**TRANSPORTATION POOLED FUND PROGRAM QUARTERLY PROGRESS REPORT**

Lead Agency (FHWA or State DOT): Colorado Department of Transportation

**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.*

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| --- | --- | --- | --- |
| **Transportation Pooled Fund Program Project #**  TPF-5(380) | | **Transportation Pooled Fund Program - Report Period:**  2021  ☐Quarter 1 (January 1 – March 31)  ☐Quarter 2 (April 1 – June 30)  ☐Quarter 3 (July 1 – September 30)  ☒Quarter 4 (October 1 – December 31) | |
| **Project Title:**  Autonomous Maintenance Technology (AMT) Pool Fund | | | |
| **Name of Project Manager(s):**  David Reeves | **Phone Number:**  303-757-9518 | | **E-Mail**  [david.reeves@state.co.us](mailto:david.reeves@state.co.us) |
| **Lead Agency Project ID:**  WBS 22610.06.01 | **Other Project ID (i.e., contract #):** | | **Project Start Date:**  8/14/2018 |
| **Original Project End Date:**  12/31/2024 | **Current Project End Date:**  12/31/2024 | | **Number of Extensions:**  0 |

# Project schedule status:

☒ 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** |
| $321,387 (6 projects active)  $575,615 (6 projects in purchasing)  $1,125,000 (transferred to CDOT)  $227,998 (Available for future projects) | $206,864 (invoiced to date) | 64.4% (active projects only)  23% (active & in purchasing) |

***Quarterly*** Project Statistics:

|  |  |  |
| --- | --- | --- |
| **Total Project Expenses and Percentage This Quarter** | **Total Amount of Funds Expended This Quarter** | **Total Percentage of Time Used to Date** |
| Ongoing Project (N/A) | Ongoing Project (N/A) | Ongoing Project (N/A) |

**Project Description**:

The Colorado Department of Transportation (CDOT) has helped to develop a first‐of‐its kind work zone vehicle designed to advance safety for roadway maintenance crews. Customarily positioned behind road construction crews in order to protect workers from the traveling public, the Autonomous Impact Protection Vehicle (AIPV) increases work zone safety by removing the driver from a truck that is actually designed to be hit. The objective of the Autonomous Maintenance Technology (AMT) Pool Fund is to develop, demonstrate and refine the AIPV in preparation for its wide‐spread deployment nationwide in DOT maintenance operations.

Currently there are twelve projects related to this pooled fund:

* 5380-18-01 AMT Coordination (CSU) $150,000 - Dr. Tom Bradley (PI), Dr. Erika Miller (Co-PI), and Janine-Marie Conrad. Colorado State University (CSU). Provides administrative management and support of the pool fund. This includes travel for annual meetings.
* 5380-19-02 Evaluating the Human‐Automated Maintenance Vehicle for Improved Safety and Facilitating Long Term Trust (CSU) $75,000 – Dr. Erika Miller (PI). Completed final report [CDOT-2021-05](https://www.codot.gov/programs/research/pdfs/2021/2021-05.pdf).
* 5380-19-03 Development of ATMA/AIPV Deployment Guidelines Considering Traffic and Safety Impacts $92,572 (PennState) - Dr. Xianbiao (XB) Hu (PI). This project was originally with Missouri State University. The PI moved to PennState. This project is currently in purchasing.
* 5380-20-04 ATMA Tabletop (All Clear Emergency Management) $22,300 – Will Moorhead (PI). Completed final report [CDOT-2021-09](https://www.codot.gov/programs/research/pdfs/2021/cdot202109atma-tabletopexercise.pdf).
* 5380-20-05 ATMA Cybersecurity Complement (CSU) $50,000 – Dr. Jeremy Daily (PI).
* 5380-20-06 ATMA Documentation $130,000 – Dr. Xianbiao (XB) Hu (PI), PennState. This project was originally with Missouri State University. The PI moved to PennState. This project is currently in purchasing.
* 5380-21-07 ATMA Incident Form Workshop (All Clear Emergency Management) – Jake Peterson (PI).
* 5380-21-08 ATMA Cost-Benefits (KSU) - Planning and Investing with informed Cost Benefit under Various Environments – Dr. Husain Aziz (PI) Kansas State University (KSU). This project is currently in purchasing.
* 5380-22-09 Literature Review Synthesizing the current and Potential ATMA Applications (CSU) – Dr. Erika Miller (PI)
* 5380-22-10 Impact Performance of Autonomous Impact Protection Vehicle (AIPV) with Truck Mounted Attenuator (Texas A&M) – Roger Bligh. This project is currently in purchasing.
* 5380-22-11 Building Cloud Based Interactive Data Visualization (TTU & DU) - Xuantong (Tony) Wang, Texas Tech University (TTU) (PI) and Jing Li - U of Denver (DU) sub (Co-PI). This project is currently in purchasing.
* 5380-22-12 Risk Assessment for Operational Safety of ATMA (UCLA) – Jaiqu Ma, UCLA (PI). This project is currently in purchasing.

Each project has a separate quarterly progress report in the lead’s state desired format and available upon request.

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

Progress in Q4 2021 includes:

5380-18-01 AMT Coordination (CSU) $150,000 - Dr. Tom Bradley (PI), Erika Miller, and Janine-Marie Conrad. Colorado State University (CSU). Provides administrative management and support of the pool fund. This includes travel for annual meetings.

5380-19-03 ATMA Dev Guide (MST) $92,572 - Dr. Xianbiao (XB) Hu (PI), PennState

**Project Update**: Grant transfer: the contract has arrived at PennState. OSP is reviewing the languages and terms in the contract. Attended the pool fund annual meeting in Denver, CO, in person. Continued to work on Tasks 4 optimal deployment strategy development, and task 5 open-source software tools development.

5380-20-04 ATMA Tabletop $22,300 – Will Moorhead (PI), All Clear Emergency Mgmt, Golden, Colorado

**Project Update:** Final deliverables for the tabletop exercise project were provided. Those included the After-Action Report (AAR) and a project summary. All Clear met with the planning team on October 7 to review the final deliverables and next steps. We also discussed, and recorded in the final documents, additional next steps for preparedness/readiness and incident response within the ATMA. The additional steps discussed included holding a workshop to develop a checklist/worksheet that would be made available to all crews working with autonomous vehicles to guide the response of the crews in the event of an accident involving an DOT autonomous vehicle.

5380-20-05 ATMA Cybersecurity Complement $50,000 – Dr. Jeremy Daily (PI), CSU, Fort Collins.

**Project Update:** 2022Q1 – Collected data from the ATMA systems to include logs, CAN data, VBox Data, Event Recorder Data and Ethernet pcap files.

2021Q4 – Reviewed digital log files from the ATMA. Found the context was missing while parsing the data, so no conclusions could be drawn. Planned for an data collection trip to Limon. Presented a review of the data issues from the tabletop exercise in the form of a powerpoint presentation.

2021Q3 – Participated in the ATMA Table top exercise

2021Q2 – Developed Scenario with the table top exercise team. Provided details and questions to consider. Traveled to Limon, CO to examine the vehicles and collect data.

2021Q1 – Kick-off meeting with All Clear, preliminary research on data availability on the ATMA system.

**ANTICIPATED WORK NEXT PERIOD**

Completion of report comparing the log files and data analysis. The report will also include recommendations and procedures for data collection for post-incident response. Finally, recommendations for improving the cybersecurity of the systems will be discussed.

**ISSUES**

The acquisition of the Racelogic VBoc 3i RTK unit delayed the on-vehicle testing. With the testing completed, this issue is resolved.

5380-20-06 ATMA Documentation $130,000 – Dr. Xianbiao (XB) Hu (PI), PennState.

**Project Update:** Grant transfer: the contract has arrived at PennState. OSP is reviewing the languages and terms in the contract. Finished report of “Task 2 – system description”. We have received comments from the pool fund, and have addressed all of them in the new version. Attended the pool fund annual meeting in Denver, CO, in person. Started to work on Tasks 2.2 System Test Manual, and Tasks 2.3 Concept of Operation.

**Anticipated work next quarter**:

In the 4th quarter of 2021, the team plans to accomplish the following:

Continued refinement of the Toolkit

Continued monthly meetings

Quarterly report and project status

Maintaining and updating outwardly facing website

Continued work on all projects and contract projects

**Significant Results:**

Annual Autonomous Maintenance Technology (AMT) Peer Exchange Hybrid (In-person meeting and remote participation via Zoom) was held in Denver, Colorado on October 21 and 22, 2021. Participants from states, local governments, federal, academia and industry were all in attendance. Meeting featured Problem Statement Presentations from researchers involved the pooled fund, state deployer updates, and operations and planning for the upcoming research round.

The following problem statements were approved unanimously.

PS2021-03 - Planning and Investing for AMT Deployments with Informed Cost-Benefits under Varying Environmental Conditions, Husan Aziz, Kansas State University

PS2021-04 - Impact Performance of Autonomous Impact Protection Vehicle (AIPV) with Truck Mounted Attenuator (ATMA), Roger Bligh, Texas A&M

PS2021-06 - Building a cloud-based, interactive data visualization system to support collaborative safety enhancements in Autonomous Truck Mounted Attenuator (ATMA) deployed work zones, Jinq Li, University of Denver

PS2021-08 - Literature Review Synthesizing the Current and Potential Autonomous Maintenance Technology Applications, Erika Miller, CSU

PS2021-09 - Risks Assessment for Operational Safety of Autonomous Truck Mounted Attenuator (ATMA), Jiaqi Ma, UCLA, Jiaqi Ma

PS2021- Table Top Add-on, All Clear Management

CDOT UPDATE

CSU for pooled fund support, management, and coordination activities.

Engaged with states on several data sharing requests. Collaboration and information sharing is one of the most valuable components as states tackle these innovative technology deployments.

**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).**

No challenges at this time.

**Potential Implementation:**

Currently five states in some phase of deployment with purchase of a vehicle: California, Colorado, Missouri, Minnesota, and Virginia. This has increased since 2018 when Colorado was the only infrastructure owner operator of an ATMA and who had deployed an ATMA.

Assisting new states with ideation and project discovery