Michigan Transportation Asset Management Council

Meeting Agenda

Wednesday, June 1, 2022 @ 1:00 PM
MDOT Aeronautics Bldg., 1st Floor Auditorium
2700 Port Lansing Road, Lansing, Michigan

A meeting of the Transportation Asset Management Council (TAMC), A Michigan Public Body, will take place at the time and location listed above. Accommodations can be made for persons who require mobility, visual, hearing, written, or other assistance for participation. Large print materials, auxiliary aids or the services of interpreters, signers, or readers are available upon request. Please contact Orlando Curry at 517-335-4381 or complete Form 2658 for American Sign Language (ASL). Requests should be made at least five days prior to the meeting date. Reasonable efforts will be made to provide the requested accommodation or an effective alternative, but accommodations may not be guaranteed.

Public Comment for non-agenda items is available at the beginning and ending of the meeting, typically limited to 3 minutes. Public comment on agenda items is also available with each item when called upon by the TAMC Chair.

Meeting Telephone Conference Line: +1 248-509-0316 Access Code: 831 066 359 #

Web Meeting Access Link: Click here to join the meeting

1. **Welcome - Call to Order**

2. **Changes or Additions to the Agenda (*Action Item as needed*)** *Any items under the Consent Agenda may be moved to the regular agenda upon request of any Council member, member of the public or staff member.*

3. **Public Comments on Non-Agenda Item**

4. **Consent Agenda *(Action Items)***
   - **4.1.** Approval of the April 6, 2022 Meeting Minutes ***(Attachment 1)***
   - **4.2.** TAMC Financial Report ***(Attachment 2)***

5. **MIC Update –** Ryan Laruwe, MIC Executive Director

6. **Action Item**
   - **6.1.** Transportation Asset Management Plans ***(Attachment 3)***
   - **6.2.** EPA Environmental Finance Center ***(Attachment 4)***
   - **6.3.** Consideration of Budget Amendment for SEMCOG (***Attachment 5)***

7. **Presentations & Announcements**
   - **7.1.** Data Collection State of Practice Report by Tim Colling, PhD PE, MTU Director, Center for Technology & Training ***(Attachment 6)***
   - **7.2** Gary Mekijan Resignation

8. **Old Business**
   - **8.1.** TAMC Schedule of Activities & Training 2022 ***(Attachment 7) Council members if you have not volunteered for a session, please sign up.***
   - **8.2.** TAMC Coordinator Update
   - **8.3.** 2021 TAMC Michigan Roads and Bridges Annual Report April 29, 2022
   - **8.4.** State Transportation Commission April 21, 2022 Meeting
     - **8.4.1.** Appointment of Jacob Hurt as the new MAR Representative and the reappointment of Joanna Johnson as the CRA Representative Approved

9. **Committee Review & Discussion Items**
   - **9.1. Bridge Committee Update –** *Wieferich/Jones*

9.2. ACE Committee Update – *Mekjian/Buck/Surber/White/Hurt*

9.2.1. 20 Year TAMC Celebration and Conference

- Presentations
- Awards – Carmine Palombo and Organization

- Sponsorships

9.2.2. Asset Management Orientation for New Staff (for Planning Agencies/Local Agencies/Center for Technology and Training)

9.3. Data Committee Update – *McEntee/Tubbs/Surber/Slattery/Buck*

10. Public Comments

11. Member Comments

12. Adjournment

Next Meeting, July 6, 2022 1 PM – 3 PM
MDOT Aeronautics Bldg., 2700 Port Lansing Road, Lansing, Michigan

TRANSPORTATION ASSET MANAGEMENT COUNCIL MEETING
April 6, 2022 at 1:00 p.m.
MEETING MINUTES

This meeting was held via hybrid with Microsoft Teams and at the Michigan Department of Transportation Aeronautics Building Auditorium, 2700 Port Lansing Road, Lansing, Michigan. Below are meeting minutes as provided under Act 267 of the Public Acts of 1976 as amended, or commonly referred to as the Open Meetings Act. Accommodations can be made for persons who require mobility, visual, hearing, written, or other assistance for participation. Large print materials, auxiliary aids or the services of interpreters, signers, or readers are available upon request. Please contact Orlando Curry at 517-335-4381 or complete Form 2658 for American Sign Language (ASL). Requests should be made at least five days prior to the meeting date. Reasonable efforts will be made to provide the requested accommodation or an effective alternative, but accommodations may not be guaranteed.

**** Frequently Used Acronyms List attached**

Members Present:
Derek Bradshaw, MAR, Lansing, MI
Joanna Johnson, CRA, Lansing, MI – Chair
Bill McEntee, CRA, Lansing, MI – Vice-Chair
Rob Surber, DTMB/CSS, Lansing, MI
Todd White, MDOT, Lansing, MI
Ryan Buck, MTPA, Lansing, MI
Kelly Jones, MAC, Lansing, MI
Robert Slattery, MML, Lansing, MI
Jennifer Tubbs, MTA, Lansing, MI
Brad Wieferich, MDOT, Lansing, MI

Support Staff Present:
Tim Colling, MTU/LTAP
Cheryl Granger, DTMB/CSS
Dave Jennett, MDOT
Gloria Strong, MDOT
Rebecca Curtis, MDOT
Rob Green, MDOT
Eric Mullen, MDOT
Mike Toth, MDOT

Public Present:
Heather Hoeve, MDOT
Jacob Hurt, R2PC
Ed Hug, SEMCOG
Ryan Laruwe, MIC, Treasury

Members Absent:
Gary Mekjian, MML

1. Welcome – Call-To-Order:
The meeting was called-to-order at 1:00 p.m.. Everyone introduced themselves and were welcomed to the meeting.

2. Changes or Additions to the Agenda (Action Item, as needed):
None

3. Public Comments on Non-Agenda Items:
None

4. Consent Agenda (Action Item):

4.1. – Approval of the March 2, 2022 Meeting Minutes (Attachment 1)

4.2. – TAMC Financial Report (Attachment 2)

R. Green provided an updated copy of the TAMC Budget Financial Report. The changes for the regions have not been accounted for in the budget.

Motion: B. McEntee made a motion to approve the Consent Agenda with amendments to the meeting minutes as provided to G. Strong from J. Johnson; R. Slattery seconded the motion. The motion was approved by all members present.

5. Presentation:

5.1.-2021 Michigan Roads and Bridges Annual Report –R. Green/D. Jennett (Attachment 3)

R. Green received four comments that have been included in the annual report. D. Jennett sent a draft of the annual report to all TAMC members. He did a review of the updated annual report that will be sent to the State Transportation Commission on Friday, April 29, 2022, to meet the mandated May 2, 2022, deadline.

6. ACTION ITEMS:

6.1.–2021 Michigan Roads & Bridges Annual Report ***(Due May 2, 2022 to STC)***

Any questions regarding the annual report should be directed to J. Johnson and R. Green for response. The Council does not want the data released until the annual report is released. Behind the scenes CSS is updating the dashboards with the current PASER data. R. Slattery complimented TAMC support staff on a job well done on the annual report.

Motion: J. Tubbs made a motion to approve the 2021 Michigan Roads and Bridges Annual Report as amended to be released when completed no later than May 2, 2022; K. Jones seconded the motion. The motion was approved by all members present.

6.2. – Transportation Asset Management Plans - Group B – G. Strong (Attachment 4):

For Public Act 325, Group B, there are 41 agencies due; 15 TAMPs were received by the October 1, 2021 deadline. There has been 13 TAMPs received after the October 1, 2021 deadline. A total of 13 agencies did not submit a TAMP as required by Public Act 325. G. Strong has done a review of the submitted TAMPs where four TAMPs were found to need additional information. G. Strong recommended today to the ACE Committee approval of the following four Group B TAMPs: City of Taylor, Arenac County Road Commission, Charlevoix County Road Commission, and Menominee County Road Commission. The ACE Committee approved the four agency TAMPs to go on to the Council for final approval.

J. Johnson shared an article from the Oakland Road Report newsletter regarding TAMPs.

7. Old Business:

7.1. – TAMC Schedule of Activities and Trainings 2022 – J. Johnson/R. Green (Attachment 5)

Council members were encouraged to sign up to represent TAMC at the highlighted (April 13, 2022, only for 15-20 minutes at 8:00am, April 19, 2022, at 9:00am, and June 16, 2022 at 8:00am) events on the schedule that was provided in the agenda packet. J. Tubbs volunteered to attend the April 19, 2022, IRT training.

7.2. – TAMC Coordinator Update – J. Johnson/R. Green

J. Johnson has not had an opportunity to talk with T. White regarding the TAMC Coordinator position. There may be an opportunity for TAMC to work in collaboration with the MIC. Discussions are being had within MDOT regarding the position and more to come on this in the future.

8. New Business;

8.1. – State Transportation Commission April 21, 2022 Meeting (Attachment 6) – J. Johnson

Letters have been sent to TAMC requesting the appointment of Jacob Hurt to replace Derek Bradshaw as the MAR representative for TAMC. The County Road Association (CRA) has also submitted a letter on behalf of J. Johnson, supporting her reappointment to the TAMC for the CRA representative. J. Johnson will present the letters to the STC at their April 21, 2022 and request the approval from the STC of the appointments.

Action Item: J. Johnson will need to be added to the July 2022 STC meeting to discuss the 2021 Michigan Roads and Bridges Annual Report.

8.2. - Citizens Research Council of Michigan Article (Attachment 7)

J. Johnson, B. McEntee, and T. Colling spoke with the author of the article that was unfavorable to TAMC, and the Director of the Citizens Research Council of Michigan. They tried to explain that TAMC did not have complete data sets at the time of the unfavorable article, and it could be seen where they could come to some conclusions as placed in the unfavorable article but TAMC should have been offered a chance to explain the data. It was decided not to proceed any further on this article as the author was not going to change his viewpoint. J. Johnson shared the article with MIC Director, John Weise. It was unfortunate that the Citizens Research Council of Michigan chose not to speak with TAMC prior to doing the publication.

9. Committee Review and Discussion Items:

9.1. – Bridge Committee Update – B. Wieferich/K. Jones

The Bridge Committee briefly discussed the annual report. The Committee will be discussing whether to change their meetings to quarterly meetings or continue to do them monthly.

9.2. – ACE Committee Update – D. Bradshaw

Gary Mekjian, who is the current vice-chair for the ACE Committee has been voted in by the ACE Committee as the new Chair. R. Buck was voted in as the new Vice Chair for the TAMC ACE Committee. J. Hurt has been appointed to the ACE Committee. There was one recommendation received to possible hold future TAMC Conferences on a Friday to make it easier for traveling.

The TAMC 20 Year Celebration and Conference will be held September 28, 2022, at the Great Wolf Lodge in Traverse City, MI. The Conference Planning Committee has met, and good progress is being made on the event. G. Strong worked with MDOT graphics and created a Save-the-Date for the event which has been sent out along with a call for presenters.

9.3. – Data Committee Update – B. McEntee

The majority of the last Data Committee meeting was reviewing E. Costa's data analysis for the annual report. Discussions were had about getting back into the statewide strategy. The Data Committee would like to put together a timetable for key tasks that need to be done for the annual report. The timetable needs to include when the data needs to be ready to go and when it needs to be added to the TAMC website. The Committee would like E. Costa to look into the mix-a-fixes from the 2021 PASER data.

10. Public Comments:
None

11. Member Comments:
Derek Bradshaw's, MAR, TAMC position will be up at the end of April 2022. D. Bradshaw has taken on added responsibilities at his job and will no longer be working with TAMC. MAR has sent a formal request for Jacob Hurt to replace D. Bradshaw on the TAMC. Mr. Hurt was present at today's meeting and was welcomed. J. Hurt is the Executive Director of the Region 2 Planning Commission. J. Johnson presented a letter to D. Bradshaw thanking him for his services to the TAMC. D. Bradshaw became a member of the TAMC in May 2016. Mr. Bradshaw will receive a plaque from TAMC acknowledging his service to the TAMC. It will be mailed to his home address.

J. Johnson informed the Council that the MIC is looking for people to participate in their Champions Program.

Action Item: J. Johnson will provide an orientation to the TAMC to J. Hurt.

12. Adjournment:
The meeting adjourned at 3:15 p.m. The next meeting is scheduled for May 5, 2022, 1:00 p.m., MDOT Aeronautics Building Auditorium, 2700 Port Lansing Road, Lansing, Michigan.

TAMC FREQUENTLY USED ACRONYMS:		
AASHTO	AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS	
ACE	ADMINISTRATION, COMMUNICATION, AND EDUCATION (TAMC COMMITTEE)	
ACT 51	PUBLIC ACT 51 OF 1951-DEFINITION: A CLASSIFICATION SYTEM DESIGNED TO DISTRIBUTE MICHIGAN'S ACT 51 FUNDS. A ROADWAY MUST BE CLASSIFIED ON THE ACT 51 LIST TO RECEIVE STATE MONEY.	
ADA	AMERICANS WITH DISABILITIES ACT	
ADARS	ACT 51 DISTRIBUTION AND REPORTING SYSTEM	
BTP	BUREAU OF TRANSPORTATION PLANNING (MDOT)	
CFM	COUNCIL ON FUTURE MOBILITY	
CPM	CAPITAL PREVENTATIVE MAINTENANCE	
CRA	COUNTY ROAD ASSOCIATION (OF MICHIGAN)	
CSD	CONTRACT SERVICES DIVISION (MDOT)	
CSS	CENTER FOR SHARED SOLUTIONS	
DI	DISTRESS INDEX	
ESC	EXTENDED SERVICE CONTRACT	
ETL	Exchange, Transfer, and Load	
FAST	FIXING AMERICA'S SURFACE TRANSPORTATION ACT	
FHWA	FEDERAL HIGHWAY ADMINISTRATION	
FOD	FINANCIAL OPERATIONS DIVISION (MDOT)	

FY	FISCAL YEAR	
GLS REGION V	GENESEE-LAPEER-SHIAWASSEE REGION V PLANNING AND DEVELOPMENT COMMISSION	
GVMC	GRAND VALLEY METRO COUNCIL	
HPMS	HIGHWAY PERFORMANCE MONITORING SYSTEM	
IBR	INVENTORY BASED RATING	
IRI	INTERNATIONAL ROUGHNESS INDEX	
IRT	INVESTMENT REPORTING TOOL	
KATS	KALAMAZOO AREA TRANSPORTATION STUDY	
KCRC	KENT COUNTY ROAD COMMISSION	
LDC	LAPTOP DATA COLLECTORS	
LTAP	LOCAL TECHNICAL ASSISTANCE PROGRAM	
MAC	MICHIGAN ASSOCIATION OF COUNTIES	
MAP-21	MOVING AHEAD FOR PROGRESS IN THE 21ST CENTURY (ACT)	
MAR	MICHIGAN ASSOCIATION OF REGIONS	
MDOT	MICHIGAN DEPARTMENT OF TRANSPORTATION	
MDTMB	MICHIGAN DEPARTMENT OF TECHNOLOGY, MANAGEMENT AND BUDGET	
MIC	MICHIGAN INFRASTRUCTURE COMMISSION	
MITA	MICHIGAN INFRASTRUCTURE AND TRANSPORTATION ASSOCIATION	
MML	MICHIGAN MUNICIPAL LEAGUE	
MPO	METROPOLITAN PLANNING ORGANIZATION	
MTA	MICHIGAN TOWNSHIPS ASSOCIATION	
MTF	MICHIGAN TRANSPORTATION FUNDS	
MTPA	MICHIGAN TRANSPORTATION PLANNING ASSOCIATION	
MTU	MICHIGAN TECHNOLOGICAL UNIVERSITY	
NBI	NATIONAL BRIDGE INVENTORY	
NBIS	NATIONAL BRIDGE INSPECTION STANDARDS	
NFA	NON-FEDERAL AID	
NFC	NATIONAL FUNCTIONAL CLASSIFICATION	
NHS	NATIONAL HIGHWAY SYSTEM	
PASER	PAVEMENT SURFACE EVALUATION AND RATING	
PNFA	PAVED NON-FEDERAL AID	
PWA	PUBLIC WORKS ASSOCIATION	
QA/QC	QUALITY ASSURANCE/QUALITY CONTROL	
RBI	ROAD BASED INVENTORY	
RCKC	ROAD COMMISSION OF KALAMAZOO COUNTY	
ROW	RIGHT-OF-WAY	
RPA	REGIONAL PLANNING AGENCY	
RPO	REGIONAL PLANNING ORGANIZATION	
SEMCOG	SOUTHEAST MICHIGAN COUNCIL OF GOVERNMENTS	
STC	STATE TRANSPORTATION COMMISSION	
STP	STATE TRANSPORTATION PROGRAM	
TAMC	TRANSPORTATION ASSET MANAGEMENT COUNCIL	
TAMP	TRANSPORTATION ASSET MANAGEMENT PLAN	
TPM	TRANSPORTATION PERFORMANCE MEASURES	

UWP	UNIFIED WORK PROGRAM	
WATS	WASHTENAW AREA TRANSPORTATION STUDY	

S:/GLORIASTRONG/TAMC FREQUENTLY USED ACRONYMS.03.15.2021.GMS

TAMC Budget Financial Accounting: FY20-FY22

5/31/2022

Michigan Transportation Asset Management Council (TAMC)

	(most recent invoice)	FY20 Budget $	FY20 Year to Date Spent	FY20 Balance	FY21 Budget $	FY21 Year to Date Spent	FY21 Balance	FY22 Budget $	FY22 Year to Date Spent	FY22 Balance
		Indicates Contract Completed			Indicates Contract Completed					
I. Data Collection & Regional-Metro Planning Asset Management Progam										
Battle Creek Area Transporation Study	Dec	$ 20,500.00	$ 20,346.46	$ 153.54	$ 20,500.00	$ 14,858.26	$ 5,641.74	$ 20,500.00	$ -	$ 20,500.00
Bay County Area Transportation Study	4QTR-21	$ 19,900.00	$ 18,217.13	$ 1,682.87	$ 19,900.00	$ 19,462.55	$ 437.45	$ 19,900.00	$ 8,419.64	$ 11,480.36
Central Upper Peninsula Planning and Development	4QTR-21	$ 50,000.00	$ 50,000.00	$ -	$ 50,000.00	$ 50,000.00	$ -	$ 50,000.00	$ 6,955.76	$ 43,044.24
East Michigan Council of Governments	Jan	$ 108,000.00	$ 108,000.00	$ -	$ 108,000.00	$ 73,313.26	$ 34,686.74	$ 108,000.00	$ 31,244.07	$ 76,755.93
Eastern Upper Peninsula Regional Planning & Devel.	1QTR-22	$ 25,000.00	$ 25,000.00	$ -	$ 25,000.00	$ 13,897.47	$ 11,102.53	$ 25,000.00	$ 2,824.35	$ 22,175.65
Genesee Lapeer Shiawasse Region V Planning Com.	Jan	$ 46,000.00	$ 46,000.00	$ -	$ 46,000.00	$ 20,287.67	$ 25,712.33	$ 46,000.00	$ -	$ 46,000.00
Grand Valley Metropolitan Council	1QTR-22	$ 24,000.00	$ 24,000.00	$ -	$ 24,000.00	$ 23,864.31	$ 135.69	$ 24,000.00	$ 55.00	$ 23,945.00
Kalamazoo Area Transportation Study	1QTR-22	$ 22,000.00	$ 21,990.19	$ 9.81	$ 22,000.00	$ 11,463.59	$ 10,536.41	$ 22,000.00	$ -	$ 22,000.00
Macatawa Area Coordinating Council	4QTR-21	$ 19,000.00	$ 2,357.60	$ 16,642.40	$ 19,000.00	$ 14,093.57	$ 4,906.43	$ 19,000.00	$ -	$ 19,000.00
Midland Area Transportation Study	1QTR-22	$ 21,000.00	$ 21,000.00	$ -	$ 21,000.00	$ 21,000.00	$ -	$ 21,000.00	$ 2,217.08	$ 18,782.92
Northeast Michigan Council of Governments	Dec	$ 51,000.00	$ 51,000.00	$ -	$ 59,528.49	$ 59,528.49	$ -	$ 51,000.00	$ 18,396.58	$ 32,603.42
Networks Northwest	4QTR-21	$ 75,000.00	$ 75,000.00	$ -	$ 75,000.00	$ 31,404.03	$ 43,595.97	$ 75,000.00	$ -	$ 75,000.00
Region 2 Planning Commission	Sept	$ 40,000.00	$ 40,000.00	$ -	$ 40,000.00	$ 3,402.00	$ 36,598.00	$ 40,000.00	$ -	$ 40,000.00
Saginaw Area Transportation Agency	4QTR-20	$ 21,000.00	$ 14,790.13	$ 6,209.87	$ 21,000.00	$ -	$ 21,000.00	$ 21,000.00	$ -	$ 21,000.00
Southcentral Michigan Planning Commission	1QTR-22	$ 55,000.00	$ 54,994.44	$ 5.56	$ 55,000.00	$ 23,320.04	$ 31,679.96	$ 55,000.00	$ -	$ 55,000.00
Southeast Michigan Council of Governments	Dec	$ 174,000.00	$ 174,000.00	$ -	$ 174,000.00	$ 174,000.00	$ -	$ 174,000.00	$ 81,842.04	$ 92,157.96
Southwest Michigan Planning Commission	4QTR-21	$ 41,000.00	$ 39,412.78	$ 1,587.22	$ 41,000.00	$ 14,268.35	$ 26,731.65	$ 41,000.00	$ 1,122.08	$ 39,877.92
Tri-County Regional Planning Commission	4QTR-21	$ 40,000.00	$ 40,000.00	$ -	$ 40,000.00	$ 15,049.00	$ 24,951.00	$ 40,000.00	$ -	$ 40,000.00
West Michigan Regional Planning Commission	4QTR-20	$ 88,000.00	$ 73,951.79	$ 14,048.21	$ 88,000.00	$ 7,740.66	$ 80,259.34	$ 88,000.00	$ -	$ 88,000.00
West Michigan Shoreline Regional Development Com.	Jan	$ 54,000.00	$ 53,898.70	$ 101.30	$ 54,000.00	$ 48,380.56	$ 5,619.44	$ 54,000.00	$ 269.74	$ 53,730.26
Western Upper Peninsula Regional Planning & Devel.	4QTR-21	$ 42,000.00	$ 42,000.00	$ -	$ 42,000.00	$ 18,390.47	$ 23,609.53	$ 42,000.00	$ 1,043.45	$ 40,956.55
MDOT Region Participation & State Vehicle Use	10/28/20	$ 30,000.00	$ 9,570.41	$ 20,429.59	$ 30,000.00	$ 27,001.73	$ 2,998.27	$ 30,000.00	$ -	$ 30,000.00
PASER Quality Review Contract	8/25/20	$ 50,000.00	$ -	$ 50,000.00	$ 50,000.00	$ -	$ 50,000.00	$ 50,000.00	$ -	$ 50,000.00
Data Collection & Regional-Metro Progam Total		**$ 1,116,400.00**	**$ 1,005,529.63**	**$ 110,870.37**	**$ 1,124,928.49**	**$ 684,726.01**	**$ 440,202.48**	**$ 1,116,400.00**	**$ 154,389.79**	**$ 962,010.21**
III. TAMC Central Data Agency (MCSS)										
Project Management	12/22/21	$ 64,200.00	$ 72,225.00	$ (8,025.00)	$ 56,580.00	$ 45,844.73	$ 10,735.27	$ 65,093.00	$ 29,622.58	$ 35,470.42
Data Support /Hardware / Software	12/22/21	$ 37,000.00	$ 28,675.55	$ 8,324.45	$ 25,870.00	$ 23,237.98	$ 2,632.02	$ 44,298.00	$ 3,786.00	$ 40,512.00
Application Development / Maintenance / Testing	12/22/21	$ 166,000.00	$ 167,217.02	$ (1,217.02)	$ 171,250.00	$ 174,634.38	$ (3,384.38)	$ 202,880.00	$ 90,201.07	$ 112,678.93
Help Desk / Misc Support / Coordination	12/22/21	$ 53,250.00	$ 49,634.15	$ 3,615.85	$ 67,360.00	$ 98,289.56	$ (30,929.56)	$ 26,679.00	$ 29,108.68	$ (2,429.68)
Training	12/22/21	$ 26,000.00	$ 18,486.22	$ 7,513.78	$ 16,170.00	$ 9,619.47	$ 6,550.53	$ 14,000.00	$ 10,788.45	$ 3,211.55
Data Access / Reporting	12/22/21	$ 28,500.00	$ 36,500.00	$ (8,000.00)	$ 37,720.00	$ 23,216.90	$ 14,503.10	$ 22,000.00	$ 8,871.40	$ 13,128.60
TAMC Central Data Agency (MCSS) Total		**$ 374,950.00**	**$ 372,737.94**	**$ 2,212.06**	**$ 374,950.00**	**$ 374,843.02**	**$ 106.98**	**$ 374,950.00**	**$ 172,378.18**	**$ 202,571.82**
IV. MTU Training & Education Program Contract	Dec	**$ 225,000.00**	**$ 224,280.94**	**$ 719.06**	**$211,391.21**	**$ 165,599.61**	**$ 45,791.60**	**$210,658.15**	**$ 47,025.28**	**$ 163,632.87**
V. MTU Activities Program Contract	Dec	**$ 115,000.00**	**$ 115,011.82**	**$ (11.82)**	**$129,464.81**	**$ 55,085.04**	**$ 74,379.77**	**$128,424.93**	**$ 16,936.34**	**$ 111,488.59**
VI. TAMC Expenses										
Fall Conference Expenses	12/10/19	$ 10,000.00			$ -	$ -	$ -	$ 10,000.00	$ -	$ 10,000.00
Fall Conf. Attendence Fees + sponsorship Fees	12/10/19		$ 6,890.00		$ -	$ -	$ -	$ -	$ -	$ -
Net Fall Conference	12/10/19	$ 16,890.00	$ 6,781.90	$ 10,108.10		$ -	$ -		$ -	$ -
Spring Conference Expenses	6/27/19	$ 10,000.00			$ 1,471.51	$ -	$ 1,471.51	$ 10,000.00	$ -	$ 10,000.00
Spring Conf. Attendence Fees + sponsorship Fees	6/27/19		$ -		$ -	$ -	$ -	$ -	$ -	$ -
Net Spring Conference	6/27/19	$ -	$ -	$ 10,000.00		$ -	$ -		$ -	$ -
Unallocated / Contingency		$ 10,000.00	$ -	$ 10,000.00	$ 20,000.00	$ -	$ 20,000.00	$ 10,000.00	$ -	$ 10,000.00
Other Council Expenses (Member Mileage Expenses/Printing/Etc.)	3/12/20	$ 10,000.00	$ 2,046.24	$ 7,953.76	$ 10,000.00	$ 161.50	$ 9,838.50	$ 10,000.00	$ -	$ 10,000.00
TAMC Expenses Total		**$ 46,890.00**	**$ 8,828.14**	**$ 38,061.86**	**$ 31,471.51**	**$ 161.50**	**$ 31,310.01**	**$ 40,000.00**	**$ -**	**$ 40,000.00**
Total Program		**$ 1,878,240.00**	**$ 1,726,388.47**	**$ 151,851.53**	**$ 1,872,206.02**	**$ 1,280,415.18**	**$ 591,790.84**	**$ 1,870,433.08**	**$ -**	**$ 1,870,433.08**
Appropriation		**$ 1,876,400.00**		**8.08%**	**$ 1,876,400.00**		**31.61%**	**$ 1,876,400.00**		**100.00%**

VII. Special Projects with Separate Budgets		FY20 Budget $	FY20 Year to Date Spent	FY20 Balance	FY21 Budget $	FY21 Year to Date Spent	FY21 Balance	FY22 Budget $	FY22 Year to Date Spent	FY22 Balance
MI Local Agency Culvert Inventory Pilot (FY18 HB4320 S-3)										
Central Data Agency (MCSS)	9/16/20	$ 25,000.00	$ 18,738.00	$ 6,262.00	$ 70,000.00	$ 995.55	$ 69,004.45	$ 69,004.45	$ -	$ 69,004.45
MTU Culvert Project Activities & Training Program	Dec	$ 55,011.46	$ 55,011.46	$ -	$ 135,007.92	$ 60,085.15	$ 74,922.77	$ 77,258.02	$ -	$ 77,258.02
TAMC Administration & Contingency (Unencumbered)	2/25/21	$ 472,863.51	$ -	$ 472,863.51	$ 274,117.59	$ -	$ 274,117.59	$ 117.59	$ -	$ 117.59
Central Upper Peninsula Planning and Development		$ -	$ -	$ -	$ -	$ -	$ -	$ 24,000.00	$ -	$ 24,000.00
East Michigan Council of Governments	Nov	$ -	$ -	$ -	$ -	$ -	$ -	$ 42,000.00	$ -	$ 42,000.00
Northeast Michigan Council of Governments		$ -	$ -	$ -	$ -	$ -	$ -	$ 10,000.00	$ -	$ 10,000.00
Networks Northwest		$ -	$ -	$ -	$ -	$ -	$ -	$ 16,000.00	$ -	$ 16,000.00
Southcentral Michigan Planning Commission	Dec	$ -	$ -	$ -	$ -	$ -	$ -	$ 6,000.00	$ -	$ 6,000.00
Southeast Michigan Council of Governments		$ -	$ -	$ -	$ -	$ -	$ -	$ 33,000.00	$ -	$ 33,000.00
Southwest Michigan Planning Commission		$ -	$ -	$ -	$ -	$ -	$ -	$ 27,000.00	$ -	$ 27,000.00
Tri-County Regional Planning Commission		$ -	$ -	$ -	$ -	$ -	$ -	$ 34,000.00	$ -	$ 34,000.00
West Michigan Regional Planning Commission		$ -	$ -	$ -	$ -	$ -	$ -	$ 34,000.00	$ -	$ 34,000.00
West Michigan Shoreline Regional Development Com.	Nov	$ -	$ -	$ -	$ -	$ -	$ -	$ 36,000.00	$ 909.93	$ 35,090.07
Western Upper Peninsula Regional Planning & Devel.		$ -	$ -	$ -	$ -	$ -	$ -	$ 12,000.00	$ -	$ 12,000.00
MI Local Agency Culvert Inventory Pilot Project Total		**$ 552,874.97**	**$ 73,749.46**	**$ 479,125.51**	**$ 479,125.51**	**$ 61,080.70**	**$ 418,044.81**	**$ 420,380.06**	**$ 909.93**	**$ 419,470.13**
Total Special Program		**$ 552,874.97**	**$ 73,749.46**	**$ 479,125.51**	**$ 479,125.51**	**$ 61,080.70**	**$ 418,044.81**	**$ 420,380.06**	**$ 909.93**	**$ 419,470.13**
				86.66%						

Notes:

TAMC voted to extend service dates of FY20 contracts with Regional-Metro Planning to expire on 9-30-21; the contract for PASER Quality Review has been extended to 9-30-21

TAMC voted to extend service date of FY21 contracts with Regional-Metro Planning to expire on 9-30-22; TAMC voted to move the balance of unspent Mi Local Agency Culvert Inventory Pilot funds from FY18 into FY22's Special Projects Program

TAMC Michigan Transportation Asset Management Council

June 1, 2022

GROUP B

Based upon my review of the following transportation agencies Group B TAMPs, the agencies below were approved to go on to the Council by the TAMC ACE Committee at their April 6, 2022 and May 4, 2022 meetings. I am recommending approval of the following agencies from the Council.

1. City of Taylor
2. Arenac County Road Commission
3. Charlevoix County Road Commission
4. Menominee County Road Commission
5. City of Garden City

Group B TAMPs Current Status:

# of Group B Agencies Due by October 1, 2021	# TAMPs Received by October 1, 2021	# TAMPs Received After October 1, 2021	# TAMPs Not Submitted	Pending Review or Awaiting Additional Information –	Total TAMPs Received & Recommended for Approval To-date
41	15	13	13	3	25

TAMPs with Dates Received:

1. Gogebic County TAMP received 03/24/2021 & 11/09/2021 Approved by ACE 01/05/2022 Approved by Council 03/02/2022	22. City of Garden City TAMP received 01/05/2022; 03/21/2022 Approved by ACE 05/04/2022 Recommending to Council 6/01/22
2. Emmet County Road Commission TAMP received 09/09/2021 Approved by ACE 11/03/2021 Approved by Council 01/05/2022	23. Kent County Road Commission TAMP received 01/06/2022 Approved by ACE and Council 03/02/2022
3. Washtenaw County TAMP received 09/14/2021 Approved by ACE 11/03/2021 Approved by Council 01/05/2022	24. City of Taylor TAMP Received 01/06/2022 Approved by ACE 04/06/2022 Recommending to Council 6/01//2022

4. City of Rochester Hills TAMP received 09/23/2021 Approved by ACE 11/03/2021 Approved by Council 01/05/2022	25. Gratiot County Road Commission TAMP Received 01/07/2022 Needs additional information
5. Livingston County TAMP received 09/24/2021 Approved by ACE 11/03/2021 Approved by Council 01/05/2022	26. Arenac County Road Commission TAMP received 03/02/2022 Approved by ACE 04/06/2022 Recommending to Council 06/01/2022
6. Road Commission of Oakland County TAMP received 09/27/2021 Approved by ACE 11/03/2021 Approved by Council 01/05/2022	27. Charlevoix County Road Commission TAMP received 03/07/2022 Approved by ACE 04/06/2022 Recommending to Council 06/01/22
7. Montmorency County (Submitted in TAMP Survey) TAMP received 09/24/2021 Approved by ACE and Council 03/02/2022	28. Menominee County Road Commission TAMP received 03/15/2022 Approved by ACE 04/06/2022 Recommending to Council 06/01/2022
8. Alpena County TAMP received 09/28/2021 Approved by ACE 11/03/2021 Approved by Council 01/05/2022	29.
9. City of Battle Creek TAMP received 09/28/2021 Approved by ACE 11/03/2021 Approved by Council 01/05/2022	30.
10. City of Kalamazoo TAMP received 09/29/2021 Approved by ACE 11/03/2021 Approved by Council 01/05/2022	31.
11. Shiawassee County Road Commission TAMP Received 09/30/2021 Approved by ACE 02/02/2022 Approved by Council 03/02/2022	32.
12. Marquette County Road Commission TAMP received 09/30/2021 Approved by ACE 11/03/2021 Approved by Council 01/05/2022	33.
13. City of Saginaw TAMP received 09/30/2021 Approved by ACE 11/03/2021 Approved by Council 01/05/2022	34.

14. Wexford County Road Commission TAMP received 09/30/2021 Approved by ACE 11/03/2021 Approved by Council 01/05/2022	35.
15. City of Roseville TAMP received 09/30/2021 Needs Additional Information	36.
16. City of Dearborn TAMP received 10/01/2021 Approved by ACE 02/02/2022 Approved by Council 03/02/2022	37.
17. Houghton County Road Commission TAMP received 10/06/2021 Approved by ACE 11/03/2021 Approved by Council 01/05/2022	38.
18. Van Buren County Road Commission TAMP received 10/12/2021 Needs additional information	39.
19. Missaukee County Road Commission TAMP received 10/15/2021 Approved by ACE 02/02/2022 Approved by Council 03/02/2022	40.
20. Mackinac County Road Commission TAMP received 10/28/2021 Approved by ACE 11/03/2021 Approved by Council 01/05/2022	41.
21. City of Port Huron TAMP received 12/15/2021 Approved by ACE 01/05/2022 Approved by Council 03/02/2022	

Group B Agencies that Have Not Submitted Their TAMPs:

1. Alcona County
2. Benzie County
3. City of Burton
4. Clare County
5. City of Detroit
6. Ionia County
7. Isabella County
8. Lake County

9. Leelanau County
10. Newaygo County
11. Ontonagon County
12. Otsego County
13. City of St. Clair Shores

Michigan Department of Transportation TAMP

Although the Michigan Department of Transportation (MDOT) is not listed amongst the agencies in Group A, TAMC would like to acknowledge that MDOT submits their TAMP to the Federal Highway Administration (FHWA) every four years. The MDOT TAMP was certified by FHWA on July 12, 2018, therefore, MDOT's next TAMP is not due until July 12, 2022 (four years from when FHWA certified their first TAMP). MDOT has begun working on their TAMP for 2022.

Respectfully submitted,
Gloria M. Strong
June 1, 2022
TAMC Group B TAMP Status Update 06.01.2022

June 1, 2022

Dr. Tim Colling, PhD, P.E.
Michigan Technological University
309 Dillman Halls
1400 Townsend Drive
Houghton, Michigan 49931

Subject: Environmental Finance Center at Michigan Tech University

Dear Dr. Colling:

The Michigan Transportation Asset Management Council is pleased to offer our support to Michigan Tech University in its application for funding to the Environmental Protection Agency to continue operating an Environmental Finance Center for the Great Lakes Region titled, *Great Lakes Environmental Infrastructure Center (*GLEIC). We believe that the proposed project team will continue to be well received by local and tribal governments and is well suited to assist underserved and rural communities with the technical, managerial and financial challenges that they face. The GLEIC will provide much needed training, technical assistance, and research projects to guide our member agencies on sustainability and asset management systems issues that they face every day.

Our member agencies are constantly challenged with finding sustainable, long-term solutions to these issues and we look forward to assistance from the GLEIC.

.

We are pleased to collaborate with Michigan Tech University and their project team on the formation of this Center and look forward to the benefits it will provide to our members by helping them to address their environmental infrastructure issues.

Sincerely,

Joanna I. Johnson, Chair
Michigan Transportation Asset Management Council

MEMO

Southeast Michigan Council of Governments
1001 Woodward Avenue, Suite 1400
Detroit, Michigan 48226
(313) 961-4266
www.semcog.org

DATE: May 26, 2022

TO: Rob Green

CC: Ed Hug, Planner II
Amy O'Leary, Executive Director
Kevin Vettraino, Director of Planning
Misty Jordan, Director of Administration

FROM: Margaret Warner, Finance Manager

SUBJECT: Asset Management Invoices for Data Collection FY21

Per my conversation with Ed Hug on 5/26/22 regarding asset management invoices received for FY21 data collection, he asked that I construct a memo addressing the two invoices received and initially billed under the Asset Management Program for FY22 which were rejected.

We received invoices from the Monroe County Road Commission and Oakland County Road Commission for data collection for the periods of August – September 2021.

See details below:

1) Monroe County Road Commission – $2,705.50 for September 2021 data collection
2) Oakland County Road Commission – $10,484.94 for August – September 2021 data collection

We are requesting an amendment to the asset management contract for FY21 so that we may bill the above mentioned expenses under that contract and pay the vendors for the work they have performed.

While we believe this may be the last of the invoices for FY21 data collection, we are not certain. Therefore, we would like to do a final call for all FY21 invoices, where we would set a deadline for submission and then do a final amendment to the FY21 asset management contract.

Due to the pandemic, data collection had to be halted. Once the restrictions were lifted, communities were able to resume collection work but they were also working to get caught up due to the shutdown of many activities, hence the delay in billing.

We ask that you please take all of this into consideration when reviewing our request of this important matter. Thank you.

State of Practice Scan for Pavement Data Collection

Project Report

April 1, 2022

Tim Colling, PhD, PE, Director
Center for Technology & Training

Peter Torola, Research Engineer
Center for Technology & Training

Thomas Page, Technical Writing Intern
Center for Technology & Training

Michigan Transportation Asset Management Council

Michigan Tech
Civil, Environmental, and Geospatial Engineering

CONTENTS

EXECUTIVE SUMMARY

The goal of this study was to investigate new, market-ready technologies for collecting asset condition data that could be used on a statewide scale to accomplish the Transportation Asset Management Council's (TAMC) goals for data collection. The TAMC currently collects Pavement Surface Evaluation and Rating (PASER) data using trained human raters and the Roadsoft Laptop Data Collector (LDC) to assist with data entry and storage.

This study was performed by researching specific solutions through internet searches, vendor brochures, one-on-one meetings, and/or email communication; the findings were then classified based on general similarities and differences (i.e., data collection equipment, primary pavement condition metric, or data channel). The study grouped the solutions into six main data collection types: human visual inspection, specialized sensors package-equipped vehicle, smartphone sensors, vehicle electronic control units, embedded pavement infrastructure sensors, and remote sensing. Commercial solutions were not available for all data collection types.

A total of ten market-ready and two emerging solutions were identified as possibly offering a similar or greater level of detail to PASER and warranted further research. Several identified solutions were eliminated from further study because they did not operate in the United States or were unresponsive to requests. The study identified six representative vendors that have commercially-available solutions.

The PASER system uses a simple condition rating scale. It generates a "single channel" of data that only provides a 1 to 10 rating of the road segment's condition. Complex condition rating scales, like the U.S. Army Corps of Engineers Pavement Condition Index, generate "multiple channels" of data, , such as measurements of cracking or rutting over time and pavement ride (or roughness). These "multiple channels" of data are used to derive a final 0 to 100 PCI index number. This richer data set can have value in research or in project selection at a road-owner level, however additional data needs to be collected and stored for this benefit to be realized.

The TAMC's PASER data collection effort follows a distributed collection model: Road-owning-agency personnel individually collect data in their own jurisdiction and aggregate that data first at a region level and then to a state level. Local road-owning agencies are responsible for data collection, and the condition data is immediately available upon collection in the local road-owning agency's asset management system for their own use. This direct connection to the data collection and use builds confidence in the quality of the data, provides agencies with a sense of ownership over the data, and helps agencies realize the value of the data. Distributed data collection models are difficult to set up, but they provide a high degree of resiliency since a failure or lack of capacity in one agency can be overcome by peers.

Centralized data collection becomes attractive when expensive or specialized equipment is used. Centralization can also be necessary when specialized experience or services are needed for data collection. Many alternative data collection methods tend toward centralized collection. Centralization separates road-owning agencies from the data collection process, which removes their autonomy in the data collection process. Centralization has the further concern of limiting the capacity of local road-owning agencies to collect their own data outside of the TAMC's collection interests.

The largest consideration to any data collection system for asset management is the ongoing cost of data collection on a per-mile basis. PASER data collection using the TAMC's model has a long history of cost and productivity measures associated with it. Calculated average costs from this historical data for PASER data collection range between $11.99 and $13.75 per centerline mile depending on if training is considered part of the expense.

Investigation of other pavement condition data collection types and related market-ready solutions has revealed a large range in the cost per mile to generate useable condition data. The data collected by this study points to a reasonable price point between $40 and $60 per centerline mile while a 2019 NCHRP synthesis found price points between $28 and $300 per centerline mile, with most options between $50 and $80 per mile and an average of $84 per mile.

At best, considering an alternative data collection method represents a more than doubling of the TAMC's data collection budget going from $13.75 per centerline mile to $28 centerline mile. At worst, an alternative data collection method represents a fivefold increase in the collection budget when going from $11.99 per centerline mile to $60 per centerline mile. This equates to an additional data collection cost of $600,000 to $2 million for the collection of the paved federal-aid road network in Michigan on top of the approximately $528,000 that the TAMC normally spends on this collection.

The primary benefits that the TAMC would see from using a market-ready solution in an alternative data collection type are the increase in the repeatability of data and the streamlining of data collection since all data collection would be completed by a central authority using a small number of collection devices. The TAMC's current method of PASER data collection appears to provide data that is reasonably repeatable as shown by the TAMC's annual quality review process, which performs a repeated measure on a specific set of pavements by an outside firm. This raises the question of how much the additional repeatability is needed and what is it worth?

BACKGROUND

Asset condition data collection is an important part of any asset management process regardless of the rating scale, collection method, or analysis program used. Asset condition data provides reliable, actionable information that infrastructure owners can use to support their decisions. These data-driven decisions can include determining the current and future state of assets, planning preventive maintenance and replacement strategies, assessing funding and project needs to accomplish condition goals, or determining the efficacy of maintenance and rehabilitation programs. Asset condition data collected through the TAMC's data collection effort provides all the necessary information to make these data-driven decisions at a road-owning agency's level, a statewide level, or both.

When it comes to pavement assets, there is a wide range in the complexity and amount of detail provided by the different asset condition rating scales. Simple condition rating scales, like the Pavement Surface Evaluation Rating (PASER) scale, assess cardinal pavement distresses such as rutting, alligator cracking, shear cracking, raveling, thermal cracking, block cracking, and polishing; but, these scales forego detailed distress measurements, relying instead on a trained human observer, or rater, to estimate the extent of each distress and its severity. The PASER scale uses the extent and severity of each distress to generate an overall assessment of a pavement asset on a 1 to 10 (failed to good, respectively) scale. These simple condition rating scales are based on a set of rules rather than discrete formulas that are used in complex condition rating scales. The simplicity of simple condition rating scales make them cost efficient; however, these scales do not collect and record individual distress type data and do not include detailed measurements that can be used in asset management or research programs.

Complex condition rating scales, such as the U.S. Army Corps of Engineers Pavement Condition Index (PCI) and its standardization by the ASTM into the D6433-20 method, include a classification of the type and severity of the same cardinal pavement distresses as the simple condition rating scales. However, complex condition rating scales use detailed measurements that include the extent of each specific distress and, in some cases, precise depth measurements that can be used to classify the severity of the distress. Traditionally, complex condition rating scales rely on trained engineers or technicians to identify each distress type that is present, define its extent, and assess its severity in low, medium, or high categories. These data points combine in a formula that relates the type, extent, and severity of the individual distresses to an index that provides an overall assessment of the pavement asset on a 0 to 100 (failed to good, respectively) scale. These complex condition rating scales require both the collection of detailed measurements as well as review by a trained engineer or technician; consequently, pavement condition data collection for these rating scales is relatively costly. Advances in spatially-related, high-quality imagery and sensor data has reduced the time and effort to collect data for these complex rating scales. Recent innovations in machine vision and artificial intelligence have also helped to streamline and reduce the cost of collection and analysis for this type of data.

In addition to simple and complex condition rating scales, other pavement metrics can be measured separately and used to support pavement asset management decisions. Metrics like the international roughness index (IRI) do not measure distress directly but provide useful information that relates to driver experience by measuring the roughness of the road. IRI is a measurement of the inches of wheel travel experienced by a theoretical vehicle as it travels down a pavement section.

Pavement structural measures such a pavement stiffness can be measured by a falling weight or rolling weigh deflectometer. Stiffness can be used as a factor for decision support when determining when a reconstruction or heavy rehabilitation may be necessary. Pavement layer thickness measured with ground penetrating radar may serve a similar purpose.

Some custom rating scales include metrics like structural measures or roughness measures as combined factors with distress measures to relate overall pavement condition. More traditionally, these metrics may be kept as separate measures.

In Michigan, Public Act 499 in 2002 and Public Act 325 of 2018 required road- and bridge-owning agencies to report mileage and condition data on their road and bridge network to the Michigan Transportation Asset Management Council (TAMC). The TAMC is responsible for setting policies related to pavement data collection and has had asset condition data collection as a significant part of its annual budget expenditures.

Historically, the TAMC has chosen PASER for pavement condition data collection because the data collection effort has a low price point and the data can be collected by road-owning agencies without significant specialized equipment. There are, however, many new innovations in pavement asset data collection that may make different data points efficient to collect or may provide more detailed data. As such, these innovations are worth considering for future efforts.

This study investigated new and/or innovative pavement condition data collection methods or services that could be considered market-ready solutions for collecting pavement condition data that meets the TAMC's data collection goals at statewide and local-road-owning-agency levels:

- To provide low-cost, high-quality data at the state level on a yearly cycle
- To be accessible for local road-owning agencies to do their own collection over and above the TAMC's efforts
- To provide a network-level metric for the state to identify overall condition trends
- To provide project-level planning guidance at a road-owning-agency level
- To provide condition modeling opportunities at a state and local level
- To be relatable to historical data.

This study evaluated market-ready solutions for pavement condition data collection only. Bridge condition data collection was not considered in this study since bridge condition data is collected under federal guidelines and cannot be modified by the TAMC.

For the market-ready solutions for pavement condition data collection, this study identified:

1. The type of pavement condition data output
2. The cost of data collection and the cost associated with data processing
3. The technology or equipment needed for collection and its associated load on collection costs
4. The availability of data collection personnel—either service providers or road-owning-agency staff.

The goal of this study was to identify those market-ready solutions for pavement data collection that could provide alternative or supplemental data to PASER system data. These solutions would be mature or almost-mature methods or services that are commercially available and provide a similar or greater level of detail to the PASER system, which is the current system used by Michigan's road-owning agencies to collect and submit pavement condition data to the TAMC.

METHODS

This study conducted extensive searches to identify the range of pavement condition data collection methods and services that were available as potential solutions for Michigan's pavement condition data collection effort. Identified solutions were classified into data collection types based on general similarities in features, specifically the technology used for data collection, the data processing and analysis requirements/options, and the pavement condition rating collected. These features were selected because they were expected to influence the collection cost per mile and the usability of the data.

The study attempted to identify at least one representative, responsive vendor for each data collection type. Responsive vendors were asked to provide data on their technology and associated costs through emails, interviews, and technical documents.

Identifying Solutions and Literature Review

The range of specific solutions were identified through word-of-mouth, industry communications, and internet searches using Google's search engine to find commercial and research sites of interest. The Transportation Research Information Systems databases from the National Academies of Science were accessed to identify solutions that may be in development at research institutions although less emphasis was given to these solutions since they were not commercially available. Search terms for commercial web sites and research databases were:

AI	collection	intelligence	PCI	smartphone
analysis	data	IRI	penetrating	software
artificial	distress	low cost	radar	street
asset	equipment	management	rate	survey
automated	GIS	modular	rating	system
automatic	GPS	new	road	technician
camera	ground	PASER	roughness	van
car	image	paved	scanner	vehicle
collect	innovation	pavement	sensor	video

For identified solutions, vendors and/or research groups were contacted for further information. Information was collected from each responsive vendor/group regarding the pavement distress scale used, equipment and personnel costs, productivity rates, data processing and analysis requirements/options, and other useful information that would further define the collection system. Information was gathered from each vendor/research group from website, informational brochures, email communication, phone calls, and one-on-one web meetings. Vendors and research groups that did not provide further information and did not have data available on their websites or in their brochures were discounted from further evaluation by this study. In some cases, vendors were not forthcoming or helpful in providing the requested data when the intent of the study was disclosed, which lead to elimination of their solution from further review due to lack of information.

Classification of Data Collection Types

The identified solutions were classified into six data collection types primarily based on the methods and technologies used for data collection, the data processing and analysis requirements/options, and the pavement condition rating collected. These data collection types are human visual inspection, specialized sensors package-equipped vehicle, smartphone applications, vehicle electronic control units, embedded pavement infrastructure sensors, and remote sensing.

Human Visual Inspection

Human visual inspection is defined by physically traveling down the road and collecting surface condition data through the use of a trained human observer, or “rater”. The vehicle is usually equipped with a global positioning system (GPS) unit that locates the condition rating or distress along the road segment.

Data entry tools used with human visual inspection greatly aid the data collection process by reducing data processing time, reducing errors, and allowing direct entry of data without a paper form intermediary step.

The human visual inspection data collection type is the benchmark for this study because this is the current method used by the TAMC for collecting pavement condition data on Michigan roads.

Specialized Sensors Package-equipped Vehicle

The specialized sensors package-equipped vehicle data collection type is characterized by physically travelling down the road and collecting pavement surface condition data through the use of a dedicated specialized-sensors package installed in either an existing, multi-use vehicle or a new, purpose-built vehicle (usually a van).

Smartphone Applications

The smartphone applications data collection type is characterized by physically travelling down the road and collecting pavement condition data through the use of an off-the-shelf smartphone mounted inside a vehicle. This data collection type collects data using the smartphone’s built-in sensors and cameras. This data collection type is an attempt to emulate some of the data that can be collected using the specialized sensors package-equipped vehicle data collection type without the significant cost of a purpose-built vehicle, the associated sensors, and the data storage equipment.

The smartphone applications data collection type is divided based on the primary data channel used for the condition scale into two categories:

- pavement imagery
- pavement roughness data.

Vehicle Electronic Control Units

The vehicle electronic control units (ECUs) data collection type is defined by the public or agency personnel physically travelling down the road as part of their day-to-day operations and having pavement condition data collected through the use of a vehicle's control and monitoring packages, which have sensing devices that can measure some aspect of the pavement without the need for a specialized sensors package or externally-mounted data collection tools.

Embedded Pavement Infrastructure Sensors

The embedded pavement infrastructure sensors data collection type is characterized by collecting pavement data through the use of sensors that are placed as part of the pavement infrastructure itself in order to measure some aspect of the pavement.

Remote Sensing

The remote sensing data collection type is characterized by non-ground-based data collection methods that are physically distant from the collection site. Remote sensing of the pavement surface varies based on the distance the data collection platform is from the pavement as a result of the platform lofting the sensor. The remote sensing data collection type has three sub-types: satellite sensors, manned aircraft sensors, and unmanned aerial vehicle sensors.

Satellite Sensors

The satellite collection sub-type uses commercial orbiting satellites that collect high-resolution imagery or other sensor data of the Earth's surface within their range of view. Satellite imagery has the largest distance between the sensor and target.

Manned Aircraft Sensors

The manned aircraft sub-type is classified by collection that occurs primarily from airplanes; however, data collection from other types of aircraft is possible. Manned aircraft operate relatively near to the target.

Unmanned Aerial Vehicle Sensors

The unmanned aerial vehicles (UAVs) sub-type is characterized by data collection that occurs from UAVs, which can fly very close to target (within 500 feet [ft]).

RESULTS

The literature review phase generated detailed descriptions of the six main pavement data collection types. These detailed descriptions are presented in the Results section (below).

In addition, a total of ten market-ready data collection solutions and two emerging solutions were identified during the literature review phase. These twelve solutions offered a similar or greater level of condition data detail as the PASER system and were selected for further investigation and information gathering. The information gathering phase eliminated six of the potential solutions as not commercially viable or unresponsive. The remaining six solutions were all market-ready solutions.

Solutions eliminated from consideration in this report were Pathway Services, Inc.'s Pathrunner solution and Surface Systems Instrument's pavement management technology, both of which did not respond to inquiries. The Totalpave, Inc.'s Totalpave solution and Data Collection Ltd's ROMDAS solution, both of which are based outside the United States, were eliminated from the study because it was unclear if they conducted business domestically.

The Pathrunner solution from Pathway Services, the ROMDAS solution from Data Collection Ltd, and Surface Systems Instrument's pavement management technology are all instrumented van systems that are typical for the specialized sensors package-equipped vehicle data collection type. The Pathrunner solution and the ROMDAS solution appear from marketing information to be full-service, broad-spectrum data collection services that integrate sensors from several manufacturers to sell data collection as a service. Surface Systems Instrument's pavement management technology appears to be an equipment vendor for profilometers.

While it would have been beneficial to have data cost and productivity data for these three solutions for the purposes of comparison, it is expected that that their efficiency or per-mile cost would not have been significantly different than the representative solutions included in the specialized sensors package-equipped vehicle data collection type.

The Totalpave solution from Totalpave, Inc., is a smartphone-based application that uses built-in smartphone sensors to collect pavement roughness data; in particular, it uses the built-in accelerometer as a proxy for international roughness index (IRI) data. Totalpave also acts as a data collection aid by calculating PCI index numbers for a given pavement; however, the user must manually identify and measure the pavement distresses, so it is a calculator rather than a tool for data extraction. Manual collection of PCI data is not expected to be cost competitive due to the significant labor involved, and the creation of a calculator as an aid to manual collection of PCI index values has a minimal impact on the cost to collect pavement data. IRI proxy data is collected by a smartphone accelerometer and is widely available from several vendors. The representative solutions shown in this category appear to be more widely used.

Two emerging research solutions using unmanned aerial vehicles and manually-identified distress from satellite imagery are not commercially viable at this time and were not given further consideration for this report. A 2005 study, *Transportation Applications of Restricted Use Technology (TARUT)*, by the Michigan Tech Research Institute (MTRI) evaluated restricted use satellite technology and the possibilities of their use in transportation (Brooks, Shuchman, & Leonard, 2009). A similar study, *Implementation of Unmanned Aerial Vehicles (UAVs) for Assessment of Transportation Infrastructure*, by MTRI for the Michigan Department of Transportation (MDOT) evaluated the use of UAVs for transportation purposes (Brooks, et al., 2018). Both of these studies are in the research phase and are not commercially-available solutions.

Human Visual Inspection

Human visual inspection is the oldest pavement condition data collection type.

Early methods of human visual inspection often used complex condition rating scales, such as PCI, with manual measurements made by a team of trained engineers or technicians using basic measuring tools (e.g., tape measure, measuring wheel, and straight edge). The time and access to the pavement necessary to complete a complex condition rating with manual inspection has made human visual inspection using complex condition rating scales a relatively-infrequent data collection option outside of airfield pavements or research test sections. In most cases, it is more appropriate to use vendors outlined in the specialized sensors package-equipped vehicle data collection type on in service pavement when collecting complex condition ratings since extended lane closures have significant operational and safety related issues. Therefore, representative vendors/solutions for human visual inspection using complex condition rating scales were eliminated from analysis in this study.

Human visual inspection is frequently used for simple condition rating scales, like PASER, that depend upon estimated condition ratings provided by a trained rater. Manual collection of simple condition rating scales is very popular because of its low cost, high production rate, and the need for only basic equipment. Human visual inspection is accessible to even the smallest local road-owning agency since it can be completed with their own staff.

Representative Vendors/Solutions: PASER System (Benchmark Solution)

The baseline or benchmark market-ready solution for this study is PASER system, which is a human visual inspection data collection type; the PASER system serves as the benchmark solution since it is the system currently used in Michigan and it is both familiar and accessible to Michigan road-owning agencies.

The PASER system is an example of a market-ready solution for pavement condition data collection in the human visual inspection data collection type. The TAMC has a long history of using PASER data on Michigan roads and has developed a business process and associated systems to allow state and local road-owning agencies to collect their pavement inventory and PASER condition data and, in turn, share it at the local, regional, and state levels. Since the early 2000s, the TAMC has annually collected PASER data for Michigan's federal-aid-eligible roads (over 44,000 centerline miles) in a two-year cycle in which agencies submit data on at least 50 percent of their federal-aid-eligible network each year for a total of 100 percent over the course of two years.

The TAMC's pavement condition data collection process relies on a team of two or three trained raters in a single vehicle. One person on the team is responsible for driving and routing the vehicle. The second person on the team is responsible for completing the condition assessment needed to rate each road segment, updating inventory information, and recording that data using a laptop with GPS-enabled data collection program. One common application for recording pavement data during data collection is the Roadsoft Laptop Data Collector (LDC) software; the application stores the data until the data collection team returns to their base of operations and uploads their collected data into Roadsoft, a roadway asset management software that allows for storage, analysis, and reporting of the data. Routinely, a third person is present as part of the data collection team to help with recording ratings and routing the vehicle, which reduces the individual team member's workloads.

The PASER system does not require special equipment to collect data, which gives it a significant advantage over solutions in other data collection types as far as accessibility is concerned. It is a flexible method that can be adapted to collect additional data or to changing collection protocols simply by re-training data collection teams. This flexibility and reliance on a trained rater is not without disadvantages, however.

The PASER system is like all rating methods that rely on a trained rater: it is susceptible to a degree of subjectivity because raters may have slight difference in how they identify distress types, extents, or severities and their relationship to the overall rating. The PASER system also relies on estimates rather than discrete measurements, which can be a source of disagreement when a distress is near a threshold value between two ratings. Nonetheless, many other rating methods, especially those that rely on complex condition rating scales, are still subject to human decision-making. In fact, most pavement condition rating methods have some distress components that are not directly measured and require a trained rater to classify the type, extent, and severity of those distresses. These rater decisions are susceptible to the same subjectivity that PASER has, but the ability of complex condition rating scales to measure extent and use a defined mathematical relationship to relate distress type, extent, and severity with the overall rating scale does have an added advantage of minimizing disagreement.

The PASER system and other methods like it require a large number of raters to do a state-wide collection. It is easier to minimize rater subjectivity with a smaller number of highly-trained raters that rate a larger portion of the network, but rater burnout is a concern since the effort comes with a higher workload. It takes a significant training and coordination effort to collect PASER data consistently on a statewide scale. Annually, the TAMC trains between 300 and 500 local road-owning agency staff to conduct PASER condition data collection.

Over the years, the TAMC has developed business process, training, and resource material to support and guide this effort. An annual quality review process is conducted on a small set of rated roads to assess the quality of the overall rating effort and adjust processes and training as needed.

Between 2013 and 2019, over 177,000 total centerline miles of paved federal-aid-eligible road data was collected for the TAMC. Costs for this same period are show in Table 1. Costs include the field equipment costs like GPS units and computers, the planning organizations (i.e., regional planning organizations [RPOs] and metropolitan planning organizations [MPOs]) costs that further include costs for coordinating the rating teams and reimbursing local road-owning agencies for their data collection efforts, and the MDOT collection costs that further include costs for their participation in collection. The average cost for PASER data collection is calculated to be $11.99 per centerline mile.

The TAMC has historically reimbursed local road-owning agencies at $11.65 per centerline mile for PASER data collected on the non-federal-aid-eligible road network, which is in line with the current estimate. This reimbursement was based on data collection costs for three-person teams in the early 2000s when the TAMC began funding PASER data collection for the federal-aid-eligible road network.

Table 1: TAMC PASER Data Collection Costs

	Collection Equipment	RPO/MPO Fed-Aid Collection	MDOT Fed-Aid Collection	Total Collection Cost	Fed-Aid Centerline Miles Collected	Cost per Centerline Mile
FY2013	$ 2,706	$ 248,259	NA	$ 250,965	24000	$10.46
FY2014	$ 11,818	$ 270,661	NA	$ 282,479	27200	$10.39
FY2015	$ 5,996	$ 256,496	$ 62,305	$ 324,797	24400	$13.31
FY2016	$ 4,484	$ 277,122	$ 21,990	$ 303,596	26400	$11.50
FY2017	$ 7,611	$ 342,504	$ 85,028	$ 435,144	25200	$17.27
FY2018	$ 5,160	$ 180,382	$ 51,310	$ 236,852	26400	$8.97
FY2019	$ 7,429	$ 229,760	$ 52,991	$ 290,180	23600	$12.30
Totals	$ 45,205	$ 1,805,185	$ 273,624	$ 2,124,013	177,200	$11.99

A cost that could be associated with PASER data collection is the training cost for the roughly 300 to 500 raters (or data collectors) who require training each year. It is assumed that any data collection effort will require training but, since visual inspection is labor intensive, the cost of training was considered.

The TAMC's training policy between 2013 and 2019 required all data collectors to attend training each year on site. This was deemed necessary to ensure high-quality data and to coordinate such a large effort. Assigning 100 percent of the PASER training cost to the paved federal-aid-eligible road network is not appropriate since trained raters also rate non-federal-aid-eligible roads each year for local-agency use.

Between 2017 and 2019, over 300 local road-owning agencies reported PASER data on 22,665 centerline miles of paved non-federal-aid-eligible roads (or 7,555 centerline miles per year on average). In 2019 alone, local road-owning agencies reported PASER data on over 12,000 centerline miles of paved non-federal-aid-eligible roads to the TAMC. The TAMC's implementation survey of local road-owning agencies also supports that this level of data collection on the local level is occurring.

Dividing the cost of PASER training on a state level by the total mileage of PASER data reported to the TAMC on the federal-aid and non-federal-aid eligible road networks results in a minimal cost per mile. For data collected in 2019, training adds approximately $1.76 per centerline mile to the cost of PASER data collection. In 2021, PASER training was offered as an online training; remote delivery of the training reduced the cost of PASER training by about 32 percent from past years, so a proportional reduction in training costs could be expected if PASER training continues to be offered by remote delivery in a virtual format (Johnson, 2020). Continued remote delivery of PASER training would further reduce training costs to $1.20 per mile.

Specialized Sensors Package-equipped Vehicle

The specialized sensors package-equipped vehicle data collection type can gather a vast array of condition data due to the wide variety of sensor equipment that installed in a data collection vehicle.

The specialized sensor packages can be as simple as a high-resolution camera array that can collect spatially-related high-speed pavement images, which can later be used to identify and measure distresses. Sensor packages routinely include other measurement devices that aid in the detection and measurement of distresses. These devices include laser profilometers; automated crack detection systems that can measure rutting, faulting, and surface texture; pavement crack detectors that determine the extent and width or depth of pavement cracks; and accelerometers that record pavement roughness data.

Some specialized-sensors packages include sensors to collect additional data such as digital terrain models using LiDAR or panoramic roadscape images while collecting pavement data. This allows the vendors to extract ancillary roadway assets like signs, fire hydrants, bus stops, and parking areas, or to provide panoramic roadscape views.

The specialized sensors package-equipped vehicle data collection type is the most applicable type for complex condition rating scales where many pavement metrics and distresses need to be captured and recorded separately. This data collection type has a high production rate and the flexibility to collect the necessary data for different complex condition rating scales.

Specialized sensors package-equipped vehicles are outfitted with data storage in the form of racks of hard drives or solid-state drives that store the large quantity of data during data collection until the vehicle returns to the base of operations. At that time, data can be transferred to permanent storage. A specialized sensors package-equipped vehicle data collection effort can generate from 1 gigabyte to 19 gigabytes of data per mile of data collected (Pierce & Weitzel, 2019). This large quantity of data can quickly become significant when working beyond a single agency or when working with multiple years of data.

The specialized sensors package-equipped vehicle data collection type has the largest array of vendors offering packages and services, each with slightly different capabilities and processes. Major vendors in this data collection type are typically system integrators who procure sensor units or entire subsystems from specialized-sensor manufacturers and combine them into a functioning data collection package for either an existing, multi-use or a purpose-built data collection vehicle. There does not appear to be a major technological advantage between different vendors since there is a relatively open market for the sensor packages.

Vendors who act as system integrators bring value to the data collection process by creating data handling and analysis services that produce useful data for their clients from their available sensors. These vendors can provide a range of products including delivery of raw spatially-located imagery and sensor data on which the client can do data processing with their own staff to save money; or, these vendors can provide data sets that have been completely processed by either software or a trained observer in order to extract features of interest (e.g., pavement distress measurements). Raw data delivery is attractive from an external cost standpoint since there is a significant effort in analyzing raw data. It may make financial sense for road agencies with staff capable of doing the analysis to complete this work in house. However, this typically requires the road agency to store large quantities of raw data and then review imagery with a trained observer to classify the extent and severity of pavement distress shown in the imagery. This manual review represents a significant internal cost.

Most vendors in the specialized sensors package-equipped vehicle data collection type will provide data collection as a service or will sell purpose-built data collection vehicles or sensor package add-ons to road-owning agencies wishing to collect their own data. However, these specialized-sensor packages are relatively expensive and the equipment is specialized and sensitive to use, requiring dedicated, trained staff.

Specialized Sensors Package Options

Downward-facing Pavement Imagery

Most specialized-sensors packages include the capability to capture spatially-related, high-resolution, downward-facing imagery of the pavement. Downward-facing pavement imagery is typically collected at normal vehicle travel speeds. These images have a resolution as fine as 1 millimeter (mm; or 0.04 inches [in]), meaning that the smallest-size defect they can capture is 1 mm in size. Downward-facing imagery is used to create a mosaic of the pavement surface that can be analyzed by a trained observer or using machine vision and artificial intelligence after the data collection event. The spatially-related imagery allows a trained observer to use software tools to classify the type of distress and virtually measure the extent of each distresses. This process is similar to manual field measurement of distresses; however, it has several advantages over manual field measurement including the creation of a permanent record that can be revisited, automatic tallying of identified distresses, elimination of the need for lane closures, and increased productivity for a single observer.

Several vendors offer downward-facing pavement imagery technology, which uses machine vision and artificial intelligence (AI) to process downward-facing pavement imagery to extract the pavement distress data of interest. Using AI to process pavement images and extract pavement condition data saves staff time for the review and measurement of large quantities of road images. However, downward-facing pavement imagery technology generates a large quantity of data that requires a high-performance computer in order to be processed; so, this variation of specialized sensors package-equipped vehicle data collection has associated costs and data processing time.

Laser Profilometer

Specialized-sensors packages may include a laser profilometer. Laser profilometers are an array of fixed lasers and an accelerometer that work together to record a road profile at highway speeds. The laser array measures the distance between a theoretical reference line and the pavement surface at different points across the pavement. The accelerometer data negates the effect of the vehicle suspension allowing a true measure of the road profile to be derived from the laser array measurements.

Laser profilometers can collect a wide range of data that can be used to calculate several key pavement distresses and metrics. Profilometers with single or double laser arrays can be used at near-normal vehicle travel speeds to measure pavement roughness in the wheel path on scales such as the international roughness index (IRI). They can also create longitudinal (i.e., parallel to direction of travel) pavement profiles, which include measures of faulting in concrete slabs. The addition of multiple lasers (three to twelve) to the array allow the system to create cross-sectional (i.e., perpendicular to direction of travel) pavement profiles that can allow for the measure rutting in asphalt pavements. More recent upgraded profilometers can also measure surface texture, which gives clues to pavement friction and may suggest surface distresses such as raveling and polishing.

Laser Crack Measurement System

Another option for specialized-sensors packages is a laser crack measurement system (LCMS), which is a scanning laser array that evolved from laser profilometers. The LCMSs, which operate at near-normal vehicle travel speeds, use a scanning laser combined with an accelerometer to pick up data on thousands of surface points along a pavement cross-section rather than only a few discrete points as fixed laser systems do. LCMSs detect a number of different pavement metrics that include pavement roughness (or IRI data), rutting, longitudinal and cross-sectional profiles, and micro- and macro-textures similar to a laser profilometer. Additionally, LCMSs' higher density of laser measurements combined with high-resolution, downward-facing pavement imagery allows for the detection and mapping of cracks, patches, manholes, and other surface details in the pavement with the use of software and data processing to integrate the data streams.

Panoramic Roadscape Imagery

Specialized-sensors packages may include panoramic roadscape imagery technology. This technology relies on an array of cameras to capture images at a given location and software that assembles modern 360-degree panoramic imagery by stitching together images with software from an array of cameras at a given location. The photomosaic gives a full view of the surroundings and allows users the ability to pan and zoom. Most people are familiar with this technology from using Google Streetview products. Panoramic imagery is not typically used for pavement data collection but is helpful in collecting inventory data for ancillary assets such as guardrails, signs, fire hydrants, and bus stop shelters.

Light Detection and Ranging (LiDAR)

Specialized-sensors packages may include light detection and ranging (LiDAR) sensors. LiDAR generates a scaled digital representation of the physical world using a scanning laser to collect a series of data points that represent a surface. Early uses of LiDAR from aerial platforms have revolutionized large-area topographic (i.e. describing surface elevation contours and features) and bathymetric (i.e., describing water depths and underwater features) surveys, providing a significant quantity of high-quality position data. Spatially-located imagery can be mapped to the surfaces created by LiDAR measurements to create a realistic, three-dimensional model of a space that can be used for asset inventory, specifically for ancillary roadway assets.

Ground Penetrating Radar (GPR)

Specialized-sensors packages may be outfitted with ground penetrating radar (GPR) sensors. GPR, which is typically collected at slower-than-normal vehicle travel speeds, measures the thicknesses of pavement layers and can determine characteristics of road subgrades. GPR can be used in structural assessments of pavement or to find and map buried structures.

Representative Vendors/Solutions

Specialized sensor package-equipped vehicle data collection has the largest array of vendors offering services, each with slightly different capabilities, services and processes. Several representative vendors were contacted for this study, but most were non-responsive when the intent of the study was relayed to them. The two market-ready solutions showcased in this study are PaVision®, which is provided by Applied Research Associates, Inc., and Road Doctor® Survey Van and Road Doctor® 3, which is provided by Roadscanners. Details on these two market-ready solutions are shown in Table 2 and Table 3.

PaVision® provides a compact, integrated sensor package that can be added to an existing, multi-use vehicle via a trailer hitch receiver mount (Applied Research Associates, Inc., 2022). The business model for PaVision® centers around providing an integrated sensor package rather than a turnkey vehicle (M. Harrell, e-mail communication, 2021). PaVision® represents an economic solution for specialized sensors package-equipped vehicle collection since the equipment is readily deployable on a typical light duty truck (Applied Research Associates, Inc., 2022). The PaVision® package includes a downward-facing camera that collects pavement imagery, a LiDAR sensor that measures pavement rutting, and an accelerometer that allows for the measurement of pavement roughness (Applied Research Associates, Inc., 2022). The package also has a forward-facing camera that collects images of the road's right of way and a GPS receiver (Applied Research Associates, Inc., 2022). PaVision® does data processing to detect both pavement distresses, which can be related to the PCI scale, and roughness, which can be related to the IRI scale (Applied Research Associates, Inc., 2022).

Road Doctor® Survey Van is a highly-instrumented, purpose-built, data collection van built by a systems integrator, Roadscanners [*Road Doctor*® Surface Van (Roadscanners, n.d.)]. The vehicle can be equipped with GPR, laser crack detectors, visual and thermal imaging cameras, and a falling weight deflectometer for determining pavement structure [*Road Doctor® Surface Van* (Roadscanners, n.d.)]. Roadscanners offers companion software, Road Doctor® 3, that can be licensed in modules to view and manipulate the different data streams that the Road Doctor® Survey Van package collects [*Road Doctor® 3* (Roadscanners, n.d.)].

These two vendors are representative of the range of solutions available in the specialized sensors package-equipped vehicle data collection type.

Table 2: PaVision®

General Information	 Photo source: https://www.ara.com
Data Collection Type: Specialized Sensors Package-equipped Vehicle Availability: Commercially available Provider: Applied Research Associates, Inc. Contact information: 217-356-4500	
Equipment	
Vehicle requirements: 2" hitch on vehicle Type-specific hardware: Sensors package Personnel: 1 driver and 1 data collector	
Data Collection	
Data channel: Image	Collection area: One lane
Vehicle speed: Up to 60 mph	Imagery: Yes
Roughness: Yes	Imagery rating scale: PCI
Roughness rating scale: IRI	GPS: Yes
Data collection rate: Downward/forward image every 30 ft Primary data metric(s): Imagery and roughness Secondary data metric(s): Rutting measurement using LiDAR sensor Training needs: Advanced data collection training	
Data Processing	
Data access method: From application Cloud storage: Yes Data format(s): CSV file and shapefile Data processing time: Would not disclosed	
Cost	
Approximate additional equipment/app cost: $4,000/week rental or $50,000 one-time purchase Approximate processing cost: $40 per mile driven + collection costs	
Reference(s): PaVision® representative Mike Harrell, e-mail communication, 2021; (Applied Research Associates, Inc., 2022)	

Table 3: Road Doctor® Surface Van and Road Doctor® 3

<table>
<tr><th>General Information</th><td rowspan="4">
Photo source: www.roadscanners.com</td></tr>
<tr><td>Data Collection Type: Specialized Sensors Package-equipped Vehicle
Availability: Commercially available
Provider: Roadscanners
Contact information: +358 (0)50 543 0021</td></tr>
<tr><th>Equipment</th></tr>
<tr><td>Vehicle requirements: Specialized van
Type-specific hardware: Retrofitted or new van with sensors package
Personnel: 1 driver and 1 data collector</td></tr>
<tr><th colspan="2">Data Collection</th></tr>
<tr><td>Data channel: Image and roughness
Vehicle speed: Typical driving speeds
Roughness: Yes
Roughness rating scale: IRI</td><td>Collection area: One lane
Imagery: Yes (optional)
Imagery rating scale: Proprietary custom surface scale
GPS: Yes</td></tr>
<tr><td colspan="2">Data collection rate: Typical driving speeds for surface rating and roughness collection
Primary data metric(s): Imagery and roughness
Secondary data metric(s): GPR, LiDAR, plus other modules and add-ons
Training needs: Advanced data handling training</td></tr>
<tr><th colspan="2">Data Processing</th></tr>
<tr><td colspan="2">Data access method: From application
Cloud storage: Yes
Data format(s): CSV file and shapefile
Data processing time: Less than one week
Analysis needs: Advanced software training and programing</td></tr>
<tr><th colspan="2">Cost</th></tr>
<tr><td colspan="2">Approximate additional equipment/app cost: Varies from being included in the collection cost to over $100,000
Approximate processing cost: Typically, between $100 to $300 per mile driven depending on the data collected</td></tr>
<tr><td colspan="2">Reference(s): Road Doctor® Surface Van (Roadscanners, n.d.); Road Doctor® 3 (Roadscanners, n.d.)</td></tr>
</table>

Smartphone Applications

There are an ever-increasing number of providers that are creating solutions for pavement condition data collection using the sensors integrated into a modern smartphone. While this data collection type is relatively new, there are several market-ready solutions available.

Modern smartphones can collect data by one of two primary channels. Smartphones have multiple cameras that are very capable at collecting pavement image and video data. Smartphones also have built-in accelerometers that can collect pavement roughness data to create a proxy for IRI data.

Most smartphone applications cannot collect the data to assess complex condition rating scales and, as a result several smartphone application market-ready solutions have proprietary rating scales that are usually “black box” systems. Smartphone-based data collection methods are limited on data storage capacity due to the inherent limitations of smartphone devices. The limited data storage capability requires frequent data transfers to a server and limits both the resolution and quality of the collected data in comparison to the specialized sensors package-equipped vehicle data collection type. A smartphone’s internal GPS can be used to locate the vehicle on the road network as condition data is being collected.

Smartphone applications market-ready solutions for data collection typically upload data to the vendor’s cloud servers due to smartphone storage limitations during the data collection process. Stored data is then processed using propriety data processing. Data processing time may take as little as one day to as long as a month depending on the vendor. Most vendors return the analyzed results through interactive-map or similar user interfaces that are like the TAMC’s interactive map. The pavement condition data can be exported from these interfaces for use in other asset management or GIS systems. Exported data formats include comma separated value (CSV) files or shapefiles (for GIS-based systems) although the specific data output is dependent on the vendor.

Smartphone applications market-ready solutions rely on lower-quality sensors when compared to specialized sensors package-equipped vehicle data collection solutions due to the inherent limitations of modern smartphones. However, these solutions do save significantly on hardware costs by using standard off-the-shelf smartphones rather than custom, integrated specialized-sensors packages. The significant expenses for smartphone-based data collection are the costs of using the software system and the costs for data processing.

Primary Data Channel

Pavement Imagery Data

The smartphone applications data collection type commonly makes uses of a smartphone’s built-in camera to collect forward-facing pavement imagery by mounting a smartphone to the windshield or dashboard and recording images from the driver’s perspective. Imagery data can be collected at normal vehicle travel speeds. Images are either collected at a set distance interval or a time-based frame rate.

Forward-facing pavement imagery will typically be lower resolution than downward-facing pavement imagery collected by the same camera. This is a result of the added distance between the camera and the pavement as well as the acute angle of view for forward-facing pavement imagery compared to the perpendicular view of downward-facing pavement imagery.

The smartphone applications data collection type uses an AI model to analyze each frame of collected imagery and detect visual signatures of pavement distress. Smartphone-based data collection typically does not include individual measurements of specific distresses detected and instead output a pavement condition rating using proprietary image processing.

Pavement Roughness Data

Pavement roughness was one of the first data types collected using smartphone sensors. A smartphone's built-in accelerometer is capable of measuring vibrations in the cabin of the vehicle, which can be translated into a proxy for standard roughness measures like IRI or, more commonly, custom roughness rating scales. Roughness values are recorded along with their location using the smartphone's built-in GPS. Roughness values are created in real-time for a given segment of road. As with most smartphone sensors data collection, the data is uploaded to a remote server for inclusion in an asset management system from which the data can be analyzed.

Representative Vendors/Solutions

The representative market-ready solutions for the smartphone applications data collection type are RoadAI provided by Vaisala, RoadWay Pavement AI provided by RoadBotics, Inc, and Roadroid Pro3 provided by Roadroid (shown in Table 4, , and Table 6 respectively). The identified cost per mile driven is representative for market-ready solutions in this data collection type.

RoadAI and Roadroid Pro 3 return a proprietary condition score that is related to the quantity of visual distress; however, this pavement condition score may not be relatable to other condition rating scales. Road AI's primary data channel is image (15 images per second) and returns pavement condition assessment on a custom scale (Vaisala representative, Zoom meeting, 2021). Costs are $40 per processed mile driven plus costs of collection; approximate additional equipment cost is $24,000 per year per county for signs or markings (Vaisala representative, Zoom meeting, 2021). Roadroid Pro 3 uses image (1 image per second) and roughness data to return pavement condition assessment on a custom five-point scale that is entered by a technician manually after data processing (Roadroid, 2022). Costs vary by customer, and Roadroid would not disclose approximate application costs (Roadroid, 2022).

RoadWay Pavement AI advertises that it can return PASER and PCI scores (RoadBotics, 2021). RoadWay Pavement AI uses image data (1 image every 10 ft) to return pavement condition assessment in multiple condition rating scale options including PASER and PCI (Sarah Kilroy, Zoom meeting, n.d.). Costs are $40 per processed mile driven plus costs of collection; approximate additional equipment/app cost is $48,000 per year per 300 miles (Sarah Kilroy, Zoom meeting, n.d.).

Table 4: RoadAI

General Information

Data Collection Type: Smartphone Sensors

Availability: Commercially available

Provider: Vaisala

Contact information: www.vaisala.com

Equipment

Vehicle requirements: Any vehicle

Type-specific hardware: Smartphone package

Personnel: 1 driver

Photo source: www.vaisala.com

Data Collection

Data channel: Image

Vehicle speed: Typical driving speeds

Roughness: No

Roughness rating scale: None

Collection area: Entire pavement

Imagery: Yes

Imagery rating scale: Proprietary custom scale

GPS: Yes

Data collection rate: 15 images per second

Primary data metric(s): Imagery

Secondary data metric(s): None

Training needs: No

Data Processing

Data access method: From application

Cloud storage: Yes

Data format(s): CSV file, GIS-compatible format

Data processing time: Less than one day

Analysis needs: No

Cost

Approximate additional equipment/app cost: $24,000/year/county for signs or markings

Approximate processing cost: $40 per processed mile driven + costs of collection

Reference(s): Vaisala representative, Zoom meeting, 2021; (Vaisala, 2022)

Table 5: RoadWay Pavement AI

General Information

Data Collection Type: Smartphone Sensors
Availability: Commercially available
Provider: RoadBotics, Inc.
Contact information: 412-345-3398

Equipment

Vehicle requirements: Any vehicle
Type-specific hardware: Smartphone package
Personnel: 1 driver

Photo source: www.roadbotics.com

Data Collection

Data channel: Image
Vehicle speed: Slower speeds
Roughness: No
Roughness rating scale: None

Collection area: Entire pavement
Imagery: Yes
Imagery rating scale: Multiple options, PCI and PASER included
GPS: Yes

Data collection rate: 1 image every 10 ft
Primary data metric(s): Imagery
Secondary data metric(s): None
Training needs: No

Data Processing

Data access method: From application
Cloud storage: Yes
Data format(s): CSV file and shapefile
Data processing time: Approximately a month
Analysis needs: No

Cost

Approximate additional equipment/app cost: $48,000 per year per 300 miles
Approximate processing cost: $40 per processed mile driven + costs of collection

Reference(s): Roadbotics representative Sarah Kilroy, Zoom meeting, n.d.; (RoadBotics, 2021); (RoadBotics, n.d.)

Table 6: Roadroid Pro3

General Information	
Data Collection Type: Smartphone Sensors Availability: Commercially available Provider: Roadroid Contact information: lars.forslof@roadroid.com	 Photo source: www.roadroid.com
Equipment	
Vehicle requirements: Any vehicle Type-specific hardware: Smartphone package Personnel: 1 driver	

Data Collection	
Data channel: Image/Roughness Vehicle speed: Typical driving speeds Roughness: Yes Roughness rating scale: IRI	Collection area: Vehicle tire path Imagery: Yes (optional) Imagery rating scale: Custom 5-point scale entered by a technician manually after data processing GPS: Yes
Data collection rate: 1 image per second Primary data metric(s): Roughness Secondary data metric(s): Manual rating of images Training needs: Advanced image rating training	

Data Processing
Data access method: From application Cloud storage: Yes Data format(s): GIS-compatible format (geometry only), Keyhole markup language (KML) (geometry and roughness) Data processing time: Less than one day Analysis needs: No
Cost
Approximate additional equipment/app cost: Would not disclosed Approximate processing cost: Varies by customer
Reference(s): (Roadroid, 2022)

Vehicle Electronic Control Units

Most modern vehicle control and monitoring packages have integrated sensors that measure aspects of vehicle performance, including individual wheel speed, engine rotations per minute, steering wheel angle, and braking torque. A series of up to 70 electronic control units (ECU) take vehicle sensor readings as inputs to control aspects of the vehicle, including engine torque request, brake torque request, and transmission gear selection.

Vehicle ECUs collect streams of data that are continuously being created by such sensors as the traction control sensors, brake sensors, road-facing camera systems, and suspension-monitoring sensors, and vehicle-proximity radar units while the vehicle is in operation.

All vehicle ECU information is communicated through the vehicle's controller area network (CAN) bus. The information on the CAN bus can be read by a device that has access to the bus.

Pavement condition influences the dynamics of a vehicle in small ways, such as wheel slippage or a sudden wheel angle change. Recording and analyzing vehicle dynamics data from data stored on the CAN bus theoretically would allow software to make inferences about the pavement condition. Data on vehicle dynamics from several vehicles on the same road can be pieced together to give insights into pavement condition through repeated measures.

Highly-advanced vehicles that have driver assistance systems or autonomous driving modes rely on cameras, ultrasonic sensors, and radar sensors to make piloting decisions for the vehicle and on machine vision to identify objects and neural networks and make decisions from the image and sensor inputs. Highly-instrumented autonomous vehicles, like the Tesla Model 3, can produce and analyze 20 to 40 terabytes of data per hour. These data streams represent a massive potential data source for determining pavement condition. This data collection type is different from all other types because the data collected is a byproduct of road users' normal driving rather than a dedicated data collection event.

Vehicle ECUs are not typically deployed with the express purposes of collecting pavement condition data for use in an asset management process; rather, their main purpose is the safe and comfortable operation of the vehicle. However, data collected by vehicle ECUs could be repurposed for asset management uses. Vehicle ECU data is technically "free" data sources from the perspective that road users generate the data through normal driving making dedicated data collection trips unnecessary.

Vehicle manufacturers are keenly aware of the potential value of vehicle-produced data and are working to monetize it in many different ways. Business consulting firm McKinsey and Company projected in 2016 that automotive data would develop into a $450 billion to $750 billion a year industry by 2030 (McKinsey & Company, 2016). Vehicle-produced data directly supports research and development of the manufacturer's main product, the vehicle. This data also creates new revenue sources through services that manufacturers can directly offer either through subscription or as a feature of their vehicles to increase market share. Vehicle-produced data may also be sold to outside consumers for uses that are beyond the reach or business interest of vehicle manufacturers. These uses include providing data to insurance companies to offer specialized insurance rates, providing data to carpooling or ride share services, providing intelligence about the road's physical condition or operational status, or providing targeted advertising.

An example of using vehicle data to generate a new revenue stream is Ford's service called Telematics (https://pro.ford.com/en-us/intelligence/) that uses vehicle ECU data to provide vehicle fleet managers with information on all of its vehicles and how drivers are using them. This data helps managers determine how vehicles are being used, identify when vehicles need specific service, and track each vehicle's location.

It is the opinion of the research team that the large internal market potential for vehicle-produced data makes it unlikely that this data will be available to pavement managers for free or at a low cost. This data appears to have too much value for vehicle manufacturers' core and subsidiary business applications that the manufacturers may not consider low-cost or low-value uses of the data by third parties.

Representative Vendor/Solution

This study identified one market-ready solution in the vehicle ECUs data collection type: SurfaceDNA™, provided by Tactile Mobility (Table 7). While Tactile Mobility does offer pavement roughness data as a service, it markets the same data to car manufacturers, tire manufacturers, and insurance companies, so pavement management is not necessarily their core business (Tactile Mobility, n.d.; Tactile Mobility, 2022).

The SurfaceDNA™ solution works by installing data storage and relay devices on the CAN bus of fleet vehicles controlled by a road owner (e.g., city, county, or state agencies) (Tactile Mobility, n.d.; Tactile Mobility, 2022). These SurfaceDNA™-equipped vehicles relay data on pavement roughness and can detect areas of low surface friction as the vehicles travel for their normal operations (Tactile Mobility, n.d.; Tactile Mobility, 2022). Data is collected by the road owner only on fleet vehicles, so the data's reach is limited to where these vehicles are scheduled to go. Network-wide data would be better accessed at a manufacturer level (Tactile Mobility, n.d.; Tactile Mobility, 2022). SurfaceDNA™ does data processing to create a proxy for roughness data on a custom scale (Tactile Mobility, n.d.; Tactile Mobility, 2022).

SurfaceDNA™ continuously collects roughness data and low surface-friction data, so this solution may be advantageous where early identification of road roughness is important, such as in hazard detection for patching potholes or winter maintenance (Tactile Mobility, n.d.; Tactile Mobility, 2022). Continuously collecting data does come at a cost per mile that exceeds standard roughness data collection.

Table 7: SurfaceDNA™

General Information

Data Collection Type: Vehicle ECUs

Availability: Commercially available

Provider: Tactile Mobility

Contact information: +972-4-375-0050

Equipment

Vehicle requirements: Vehicle with connection port (currently) / Vehicle with software on ECU (in future)

Type-specific hardware: CAN bus/networking communication package

Personnel: 1 driver

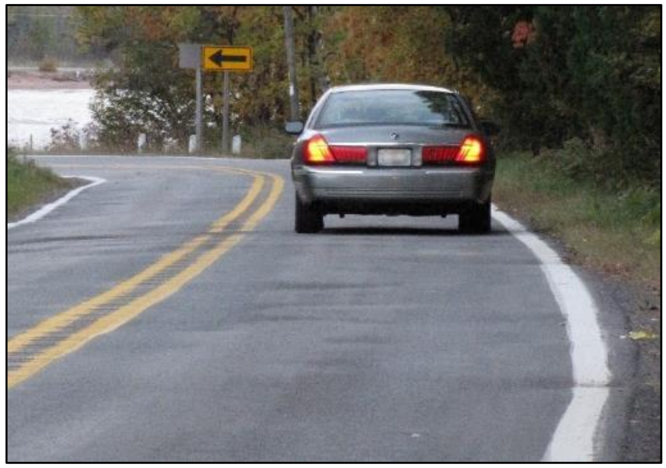

Photo source: CTT Archive

Data Collection

Data channel: Roughness

Vehicle speed: Typical driving speeds

Roughness: Yes

Roughness rating scale: Custom 1-10 scale

Collection area: Conglomeration of all vehicle tire paths that traveled a segment

Imagery: No

Imagery rating scale: None

GPS: Yes

Data collection rate: Continuous

Primary data metric(s): Wheel events

Secondary data metric(s): None

Training needs: None

Data Processing

Data access method: From application

Cloud storage: Yes

Data format(s): CSV file, Java script object notation (JSON), or GIS-compliant format

Data processing time: Less than one week

Analysis needs: None

Cost

Approximate additional equipment/app cost: None expected

Approximate processing cost: $50 per network mile + costs of collection if collected as a unique trip

Reference(s): SurfaceDNA™ representative Yagil Tzur via Zoom meeting, 2021; (Tactile Mobility, 2022); (Tactile Mobility, n.d.)

Embedded Pavement Infrastructure Sensors

Inexpensive sensors that are installed as part of the pavement infrastructure itself can collect and relay data continuously for years. Examples of embedded pavement infrastructure sensors include strain gauges or moisture sensors poured into a concrete pavement.

Sensors embedded in a pavement can measure deflection of the road in localized areas. A network of such sensors could produce a network-wide deflection map, which would be useful to view some forms of road distress, but not all. A pavement infrastructure sensor would need to be inexpensive, durable, and small so that it could be placed at the time of paving since retrofitting a pavement would likely not be cost effective.

Representative Vendor/Solution

This study did not locate any market-ready solutions in the embedded pavement infrastructure sensors data collection type or any published research on the use of in-road sensors for network-wide pavement condition assessment. However, smaller-scale infrastructure sensors have been embedded on bridges and tested for bridge condition assessment. MDOT has instrumented the Cut River Bridge, which is located on US-2 just west of St. Ignace, Michigan, with strain gauges to monitor the bridge's structural health (Cook, 2017).

Remote Sensing

The remote sensing data collection type is not fundamentally different than collecting data with a specialized sensors package-equipped vehicle with the exception that the pavement is much further away from the sensor necessitating higher-resolution equipment. In general, the longer the distance between the sensor and the pavement, the more expensive the sensor becomes. Common remote sensing instruments that have application in pavement management include imagery, radar, and LiDAR.

Commercial remote sensing has advanced significantly with the advent of high-quality, low-weight, lower-cost sensors and the aerial platforms to loft them. However, pavement condition assessment through remote sensing is not viable yet even though it has been the topic of much research.

Remote sensing can be subdivided by the type of platform used to loft the sensor, which includes long range satellite-based solutions, mid-range manned aircraft-based solutions, and near-target unmanned aerial vehicle-based solutions.

Satellite Sensors

Remote sensing by satellite imagery leverages the extensive coverage of high-quality imagery from satellite networks that have mapped virtually all of the world. Manmade satellites orbit between 100 and 22,000 miles above earth's surface and rely on extremely expensive and highly-sensitive equipment.

Very high-resolution satellite imagery of the type that would be necessary for pavement asset management is cost prohibitive and has related government security concerns. United States regulations limit the release of satellite imagery that exceeds 25 centimeters (cm; or 10 in) in resolution, with most providers releasing 30 cm (12 in) in resolution. While 30 cm (12 in) in resolution is impressive, it is nowhere near what would be needed to collect pavement condition data. The resolution of restricted-use government-produced imagery is a closely-guarded secret, but some speculation suggests resolutions below 10 cm (4 in) are common for military applications.

Typically, satellite imagery will be accessed as part of an already-collected repository rather than as a result of a specific customer request. Making use of already-collected imagery for pavement data collection is primarily due to the expense and technical challenges of changing satellite flightpaths. Satellite imagery has the largest distance between the sensor and target and, as a result, typically has lower resolution and higher costs per mile.

Manned Aircraft Sensors

Manned aircraft have been used for remote sensing for a long time, specifically in the area of large area surveillance for government intelligence gathering or for civilian mapping. Current aviation rules generally limit manned aircraft to no lower than 1000 ft above the highest obstacle in urban areas and 500 ft in remote areas. Even with these limits on altitude manned aircraft are many times closer to their target than satellite sensor packages. The availability of small aircraft, their relatively large payload, and their ability to fly at mid to low altitudes for long periods of time make manned aircraft an attractive option for remote sensing. Since manned aircraft have larger payloads, they are not limited as to the weight or size of the sensors they can carry.

Data collection by aircraft is performed as a dedicated collection event. It is not uncommon to find existing wide-area aerial imagery with resolutions near 8 cm (3 in) while custom flights using camera systems like the Leica DMC III Airborne Digital Camera can produce resolutions at about 3 cm (1 in). Higher resolutions than 3 cm (1 in) are possible but are uncommon. While this image resolution is a significant improvement over satellite imagery, it is still at least an order of magnitude lower than what would be necessary to collect pavement distress data similar to what surface vehicles can collect, which is typically at a resolution of 0.1 cm (0.04 in) or better.

Unmanned Aerial Vehicle Sensors

Unmanned aerial vehicles (UAVs) have become very popular for data collection due to their low cost, ability to hover and fly close to the target, and ease of operation. Civilian UAVs are limited in most cases to fly below 500 ft from the ground, keeping them separate from the airspace of larger manned aircraft. Their lower speed and lower altitude have the advantages in remote sensing of being closer to their target which, in turn, allows them to sense smaller details or objects. However, lower altitudes restrict the field of view, limiting how much of the target the camera can see at one time; as such, UAVs may need to do successive passes to collect a complete image of the target.

UAVs' limited payloads and limited flight time restrict the size and weight of the sensors that can be practically lofted. As such, currently-available UAV cameras can produce resolutions near 0.5 cm (0.2 in) at 200 ft above ground, which is about five times less than image data collected by surface vehicles. This resolution is sufficient for moderate accuracy when doing topographic surveys, but it is still insufficient for pavement asset management processes. However, recent work by the Michigan Tech Research Institute (MTRI) has shown the ability to reliably obtain 0.15 cm (0.06 in) resolution imagery using UAVs when flying at elevations of about 60 ft.

UAV technology has significant promise due to its low cost, autonomous or semi-autonomous flight, and comparatively-loose airspace use restriction. As battery charge-to-weight ratios increase and sensor-resolution-to-weight ratios increase, UAV technology will likely provide a cost-competitive data collection method that will rival ground-based systems.

Representative Vendors/Solutions

There currently are no market-ready solutions on paved roads for the remote sensing data collection type. However, there are market-ready solutions for unpaved road distress identification since unpaved road distresses (e.g., potholes, wash boarding, and aggregate berms) are typically larger in size (Brooks, et al., 2018).

DISCUSSION

Comparing Costs for Viable Collection Types

This study relates costs on the basis of data that can be gathered by one trip down the road, regardless of how much of the pavement that is analyzed. The market-ready solutions in this report evaluate pavement width differently. Some solutions evaluate the entire pavement width—up to several lanes—and provide a rating that is an aggregate for the road segment or could potentially be data per lane. Other market-ready solutions evaluate a single lane which, in these cases, is assumed to be representative of the adjacent lanes. For a statewide asset management system, it is expected that a single trip will be made down a road regardless of how many lanes it has and that the rating given to a segment represents the entire segment regardless of how much of the pavement surface area was included in the data collection area. In the case of freeways and other divided highways, each direction is considered to be a unique road and, as such, would require a pass in each direction.

Equipment Costs

All of the market-ready solutions for data collection identified in this study have a self-service model for data collection. A self-service model allows a road-owning agency to purchase the data collection equipment outright and complete a data collection effort with their own trained agency staff. This self-service model was assumed to be the lowest-cost alternative when considering the size of the TAMC's annual data collection effort. Cost estimates in this study did not include costs for training agency staff to use the data collection equipment and to do ongoing maintenance of the equipment.

For the PASER system, costs for data collection equipment were included in the cost-per-mile figure.

For the other market-ready solutions identified in this study, it is assumed that five sets of equipment would be necessary for statewide data collection on the scale of the annual TAMC data collection effort. Five sets of equipment provide for a pool of equipment to collect the data while also providing redundant units. The cost of equipment was prorated over the collection mileage of the paved federal-aid-eligible road network, which is approximately 44,000 centerline miles collected over a two-year period.

The number of units purchased and prorated mileage used to create a cost per mile can be varied for a different set of equipment assumptions. However, it was found that the high volume of miles collected each year reduces equipment costs to a relatively small proportion of the total cost, and in no case did equipment costs greatly impact competitiveness of the market-ready solution. Table 8 (below) summarizes cost estimates for the different market-ready solutions identified in this study.

Data Collection Labor Costs

The TAMC historically has required three-person teams to collect PASER data on road networks. In the last two years, the TAMC policy has allowed as few as two people for data collection due to Covid-19 restrictions. Smaller team sizes may reduce labor costs but also increase workload, increase fatigue, and potentially reduce productivity rates in some situations. Manual PASER data collection is perceived to be labor intensive regardless of the team size.

However, the other market-ready solutions have similar labor requirements with a driver and a rater/data entry person, or a driver and a data processing person.

The other market-ready solutions were not able to provide estimates of labor costs for data collection, which is primarily driving the roads to collect the data. Significant variables in data collection related to how many miles can be collected in a day and how much transit time occurs between collection segments, which depends on how the network is configured. The best available source for labor costs is the TAMC's own data collection experience on the federal-aid-eligible road network.

The productivity rate for collecting PASER data alone is an average of 16.1 miles an hour. In 2002, the PASER Cooperative Road Condition Survey Demonstration Project report was the first attempt at quantifying the productivity rates of visual distress data collection (County Road Association of Michigan and Michigan Department of Transportation, 2002). This study found that on average PASER can be collected at the rate of 16.1 miles per hour, which includes slowing or stopping the vehicle to evaluate pavement defects, transit time to and from the rating locations, and data handling time at the end of the day (County Road Association of Michigan and Michigan Department of Transportation, 2002). In 2015, the Inventory-based Rating System™ Pilot verified these findings and also found that PASER data and IBR System™ data could be collected together at rates between 12.6 and 20 miles per hour (Colling, Kiefer, & Torola, 2016).

The other market-ready solutions report the ability to collect data at near highway speeds; however, this productivity rate does not account for transit time to and from the rating locations or time for data handling at the end of collection.

A conservative labor cost estimate that favors the other market-ready solutions can be made by empirically relating the team size and an assumed productivity rate to a fraction of the PASER data collection cost per mile. This method is imperfect because it assumes that all data collection costs are variable, which is not true of the fixed costs for vehicle mileage and transit time. This method favors the other solutions by assuming that these solutions will have smaller collection teams and higher productivity rates for miles collected per hour than the PASER system.

Empirical labor costs for other market-ready solutions were estimated using the following formula:

$$PASER\ \$/\ mile\ \times \frac{Other\ Solution\ Team\ Size}{3 - person\ PASER\ Team} \times \frac{16.1 mph}{32.2\ mph} = \ Other\ Solution\ Collection\ estimate$$

The average data productivity rate for the other market-ready solutions was set at 32.2 miles per hour; this productivity rate was selected arbitrarily by assuming a collection efficiency of twice the PASER system's productivity rate. Completing this calculation for market-ready solutions that use a single-person team and for solutions that use a two-person team results in labor costs of $2.00 per mile for single-person teams and $4.00 per mile for two-person teams. These estimated labor costs for data collection are expected to be a minimum, and it is reasonable to assume that the cost for PASER data collection of $11.99 per mile would be a maximum for any of representative solutions. These conservative labor cost estimates are included in Table 8 (below) as part of a summary of costs associated with the representative market-ready solutions.

However, there is an exception to both equipment cost and labor cost estimates: vehicle ECUs market-ready solutions. Solutions characterized in the vehicle ECUs data collection type intend to have data collected by municipal vehicles that are traveling for other tasks. There is certainly a nominal equipment cost to outfit the vehicles with embedded sensors, but the representative vendor/solution includes that cost as part of the analysis fee. It is likely that dedicated collection trips would be necessary to ensure complete coverage of lower-volume road segments using vehicle embedded sensors, but these additional trips were not included in this analysis.

Data Processing Costs

Alternatives to PASER data collection require some level of data processing for the raw data in order to produce data that is usable for pavement asset management processes. This data processing is completed either by software that uses machine vision and an AI model or by a trained observer in order to output data in a condition rating scale. This data processing can include things like classifying and measuring specific distresses, distress extents, and distress severity, and calculating index numbers.

The PASER system does not need data processing; PASER data is collected as PASER scores as the rating team makes field observations and determines a condition rating. In contrast, the other market-ready solutions require significantly-large volumes of raw data that need to be collected and stored for data processing in order to produce a meaningful interpretation of pavement condition and usable data for pavement asset management processes. These costs are included in Table 8 under data processing costs.

Table 8: Summary of Data Collection Costs per Mile for Market-ready Solutions

Solution	Collection Type	Data Channel - Scale	Labor Cost Estimate	Data Processing Cost	Equipment Cost (prorated for 44,000 miles)	Total Cost/Mile for 100% Fed-aid Collection (44,000 miles)
PASER System (benchmark)	Human Visual Inspection	Visual Inspection - PASER	Included	Included	Included	$11.99-$13.75*/mile * if training inc.
PaVision	Specialized Sensors Package-equipped Vehicle	Image - PCI	$4.00/mile	$40/mile	5 collection units at $50,000 each Purchase total = $250,000	$ 59.68/mile
Road Doctor® Survey Van & Road Doctor® 3	Specialized Sensors Package-equipped Vehicle	Image - Custom Roughness - IRI	$4.00/mile	$100-$300/mile	5 collection units at $100,000 each Purchase total = $500,000	$115- $315/mile
RoadAI	Smartphone Sensors	Image - Custom	$2.00/mile	$40/mile	5 smartphones and data service at $2000 each Total = $10,000	$42.14/mile
RoadWay Pavement AI	Smartphone Sensors	Image - Multiple options, PCI and PASER included	$2.00/mile	$40/mile data handling *plus* $48,000/300 miles data analysis	5 smartphones and data service at $2000 each Total = $10,000	$206/mile
Roadroid Pro3	Smartphone Sensors	Image - Custom (entered manually) Roughness - IRI	$2.00/mile	Would not disclose -varies by customer	5 smartphones and data service at $2000 each Total = $10,000	n/a
SurfaceDNA	Vehicle Electronic Control Units	Roughness - Custom	None	$50/mile	None	$50/mile

References: PaVision® representative **Mike Harrell, e-mail communication, 2021; (Applied Research Associates, Inc., 2022);** ***Road Doctor® Surface Van*** **(Roadscanners, n.d.);** ***Road Doctor® 3*** **(Roadscanners, n.d.); Vaisala representative, Zoom meeting, 2021; (Vaisala, 2022); Roadbotics representative Sarah Kilroy, Zoom meeting, n.d.; (RoadBotics, 2021); (RoadBotics, n.d.); (Roadroid, 2022); SurfaceDNA™ representative Yagil Tzur via Zoom meeting, 2021; (Tactile Mobility, 2022); (Tactile Mobility, n.d.)**

National Data Sources of Collection and Analysis Cost

The National Cooperative Highway Research Program (NCHRP) conducted synthesis 531 on automated pavement data collection in 2019 (Pierce & Weitzel, 2019). The synthesis surveyed transportation agencies using instrumented vans to collect and analyze pavement condition data. The survey gathered the cost per mile for data collection using vendors or road-owning agency staff for a number of road network sizes. Table 9 illustrates the findings from the cost survey that was part of the NCHRP project.

The NCHRP synthesis revealed that most data collection vendors/agencies had costs between $50 and $80 per mile with an average of $84 per mile for data collection and processing/analysis (Pierce & Weitzel, 2019). Several vendors/agencies exceeded $80 per mile with costs between $100 and $199 per mile (Pierce & Weitzel, 2019). Two respondents in the survey that had costs under $40 per mile (Pierce & Weitzel, 2019). These synthesis findings support the findings from this study.

Table 9: Automated Pavement Condition Survey Costs from NCHRP Synthesis 531 (Pierce & Weitzel, 2019)

Network Size	Cost / Mile	Collector	Analyzer	Notes
Medium	$199	Agency	Agency	Cost for collected and analyzed data set
Small	$159	Agency	Agency	Cost for collected and analyzed data set
Large	$82	Vendor	Agency	Cost for collected and analyzed data set
Extra Large	$31	Vendor	Agency	Cost for collected and analyzed data set
Extra Large	$50	Vendor	NA	Only collection cost
Extra Large	$58	Vendor	Agency	Cost for collected and analyzed data set
Small	$115	Vendor	Vendor	Cost for collected and analyzed data set
Extra Large	$105	Vendor	Vendor	Cost for collected and analyzed data set
Extra Large	$76	Vendor	Vendor	Cost for collected and analyzed data set
Small	$75	Vendor	Vendor	Cost for collected and analyzed data set
Medium	$65	Vendor	Vendor	Cost for collected and analyzed data set
Medium	$43	Vendor	Vendor	Cost for collected and analyzed data set
Large	$28	Vendor	Vendor	Cost for collected and analyzed data set

NOTE: small = less than 5,000 miles; medium = 5,000 to 10,000 miles; large = 10,000 to 15,000 miles; extra large = more than 15,000 miles

Cost Summary

The PASER system of data collection costs $11.99 to $13.75 per mile if training is considered. The other market-ready solutions identified in this study ranged in price from just over $42 to $300 per mile. These data collection costs are significantly higher than PASER system data collection costs. Data from the NCHRP synthesis seems to support this range although the NCHRP synthesis did identify two lower-cost alternatives at $28 to $31 per mile.

The large differences in cost between the market-ready solutions did not warrant further evaluation of expected costs like training, equipment replacement, and data storage for those solutions.

Proprietary Rating Scales

Several of the market-ready solutions evaluated in this study can either relate distresses observed in the field to national standard condition rating or roughness scales, such as PASER, PCI and IRI, or provide direct distress measurements that can be used to calculate ratings on these scales. In general, the human visual inspection data collection type and the specialized sensors package-equipped vehicle data collection types are the most likely to generate results on a standard scale or in standard distress measurements.

Several of the solutions produce condition data on custom or proprietary scales. In many cases, information about how these propriety scales have been developed is not available or shared with users. This presents a problem when relating condition data collected on custom or proprietary scales to condition data previously collected, collected by others on standard condition rating scales, or stored as component distress data. Custom or proprietary condition rating scales also lock users into the service provider since they are the only source of knowledge for creating the custom condition rating scale. Another problem with custom or proprietary condition rating scales is an inability to check for quality control since it is impossible to generate data manually to verify these systems.

However, full disclosure of the methods used or factors considered in generating a custom or proprietary condition rating scale would provide insights to other competitors about the technology or algorithms used and would potentially undermine the intellectual property of the solution developers. But, without full disclosure, new users may be dissuaded from committing to the system.

Data Storage

Some of the other data collection types evaluated in this study generate a significant quantity of raw data per mile that is orders of magnitude beyond what the TAMC currently stores in

PASER data. For example, the storage requirements from specialized sensors package-equipped vehicle data collection can range from 1 to 19 gigabytes of data per mile (Pierce & Weitzel, 2019). For a full collection of the paved federal-aid-eligible road network (approximately 44,000 centerline miles), storage requirements from specialized sensors package-equipped vehicle data collection would be between 5.4 and 100 terabytes of data per year. Even though data storage at this scale is common in today's world for data-intensive businesses, data storage on this scale does present additional costs and complications when moving and accessing data between, state, regional and local road-owning agencies.

Data Accessibility

One significant value that the TAMC provides is that their asset data collection processes not only meet the TAMC's legislative charge but also support and build capacity for individual road-owning agencies to carry out their own asset management processes. The distributed mode of the PASER data collection effort is a classic example of this capacity building. As part of the TAMC data collection process, each local road-owning agency gains the necessary tools and training to collect their own additional asset data concurrently at a minimal cost. Most Michigan county road commissions, large cities, and regional and metropolitan planning organizations have at least one person trained in and proficient at collecting PASER data. There is significant consultant capacity in Michigan as well. Historically, between 300 to 500 individuals participate in training every year for collecting PASER data in Michigan. With this number of available trained individuals, it would be hard to argue that access to a trained PASER data collector would limit an agency's data collection activities.

Most of the other data collection types rely on centralized collection efforts in order to minimize equipment costs or system costs. It is not cost efficient to provide more than a few vehicles equipped with specialized-sensor packages at a state level, nor is it prudent to have such expensive equipment sitting idle. The smartphone applications or the vehicle ECUs data collection types have an advantage from an equipment perspective due to their use of low-cost, common equipment (e.g., smartphones and vehicles with built-in sensors).

In comparison to PASER, all of the alternative data collection types have some limitations on individual road-owning agency autonomy and access to self-collected data. The degree to which these limitations impact road-owning agency use of solutions in the different data collection types is not clear due to the many factors involved.

Collecting Ancillary Roadway Assets

One advantage that some of the other data collection types have over PASER is that raw data can be used to gather not only pavement asset data but also ancillary roadway asset data, such as data about signs, driveways, guardrails, pavement markings, sidewalks, and curb and gutters.

This ancillary roadway asset data can be located by a technician with data processing of camera imagery data. For the most part, only rudimentary condition ratings can be made by using camera imagery as it would only be sufficient to indicate if a sign is still upright or if guardrail has been substantially damaged by a vehicle. Culvert locations data can be identified by a technician with data processing of ground-penetrating radar imagery data; however, culvert condition rating data cannot be collected. Ditches can be located and a depth rating can be assigned with data processing of LiDAR imagery data, which would be useful for ditch condition assessment. Even though collecting ancillary roadway asset data is possible using imagery data, it does come with increased costs for additional specialized sensors and/or additional data processing.

CONCLUSIONS

This study focused on market-ready solutions for collecting pavement condition data that could be used on a statewide scale to accomplish the TAMC's data collection goals. This study identifies three major considerations that would result from a change in data collection types or from a change to a different data collection solution.

Condition Data Complexity

The PASER system is a simple, "single channel" condition rating system that only provides a 1 to 10 rating on a road segment. No other distress data is retained. The TAMC has collected hundreds of thousands of miles of pavement condition data using the PASER system since its inception. This data has value both from a historical standpoint and from a standpoint of the investment made in the collection. A change in the collection method will likely lead to a necessary change in the rating scale that the TAMC uses.

Alternative data collection types that classify and measure pavement distresses and that output pavement condition on standard rating scales, like PCI, can provide an additional value due to the richer data stream they produce. Complex condition rating scales, like PCI, require individual measurements of each distress and their respective severity; as such, they retain "multiple channels" of data that are used to derive the final rating, like the 0 to 100 PCI index number.

There are no financial advantages for collecting data using other data collection types identified in this study in "multiple channels" and then reducing the data to PASER's "single channel". The only obvious benefit to reducing a complex condition rating scale down to a PASER scale would be to provide compatibility with previous data sets.

However, the "multiple channels" of data generated from complex condition rating scales, like PCI, may be beneficial for research. For example, having data that physically measures the spread of rutting or thermal cracking may allow research into pavement mix design performance or the efficacy of a specific asphalt binder to resist cold weather cracking. While these "multiple channels" of distress data make this kind of research possible, other specific information needs to be retained for that research to be successful. For instance, an agency would also need to retain specifics of the mix designs and materials used in every project in order to be analyzed in the research, so there is additional cost and effort to make use of the richer condition data set.

In many cases, asset condition data used for pavement management (i.e., operational data) may not meet the needs of researchers who may require very specific, consistent, and precise data. In these cases, a small number of well-controlled and representative sites may serve research purposes better. This concern was illustrated by a Kansas Department of

Transportation study's literature review section on calibrating the Mechanistic-Empirical Design Guide (MEPDG) (Xiaohui Sun, 2015).

The additional channels of condition data from complex condition rating scales can also be used to fine tune project or treatment selection on a road-owning-agency level. Research can be conducted to determine the range of pavement condition factors that impact the success or service life of preventive and rehabilitative pavement treatments. For example, an agency could determine the acceptable range of alligator cracking that can be present before a thin overlay would prematurely deteriorate and could modify their project selection criteria to follow this analysis. Then, project selection guidance could be developed to better select projects based on a broad number of data factors. However, there is a significant research and development component that would need to be completed in order to take advantage of these additional channels of data to know when specific levels of a distress would be relevant to performance. New tools and a technical capacity to use this type of data would also need to be developed at the road-owning-agency level.

Distributed Collection vs. Centralized Collection

The TAMC's PASER data collection effort uses a distributed collection model. Road-owning agencies individually collect data in their own jurisdiction; their data is then aggregated at a region level and then at a state level. In a distributed collection model, the condition data is immediately available upon collection in the local road-owning agency's asset management system for their own use. Distributed collection makes road-owning agencies responsible for condition data collection. This responsibility for data collection gives road-owning agencies confidence in the quality of the data, provides agencies with a sense of ownership over the data, and helps agencies appreciate the value of the data.

Distributed collection models are difficult to set up since they depend on hundreds of people from hundreds of agencies coordinating for a single goal in a relatively tight timeframe. Once distributed collection models are set up, however, they provide a high degree of resiliency since a failure or lack of capacity in one agency can be overcome by peers.

Centralized collection models become attractive when expensive or specialized equipment are used. Centralized collection models can also be necessary when specialized experience or services are needed for data collection. In a centralized collection model, centralization of the data collection effort protects high-end resources from becoming idle, maximizing their use while minimizing the capital expenses related to owning the resource. Many of the alternative data collection types and their related solutions tend toward centralized collection models. For example, a purpose-built data collection vehicle (i.e., specialized sensors package-equipped vehicle) can cost in excess of $100,000 and requires trained operators; it is not practical to have one of the vehicles at each county roads commission, large city, and department of transportation region office; however, some of these vans could be purchased and used by a single agency to collect data on a statewide level.

A centralized collection model for the TAMC data collection effort would separate road-owning agencies from the data collection process. While this may free up agency staff time, road-owning agencies would no longer be associated with the data collection effort and would lose autonomy in the data collection process, potentially resulting in individual road-owning agency's lower confidence in the data, lower sense of ownership over the data, and lower perceived value of the data.

Furthermore, a centralized collection model has the concern of limiting local road-owning agencies' capacity to collect their own data outside of the TAMC's collection interests. A centralized collection model relies heavily on a few well-equipped data collection teams, so capacity and resiliency of the data collection process are outside of individual road-owning agency's control.

Cost

The PASER data collection effort using the TAMC's distributed-collection model has a long history of cost and productivity measures associated with it. Calculated average costs from this historical data for PASER data collection range from $11.99 to $13.75 per centerline mile depending on if training is considered as part of the expense.

An investigation of other pavement condition data collection types and related market-ready solutions has revealed a large range in the cost per mile to generate useable condition data. The data collected by this study points to a reasonable price point between $40 and $60 per centerline mile while a 2019 NCHRP synthesis found price points between $28 and $300 per centerline mile, with most options between $50 and $80 per centerline mile and an average of $84 per centerline mile.

At best, an alternative solution is more than double the TAMC's data collection budget: $28 per centerline mile compared to $13.75 per centerline mile for PASER inclusive of the cost for training. It should be noted that the $28 per centerline mile collection cost was an outlier when compared to average vendor cost data reviewed by this study and that other market-ready solutions did not include training in their per mile cost data. A more comparable relationship between alternative solutions and PASER shows a fivefold increase in the TAMC's data collection budget: $60 per centerline mile based on the majority of cost benchmarks for alternative solutions compared to $11.99 per centerline mile for PASER excluding training, even though training will be necessary for all solutions. In terms of collecting data on Michigan's paved federal-aid-eligible road network, these cost differences equate to a data collection cost of between $600,000 and $2 million over the TAMC's current data collection budget of approximately $528,000.

Overall Potential Benefits from Changing to Another Market-ready Solution

The primary benefits that the TAMC would see from using a market-ready solution in an alternative data collection type are the increase in the repeatability of data and the streamlining of data collection since all data collection would be completed by a central authority using a small number of collection devices. The TAMC's current method of PASER data collection appears to provide data that is reasonably repeatable as shown by the TAMC's annual quality review process, which performs a repeated measure on a specific set of pavements by an outside firm. This raises the question of how much the additional repeatability is needed and what is it worth?

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FY2022 Calendar of Events - Transportation Asset Management Council

Date	Event	Council Member or TAMC Support Staff	Time & Location	TAMC Booth	Presentation	Comments and added Information / website / flyer
OCTOBER					No	
10/278/21 - 10/28/21	Fall Transportation Asset Management Virtual Conference		9 AM - 1 PM Each Day	No	Yes	https://www.michigan.gov/tamc/0,7308,7-356-82157---,00.html
NOVEMBER					No	
11/4/21	State Transportation Commission Meeting		MDOT Aeronautics & Web Meeting	No	No	
DECEMBER					No	
12/9/21	MIC Meeting		1 PM - 4 PM - Web Meeting	No	No	
12/14/21	TAMC IRT Training	Roger Belknap/Dave Jennett	WEBINAR: 9 AM-Noon	No	Yes	
12/15/21	Roadsoft User's Conference - RUCUS	TAMC Support Staff	Mt. Pleasant - 8 AM-5PM	No	Yes	http://ctt.nonprofitsoapbox.com/component/events/event/1126
JANUARY						
1/25/22 - 1/27/22	PASER & IBR Training (Webinar)	Roger Belknap	WEBINAR: 8 AM-11 AM	No	Yes	http://www.ctt.mtu.edu/sites/ctt/files/flyers/2022tamc-paseribr.pdf
1/25/22	TAMC IRT Training	Joanna Johnson	WEBINAR: 9 AM-Noon	No	Yes	https://www.michigan.gov/documents/tamc/2022_TAMC_IRT_Training_Schedule_745738_7.pdf
FEBRUARY						
2/8/22 - 2/10/22	County Engineers Workshop	Joanna Johnson	Hybrid - Web & Shanty Creek	Maybe	No	http://ctt.nonprofitsoapbox.com/upcoming-events/event/1087
2/22/22	TAMC IRT Training	Bill McEntee	WEBINAR: 9 AM-Noon	No	Yes	https://www.michigan.gov/documents/tamc/2022_TAMC_IRT_Training_Schedule_745738_7.pdf
2/22/22	Culvert Asset Management Training	Kelly Jones	WEBINAR: 9 AM-11AM	No	Yes	http://ctt.nonprofitsoapbox.com/2022culvertfeb
2/23/22	PASER & IBR Training (On Site)	Joanna Johnson	Road Commission of Kalamazoo County, 3801 E Kilgore Rd, Kalamazoo, MI 49001 8 AM-12 PM	No	Yes	http://www.ctt.mtu.edu/sites/ctt/files/flyers/2022tamc-paseribr.pdf
2/24/22	PASER & IBR Training (On Site)	Joanna Johnson	Weber's Restaurant & Boutique Hotel, 3050 Jackson Ave, Ann Arbor, MI 48103 8 AM-12 PM	No	Yes	http://www.ctt.mtu.edu/sites/ctt/files/flyers/2022tamc-paseribr.pdf
MARCH						
3/1/2022	Culvert Asset Management Training	Kelly Jones	WEBINAR: 9 AM-11AM	No	Yes	http://ctt.nonprofitsoapbox.com/2022culvertmar
3/8/2022	TAMC IRT Training	Rob Surber	WEBINAR: 9 AM-Noon	No	Yes	https://www.michigan.gov/documents/tamc/2022_TAMC_IRT_Training_Schedule_745738_7.pdf
3/8/22 - 3/10/22	Annual CRA Highway Conference & Roadshow	Staff	Lansing Center, Lasing, MI	Yes	No	https://info.micountyroads.org/events/details/2022-highway-conference-and-road-show-576
3/10/2022	Transportation Asset Management for Local Officials Webinar		WEBINAR: 9 AM-Noon	No	No	http://www.ctt.mtu.edu/sites/ctt/files/flyers/2022tamlo-march.pdf
3/15/22-3/16/22	Michigan Municipal League Capital Conference	Staff	Lansing, TBD	No	No	
3/15/22 - 3/17/22	2021 Michigan Bridge Week Conference	Al Halbeison	Ann Arbor Marriott Ypsilanti at Eagle Crest 1275 S Huron Street, Ypsilanti, MI, 48197	No	Yes	http://ctt.nonprofitsoapbox.com/component/events/event/1090
APRIL						
4/12/22 - 4/14/22	PASER & IBR Training (Webinar)	Jennifer Tubbs	WEBINAR: 8 AM-11 AM	No	Yes	http://www.ctt.mtu.edu/sites/ctt/files/flyers/2022tamc-paseribr.pdf
4/19/22	TAMC IRT Training	Jennifer Tubbs	WEBINAR: 9 AM-Noon	No	Yes	https://www.michigan.gov/documents/tamc/2022_TAMC_IRT_Training_Schedule_745738_7.pdf
4/20/22	PASER & IBR Training (On Site)	Bob Slattery	Treetops Resort, 3962 Wilkinson Rd, Gaylord, MI 49735 8 AM-12 PM	No	Yes	http://www.ctt.mtu.edu/sites/ctt/files/flyers/2022tamc-paseribr.pdf
4/21/22	PASER & IBR Training (On Site)	Bob Slattery	Marquette Charter Township, 1000 Commerce Dr, Marquette, MI 49855 8 AM-12 PM	No	Yes	http://www.ctt.mtu.edu/sites/ctt/files/flyers/2022tamc-paseribr.pdf
4/26/22 - 4/27/22	2022 Highway Maintenance Conference		Shanty Creek Resort, 5780 Shanty Creek Rd, Bellaire, MI,49615	No	No	http://ctt.nonprofitsoapbox.com/component/events/event/1089
MAY						
5/10/22	TAMC IRT Training	Brad Wieferich	WEBINAR: 9 AM-Noon	No	Yes	https://www.michigan.gov/documents/tamc/2022_TAMC_IRT_Training_Schedule_745738_7.pdf
5/24/22 - 5/26/22	APWA Great Lakes Expo		Boyne Mountain Resort - 1 Boyne Mountain Rd, Boyne Falls, MI 49713	No	Opportunity?	http://michigan.apwa.net/EventDetails/27280
JUNE						
6/15/22 - 6/17/22	PASER & IBR Training (Webinar)		WEBINAR: 8 AM-11 AM	No	Yes	http://www.ctt.mtu.edu/sites/ctt/files/flyers/2022tamc-paseribr.pdf
JULY						

FY2022 Calendar of Events - Transportation Asset Management Council

Date	Event	Council Member or TAMC Support Staff	Time & Location	TAMC Booth	Presentation	Comments and added Information / website / flyer
7/26/22 - 7/29/22	MTPA Annual Conference	Ryan Buck	THE UNIVERSITY OF MICHIGAN-FLINT RIVERFRONT BANQUET CENTER & THE HILTON GARDEN INN FLINT	No	Yes	http://www.mtpa-mi.org/
AUGUST						
8/30/2022	Culvert Asset Management Training	Kelly Jones	WEBINAR: 9 AM-11AM	No	Yes	http://ctt.nonprofitsoapbox.com/2022culvertaug
SEPTEMBER						
9/28/2022	TAMC Conference	All Hands on Deck	Great Wolf Lodge, Traverse City, MI	Yes	Yes	