITTED FUNDS AVAILABLE		$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 ACCOMPLISHMENTS

Worked on Tasks 4, 5 and 6 and starting to summarize work, as noted in Task 7, as noted above.

Published “Peak Streamflow Trends in Michigan and Their Relation to Changes in Climate, Water Years 1921-2020.” The document has been shared with EGLE’s Hydrologic Studies Unit.

Peak streamflow trends in Michigan and their relation to changes in climate, water years 1921–2020 (usgs.gov)

FISCAL YEAR 2025 PROPOSED ACTIVITIES
Finalize all tasks and project.
JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))
None.
SUMMARY OF THE IMPLEMENTATION RECOMMENDATION
Project expected completion FY 2025.

Michigan Department
Of Transportation
5307 (11/17)

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2024

STUDY TITLE: Consortium for Asphalt Pavement Research and Implementation (CAPRI)

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF-5(465)		MDOT START DATE	10/1/2022
PROJECT NO.	OR23-205		MDOT COMPLETION DATE (Original)	9/30/2025
			COMPLETION DATE (Estimate Revised Date)	12/31/2027
MDOT TECHNICAL CONTACT	Michelle Miller, 517-256-6799 Email: MillerM81@Michigan.gov			
LEAD AGENCY	Alabama DOT			
PROJECT MANAGER	Kidada Dixon, 334-353-6940 Email: dixonk@dot.state.al.us			
CONTRACTOR				

BUDGET STATUS

FY 2024 MDOT Budget				MDOT Total Budget		
FY FUNDS	(Original)	$10,000.00		TOTAL BUDGET	(Original)	$30,000.00
	(Revised)				(Revised)	
TOTAL FY 2024 EXPENDITURES		$10,000.00		TOTAL COMMITTED FUNDS AVAILABLE		$10,000.00

PARTICIPATING STATES

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 ACCOMPLISHMENTS

Spring and Fall meetings were held. Provide technical guidance on current and evolving specifications for asphalt materials. Develop asphalt pavement research needs. Conducted a lag and dwell time study. Developed implementation resources for Balance Mix Design, Density and Longitudinal Joint Density to help improve the performance, sustainability, value, and safety of asphalt pavements.

FISCAL YEAR 2025 PROPOSED ACTIVITIES
Spring and Fall Meeting will be held. Identify and prioritize gaps in policies, procedures and practices for CAPRI to focus on next. Evaluate the readiness level of the available technologies and barriers to implementation. Provide implementation strategies to move technologies into practice. Make recommendations of research needs, prioritize needs and develop research need statements.
JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))
None.
SUMMARY OF THE IMPLEMENTATION RECOMMENDATION
Project expected completion FY 2027.

Michigan Department
Of Transportation
5307 (11/17)

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2024

STUDY TITLE: National Road Research Alliance - NRRA (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)	1/31/2026
OR NO.	OR21-209		COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Kevin Kennedy, 517-749-9067 Email: KennedyK@Michigan.gov			
LEAD AGENCY	Minnesota DOT			
PROJECT MANAGER	Ben Worel, 763-381-2130 Email: ben.worel@state.ms.us			
CONTRACTOR				

BUDGET STATUS

FY 2024 MDOT Budget				MDOT Total Budget		
FY FUNDS	(Original)	$150,000.00		TOTAL BUDGET	(Original)	$750,000.00
	(Revised)				(Revised)	
TOTAL FY 2024 EXPENDITURES		$150,000.00		TOTAL COMMITTED FUNDS AVAILABLE		$150,000.00

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 (NRRA Phase-II) are:

- Implementation and technology transfer of NRRA Phase-I research efforts and other common interests.
- Continue to fund and support research and implementation efforts of common interest.
- Continue 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 measures 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 though 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 NRRA research projects through communication products that emphasize lessons learned and implementation.
- Assistance in putting research results into practice through technology transfer events.
- NRRA 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 NRRA 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:
- NRRA 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. NRRA 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 NRRA 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 NRRA tracks for each technical team.

FISCAL YEAR 2023 ACCOMPLISHMENTS

NRRA 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. NRRA had a technical track at the Minnesota Transportation Conference and Expo on May 15-17, 2023.

FISCAL YEAR 2024 ACCOMPLISHMENTS

Various technologies transfers and long-term research needs were completed and/or placed under contract. The project progress/final products were posted on the NRRA website. The conference was held in the spring. NRRA paid for travel to the International Concrete Conference and the International Society for Intelligent Construction Conference. NRRA Technical Teams have met every month which also acts as TAP meetings for each team's short and long-term research efforts. Monthly Research Pays Off webinars have been completed and a plan for 2025 topics is under development.

FISCAL YEAR 2025 PROPOSED ACTIVITIES
- Final contracts for 3 of the RFP's will be finalized in late 2024 or early 2025
- Final contract being worked on for the Missouri reflective cracking/NCAT additive study that Missouri is funding with SPR dollars
- Continued work on Phase-I pooled fund efforts and reporting progress in the team meetings
- Continued work on Phase-2 pooled fund efforts and reporting progress in the team meetings
- Conference planned for April 2025
- NRRA team will continue to meet monthly

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

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Project expected completion FY 2026.

1Michigan Department
Of Transportation
5307 (11/17)

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2024

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 Email: WagnerB@michigan.gov		
LEAD AGENCY	FHWA		
PROJECT MANAGER	Benjamin Graybeal, 202-493-3122 Email: Benjamin.graybeal@dot.gov		
CONTRACTOR			

BUDGET STATUS

FY 2024 MDOT Budget			MDOT Total Budget		
FY FUNDS	(Original)	$10,000.00	TOTAL BUDGET	(Original)	$50,000.00
	(Revised)			(Revised)	
TOTAL FY 2024 EXPENDITURES		$10,000.00	TOTAL COMMITTED FUNDS AVAILABLE		$0.00

PARTICIPATING STATES

FL, GA, 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 the 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. Members’ 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 ACCOMPLISHMENTS

- Continued 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.
- Continued 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.
- Published 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.
- 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.

FISCAL YEAR 2025 PROPOSED ACTIVITIES

- Continue to support AASHTO Committee on Bridges and Structures (CBS) Concrete Structures Committee as they evaluated the FHWA proposed draft UHPC Materials Conformance Guidance.
  TPF Program Standard Quarterly Reporting Format – 7/2011
- Continued work on a journal paper draft detailing the results of the experimental investigation utilizing servohydraulic and non-servo hydraulic loading frames in performing direct tension tests of UHPC specimens in accordance with AASHTO T 397.
- Continue work on the UHPC tensile fatigue behavior project: install third girder and initiate cycling.
- Draft document containing the results of 12 pretensioned beams that were designed to investigate the development length of prestressing strands. The document will also contain results from pullout block tests on untensioned strands. Document will also contain strand transfer length results from the variety of pretensioned elements that have been cast for testing at TFHRC in the past 6 years.

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.

Michigan Department
Of Transportation
5307 (11/17)

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2024

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	Carl Fedders, 517-897-6730 Email: feddersc@michigan.gov			
LEAD AGENCY	Minnesota Department of Transportation			
PROJECT MANAGER	Tom Peters, 651-366-3578 Email: tom.peters@state.mn.us			
CONTRACTOR				

BUDGET STATUS

FY 2024 MDOT Budget				MDOT Total Budget		
FY FUNDS	(Original)	$25,000.00		TOTAL BUDGET	(Original)	$125,000.00
	(Revised)				(Revised)	
TOTAL FY 2024 EXPENDITURES		$25,000.00		TOTAL COMMITTED FUNDS AVAILABLE		$50,000.00

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

Project 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.]

- *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 brine 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 ACCOMPLISHMENTS

Completed Projects

- Calculating Plow Cycle Times from AVL Data (CR 21-06)
- Using GIS to Highlight Highway Segments Sensitive to Deicing Materials (CR 20-05)
- Standard Test Procedures for Ice Melting Capacity of Deicers (CR 18-06)
- Training Module Development for Evaluation of Storm Severity Index and Winter Severity Index Variables (CR 21-04)
- Update to CR 13-04: Best Practices for Protecting DOT Equipment from the Corrosion Effect of Chemical Deicers (CR 21-02)

Funded Projects

- Toxicity Standards for the QPL (CR 24-01)
- Effective Pretreatment Methods for Events Beginning as Rain (CR 24-02)
- Salt Management Training for Non-DOT End Users (CR 24-03)
- Synthesis: Predictive Methods to Update the Road Report (CR 24-s1)
- Synthesis: Snow & Ice, 2030 - Be Ready for Change with the Snow & Ice Fighting Industry (CR 24-s2)
- Synthesis: Update of the Status of AVL / GPS for Winter Operations (CR 24-s3)
- Synthesis: Best Practices for Research Implementation (CR 24-s4)

Ongoing Projects

- pH Waiver for Deicing Products and the QPL (CR 22-06)
- Development of Public Service Announcement Library (CR 23-01)
- Quantifying the Economic Value of Snow and Ice Operations Success (CR 23-02)
- Updating the Capital Projects Decision Support Tool (CR 23-03)
- Using Vegetation Management Practices Near Roads to Leverage the Benefits of Solar Radiation (CR2 23-04)
- Synthesis: Management of Video Recordings and Images Taken from Truck-Mounted Cameras (CR 23-s1)
- Synthesis: Brine-Making Practices (CR 23-s2)
- Synthesis: UAV Uses for Winter Maintenance (CR 23-s3)

In-Person Meetings

- 2024 Spring Meeting (Annapolis, MD)
- 2024 Fall Meeting (Kalispell, MT)

Feature Articles

- October 2023: Taking the Guesswork Out of Deicer Selection
- October 2024: Tools to Make Better Winter Maintenance Decisions

Other

- Published the 2022-2023 State Winter Maintenance Data and Statistics database
- Continued to populate the Clear Roads Equipment Online Database
- Continued to manage the Clear Roads Qualified Products List

FISCAL YEAR 2025 PROPOSED ACTIVITIES

Select new projects at the 2025 Spring Meeting
Complete the following projects:

- Salt Shed Design Template (CR 20-06)
- Grip Sensor Technology and Salt Applications (CR 21-01)

- Determining the Migration of Chloride-based Deicers through Different Soil Types (CR 21-07)
- 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)
- Use of Dashboards for Winter Maintenance (CR 22-05)
- Development of a Public Service Announcement Library (CR 23-01)
- Quantifying the Economic Value of Snow and Ice Operational Success (CR 23-02)

Conduct the following in-person meetings:

- 2025 spring meeting (Richmond, VA)
- 2025 fall meeting (St. Paul, MN)

Other

- Publish an article in the APWA Reporter related to the Standard Test Method for Ice Melting Capacity of Deicers
- Publish the 2023-2024 State Winter Maintenance Data and Statistics database
- Continue to populate the Clear Roads Equipment Online Database
- Continue to manage the Clear Roads Qualified Products List

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

This continuation project (formerly 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.

Michigan Department
Of Transportation
5307 (11/17)

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2024

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 Email: ArnoldL1@michigan.gov			
LEAD AGENCY	Iowa DOT			
PROJECT MANAGER	Khyle Clute, 515-239-1646 Email: Khyle.Clute@iowadot.us			
CONTRACTOR				

BUDGET STATUS

FY 2024 MDOT Budget				MDOT Total Budget		
FY FUNDS	(Original)	$30,000.00		TOTAL BUDGET	(Original)	$150,000.00
	(Revised)				(Revised)	
TOTAL FY 2024 EXPENDITURES		$30,000.00		TOTAL COMMITTED FUNDS AVAILABLE		$30,000.00

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 a 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 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 RPF 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

Summary:
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.

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 ACCOMPLISHMENTS

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 in their state. This guidebook will be evaluated and updated every year.

Started work to create a data dictionary for road objects and their attributes or property sets.
Documented a process for how to create an information delivery manual for roads.
Conducted survey to Identify field tools (software) and resources that state DOTs are currently using.

FISCAL YEAR 2025 PROPOSED ACTIVITIES

Continue to develop data dictionary for roadway objects
Finalize clearinghouse website as a one stop searchable site for finding BIM topics and research
Develop information delivery manual and information delivery specifications for the design to construction workflow
Begin work developing the digital workflow for digital as-built plans.

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

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Project expected completion FY 2027.

Michigan Department
Of Transportation
5307 (11/17)

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2024

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 Email: CurtisR4@michigan.gov			
LEAD AGENCY	Indiana DOT			
PROJECT MANAGER	Anne Rearick, 317-232-5152 Email: arearick@indot.in.gov			
CONTRACTOR				

BUDGET STATUS

FY 2024 MDOT Budget				MDOT Total Budget		
FY FUNDS	(Original)	$50,000.00		TOTAL BUDGET	(Original)	$60,000.00
	(Revised)			FYs 24-26 $50k ea.	(Revised)	$210,000.00
TOTAL FY 2024 EXPENDITURES		$50,000.00		TOTAL COMMITTED FUNDS AVAILABLE*		$100,000.00

PARTICIPATING STATES

AK, AR, FHWA, IA, 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 the 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 institutions. 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 stakeholders’ 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. The outcome was replacement.
- Parish Road's span bridge with damaged 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 Colley 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 ACCOMPLISHMENTS

Technical assistance and instrumentation of Cut River for determination of fatigue life for hold down plates
Technical Review and evaluation of cracks on M-14 over the Huron River
Continued support for I-696 over I-75 project for evaluation of the retrofit holes in the web of the cross girder that were placed to arrest potential fractures that could pop in where the longitudinal girder flange passes through the web of the cross girder

FISCAL YEAR 2025 PROPOSED ACTIVITIES

Technical Assistance and Training. Testing and Monitoring of M-14 over the Huron River.

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 FYs 2024-2026 for a revised total commitment of $210,000.00.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Project expected completion FY 2026.

Michigan Department
Of Transportation
5307 (11/17)

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2024

STUDY TITLE: Transportation Management Centers Pooled Fund Study Phase II

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF-5(487)		MDOT START DATE	4/17/2022
PROJECT NO.	OR22-211		MDOT COMPLETION DATE (Original)	4/16/2027
			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 2024 MDOT Budget				MDOT Total Budget		
FY FUNDS	(Original)	$25,000.00		TOTAL BUDGET	(Original)	$125,000.00
	(Revised)				(Revised)	
TOTAL FY 2024 EXPENDITURES		$25,000.00		TOTAL COMMITTED FUNDS AVAILABLE		$75,000.00

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 was 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 ACCOMPLISHMENTS

The annual meeting and tour were held in May 2024 to review progress on current projects and select new projects and to tour the Kansas City SCOUT facilities. Additionally, four webinars were completed for TMS Emerging Topics. The Webinars were opened and hosted by NOCOE.

Quarterly virtual technical exchange meetings were held with member states.

Completed Reports:
1. Managing TMS Assets
2. Assessing and Reporting on TMS Capabilities and Performance
3. Predictive Analytics for TMS
4. Aligning TMC Staffing Capabilities for the Future of Systems Operations
5. Performance Measures and Health Index of Intelligent Transportation Systems Assets

FISCAL YEAR 2025 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, 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, Using Information on the Conditions of TMS Assets, and Locating and Placing TMS Field Devices.

Six webinars are scheduled for presenting TMS Emerging Topics.

MDOT plans to host a pilot workshop to assess our internal TMS capabilities for several dimensions of our TSMO program.

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

This PFS Phase 2 is active and running concurrently with TPF-5(319) Phase 1.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Project expected completion FY 2027.

Michigan Department
Of Transportation
5307 (11/17)

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2024

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 Email: GillS@michigan.gov			
LEAD AGENCY	FHWA			
PROJECT MANAGER	Paul Jodoin, 202-366-5465 Email: paul.jodoin@dot.gov			
CONTRACTOR	Volpe			

BUDGET STATUS

FY 2024 MDOT Budget				MDOT Total Budget		
FY FUNDS	(Original)	$25,000.00		TOTAL BUDGET	(Original)	$100,000.00
	(Revised)				(Revised)	
TOTAL FY 2024 EXPENDITURES		$25,000.00		TOTAL COMMITTED FUNDS AVAILABLE		$25,000.00

PARTICIPATING STATES

LTRC, CA, FHWA, FL, GA, IN, LA, MDOT SHA, MI, MN, MO, NC, NJ, NY, PA, TN, TX, UT, WA, MD, AL

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 will cover the 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 the remaining information.
FISCAL YEAR 2024 ACCOMPLISHMENTS
The second annual meeting took place in Cambridge, MA on May 1st and 2nd with Tim Schneider in attendance. The meeting was held at the USDOT Volpe Center and MassDOT. The pooled fund has developed a draft for the synthesis report, *Safety Service Patrol (SSP) Overview: A Synthesis Report*, which will be the deliverable for Phase 1 of the initial PFS research project. In Fiscal Year 2024 the team completed draft Chapters 1, 2, and 4 were circulated and updated with comments and feedback, Chapter 3 Draft is complete, Revised State Profile Drafts, draft white paper on sponsorship delivered, members continued to upload files to the filesharing structure to inform the research, and Phase 2 is in the planning stages.
FISCAL YEAR 2025 PROPOSED ACTIVITIES
Work on Phase 2 and potentially a whitepaper on PFS Challenges with EVs. The next SSP PFS Annual Meeting will be April 8-9, 2025, in New Orleans.
JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))
None.
SUMMARY OF THE IMPLEMENTATION RECOMMENDATION
Project expected completion FY 2025.

Michigan Department
Of Transportation
5307 (11/17)

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2024

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)	10/21/2028
MDOT TECHNICAL CONTACT	Marlon Spinks, 586-634-3952 Email: SpinksM@Michigan.gov		
LEAD AGENCY	Michigan Department of Transportation		
PROJECT MANAGER	Marlon Spinks		
CONTRACTOR			

BUDGET STATUS

FY 2024 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
TOTAL FY 2024 EXPENDITURES		$35,000.00	**TOTAL FUNDS AVAILABLE**		$415,980.00

Year	Total MDOT Contributions	Project Total Expenditures
2022	$35,000.00	*$15,352.95
2023	$35,000.00	$163,651.81
2024	$35,000.00	$238,402.04

*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 literature.

Project 6: State of the Art of Roadway Sensors – Phase 2

- Conducted project kickoff during September ENTERPRISE Board meeting.

FISCAL YEAR 2024 ACCOMPLISHMENTS

The following Phase III research secondary projects were initiated in FY 2024:

- 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

Planned/Scheduled the next in-person Board Meeting to be held in Detroit, MI on October 23rd and 24th.

FISCAL YEAR 2025 PROPOSED ACTIVITIES

Meet and report on the primary/secondary projects progress throughout the fiscal year. Sharing research results and implementation initiatives.

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 expected completion FY 2028.

Michigan Department
Of Transportation
5307 (11/17)

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2024

STUDY TITLE: Roadside Safety Pooled Fund – Phase 3

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF-5(501)		MDOT START DATE	1/1/2023
PROJECT NO.	OR23-204		MDOT COMPLETION DATE (Original)	9/30/2025
			COMPLETION DATE (Revised)	12/31/2027
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 2024- MDOT Budget				MDOT Total Budget		
FY FUNDS	(Original)	$65,000.00		TOTAL BUDGET	(Original)	$195,000.00
	(Revised)				(Revised)	
TOTAL FY 2024 EXPENDITURES		$65,000.00		TOTAL COMMITTED FUNDS AVAILABLE		$65,000.00

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 ACCOMPLISHMENTS

Completed Projects

1. T1969-AG: MASH TL-3 Transition Design with a Storm Drain Inlet: Phase II

Ongoing Projects

2. T1969-AA: 2023 Program Development & Coordination Effort
3. T1969-AB: Optimized Guardrail Blockouts
4. T1969-AC: W-Beam Guardrail in Front of Retaining Wall or Rip Rap
5. T1969-AD: Barrier Deflections at Lower Impact Severities
6. 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
7. T1969-AF: MASH TL-3 Evaluation of Signposts with Flashing Beacon Equipment
8. T1969-AH: 2023 Travel and Meeting Assistance
9. T1969-AI: Design and MASH Full-Scale Crash Testing and Evaluation of the Merritt Parkway Guiderail
10. T1969-AJ: Engineering Support Services and Recommendations for Roadside Safety Issues/Problems for Member States
11. T1969-AL: Guidelines for Overlapping Precast Portable Barriers
12. T1969-AM: MASH TL-5 Concrete Median Barrier with Shallowest Embedment or Footing in Asphalt
13. T1969-AN: MASH TL-3 Enhancement of Short Radius Guardrail System (SRGS) in Front of 2:1 Slope, Phase I
14. T1969-AO: MASH TL-3 Design, Testing, and Evaluation of a Flared Guardrail System, Phase II
15. T1969-AP: Evaluation of Multi-Post Large Sign Supports with Slip Base and Slip Hinge
16. T1969-AQ: Bridge Rail End Treatments Guidance for constrained Sites
17. T1969-AR: MASH Evaluation of Square Tubing Slip Base Sign Support Systems
18. T1969-AS: Simulation Modeling Improvements and Updates

FISCAL YEAR 2025 PROPOSED ACTIVITIES

Continued work on projects initiated in FY 2024. Also, additional projects will be selected for initiation at the upcoming annual pooled fund meeting in October 2024.

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

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Expected project completion FY 2027.

Michigan Department
Of Transportation
5307 (11/17)

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2024

STUDY TITLE: Concrete Bridge Engineering Institute (CBEI)

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF-5(508)		MDOT START DATE	10/1/2022
PROJECT NO.	OR23-206		MDOT COMPLETION DATE (Original)	9/30/2026
			COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Bradley Wagner, 517-256-6451 Email: wagnerb@michigan.gov			
LEAD AGENCY	Texas DOT			
PROJECT MANAGER	Darrin Jensen, 512-416-4728 Email: Darrin.jensen@txdot.gov			
CONTRACTOR				

BUDGET STATUS

FY 2024 MDOT Budget				MDOT Total Budget		
FY FUNDS	(Original)	$50,000.00		TOTAL BUDGET	(Original)	$200,000.00
	(Revised)				(Revised)	
TOTAL FY 2024 EXPENDITURES		$50,000.00		TOTAL COMMITTED FUNDS AVAILABLE		$100,000.00

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:
  - 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.
  - 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.
  - 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.
- 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. Most 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 ACCOMPLISHMENTS

Major development on the project began in earnest in January 2024. Accomplishments included development of a Concrete Bridge Materials Course and significant development for Bride Deck Construction Inspection course, something MDOT Subject Matter Experts are integrally supporting. The Concrete Solutions Center officially launched, and MDOT asked and received guidance on several topics including:

- Guidance on concrete bearing arrangements and national best practices.
- Guidance on equipment for measuring cracks in concrete
- Guidance on reasonable hold down forces for harped strands
- Guidance on Structural Health Monitoring for Pot Bearings

FISCAL YEAR 2025 PROPOSED ACTIVITIES

During FY 2025, the pooled fund will continue work on development of a Bride Deck Construction Inspection course. MDOT also plans to send our first person to a CBEI class, Concrete Bridge Materials Course in January 2025. The team also plans continued development on its on-site display of concrete members.

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

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Project expected completion FY 2026.

Michigan Department
Of Transportation
5307 (11/17)

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2024

STUDY TITLE: Work Zone Analytics

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF-5(514)		MDOT START DATE	11/15/2023
PROJECT NO.	OR24-208		MDOT COMPLETION DATE (Original)	9/30/2026
			COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Chris Brookes, 517-242-6486 Email: BrookesC@michigan.gov			
LEAD AGENCY:	Indiana Department of Transportation			
PROJECT MANAGER	Tommy Nantung, 765-463-1521 ext. 248 Email: tnantung@indot.in.gov			
CONTRACTOR				

BUDGET STATUS

FY 2024 MDOT Budget				MDOT Total Budget		
FY FUNDS	(Original)	$30,000.00		TOTAL BUDGET	(Original)	$90,000.00
	(Revised)				(Revised)	
TOTAL FY 2024 EXPENDITURES		$30,000.00		TOTAL COMMITTED FUNDS AVAILABLE		$60,000.00

PARTICIPATING STATES

FHWA, IL, MD, MI, PA, TX, UT, WI

PURPOSE AND SCOPE

Over a three-year period, Purdue University and the Indiana Department of transportation have been monitoring congestion and hard braking data across all 2,600 miles of Indiana Interstates using connected vehicle data. Reports from this data monitoring can provide insights into the impact of construction activities on congestion and have evolved over the three-year period. Indiana recognized there is a need to develop a multi-state consensus on the most effective reports.

This study will provide a framework to formalize reporting models, data reduction processes, and the decision making process so these techniques can be scaled to other states to assist them in proactively identifying emerging safety concerns in their work zones, conduct effective after action reviews of past work zones, and ultimately identify best practices for future work zones that minimize congestion, hard braking and ultimately crashes.

FISCAL YEAR 2024 ACCOMPLISHMENTS

A webinar was held on February 15, 2024. The research team shared examples of weekly heatmaps using Omnitracs connected truck data. Partner states were asked to submit interstate work zones of interest for their states, with SharePoint sites set up for each state to receive heatmaps, which were provided weekly.

The Purdue Research team presented “Work Zone Analytics” at the Midwest Work Zone Roundtable on May 9, 2024, to share pooled fund activities with a broader audience. A webinar was held on May 10, 2024, for partner states to review weekly heatmaps for selected case studies for work zones of interest as previously submitted. Weekly heatmaps were generated on all interstates for each TPF partner state, along with heatmaps specific to work zones (43 total) previously submitted by the states, which are updated every Monday in a shared one-drive folder. A heatmap monograph entitled “Measuring and Visualizing Freeway Traffic Conditions: Using Connected Vehicle Data” that demonstrates approximately 50 use cases was published.

Beginning in July, the weekly heatmap distribution to partner states included commentary that identified the top two or three noteworthy changes from the week before for each state. Another webinar was held on August 9, 2024, to review the weekly heatmaps for the partner states and select case studies for work zones of interest from those previously submitted by states. Dialogue on available data sources to monitor work zones included the more affordable truck data, but in some cases passenger car data provides better coverage of work zones. Potential application of hard braking data to monitor work zones was also included, along with the use of Vizzion truck dash cam images to monitor work zones conditions. Tactical webinars with individual states provided opportunities to discuss their work zones of interest in more detail and review associated heatmaps and noteworthy changes from previous weeks. These state specific webinars included: Wisconsin (July 29, 2024), Illinois (July 31, 2024), Texas (Aug. 2, 2024), and Illinois (Sept. 13, 2024).

FISCAL YEAR 2025 PROPOSED ACTIVITIES

Present pooled fund information at the Ohio Traffic Engineering Conference on October 9, 2024, and explore opportunities for Ohio DOT to join the Pooled Fund Study. Present research at the virtual National Work Zone Management Conference on October 22, 2024. Continue to prepare and distribute weekly heatmaps for the partner states with a high-level summary and key changes from the previous week for quick access and reference. Continue outreach activities to share findings with a broader audience and solicit participation in

the study. Continue to develop and strengthen private sector partnerships for collecting and analyzing connected vehicle data for work zone analysis activities. Prepare recommendations for the October 30, 2024, panel meeting.
JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))
None.
SUMMARY OF THE IMPLEMENTATION RECOMMENDATION
Project expected completion FY 2026.

Michigan Department
Of Transportation
5307 (11/17)

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 20--

STUDY TITLE: Evaluation of Low-Cost Safety Improvements

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF-5(515)		MDOT START DATE	10/1/2023
PROJECT NO.	OR24-207		MDOT COMPLETION DATE (Original)	9/30/2028
FORMER STUDY NO	TPF-(317)		COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Garrett Dawe, 989-289-2388 Email: DaweG@michigan.gov			
LEAD AGENCY:	FHWA			
PROJECT MANAGER	Kim Woon, 202-493-3383 Email: woon.kim@dot.gov			
CONTRACTOR				

BUDGET STATUS

FY 2024 MDOT Budget				MDOT Total Budget		
FY FUNDS	(Original)	$15,000.00		TOTAL BUDGET	(Original)	$75,000.00
	(Revised)				(Revised)	
TOTAL FY 2024 EXPENDITURES		$15,000.00		TOTAL COMMITTED FUNDS AVAILABLE		$60,000.00

PARTICIPATING STATES

AR, CO, KS, KY, LA, MA, MD, ME, MI, MO, MT, NE, NHDOT, PADOT, TX, UT, VA.

PURPOSE AND SCOPE

The goal of this research is to develop reliable estimates of the effectiveness of the safety improvements identified as strategies, including but not limited to, those in the National Cooperative Highway Research Program (NCHRP) Report 500 Guidebooks. These estimates will be determined by conducting scientifically rigorous before-and-after evaluations at sites in the United States where these strategies are being implemented. This work will support efforts towards Vision Zero and the Safe Systems Approach.

FISCAL YEAR 2024 ACCOMPLISHMENTS

Held Annual Meeting in Oklahoma City in June. Top safety needs were discussed, in addition to CMF development ideas and SLCI evaluation suggestions. The meeting also included topics on micromobility, motorcycles, MIRE data elements, and emerging topics.

FISCAL YEAR 2025 PROPOSED ACTIVITIES

New studies will kick off on Curb Extensions, Narrow Width Rumble Strips, and Wide Width Pavement markings.

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

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Project expected completion FY 2028.

Michigan Department
Of Transportation
5307 (11/17)

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2024

STUDY TITLE: Highway Safety Manual 2nd Edition (HSM2) Implementation

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF-5(516)		MDOT START DATE**	10/1/2022
PROJECT NO.	OR23-203		COMPLETION DATE (Original)	9/30/2027
			COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Daniel Garcia, 586-634-7671 Email: GarciaD1@michigan.gov			
LEAD AGENCY	FHWA			
PROJECT MANAGER	Matthew Hinshaw, 360-619-7677 Email: matthew.hinshaw@dot.gov			
CONTRACTOR				

BUDGET STATUS

FY 2024 MDOT Budget				MDOT Total Budget		
FY FUNDS	(Original)	$16,000.00		TOTAL BUDGET	(Original)	$80,000.00
	(Revised)				(Revised)	
TOTAL FY 2024 EXPENDITURES		$16,000.00		TOTAL COMMITTED FUNDS AVAILABLE		$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 ACCOMPLISHMENTS

The fund will have a peer exchange in Louisiana 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 length will be 3 total days.

FISCAL YEAR 2025 PROPOSED ACTIVITIES

Peer Exchange in Louisiana. Explore Active Project Ideas such as Update Part C Reference Guide for Predictive Methods, Evaluating Impact of "Adoption among the States and Incorporating Safe System Approach into the HSM.

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

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Project expected completion FY 2027.

Michigan Department
Of Transportation
5307 (11/17)

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2024

STUDY TITLE: Sustainable Performance Engineered Concrete

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF-5(517)		MDOT START DATE	10/1/2022
PROJECT NO.	OR23-207		COMPLETION DATE (Original)	9/30/2027
			COMPLETION DATE (Est. Revised End Date)	12/31/2029
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 2024 MDOT Budget				MDOT Total Budget		
FY FUNDS	(Original)	$40,000.00		TOTAL BUDGET	(Original)	$100,000.00
	(Revised)				(Revised)	
TOTAL FY 24 EXPENDITURES (Incl. FY 23 & 24)		$40,000.00		TOTAL COMMITTED FUNDS AVAILABLE		$60,000.00

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 affects 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 ensure 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 on 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 met/improved it would increase the ride quality, durability, and life of MDOT's concrete pavements. Thus, improving MDOT's transportation system.

FISCAL YEAR 2024 ACCOMPLISHMENTS

The lead researcher developed a scope and budget for the pooled fund study. After the review by TAC, the team submitted the scope and budget to Iowa DOT (pooled fund lead state) to get the project under contract. The items listed in the fiscal year 2023 were also detailed out in the scope. The Project was cleared by Federal Highway. Two additional DOTs joined the Pooled Fund study. There was a meeting to detail what the proposed project was going to include for the two additional DOTs.

FISCAL YEAR 2025 PROPOSED ACTIVITIES

Literature review will begin. Research on how construction practices impact concrete qualities will also begin. Determine how the project will specifically focus on these practices and detail out how they will be researched. The research group will visit project sites to review current practices and begin work on determining the best practices and their impact on the concrete properties.

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 2030.

Michigan Department
Of Transportation
5307 (11/17)

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2024

STUDY TITLE: Implementation of Structural Data from Traffic Speed Deflection Devices (Continuation)

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF-5(518)		MDOT START DATE	10/1/2023
PROJECT NO.	OR24-205		MDOT COMPLETION DATE (Original)	9/30/2027
			COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Paul Shapter, 517-243-7739 Email: Shapterp@michigan.gov			
LEAD AGENCY:	Virginia DOT			
PROJECT MANAGER	Brian Diefenderfer, 434-293-1944 Email: Brian.Diefenderfer@VDOT.Virginia.gov			
CONTRACTOR				

BUDGET STATUS

FY 2024 MDOT Budget				MDOT Total Budget		
FY FUNDS	(Original)	$55,000.00		TOTAL BUDGET	(Original)	$220,000.00
	(Revised)				(Revised)	
TOTAL FY 2024 EXPENDITURES		$55,000.00		TOTAL COMMITTED FUNDS AVAILABLE		$165,000.00

PARTICIPATING STATES

AR, CA, ID, IL, KS, KY, MI, MN, MO, MS, MT, ND, NM, NV, OK, PADOT, SC, SD, TN, TX, VA, VT, WI

PURPOSE AND SCOPE

The objectives of this follow-on pooled fund study include continuation of an existing research consortium that focuses on providing participating agencies guidance on how to specify and implement TSDD data within their respective pavement management systems and processes. Specific tasks within this multi-year program will be developed in cooperation with the partner agencies.

The work plan will be developed based on the priorities indicated by the pooled fund study partner agencies during the kick-off meeting. It is anticipated that the details and scope of the study will be further defined by the partner agencies throughout the life of the study. It is proposed that the project will initially include the following tasks: 1) Develop case studies that document how partner agencies have incorporated pavement structural data into their pavement management processes; 2) Develop analysis procedures to evaluate concrete-surfaced and composite pavements; 3) Develop or summarize ongoing efforts related to TSDD device calibration; 4) Investigate the effect of structural condition on the rate of pavement deterioration; 5) Provide targeted technical assistance to participating agencies for effective use of TSDD data within their specific pavement management system and processes; 6) Develop webinars and training materials for use by the partner agencies to assist with implementation of pavement structural data into their respective pavement management systems.

The technical activities for this study will be led by the Virginia Tech Transportation Institute (VTTI). The Virginia Department of Transportation (VDOT) will serve as the lead agency through its research division, the Virginia Transportation Research Council (VTRC). This collaborative research program will provide an accessible and efficient way for highway agencies and other organizations to evaluate tools and products, conduct research, and coordinate testing, training, and deployment activities to enhance the life-cycle performance of their pavement assets. Consortium participants will have access to extensive sources of data, information, and knowledge and decide on the focus of the study and the specific research projects carried out by the consortium. The benefit-cost ratio will be very significant because the cost of the different projects will be shared by a group of participants.

FISCAL YEAR 2024 ACCOMPLISHMENTS (Benefits to MDOT)

- Traffic speed deflectormeter data was collected on Michigan state trunklines. Data analyzes during 2024. The raw data along with the analyzed data will be delivered to MDOT for its use and records.
- Attend remote pool fund annual symposium.
- Develop route(s) for additional collection.
- The delivered data will assist in MDOTs project program planning, recommendations, and investigation(s). The data will help reduce construction costs and traffic delays.

FISCAL YEAR 2025 PROPOSED ACTIVITIES

- Attend remote pool fund annual symposium.
- Develop route for additional collection.

- Work to develop plan to develop Specifications for TSDD Data Collection.

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

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Project expected completion FY 2027.

Michigan Department
Of Transportation
5307 (11/17)

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2024

STUDY TITLE: National Partnership to Improve the Quality of Preventive Maintenance Treatment Construction & Data Collection Practices (PG Phase III)

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF-5(522)		MDOT START DATE	10/1/2023
PROJECT NO.	OR24-205		MDOT COMPLETION DATE (Original)	9/30/2027
			COMPLETION DATE (Revised)	12/31/2029
MDOT TECHNICAL CONTACT	Tyler Hunt, 517-256-9592 Email: HuntT2@michigan.gov			
LEAD AGENCY:	Minnesota DOT			
PROJECT MANAGER	Joel Ulring, 651-366-5432 Email: joel.ulring@state.mn.us			
CONTRACTOR				

BUDGET STATUS

FY 2024 MDOT Budget				MDOT Total Budget		
FY FUNDS	(Original)	$50,000.00		TOTAL BUDGET	(Original)	$200,000.00
	(Revised)				(Revised)	
TOTAL FY 2024 EXPENDITURES		$50,000.00		TOTAL COMMITTED FUNDS AVAILABLE		$150,000.00

PARTICIPATING STATES

AK, AL, AR, CO, DE, ID, IL, MA, MDOT SHA, MI, MN, MS, NC, ND, NY, SC, TX, WA, WI

PURPOSE AND SCOPE

This pooled-fund study is being developed to assist SHAs and LPAs in reviewing and developing pavement PM treatments which can advance their pavement preservation programs. This study also supplements ongoing data analysis of existing pavement test sections in Minnesota (NRRA-MnROAD) and Alabama (NCAT) and support continued implementation activities established. Combining these efforts will establish a national construction and data collection effort of pavement PM treatments applied to roadways at the direction of the study's Technical Advisory Committee (TAC). Participation in the study is being encouraged by SHAs, LPAs, FHWA, Federal Lands Highway Division, academia and industry representatives. Collaboration with experts from these groups will help set criteria for identifying PM construction practices and data collection requirements, discuss optimal timing for placing of PM treatments and establishing the minimum number of pavement sections required for each type of PM treatment used for statistical analysis. Non-financial participants can provide technical knowledge and input; however, financial contributors will make final decisions on treatments to be constructed.

Using the outcome from the above collaborative activities, the study partners will initiate and monitor State, local, and Federal PM treatments and projects to develop preventive maintenance solutions (i.e. decision trees, toolboxes, etc.). Implementation of practical research results from other PM cooperative projects (i.e. NCAT, MnROAD, NCPP) will be used to assess the impact of preventive maintenance treatments on extending service life of pavements. Lessons learned will be documented and shared along with information to assist in the updating of the national pavement preservation research roadmap.

The scope of this project consists of several tasks including project administration, identifying selecting pavement sections/projects, constructing PM test sections incorporating established AASHTO standards to validate and verify existing construction practices. The tasks of this study will build off the success of previous pavement preservation pooled fund projects PG1 TPF-5(267), & PG2 TPF-5(375).

The intent of the study is to assist SHAs, LPAs and Federal Lands by developing guidance and design methods. With assistance from the SHAs, the TAC will develop the scope of work for the study. It will also provide the technical knowledge and oversight of the construction and data gathering for the projects.

FISCAL YEAR 2024 ACCOMPLISHMENTS (Benefits to MDOT)

Task 1 -
Begin identifying, updating, and/or drafting project documentation forms. All LTPP data forms were collected and reviewed. Specific PG3 items included Project Nomination form (online), Project flowchart, and Chip Seal Construction field data form.

Task 5 -
Held the initial TAP Kickoff meeting on March 1. Most of the participating states attended, and their respective project contact representatives were identified.

- Starting March 8, held weekly "Touch Point" meetings with the MnDOT and NCAT leads.

- Worked out the logistics to have the second annual in person TAP meeting in conjunction with the Rocky Mountain West Pavement Preservation Partnership Meeting in November in Sacramento, CA.

Task 6 -
In preparation for the May 2024 TAP Meeting, conducted and performed planning and logistical activities that included the following:
- Procured and finalized the lodging contract.
- Coordinated with NCAT to procure a meeting facility.
- Coordinated with NCAT to procure registration for TAP Panel Members attending the NCAT Annual Meeting.
- Communicated meeting details to TAP Members and attendees.
- Made Travel Arrangements (i.e. flights, rental cars, lodging, etc.).
- Set up alternative virtual options for participation.
- Performed miscellaneous associated tasks including correspondence and documentation.

NCAT

Task 1 –
Performance data collection and analysis of existing sections continued following the same process established during Phases I and II of the study.

Task 2 –
Worked with MnDOT and NCPP to develop project nomination and construction data forms.

Task 5 –
Performed an update to the online tool for visualization of performance results of existing test sections.
Coordinated with NCPP to organize an in-person TAP meeting in conjunction with the NCAT Test Track Conference.

BENEFITS:
MOT will benefit from all deliverables, especially the NCAT and MnROAD test track data. This allows numerous test sections to be performed on one road network without each state needing to perform its own testing. This allows for economies of scale and MDOT benefits from the large research resources available in Auburn and Minnesota that would not be practical for the small MDOT CPM staff to perform in house.

FISCAL YEAR 2025 PROPOSED ACTIVITIES

NCPP
Continued development of project data forms
Project nominations reviews
Work with partner state to fill in project treatments and schedules
Hold a virtual TAP (Fall 2024) meeting

NCAT
Data collection and analysis of existing sections
Finalize online project nomination form. Review nominations.
Develop reporting requirement forms for new projects
Host 2025 spring in-person TAP meeting at NCAT

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

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Project expected completion FY 2029.

Michigan Department
Of Transportation
5307 (11/17)

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2024

STUDY TITLE: Building Information Modeling (BIM) for Bridges and Structures - Phase II

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF-5(523)		MDOT START DATE	12/1/2023
PROJECT NO.	OR24-203		MDOT COMPLETION DATE (Original)	9/30/2028
			COMPLETION DATE (Revised)	1/31/2029
MDOT TECHNICAL CONTACT	Bradley Wagner, 517-256-6451 Email: WagnerB@michigan.gov			
LEAD AGENCY:	Iowa DOT			
PROJECT MANAGER	Khyle Clute, 515-239-1646 Email: Khyle.Clute@iowadot.us			
CONTRACTOR				

BUDGET STATUS

FY 2024 MDOT Budget				MDOT Total Budget		
FY FUNDS	(Original)	$25,000.00		TOTAL BUDGET	(Original)	$100,000.00
	(Revised)				(Revised)	
TOTAL FY 2024 EXPENDITURES		$25,000.00		TOTAL COMMITTED FUNDS AVAILABLE		$75,000.00

PARTICIPATING STATES

AL, CA, DE, FL, GADOT, IADOT, IL, IN, MI, MN, MS, MT, NC, NE, NY, OH, OK, PADOT, TX, UT, VT, WA, WI

PURPOSE AND SCOPE

This pooled fund project will provide the primary mechanism for AASHTO COBS T-19 to expand and refine the outcomes of TPF-5(372) and developing additional guide specifications for open BIM national data standards to support model-based exchanges of workhorse bridges.

Major tasks in this scope of work include:

1. Based on the BIM uses prioritized under TPF-5(372), develop national standards for data definitions, requirements and validation tools for the bridge life cycle for multiple data exchanges for transportation bridges and structures. These national standards are to follow building SMART open BIM requirements.
2. Develop training materials to continue deployment of the outcomes from TPF-5(372) and additional data standards developed under this project.
3. 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.
4. Assist AASHTO members with collaboration efforts with the AASHTO Joint Subcommittee on Data Standardization, FHWA, the Transportation Research Board, and other transportation pooled funds.
5. Collaborate with building SMART and software vendors.
6. Collect and quantify the benefits of using the IFC standard per the methodology suggested in TPF-5(372).
7. Explore technology or tools to enable secure mechanisms for signing and sealing model-based deliverables.
8. Conduct a literature search on contractual provisions for digital model-based delivery and develop recommendations for a national framework.
9. Investigate opportunities to improve existing workflows to leverage model exchanges for the bridge lifecycle.

FISCAL YEAR 2024 ACCOMPLISHMENTS (Benefits to MDOT)

The project officially began in December of 2023; however, work didn't start until March/April of 2024, due to efforts to finalize TPF-5(372).

Work began on Task 1" Development of Open Data Standards". A significant amount of effort was expended to formalize a methodology for future development with BuildingSmart International. A recommendation memo was delivered and approved by the pooled fund.
Additionally, efforts were spent to prioritize data exchanges for development by the pooled fund team. Several exchanges were prioritized, including As- Built and Fabrication. Lastly, the study team developed draft recommendations for training outlines and shared for pooled fund members' review.

FISCAL YEAR 2025 PROPOSED ACTIVITIES

During FY 2025, the team will focus on software vendor engagement, development of prioritized data exchanges, and support for state DOTs' project pilots.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))
None.
SUMMARY OF THE IMPLEMENTATION RECOMMENDATION
Project expected completion FY 2029.

Michigan Department
Of Transportation
5307 (11/17)

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2024

STUDY TITLE: 2nd International Roadside Safety Conference and Peer Exchange

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF-5(525) / Sol. 1591		MDOT START DATE	10/1/2023
PROJECT NO.	OR24-209		MDOT COMPLETION DATE (Original)	9/30/2024
			COMPLETION DATE (Revised)	1/31/2025
MDOT TECHNICAL CONTACT	Kristin Schuster, 517-256-7145 Email: SchusterK@michigan.gov			
LEAD AGENCY:	Florida Department of Transportation			
PROJECT MANAGER	Jennifer Clark, 850-414-4614 Email: Jennifer.clark@dot.state.fl.us			
CONTRACTOR				

BUDGET STATUS

FY 2024 MDOT Budget				MDOT Total Budget		
FY FUNDS	(Original)	$10,000.00		TOTAL BUDGET	(Original)	$10,000.00
	(Revised)				(Revised)	
TOTAL FY 2024 EXPENDITURES		$10,000.00		TOTAL COMMITTED FUNDS AVAILABLE		$0.00

PARTICIPATING STATES

AL, FL, GA, ID, KY, MA, MI, NE, TX

PURPOSE AND SCOPE

The Transportation Research Board's (TRB's) Roadside Safety Design (AKD20) standing committee is concerned with the development and evaluation of forgiving highway roadsides through countermeasures, safety hardware, and features and practices that will reduce the number and severity of roadway departure crashes and optimize the safety benefit to the traveling public. To provide a forum for professionals from across the globe to share and discuss efforts to reduce roadway departures, the AKD20 committee held the 1st International Roadside Safety Conference (IRSC) and Peer Exchange in 2017 that had 231 participants from 25 countries. The committee is now actively planning for the 2nd International Roadside Safety Conference (IRSC) and Peer Exchange.

Partner state participants and roadside safety experts appoint committee members consisting of U.S. and International representatives to guide the planning of this two- or three-day IRSC and Peer Exchange. The conference will provide a forum to (1) explore current roadside safety problems and practices, both in the United States and abroad, (2) provide a peer exchange to discuss and disseminate research related to a full range of issues, including administration, planning, design, construction, operations, and maintenance, and (3) provide exhibition space for manufacturers and private industry to showcase new technologies and/or conduct live demonstrations. The event was originally proposed for the summer of 2024. Deliverables will include quarterly reports, a final report, electronic access to all presentations, and conference presentations/papers and refereed journal articles. Each partner state will be a member of the Technical Advisory Committee (TAC) and it is anticipated they will receive two or four complimentary conference registration fee waivers for commitments of $5,000 or $10,000 or more, respectively.

FISCAL YEAR 2024 ACCOMPLISHMENTS

Conference planning activities included: A kick-off meeting of the conference committee and follow up meetings; Development of a conference theme and key areas of interest; Issuance of a Call for Presentations and/or Papers; Production of a conference announcement and ongoing communications/marketing to advertise event; Creation of a conference web page with general event and registration information; Archive of presentations on a conference website; Publication of papers in conference proceedings and a refereed journal; Development of both preliminary and final conference agendas with posting on conference web page; Development of a prospectus to attract and register exhibitors to conference and manage all logistics; Selection of U.S. location and hotel/conference center to accommodate up to 300 participants.

FISCAL YEAR 2025 PROPOSED ACTIVITIES

Complete planning activities for the IRSC and Peer Exchange event being held January 5-9, 2025.

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

The IRSC and Peer Exchange event was delayed into FY 2026 to ensure proper planning, align with availability of selected location and accommodations, and allow sufficient time for attendees to coordinate attendance.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Expected project completion FY 2026.

Michigan Department
Of Transportation
5307 (2011)

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2024

STUDY TITLE: TRB Core Program Activities FFY 2024 (TRB FY 2025)

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF-5(530)		MDOT START DATE	10/01/2023
PROJECT NO.	Not applicable		MDOT COMPLETION DATE (Original)	09/30/2024
OR NO.	OR24-200		PROJECT COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Andre Clover, 517-749-9001 Email: CloverA@michigan.gov			
LEAD AGENCY	Federal Highway Administration (FHWA)			
PROJECT MANAGER	Jean Landolt, 202-493-3146 Email: Jean.Landolt@dot.gov			
CONTRACTOR				

BUDGET STATUS

FY 2024 MDOT Budget				Total Budget		
FY FUNDS	(Original)	$230,000.00		BUDGETED AMT.	(Original)	$230,000.00
				ACTUAL COST		$231,412.00
TOTAL FY 2024 EXPENDITURES		$231,412.00		TOTAL COMMITTED FUNDS AVAILABLE		$231,412.00

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 2025 covers the period from July 1, 2024- June 30, 2025

FISCAL YEAR 2024 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 2024 through the TPF-5(530) 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.

Michigan Department
Of Transportation
5307 (11/17)

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2024

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

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF-5(532) Sol. 1598	MDOT START DATE	6/03/2024
PROJECT NO.	OR23-309	MDOT COMPLETION DATE (Original)	9/30/2028
		COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Andre Clover, 517-749-9001 Email: CloverA@michigan.gov		
LEAD AGENCY	Michigan Department of Transportation		
PROJECT MANAGERS	Elise Feldpausch, 517-636-0036 Email: FeldpauschE1@michigan.gov		
CONTRACTOR			

BUDGET STATUS

FY 2024 MDOT Budget			MDOT Total Budget		
FY FUNDS	(Original)	$30,000.00	TOTAL BUDGET	(Original)	$150,000.00
	(Revised)			(Revised)	
TOTAL FY 2024 EXPENDITURES		$30,000.00	TOTAL COMMITTED FUNDS AVAILABLE		$120,000.00

PARTICIPATING STATES

ADOT, IL, IN, KS, KY, 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 polices 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 ACCOMPLISHMENTS

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

FISCAL YEAR 2025 PROPOSED ACTIVITIES

FY 2025 will have us posting the as-needed consultant RFP to support the actions of the pooled fund study. We will look to select up to 5 vendors that will support the actions in all 10 states. These will be selected and then the initial actions to be taken to move the committee efforts forward. These efforts will include but are not limited to, the refinement of the regional strategy into a short-term implementation plan, collaborative information sharing for 2 focus groups surrounding data sharing and community outreach.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))
None.
SUMMARY OF THE IMPLEMENTATION RECOMMENDATION
Project expected completion FY 2028.

APPENDIX

FISCAL YEAR 2023 REPORT UPDATES

The following update notes changes to the MDOT *State Planning and Research Part II Program Fiscal Year 2023 Annual Report*:

Table 1 – 80% Federally Funded Projects (Pg. 7-8):

- $258,011.19 in costs were reported for project number 211053, “Electronic Water Level Sensors for Monitoring Scour Critical Structures,” under contract with the University of Michigan (UM) number 2019-0312 Authorization 5. Expenses should have been reported as *$191,635.42* with total cost to date through fiscal year-end of *$376,129.38*. The cost reported on the project form should also be revised (Pg. 37).

- $202,076.72 in costs were reported for project number 211061, “Evaluation of MDOT’s Methodologies for Both Quantifying Pavement Distress and Modeling Pavement Performance for LCC and RSL Estimation Purposes,” under contract with Michigan State University (MSU) number 2021-0288. Expenses should have been reported as *$202,207.88* with total cost to date through fiscal year-end of *$512,093.48*. The cost reported on the project form should also be revised (Pg. 43).

- $115,852.34 in total 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. Total expenses should have been reported as *$136,638.31* with total cost to date through fiscal year-end of *$188,119.11*. The cost reported on the project form should also be revised (Pg. 55).

- $183,846.08 in costs were reported for project number 213316, “Michigan Hydrologic Calculation Procedures,” under contract with Michigan Technological University (MTU) number 2019-0311 Authorization 3. Expenses should have been reported as $195,372.94 with total cost to date through fiscal year-end of $329,031.18. Expenses should have been reported as $195,372.94 with total cost to date through fiscal year-end of $329,031.18. Expenses should have been reported as $195,372.94 with total cost to date through fiscal year-end of $329,031.18. Expenses should have been reported as *$195,372.94* with total cost to date through fiscal year-end of *$329,031.18*. The cost reported on the project form should also be revised (Pg. 58).

- $85,822.91 in costs were reported for project number 218392, “Multimodal Aircraft Charging Station Deployment - Phase I,” under contract with C&S Engineers, Inc., number 2023-0205. Expenses should have been reported as *$81,253.06.* The cost reported on the project form should also be revised (Pg. 81).