TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

Lead Agency (FHWA or State DOT): __Iowa DOT_____

INSTRUCTIONS:
Project Managers and/or research project investigators should complete a quarterly progress report for each calendar quarter during which the projects are active. Please provide a project schedule status of the research activities tied to each task that is defined in the proposal; a percentage completion of each task; a concise discussion (2 or 3 sentences) of the current status, including accomplishments and problems encountered, if any. List all tasks, even if no work was done during this period.

Transportation Pooled Fund Program Project # *TPF-5(295)*	**Transportation Pooled Fund Program - Report Period:** Quarter 1 (January 1 – March 31, 2017) X Quarter 2 (April 1 – June 30) Quarter 3 (July 1 – September 30) Quarter 4 (October 1 – December 31)
Project Title: Midwest Smart Work Zone Deployment Initiative	

Name of Project Manager(s): Dan Sprengeler	**Phone Number:** 515-239-1823	**E-Mail** Dan.Sprengeler@dot.iowa.gov
Lead Agency Project ID: Keith Knapp	**Other Project ID (i.e., contract #):** Addendum 535	**Project Start Date:** July 1, 2014
Original Project End Date: June 30, 2020	**Current Project End Date:** June 30, 2019	**Number of Extensions:** None

Project schedule status:

X On schedule ☐ On revised schedule ☐ Ahead of schedule ☐ Behind schedule

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Percentage of Work Completed to Date
$925,000 (committed)	$534,645.57	0

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
$106,570.10		0

Project Description:
The Midwest Smart Work Zone Deployment Initiative (MwSWZDI) was initiated in 1999 as a Federal Highway Administration (FHWA) Pooled Fund Study intended to coordinate and promote research among the participating states related to safety and mobility in highway work zones.

The program is an ongoing cooperative effort between State Departments of Transportation, universities, and industry. The studies completed have consisted of evaluations of various work zone related products, various innovative topics, and several synthesis studies. Completed reports and descriptions of ongoing projects can be obtained at the Iowa State University's Institute for Transportation (InTrans) website (www.intrans.iastate.edu/smartwz/) link to the Smart Work Zone Deployment Initiative. InTrans currently operates as the program manager of the pooled fund efforts and completes administrative tasks related to request for ideas and proposals, meetings, project files, quarterly reports, and recommending reimbursement.

Progress this Quarter (includes meetings, work plan status, contract status, significant progress, etc.):

Quarter Ending June 30, 2017 (Overall)
During this quarter we communicated with a number of principal investigators as needed. Resolved some progress issues as they occurred. Contracts for Years 2014 to 2016 were continued and the contracts are now finalized for all the 2017 projects. Problem statements for program year 2018 research were collected. A meeting will be held in July or August to advance the 2018 program year RFP.

The following is a summary of accomplishments from April to June 2017 for the Year 2014-2017 individual research projects under fund account TPF-5(295).

2017 Program Projects

- Extension of Safety Assessment Tool for Construction Work Zone Phasing Plans, University of Missouri-Columbia, Henry Brown as PI.

  A list of data that would be useful for developing the tool was developed, and a written request for data regarding work zones and crashes was prepared and sent to Kansas and Wisconsin. Work on the literature review has begun.

  Project started on March 1, 2017 and is expected to finish on May 31, 2018. It is 7% complete.

- Analytical Methods for Work Zone Travel Time Reliability. University of Wisconsin-Madison Susan Ahn as PI.

  A TAC has been formed. A kickoff meeting with the TAC is scheduled for July 13, 2017. A literature review is in progress. The team has so far reviewed SHRP2 L08 project report, new HCM chapters related to determining travel time reliability, and other related papers and reports. The team has also identified possible methodologies and a modeling approach. The proposed framework will be discussed during the kickoff meeting and will be refined accordingly. The team has identified available data and additional data requirement to accomplish project objectives.

  Projected started on May 15, 2017 and is expected to finish on May 14, 2018. It is 15% complete.

- Testing Non-Proprietary Devices to MASH 2016 Criteria. University of Nebraska-Lincoln, Jennifer Schmidt as PI.

We established the initial project plan. The research has not officially been started as we are finishing up summarizing results on NCHRP Project No. 3-119. Through this study, a list of non-proprietary safety work zone devices in common use by state DOTs will be available by mid-July. The research team will make sure the device selected is also commonly used by SWZDI state DOTs.

Project started on May 1, 2017 and is expected to finish on April 30, 2018. The PI has declared 0% progress.

2016 Program Projects

- Design Optimal and Effective Queue Detection and Notification: Design of a Low-Cost Work Zone Warning System, University of Wisconsin, Madhav Chitturi as PI.

  Have been in communication with TAPCO about design of the low-cost system. TAPCO has developed a potential design already. We have gone through multiple iterations to make the design MUTCD compatible as well as satisfy crashworthiness requirements. Design changes were required to satisfy crashworthiness requirements of roadside hardware without having to go through crash testing requirements. Currently, working with TAPCO on building the prototypes. The TAC meeting happened in October and we obtained their input on the proposed design. Lot of discussion in the TAC meeting about what sign should be used "Be prepared to stop" or "Slow traffic ahead" or "Watch for stopped traffic". Reached out to WisDOT to identify potential sites for testing and deploying the system.

  Project started on June 15, 2016 and is expected to finish on December 15, 2017. It is 30% complete.

- Understanding the Impact of Work Zone Activities on Traffic Flow Characteristics, University of Missouri-Columbia, Praveen Edara as PI.

  Speed flow models for study locations were developed by calibrating three single stage functions with the help of field loop detector data. To determine the best fit model out of all the three selected traffic stream models, a goodness-of-fit test was performed. To estimate the impact of work activity of work zones on the overall traffic flow characteristics of roadway segment, speed flow plots were developed based on directional traffic for both a work zone day and non-work zone day to determine the reduction in capacity and free flow speed of a roadway segments due to work activity. Plots were also developed by lane, since the locations had different lane closure configurations making comparisons among different work-zone locations difficult. It was found that the work activities in work zones can be broadly classified into two groups, (i) related to bridge and (ii) related to pavement. For comparison purposes, the speed-flow curves developed for all selected locations were merged into these two groups. Preparation of the draft final report is in progress.

  This project started on April 1, 2016 and is expected to finish on October 1, 2017. It is 70% complete.

- Best Practices for Managing Work Zone Data, University of Wisconsin-Madison, Steven Parker as PI.

  The final TAC meeting on May 15th demonstrated the project findings and recommendations. In the following weeks after the TAC meeting, additional comments from the TAC were received and later incorporate into the final report for SWZDI board review.

  This project started on April 1, 2016 and is expected to finish on March 31, 2017. The project was extended to June 30, 2017 and a new request to complete the final report is expected soon. This project is 99% complete.

- Development of a Data Collection Prototype and a Traffic Impact Assessment Tool for Moving Work Zone Operations, University of Missouri-Columbia, Praveen Edara as PI.

  Archived video data from a previous project on mobile work zone alarms were processed and analyzed. A group of moving work zones on I-44 and I-64 freeways in the St. Louis area were queried through MoDOT e-alerts. The RITIS database based on probe vehicle travel time and database of traffic flow detectors were matched to help identify the moving work zone location and time. For 18 work zones with duration more than 30 minutes, speed-flow diagrams from detectors and speed heatmaps from RITIS were plotted. It was found that the speeds for the work zone segment, 1st upstream and 1st downstream in presence of work zone were 8.3, 3.5 and 1.9 mph less than historical data, respectively. VISSIM was calibrated for an 18-mile segment of a 3-lane freeway using actual data collected on I-64, I-44, and moving work zone videos. A regression model to predict work zone speed based on variables such as speed limit, number of lanes, volumes, and work zone duration was developed. Work on the draft final report has continued.

  The project started on March 15, 2016 and was expected to be finished on July 31, 2017. A no cost extension for the project to September 30, 2017 was granted. This project is 70% complete.

2015 Program Projects

- Evaluation of Alternative Work Zone Signing, University of Wisconsin – Madison, Madhav Chitturi as PI.

  Literature Review completed. Survey protocol approved by IRBs at both UW-Madison and University of Missouri. Completed Stages 1 and 2 of Survey at DMVs in Wisconsin and Iowa. Analysis completed and Completed Stage 3 survey in early January 2017. Driving Simulator evaluation completed. Draft final report was compiled, submitted to project TAC and SWZDI Board of Directors for review. Following the review period, final report has been submitted for publication.

  This project is 100% complete (it is currently being reviewed for formatting before it is posted). It was expected to end by August 31, 2016, but has been extended to March 31, 2017. And extended further to June 30, 2017.

- Orange Work Zone Pavement Marking Midwest Field Test, University of Wisconsin – Madison, Madhav Chitturi as PI.

  Literature review is completed. We have collected information on standards and specifications of different agencies and also material specifications from different vendors. We have identified a site on I-94 (between Madison and Milwaukee) in Wisconsin. We communicated with WisDOT and FHWA and developed a test plan for the field evaluation. We developed and obtained approval for a Request to Experiment from FHWA. Purchased and integrated the equipment to collect field data. Field data collection completed. Analysis is completed. Completed survey of drivers at a rest area near the work zones. Completed agency and contractor interview. Compiling and internally reviewing the draft final report. Following the TAC review and review by the Board of Directors, we will submit the final report for publication by September 30, 2017.

  The project was expected to end by September 30, 2016, but it has been extended to March 31, 2017. And extended further to June 30, 2017. It was extended further to September 30, 2017. It is remains at about 90% complete.

2014 Program Projects

- Length of Need for Free-Standing, F-Shape, Portable 12.5' Concrete Protection Barrier, University of Nebraska, Ron Faller as PI

  Previously, MwRSF completed simulation of impacts on the upstream and downstream ends of the 200 ft long barrier system to determine the length of need. It was determined that three barriers would be recommended for both the beginning and the end of length-of-need for the TCB system, until the results could be further discussed with the TAC.

  The next step of the simulation analysis was to conduct impacts at the selected beginning and end of length-of-need lengths for a reduced system length in order to verify that the length-of-need definitions work for shorter lengths and to examine the minimum potential length of the TCB system. Simulation models were evaluated using a seven barrier long TCB system. The results of these models found that the 2270P vehicle was successfully redirected for the seven barrier installation at both the beginning and end of the LON. In both cases, the reduced barrier system increased barrier deflections by approximately 16" over the full-length, 16 barrier system. Additionally, the impact at the end of the LON indicated a potential for the last barrier in the system to rotate rapidly towards the vehicle as it was redirected and impact the vehicle door. Thus, while the vehicle was redirected and the increases in deflections were manageable, the impact of the barrier with the driver side door was a concern.

  These findings were discussed in detail at the July 21st TAC meeting in order to determine what the TAC concerns were and what was desired to be investigated through full-scale testing. The TAC indicated that the rotation and impact of the end barrier with the vehicle was a concern and wished to analyze the system with eight barriers, 3 for the beginning of LON, one in the middle, and 4 on the end of the LON. These models were simulated. Again both models successfully redirected the impacting vehicle. The addition of the fourth barrier on the end of LON mitigated the impact of the barriers on the vehicle door. Barrier deflections for impact at the beginning and end of LON for the 8 barrier installation were found to be 94.8 in. and 90 in., respectively. These results were given to the TAC in a meeting on 10-15-15. They concurred that testing should proceed on the 8 barrier installation.

  Details for the full-scale crash testing of the 8 barrier installation were developed and sent to the MwRSF Outdoor Testing Facility. Barriers for both full-scale crash tests were fabricated and received. Currently, full-scale testing of the 8 barrier installation will commence as soon as possible within the current MwRSF test queue.
  standard TL-3 impact conditions.

  MwRSF conducted the full-scale crash testing and evaluation of the reduced system lengths indicated by the simulation analysis. Two full-scale crash tests were conducted.
  1. NELON-1 = Test designation no. 3-35 at beginning of LON
  2. NELON-2 = Test designation no. 3-37 at end of LON

  In test no. NELON-1, the 2270P pickup truck vehicle impacted the eight barrier long PCB system 4.3 ft upstream of the joint between barrier nos. 3 and 4 to evaluate an impact at the beginning of length-of-need. During the impact, the vehicle was safely redirected. The deflection of the barrier system was significantly higher than previous tests with a 16 barrier long PCB system in terms of both lateral motion and longitudinal motion. A peak dynamic lateral barrier deflection of 128.3 in. was measured in test NELON-1. In addition, it was noted that the increased deflection of the barriers upstream of the impacting vehicle allowed a knee to form at the joint between barrier nos. 5 and 6 that impacted the rear passenger door on the driver's side of the vehicle. While this impact did not create an occupant risk, it was one of the behaviors noted in the simulation analysis that caused concern with reduced length PCB systems.

In test no. NELON-2, the 2270P pickup truck vehicle impacted the eight barrier long PCB system 4.3 ft upstream of the joint between barrier nos. 4 and 5 to evaluate an impact at the end of length-of-need. During the impact, the vehicle was redirected, but increased roll of the vehicle was observed that caused the vehicle to roll over 80 degrees onto the driver side after exiting the system. This vehicle instability exceeded the 75 degree limitation on vehicle roll in MASH, the test result was deemed not acceptable according to MASH TL-3. Examination of the test results are continuing, but two factors are believed to have contributed to the excess roll. First, the reduced length of the PCB system allowed increased deflection of the barrier segments upstream of the vehicle which delayed the tail slap of the back end of the vehicle with the PCB system when compared to previous testing of longer systems. This delay in the impact of the rear of the truck with the PCB system as it was redirected may have provided less lateral support for the truck as it was yawing and rolling, thus allowing for increased roll of the vehicle. A second factor that may have contributed to increased vehicle roll was the formation of a knee between barrier nos. 6 and 7. Similar to test no. NELON-1, a knee formed between barrier nos. 6 and 7 in test no. NELON-2 that extended forward and impacted the rear of the front fender as well as the driver door and the rear passenger door on the driver's side of the vehicle. The lateral loading of side of the vehicle by the knee in the barrier system may have increased vehicle roll and instability.

Preliminary review of the review of these two tests suggests that defining a minimum of 3 barriers for the beginning of length-of-need for an 8 barrier long system was acceptable, but that 4 barriers for the end of length-of-need was insufficient. Thus, an eight barrier system length is not acceptable. However, the use of a 9 barrier system with 3 barriers for the beginning of length-of-need, 1 barrier in the length-of-need, and 5 barriers for the end of length-of-need would be sufficient. We can extrapolate that this system would be successful because test no. NELON-1 worked with and 8 barrier long system with 3 barriers for the beginning of length-of-need and 5 barriers downstream of impact. Thus, it would stand to reason that a 9 barrier long system should perform equally well if the end of length-of-need is defined as 5 barriers at minimum.

Following the full-scale crash tests, the researchers have conducted simulations of both crash tests to calibrate the models to the dynamic deflection observed in the tests. These calibrated models are completed. Additional simulation models to estimate barrier deflections for intermediate lengths under MASH TL-3 impact conditions and 85 percentile impact severity levels were also completed and the results are currently were incorporated into the research report. Work continued last quarter on the final report for the research and the report draft is approximately completed and is undergoing internal review and editing at MwRSF. The edited report will be completed early in the first quarter of 2017 and sent to the sponsors for review.

Currently, MwRSF has finished the preparation of the final report with the implementation of SWZDI and NDOR edits and comments and published report copies are being printed and sent to the sponsors. A technical brief for SWZDI and NDOR has been completed and a PowerPoint presentation of research results to NDOR and the TAC was completed as the final part of completing the project. At this time the project is complete.

The final report can be found on the MwRSF website at the link below.

http://mwrsf.unl.edu/researchhub/files/Report331/TRP-03-337-17.pdf

This project is 100 percent complete and had an initial end date of December 31, 2015. An extension to December 31, 2016 was granted and then another one to August 31, 2017.

- Development of a TL-3 Transition between Temporary Concrete Barrier and Guardrail, University of Nebraska, Ron Faller as PI

  Previously, MwRSF conducted all three of the full-scale crash tests for evaluation of the MASH TL-3 guardrail to PCB transition system. The test matrix is listed below.

  1. MGSPCB-1 - Test no. 3-21 - Impact of the 2270P vehicle on the centerline of the fifth guardrail post upstream from the end-shoe attachment at a speed of 62 mph and an angle of 25 degrees.
  2. MGSPCB-2 - Test no. 3-21R - Reverse direction impact of the 2270P vehicle 12 ft – 6 in. upstream from the end-shoe attachment at a speed of 62 mph and an angle of 25 degrees.
  3. MGSPCB-3 - Test no. 3-20 - Impact of the 1100C vehicle on the critical impact point of the guardrail to PCB transition at a speed of 62 mph and an angle of 25 degrees. MASH procedures and engineering analysis will be used to determine the critical impact point.

  All three of the full-scale crash tests successfully met the MASH TL-3 criteria. Thus, the system evaluation was completely successful. A TAC meeting was held on 10-15-15 to update the project status and review the full-scale crash test results.

  MwRSF has completed the test report and recommendations for the implementation of the design, and sponsor review comments have been implemented. Final copies of the report and a technical brief are in the process of being distributed to the sponsors.

  A TRB paper for the 2017 meeting was submitted and was accepted for publication.

  MwRSF will completed a summary presentation of the research results for the TAC.

  At this time the project has been completed. The final report has been posted at the MwRSF website at the link below.

  http://mwrsf.unl.edu/researchhub/files/Report330/TRP-03-335-17.pdf

  This project is 100 percent complete and had an original end date of December 31, 2015. An extension to December 31, 2016 was granted and then another one to August 31, 2017.

Anticipated work next quarter:

Work will continue on contracted projects. All projects were contracted for 2017 program year and older projects were continued.

Significant Results:

Some rojects were completed this quarter. One project report is in review. Problem statements for 2018 were collected and distributed to the board for review. They will be selected in the next quarter and an RFP sent out for program year 2018 proposals.

Circumstance affecting project or budget. (Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints set forth in the agreement, along with recommended solutions to those problems).

Currently there are no problems to report with the administrative contract. Any issues that have come up with the individual projects that may impact schedule or budget are resolved on a case by case basis.

Potential Implementation:

Several projects neared completion and were reviewed.