Research Project Quarterly Progress Report

Date: 7/29/2022 **Project Number:** TPF-5(193) Suppl. #142; RPFP-19-TERM-1

Project Title: Generic End Terminal - Phase II

Principal Investigator: Cody Stolle, Faller, Bielenberg, Lechtenberg, Rosenbaugh, Rasmussen

Principal Contact Information Email: cstolle2@unl.edu **Phone:** (402) 472-4233

Project Start Date: 10/1/2018 **Project Completion Date:** 12/31/2022

Report Period: **Due Date:**

- ☐ Quarter 1 (July 1 – September 30) ---------- October 31
- ☐ Quarter 2 (October 1 – December 31)---------- January 31
- ☐ Quarter 3 (January 1 – March 31) ---------- April 30
- ☒ Quarter 4 (April 1 – June 30)---------- July 31

Project Schedule Status:

- ☐ **On Schedule**
- ☒ **On Approved Revised Schedule**
- ☐ **Ahead of Schedule**
- ☐ **Behind Schedule**

Progress:

Task	Total Budget	% work Completed This Quarter	Expenses This Quarter	Total % of Task Completed	Remaining Budget
1. Project Planning & CAD	$40,364.00	5	$1,824.00	100	$0.00
2. Concept Refinement & Simulation	$95,701.00	0	$0.00	100	$0.00
3. Dynamic Bogie Tests	$153,861.00	15	$14,620.98	63	$82,106.23
4. Report	$35,467.00	3	$2,040.00	58	$14,550.00
5.					
6.					
7.					
8.					
9. Total	$325,393.00	5.7%	$18,484.98	70%	$97,696.23

Progress and Accomplishments this Quarter:

(Provide an informative summary of tasks/activities that occurred this quarter includes meetings, work plan status, significant progress, etc.)

Updated generic end terminal head ideas were drafted and presented to the Midwest Pooled Fund group during the April meeting. Feedback on the constructability of the head, intellectual property, maintenance, and ownership responsibilities were discussed with the group and notes were taken for further discussion. Updated designs were created based on feedback from protoytping groups to improve constructability. A prototype concept of an end anchorage system was developed utilizing the ET-2000 cable release bracket, the prototype GET terminal head, and the MwRSF Pooled Fund Steel Post Trailing Anchorage (SPTA) system. Drawing sets were created of the impact heads and submitted to local fabricators for production. Two bogie tests were planned.

Circumstances Affecting Project, Scope, or Budget:

(Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints, along with recommended solution to those problems.)

A revised plan for performing the remaining testing and documenting simulations, test results, and next project steps remains on schedule.

The COVID-19 pandemic and business responses may play a factor in future efforts. Early in the project progress, MwRSF was partially shut down in response to national response to COVID. The partial closure continued through 2020 and continued ramifications have been experienced through 2021. Employment difficulties were augmented by supply chain disruptions, extending prototype fabrication times after each design phase recommendation. MwRSF will continue to make progress on this research in the most effective manner possible moving forward.

Anticipated Work Next Quarter:

Prototype impact heads will be fabricated. Two bogie tests will be conducted: one final test on the axial force and energy attenuation of the head; and one test on the concept design of the end anchorage of the system. Additional design work may be necessary to adapt the bogie impact head to the end anchorage system. Test reuslts will be analyzed and recommendations drafted.

Total Percentage of Project Completion:

70%

Research Project Quarterly Progress Report

Date: 7/31/2022 **Project Number:** TPF-5(193) Suppl. #144, RPFP-19-MASHHC-1

Project Title: Midwest Pooled Fund MASH Hardware Clearinghouse - Phase 1

Principal Investigator: Faller, Bielenberg, Lechtenberg, Rosenbaugh, Schmidt, Stolle

Principal Contact Information Email: kpolivka2@unl.edu **Phone:** (402) 472-9070

Project Start Date: 10/1/2018 **Project Completion Date:** 12/31/2022

Report Period: **Due Date:**

- ☐ Quarter 1 (July 1 – September 30) ---------- October 31
- ☐ Quarter 2 (October 1 – December 31)---------- January 31
- ☐ Quarter 3 (January 1 – March 31) ---------- April 30
- ☒ Quarter 4 (April 1 – June 30)---------- July 31

Project Schedule Status:

- ☐ **On Schedule**
- ☒ **On Approved Revised Schedule**
- ☐ **Ahead of Schedule**
- ☐ **Behind Schedule**

Progress:

Task	Total Budget	% work Completed This Quarter	Expenses This Quarter	Total % of Task Completed	Remaining Budget
1. Project Planing & Correspondence	$6,627.00	6%	$400.00	30%	$4,777.00
2. Survey, Website Development & Population	$40,185.00	20%	$8,019.00	25%	$30,347.00
3. Research Deliverables	$4,394.00	0%	$0.00	0%	$4,394.00
4.					
5.					
6.					
7.					
8.					
9. Total	$51,206.00	20%	$10,331.00	20%	$40,875.00

Progress and Accomplishments this Quarter:

(Provide an informative summary of tasks/activities that occurred this quarter includes meetings, work plan status, significant progress, etc.)

Continued programming of new clearinghouse website.

Review prototype website, provide feedback to programmer

Circumstances Affecting Project, Scope, or Budget:

(Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints, along with recommended solution to those problems.)

The COVID-19 pandemic and business responses may play a factor in future efforts. MwRSF has not been shut down and is still working, but much of the personnel has transitioned to working remotely, as has much of the country during this time of social distancing. This major shift in regular work operations may lead to delays and inefficiencies as well as other unforseen hurdles. MwRSF will continue to make progress on this research in the most effective manner possible moving forward.

Note the programmers will invoice once the work is completed.

Anticipated Work Next Quarter:

Survey member states to determine the desired information to be contained on the clearinghouse and feedback on initated layout of clearinghouse. Complete programming prototype of new clearinghouse website.

Total Percentage of Project Completion:

20%

Research Project Quarterly Progress Report

Date: 7/29/2022 **Project Number:** TPF-5(193) Suppl. #145 - RPFP-19-MWQA-1

Project Title: Q&A Website Improvement

Principal Investigator: Jennifer Schmidt, J. Reid, R. Faller, R. Bielenberg, K. Lechtenberg, S. Rosenbaugh

Principal Contact Information Email: cstolle2@unl.edu **Phone:** (402) 472-4233

Project Start Date: 10/1/2018 **Project Completion Date:** 12/31/2022

Report Period: **Due Date:**

- ☐ Quarter 1 (July 1 – September 30) ---------- October 31
- ☐ Quarter 2 (October 1 – December 31)---------- January 31
- ☐ Quarter 3 (January 1 – March 31) ---------- April 30
- ☒ Quarter 4 (April 1 – June 30)---------- July 31

Project Schedule Status:

- ☐ **On Schedule**
- ☒ **On Approved Revised Schedule**
- ☐ **Ahead of Schedule**
- ☐ **Behind Schedule**

Progress:

Task	Total Budget	% work Completed This Quarter	Expenses This Quarter	Total % of Task Completed	Remaining Budget
1. Project Planning and Correspondence	$4,242.00	0%	$0.00	30%	$2,583.00
2. Website Design and Improvement	$22,800.00	5.7%	$1,228.61	66%	$5,984.75
3. Reporting and Project Deliverables	$3,810.00	0%	$0.00	0%	$3,810.00
4.					
5.					
6.					
7.					
8.					
9. Total	$30,852.00	4.2%	$1,228.61	41.6%	$14,938.00

Progress and Accomplishments this Quarter:

(Provide an informative summary of tasks/activities that occurred this quarter includes meetings, work plan status, significant progress, etc.)

Following the Pooled Fund meeting in April, content on the structure and search terms were updated on the Q&A site. Additional Q&A submissions were uploaded to the site and utilized the new filter and keyword list. Some updates were made following functionality bugs and with additional experience using the new keywords.

Circumstances Affecting Project, Scope, or Budget:

(Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints, along with recommended solution to those problems.)

Transition to upgraded web platform has taken more time than expected. Some additional maintenance work is ongoing to support functionality and security.

Anticipated Work Next Quarter:

Continued progress on the techncial content review will result in more older Q&A responses navigated to the new keyword format. Additional statements will be reclassified as time and budget permit.

Total Percentage of Project Completion:

42%

Research Project Quarterly Progress Report

Date: 7/30/2022 **Project Number:** TPF-5(193) Suppl. #146 - RPFP-19-MWQA-2

Project Title: Revisions to Midwest Pooled Fund Q&A Website Technical Information

Principal Investigator: J. Reid, R. Faller, R. Bielenberg, K. Lechtenberg, S. Rosenbaugh

Principal Contact Information Email: rbielenberg2@unl.edu **Phone:** (402) 472-9064

Project Start Date: 10/9/2018 **Project Completion Date:** 12/31/2022

Report Period: **Due Date:**

- ☐ Quarter 1 (July 1 – September 30) ---------- October 31
- ☐ Quarter 2 (October 1 – December 31)---------- January 31
- ☐ Quarter 3 (January 1 – March 31) ---------- April 30
- ☒ Quarter 4 (April 1 – June 30)---------- July 31

Project Schedule Status:

- ☐ **On Schedule**
- ☒ **On Approved Revised Schedule**
- ☐ **Ahead of Schedule**
- ☐ **Behind Schedule**

Progress:

Task	Total Budget	% work Completed This Quarter	Expenses This Quarter	Total % of Task Completed	Remaining Budget
1. Project Planning and Correspondence	$4,785.00	0.0%	$0.00	15.8%	$4,028.00
2. Website Design and Improvement	$41,130.00	6.8%	$2,809.00	59.4%	$16,176.00
3. Reporting and Project Deliverables	$3,830.00	0.0%	$0.00	0.5%	$3,810.00
4.					
5.					
6.					
7.					
8.					
9.					

Progress and Accomplishments this Quarter:

(Provide an informative summary of tasks/activities that occurred this quarter includes meetings, work plan status, significant progress, etc.)

In this quarter, the research team worked on reviewing and editing responses related to MGS and W-beam variant systems, redacting portions of the responses which no longer reflect the best-available guidance and retaining portions of responses which have information which continues to reflect best-available knowledge.

Circumstances Affecting Project, Scope, or Budget:

(Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints, along with recommended solution to those problems.)

MwRSF completed the process of relocating their website within the univeristy system in June of 2020. This relocation is required for the security and continued functionality of the MwRSF website. The relocation effort limited the researchers ability to complete this effort in a timely manner. We plan to make improved progress once the website is relocated and fully functional.

The COVID-19 pandemic and business responses may play a factor in future efforts. MwRSF has not been shut down and is still working, but much of the personnel has transitioned to working remotely, as has much of the country during this time of social distancing. This major shift in regular work operations may lead to delays and inefficiencies as well as other unforseen hurdles. Additionally, changes to businesses outside of MwRSF may lead to possible delays in material acquisition. MwRSF will continue to make progress on this research in the most effective manner possible moving forward.

MwRSF requested and received an NCE until 12/31/22 to compete this effort.

Anticipated Work Next Quarter:

The review team will work to implement the revised Q&A responses related to MGS and W-beam variant systems within the revised website framework as well as incorporate state comments related to the keyward structure.

Total Percentage of Project Completion:
53.0%

Research Project Quarterly Progress Report

Date: 7/30/2022 **Project Number:** TPF-5(430) Suppl. #1, RPFP-20-MGS-2

Project Title: MGS with Reduced Embedment and Post Spacing over Low-Fill Culverts

Principal Investigator: Faller, R.K., Bielenberg, R.W., Lechtenberg, K.A., Rosenbaugh, S.K., Mojdeh Pajouh

Principal Contact Information Email: mojdeh.pajouh@unl.edu **Phone:** 402-472-0920

Project Start Date: 1/21/2020 **Project Completion Date:** 12/31/2022

Report Period: **Due Date:**

- ☐ Quarter 1 (July 1 – September 30) — October 31
- ☐ Quarter 2 (October 1 – December 31) — January 31
- ☐ Quarter 3 (January 1 – March 31) — April 30
- ☒ Quarter 4 (April 1 – June 30) — July 31

Project Schedule Status:

- ☒ **On Schedule**
- ☐ **On Approved Revised Schedule**
- ☐ **Ahead of Schedule**
- ☐ **Behind Schedule**

Progress:

Task	Total Budget	% work Completed This Quarter	Expenses This Quarter	Total Expenses to Date	Total % of Task Completed	Remaining Budget
1. Project Planning & Management & CAD	$16,853.00	0.00%	$0.00	$7,619.00	45.21%	$9,234.00
2. Dynamic Bogie Testing	$78,032.00	14.91%	$11,632.00	$66,171.00	84.80%	$11,861.00
3. Design and Analysis	$61,310.00	6.32%	$3,877.00	$16,048.00	26.18%	$45,262.00
4. Reporting and Project Deliverables	$29,717.00	0.00%	$0.00	$0.00	0.00%	$29,717.00
5.						
6.						
8. Total	$185,912	-	$15,509.00	$89,838.00	48.32%	$96,074.00

Progress and Accomplishments this Quarter:

(Provide an informative summary of tasks/activities that occurred this quarter includes meetings, work plan status, significant progress, etc.)

In the past quarter, MwRSF researchers completed calibration of LS-DYNA models for the bogie tests for MGS system analysis with shallow embedments. The research team developed improved/enhanced lumped parameter models to reproduce post-bending and dynamic post-soil resistive forces for shallow embedments. Models of both the W6x8.5 and W6x16 dynamic component tests were calibrated against the bogie tests. The soil spring models that were determined from the W6x16 post simulations were applied to the W6x8.5 post models with various embedment depths and compared with the associated bogie tests to ensure that the LS-DYNA models replicate the proper response when used to model the MGS with shallow embedment depths. Next, the project team started incorporating the calibrated soil-post model into existing MGS LS-DYNA models and subjected them to simulated MASH TL-3 vehicle impacts to determine potential vehicle and barrier responses and estimate dynamic deflection and working width. Documentation of the research conducted to date was begun, and the research team documented the dynamic component tests conducted on six W6x8.5 and three W6x16 post-soil systems at different embedment depths.

Circumstances Affecting Project, Scope, or Budget:

(Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints, along with recommended solution to those problems.)

The COVID-19 pandemic and business responses may play a factor in future efforts. MwRSF has not been shut down and is still working, but much of the personnel has transitioned to working remotely, as has much of the country during this time of social distancing. This major shift in regular work operations may lead to delays and inefficiencies as well as other unforseen hurdles. Additionally, changes to businesses outside of MwRSF may lead to possible delays in material acquisition. MwRSF will continue to make progress on this research in the most effective manner possible moving forward.

The project costs presented herein only include labor charges through June 30, 2022.

Anticipated Work Next Quarter:

In the upcoming quarter, MwRSF will analyze the simulation results of MGS design with updated soil models for reduced post embedment.

Total Percentage of Project Completion:

48.32%

Research Project Quarterly Progress Report

Date: 7/27/2022 **Project Number:** TPF-5(430) Suppl. #2

Project Title: Additional Retrofit Options for Post Conflicts within AGTs

Principal Investigator: Faller, Rosenbaugh, Rasmussen, Bielenberg, Lechtenberg, Reid, Stolle

Principal Contact Information Email: srosenabugh2@unl.edu **Phone:** (402) 472-9324

Project Start Date: 1/21/2020 **Project Completion Date:** 12/31/2022

Report Period:	**Due Date:**
☐ Quarter 1 (July 1 – September 30)	October 31
☐ Quarter 2 (October 1 – December 31)	January 31
☐ Quarter 3 (January 1 – March 31)	April 30
☒ Quarter 4 (April 1 – June 30)	July 31

Project Schedule Status:

- ☒ **On Schedule**
- ☐ **On Approved Revised Schedule**
- ☐ **Ahead of Schedule**
- ☐ **Behind Schedule**

Progress:

Task	Total Budget	% work Completed This Quarter	Expenses This Quarter	Total Expenses to Date	Total % of Task Completed	Remaining Budget
1. Planning & Correspondence	$27,155	0%	$0	$16,177	60%	$10,978
2. Design and Analysis	$106,064	50%	$4,000	$52,248	55%	$53,816
3. Bogie Testing	$99,897	50%	$3,976	$8,976	10%	$90,921
4. Reporting and Deliverables	$18,313	0%	$0	$0	0	$18,313
5.						
6.						
7.						
8.						
9. Total	$251,429	-	$7,976	$77,401	40%	$174,028

Progress and Accomplishments this Quarter:

(Provide an informative summary of tasks/activities that occurred this quarter includes meetings, work plan status, significant progress, etc.)

The research team selected promising configurations of welded W6x15 and baseplate combinations for dynamic component testing. Test article drawings were compiled included in the bogie test plan. Six bogie test will be conducted with an iterative approach. 10-15 post and baseplate assemblies will be fabricated and each test article will be selected based on the results from the previous tests. The drawings for the post-and-base plate test articles were reviewed, edited, and finalized. The drawings were then sent out for quotes, and a fabricator is currently constructing the test articles.

A project update and the selected post assemblies were presented to the sponsors during the annual Midwest Pooled Fund program meeting in April 2022.

Circumstances Affecting Project, Scope, or Budget:

(Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints, along with recommended solution to those problems.)

The budgets herein include labor charges through June 2022.

The COVID-19 pandemic and business responses may play a factor in future efforts. MwRSF has not been shut down and is still working, but much of the personnel has transitioned to working remotely, as has much of the country during this time of social distancing. This major shift in regular work operations may lead to delays and inefficiencies as well as other unforeseen hurdles. Additionally, changes to businesses outside of MwRSF may lead to possible delays in material acquisition. MwRSF will continue to make progress on this research in the most effective manner possible moving forward.

Anticipated Work Next Quarter:

Once the post assemblies are fabricated and delivered, dynamic component testing will commence with an iterative approach where the test article for each test will be determined based on the results from the previous test(s). Test results will be compared to the results of previous testing of Wx15 posts embedded in soil in hopes of obtaining similar force-deflection curves.

Total Percentage of Project Completion:

40%

Research Project Quarterly Progress Report

Date: 7/29/2022 **Project Number:** TPF-5(430) Suppl. #3, RPFP-20-AGT-2

Project Title: Guidelines for Flaring Thrie-Beam Approach Guardrail Transitions - Phase II

Principal Investigator: Scott Rosenbaugh, Faller, Bielenberg, et al.

Principal Contact Information Email: srosenbaugh2@unl.edu **Phone:** (402) 472-9324

Project Start Date: 1/21/2020 **Project Completion Date:** 12/31/2022

Report Period: **Due Date:**

- ☐ Quarter 1 (July 1 – September 30) ---------- October 31
- ☐ Quarter 2 (October 1 – December 31)---------- January 31
- ☐ Quarter 3 (January 1 – March 31) ---------- April 30
- ☒ Quarter 4 (April 1 – June 30)---------- July 31

Project Schedule Status:

- ☒ **On Schedule**
- ☐ **On Approved Revised Schedule**
- ☐ **Ahead of Schedule**
- ☐ **Behind Schedule**

Progress:

Task	Total Budget	% work Completed This Quarter	Expenses This Quarter	Total % of Task Completed	Remaining Budget
1. Project Planning & Correspondence	$12,644.00	10%	$1,000.00	75%	$2,644.00
2. Full-Scale Crash Testing	$278,516.00	80%	$17,502.00	70%	$92,890.00
3. Reporting	$11,623.00	10%	$5,000.00	25%	$6,623.00
4.					
5.					
6.					
7.					
8.					
9. Total	$302,783.00		$23,502.00	65%	$102,157.00

Progress and Accomplishments this Quarter:

(Provide an informative summary of tasks/activities that occurred this quarter includes meetings, work plan status, significant progress, etc.)

Previously, both tests FLAGT-1 and FLAGT-2 were conducted on AGT systems that were flared away from the roadway with a flare rate of 15:1. Both tests failed MASH test 3-21 due to occupant compartment deformation.

Four system modification options were presented to the project sponsors: (1) use 10-ga thrie beam, (2) reduce flare rate from 15:1 to 20:1, (3) 10-ga thrie beam and a 20:1 flare, and (4) development of a different rail shape to increase strength and reduce snag potential. These options were emailed to the sponsors in March 2022, and the responses were in favor of reducing the flare rate to 20:1. The system drawings were modified to reflect this change, including modifications to the angled attachment plate that conencts the thrie beam end terminal to the concrete buttress.

The AGT system has been rebuilt with a 20:1 flare rate and is in queue for testing, which should occur in July 2022.

Circumstances Affecting Project, Scope, or Budget:

(Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints, along with recommended solution to those problems.)

Both tests FLAGT-1 and FLAGT-2 failed to meet MASH performance criteria. As such, the project has had to be rescoped and system has had to be redesigned and the tests re-run. Additional project funds will be necessary to complete the full-scale testing on flared AGTs. A Phase III of this project has already been approved as part of the FY 2021 program, but Phase II was aimed at additional testing required on the upstream end of the AGT. A Phase IV of the project will be needed to fund retesting of the modified AGT on the downstream end near the buttress.

The budget numbers presented herein include labor charges through june 2022.

The COVID-19 pandemic and business responses may play a factor in future efforts. the pandemic has resulted in material shortages and work backlogs, which has caused the cost of vehilces and construction supplies to increase. This has resulted in increased costs for crash testing. MwRSF will work carefully in an attempt to keep the project within budget.

Anticipated Work Next Quarter:

Crash testing will resume with the AGT flared at 20:1. MASH test 3-21 with the vehilce impacting near the downstream end of the AGT adjacent to the concrete buttress will be conducted first.

Total Percentage of Project Completion:
65%

Research Project Quarterly Progress Report

Date: 7/30/2022 **Project Number:** TPF-5(430) Suppl. #4, RPFP-20-TERM-1

Project Title: Further Evaluation of the End Terminals Adjacent to Curb

Principal Investigator: Robert Bielenberg and Cody Stolle, Faller, et al

Principal Contact Information Email: rbielenberg2@unl.edu **Phone:** (402) 472-9064

Project Start Date: 1/21/2020 **Project Completion Date:** 12/31/2022

Report Period: **Due Date:**

- ☐ Quarter 1 (July 1 – September 30) ---------- October 31
- ☐ Quarter 2 (October 1 – December 31)---------- January 31
- ☐ Quarter 3 (January 1 – March 31) ---------- April 30
- ☒ Quarter 4 (April 1 – June 30)---------- July 31

Project Schedule Status:

- ☒ **On Schedule**
- ☐ **On Approved Revised Schedule**
- ☐ **Ahead of Schedule**
- ☐ **Behind Schedule**

Progress:

Task	Total Budget	% work Completed This Quarter	Expenses This Quarter	Total % of Task Completed	Remaining Budget
1. Project Planning & Correspondence	$19,248.00	0%	$0.00	65.3%	$6,679.00
2. Full-Scale Crash Testing	$176,505.00	23.3	$41,154.00	44.4	$98,079.00
3. Design & Analysis	$39,381.00	0%	$0.00	6.6%	$36,763.52
4. Reporting & Deliverables	$22,074.00	0%	$0.00	0%	$22,074.00
5.					
6.					
7.					
8.					
9. Total	$257,208.00		$41,154.00	36.4	$163,596.00

Progress and Accomplishments this Quarter:

(Provide an informative summary of tasks/activities that occurred this quarter includes meetings, work plan status, significant progress, etc.)

In this quarter, MwRSF conducted the first of two full-scale crash tests on the proposed curbs and end terminal configuration.

Test no. CET-1was conducted July 3rd. It consisted of an 1100C sedan vehicle impacting the MSKT end terminal system at a target speed of 62 mph and a target angle of 0 degrees according to MASH test designation no. 3-30. The vehicle was offset ¼ of the vehicle width towards the traffic side of the system. Note that this test was conducted with the MSKT installed adjacent to a 4" tall AAASHTO Type C curb. The MSKT was also installed at a 25:1 flare to allow for installation of the end posts and anchorage without interference from the curb, which created approximately 2' lateral offset for the impact head of the terminal. The guardrail height was 31" from the gutter line of the curb. The purpose of this test was primarily to evaluate the end terminal performance when combined with a curb and focused primarily on the safe deceleration, occupant compartment integrity, and stability of the impacting vehicle.

In test no. CET-1, the vehicle impacted the open concrete at a speed of 60.7 mph. Film analysis is still ongoing to determine the impact angle. Based on the impact point on the terminal it appears that the impact angle is within MASH limit. MwRSF will update the group if the impact angle is outside of MASH limits. At initial impact, the front corner of the 1100C vehicle interlocked with the terminal head and began to push the impact head down the guardrail. The vehicle continued downstream, pushing the impact head forward and moving rail through and out the side of the impact head for approximately 16-17 feet. As the vehicle proceeded downstream, it yawed towards the traffic side of the system. At approximately 0.310 seconds after initial impact, the impact head stopped feeding at the splice between post nos. 4 and 5, and the vehicle yawed more towards the traffic side of the system. As the vehicle yawed clockwise, the downstream end of the impact head chute contacted the front of the driver side door. As the vehicle continued to yaw, a kink in the rail formed at post no. 5 in the system impacted near the seam between the front and rear driver side doors. The vehicle continued to yaw and move downstream until losing contact with the system around 955 msec and having rotated over 360 degrees. After losing contact with the rail, the vehicle came to rest after rotating around 430 degrees clockwise from its initial orientation. Vehicle stability was good throughout the impact event including the vehicle traversing the curb as it rotated, and maximum roll and pitch angles were -12.0 degrees and 19.7 degrees, respectively.

Barrier damage was moderate. Damage to the barrier was kinked rail that moved through the impact head, damage to the impact head itself and damage to some of the end anchorage components, and deformation of several of the downstream guardrail line posts as the 1100C vehicle proceeded over them. Of note, there was some minor deformation of the front of the impact head and chute. The downstream end of the impact head chute was formed by a steel plate that was welded to the top and bottom of the closed, c-section portion of the chute. This plate fractured at the weld and released from the downstream end of the chute as it reached a kink in the rail at the rail splice between post nos. 4 and 5, and the chute stopped feeding downstream. There was also some damage noted to the groundline strut as the swaged threaded end of the cable anchor cable was pushed down into the strut during the release of post no. 1. Rail kinking was noted at the midway between post nos. 4 and 5 and at post no. 5. Post no. 1 in the system was disengaged, and post no. 2 in the system was rotated downstream to the ground about the hinge bolt at the base. Post nos. 3 and 4 were pushed downstream, and post nos. 5 and 6 displayed minor lateral deflection.

Vehicle damage was moderate. Vehicle damage was concentrated on the front-right corner of the vehicle and along the left-side of the vehicle. As noted previously, there was deformation and tearing of the of the forward section of left-front door due to contact with a end terminal chute as the rail kinked. Note that the tear in the door was only to the outer door skin and did not penetrate the inner door panel. Deformation due to contact with the rail was also noted on the driver side on the doors near the B-pillar, the back of the rear door, and the rear fender. Occupant compartment deformations were within MASH limits and not penetration was noted to the occupant compartment floor pan of the vehicle.

Pending determination of the final impact angle measurement, MwRSF concluded that the results of test no. CET-1 indicated that the MSKT end terminal installed adjacent to a 4” tall Type C curb met the MASH TL-3 criteria for test no. 3-30.

Circumstances Affecting Project, Scope, or Budget:

(Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints, along with recommended solution to those problems.)

The COVID-19 pandemic and business responses may play a factor in future efforts. MwRSF has not been shut down and is still working, but much of the personnel has transitioned to working remotely, as has much of the country during this time of social distancing. This major shift in regular work operations may lead to delays and inefficiencies as well as other unforseen hurdles. MwRSF will continue to make progress on this research in the most effective manner possible moving forward.

Currently, the full-scale testing may be delayed due to its status in the MwRSF testing que. COVID-19 has reduced avaiable staff at the outdoor test facility, created increased employee leave, and created material procurement issues. These issues have created a backlog of testing ath the facility. MwRSF is trying our best to resolve the test backlog, but delays are currently expected for most projects. We will continue to update the status of the full-scale testing and its effect on the overall project timeline.

Anticipated Work Next Quarter:

in the next quarter, MwRSF will conduct the second full-scale crash test and begin work on the summary report.

Total Percentage of Project Completion:

36.4

Research Project Quarterly Progress Report

Date: 7/30/2022 **Project Number:** TPF-5(430)_Suppl5_RPFP-20-SR-1

Project Title: Development of a Short-Radius Guardrail for Intersecting Driveways or Roadways

Principal Investigator: J. Reid, R. Faller, R. Bielenberg, K. Lechtenberg, S. Rosenbaugh

Principal Contact Information Email: rbielenberg2@unl.edu **Phone:** (402) 472-9064

Project Start Date: 1/16/2020 **Project Completion Date:** 12/31/2022

Report Period: **Due Date:**

- ☐ Quarter 1 (July 1 – September 30) ---------- October 31
- ☐ Quarter 2 (October 1 – December 31)---------- January 31
- ☐ Quarter 3 (January 1 – March 31) ---------- April 30
- ☒ Quarter 4 (April 1 – June 30)---------- July 31

Project Schedule Status:

- ☒ **On Schedule**
- ☐ **On Approved Revised Schedule**
- ☐ **Ahead of Schedule**
- ☐ **Behind Schedule**

Progress:

Task	Total Budget	% work Completed This Quarter	Expenses This Quarter	Total % of Task Completed	Remaining Budget
1. Project Planning and Correspondence	$30,952.00	0.0%	$0.00	38.3%	$19,096.00
2. Design and Analysis	$177,021.00	8.1%	$14,273.00	26.1%	$130,843.00
3. Reporting and Project Deliverables	$43,059.00	0.0%	$0.00	0.0%	$43,059.00
4.					
5.					
6.					
7.					
8.					
9.					

Progress and Accomplishments this Quarter:

(Provide an informative summary of tasks/activities that occurred this quarter includes meetings, work plan status, significant progress, etc.)

In this quarter, MwRSF began continued simulations of an short-radius system that disspates energy through interial resistance. The simulation effort started with modification of the MGS system with interial posts to determine the feasiblity of using inertial posts for vehicle redirection. That effort is still underway.

Circumstances Affecting Project, Scope, or Budget:

(Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints, along with recommended solution to those problems.)

None

The COVID-19 pandemic and business responses may play a factor in future efforts. MwRSF has not been shut down and is still working, but much of the personnel has transitioned to working remotely, as has much of the country during this time of social distancing. This major shift in regular work operations may lead to delays and inefficiencies as well as other unforseen hurdles. Additionally, changes to businesses outside of MwRSF may lead to possible delays in material acquisition. MwRSF will continue to make progress on this research in the most effective manner possible moving forward.

Anticipated Work Next Quarter:

MwRSF will make additional progress on simulation of the interial post short-radius concept. Simulation results will be evaluated to determine the feasibility of the concept and reviewed with sopnsors.

Total Percentage of Project Completion:

23.1%

Research Project Quarterly Progress Report

Date: 7/30/2022 **Project Number:** TPF-5(430) Suppl. #6 RPFP-20-CONSULT

Project Title: Annual Consulting Services Support

Principal Investigator: J. Reid, R. Faller, R. Bielenberg, K. Lechtenberg, S. Rosenbaugh

Principal Contact Information Email: rbielenberg2@unl.edu **Phone:** (402) 472-9064

Project Start Date: 1/21/2020 **Project Completion Date:** 12/31/2022

Report Period: **Due Date:**

- ☐ Quarter 1 (July 1 – September 30) ---------- October 31
- ☐ Quarter 2 (October 1 – December 31)---------- January 31
- ☐ Quarter 3 (January 1 – March 31) ---------- April 30
- ☒ Quarter 4 (April 1 – June 30)---------- July 31

Project Schedule Status:

- ☒ **On Schedule**
- ☐ **On Approved Revised Schedule**
- ☐ **Ahead of Schedule**
- ☐ **Behind Schedule**

Progress:

Task	Total Budget	% work Completed This Quarter	Expenses This Quarter	Total % of Task Completed	Remaining Budget
1. Project Planning and Correspondence	$60,647.00	15.3	$9,264.00	96.1%	$2,372.00
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					

Progress and Accomplishments this Quarter:

(Provide an informative summary of tasks/activities that occurred this quarter includes meetings, work plan status, significant progress, etc.)

This project allows MwRSF to be a valuable resource for answering questions with regard to roadside safety issues. MwRSF researchers and engineers are able to respond to issues and questions posed by the sponsors during the year. Major issues discussed with the States have been documented in our Quarterly Progress Reports and all questions and support are accessible on a MwRSF Pooled Fund Consulting web site.

In the past quarter MwRSF has responded to a series of state inquiries. The Quarterly Progress Report summarizing these responses has been attached to this document. The summary will also be available for download at the recently completed MwRSF Pooled Fund Consulting web site - http://mwrsf-qa.unl.edu/

We are continuing to work with and improve the MwRSF Pooled Fund Consulting web site as our experience with it grows. We would ask that all Pooled Fund member states use the new site from this point forward for their inquiries and to contact us with any issues they experience with the web site.

The summary of the consulting effort for this quarter is attached with the progress update.

Circumstances Affecting Project, Scope, or Budget:

(Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints, along with recommended solution to those problems.)

The COVID-19 pandemic and business responses may play a factor in future efforts. MwRSF has not been shut down and is still working, but much of the personnel has transitioned to working remotely, as has much of the country during this time of social distancing. This major shift in regular work operations may lead to delays and inefficiencies as well as other unforseen hurdles. Additionally, changes to businesses outside of MwRSF may lead to possible delays in material acquisition. MwRSF will continue to make progress on this research in the most effective manner possible moving forward

Anticipated Work Next Quarter:

MwRSF will continue to answer questions and provide support to the sponsors during the upcoming quarter.

We would ask that all questions be submitted through the web site so that they can be answered and archived therein.

http://mwrsf-qa.unl.edu/

Total Percentage of Project Completion:
96.1%

Research Project Quarterly Progress Report

Date: 7/30/2022 **Project Number:** TPF-5(430) Suppl. #8, RPFP-20-LS-DYNA

Project Title: LS-DYNA Modeling Enhancement Support

Principal Investigator: Reid, Faller, et al.

Principal Contact Information Email: rbielenberg2@unl.edu **Phone:** (402) 472-9064

Project Start Date: 1/21/2020 **Project Completion Date:** 12/31/2022

Report Period: **Due Date:**

- ☐ Quarter 1 (July 1 – September 30) ---------- October 31
- ☐ Quarter 2 (October 1 – December 31)---------- January 31
- ☐ Quarter 3 (January 1 – March 31) ---------- April 30
- ☒ Quarter 4 (April 1 – June 30)---------- July 31

Project Schedule Status:

- ☒ **On Schedule**
- ☐ **On Approved Revised Schedule**
- ☐ **Ahead of Schedule**
- ☐ **Behind Schedule**

Progress:

Task	Total Budget	% work Completed This Quarter	Expenses This Quarter	Total % of Task Completed	Remaining Budget
1. LS-DYNA Modeling Enhancement	$30,616.00	0.0%	$0.00	100%	$0.00
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9. Total	$30,616.00		$9,796.00		$0.00

Progress and Accomplishments this Quarter:

(Provide an informative summary of tasks/activities that occurred this quarter includes meetings, work plan status, significant progress, etc.)

None

Note that funding for this project has been depleted and subsequent LS-DYNA support activities will be done under the FY2021 funding.

Circumstances Affecting Project, Scope, or Budget:

(Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints, along with recommended solution to those problems.)

None.

The COVID-19 pandemic and business responses may play a factor in future efforts. MwRSF has not been shut down and is still working, but much of the personnel has transitioned to working remotely, as has much of the country during this time of social distancing. This major shift in regular work operations may lead to delays and inefficiencies as well as other unforseen hurdles. MwRSF will continue to make progress on this research in the most effective manner possible moving forward.

Anticipated Work Next Quarter:

MwRSF will continue to use the LS-DYNA funds to support modeling needs in ongoing Midwest Pooled Fund Projects. This may include the following.

1. MwRSF has recently done an extensive amount of research in advance soil modeling techniques for use in modeling dynamic post in soil interactions. These models have been primarily developed on a component level. Research is needed to more fully developed these advanced soil modeling techniques and incorporate them into existing roadside hardware models to improve our model fidelity and allow improved investigation of soil parameters effects on roadside hardware such as post embedment, slopes, and other factors.
2. MwRSF has recently developed advanced steel fracture parameters for the GISSMO material failure command in LS-DYNA. This allows users to relate the stress state of the material to the failure strain in order to aid in predicting failure under multiple types of loading conditions. To date, the research in this area has focused mainly on the simulation of coupon samples used to develop the failure parameters. Research is needed to incorporate this steel failure methodology into existing guardrail and roadside hardware models.
3. MwRSF sees a need for advancement in concrete modeling methods. Currently several concrete material models exists and previous research at MwRSF has investigated the material models themselves. However, further research is needed to investigate the incorporation of reinforcing steel and in the concrete material and ensuring effective load transfer through the reinforcing steel. Additional investigation of bonding and development of the reinforcement is needed as well.
4. Vehicle model improvements are a constant need for Midwest Pooled Fund research efforts. Currently needed vehicle model improvements include more refined tire models, enhanced suspension models with suspension failure, and upgrades to existing TL-4 single unit truck and TL-5 tractor-trailer models.

It is anticipated that summary reports on the soil modeling and AGT modeling will be completed. Additonal work may also occur on the new tire models.

Total Percentage of Project Completion:
100%

Pooled Fund
Research Project Quarterly Progress Report

Date: 7/30/2022 **Project Number:** TPF-5(430) Suppl. #15, RPFP-21-CABLE-1

Project Title: Redesign of the High-Tension Cable Phase II

Principal Investigator: Faller, Asadollahipajouh, Bielenberg, Holloway, Lechtenberg, Rosenbaugh, Steelman, Stolle

Principal Contact Information Email: kpolivka2@unl.edu **Phone:** (402) 472-9070

Project Start Date: 7/1/2021 **Project Completion Date:** 7/31/2024

Identify Quarter:	Identify Period of Performance:	Identify Quarterly Report Submittal Deadline:
Quarter 4	4/1/22 - 6/30/22	7/31/22

Project Schedule Status:

- ☒ **On Schedule**
- ☐ **On Approved Revised Schedule**
- ☐ **Ahead of Schedule**
- ☐ **Behind Schedule**

Progress:

Task	Total Budget	% work Completed This Quarter	Expenses This Quarter	Total % of Task Completed	Remaining Budget
1. Project Plan/Corresp, CAD, Material Certs	$16,861.00	6%	$1,133.00	15%	$14,242.00
2. Full-Scale Crash Testing	$217,148.00	0%	$0.00	0%	$217,148.00
3. Reporting & Project Deliverables	$19,887.00	0%	$0.00	0%	$19,887.00
4.					
5.					
6.					
7.					
8.					
9. Total	$253,893.00	1%	$2,622.00	1%	$251271

Progress and Accomplishments this Quarter:

(Provide an informative summary of tasks/activities that occurred this quarter includes meetings, work plan status, significant progress, etc.)

Continue preparing test plan for tests

Circumstances Affecting Project, Scope, or Budget:

(Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints, along with recommended solution to those problems.)

None

Anticipated Work Next Quarter:

Complete test plan for first test. Begin material acquisition.

Total Percentage of Project Completion:

0%

Pooled Fund
Research Project Quarterly Progress Report

Date: 7/30/2022 **Project Number:** TPF-5(430) Supp#16 - RPFP-21-CONC-2

Project Title: Anchoring of Temporary Barrier to Asphalt - Phase II

Principal Investigator: Faller, Bielenberg, et al.

Principal Contact Information Email: rbielenberg2@unl.edu **Phone:** (402) 472-9064

Project Start Date: 7/1/2021 **Project Completion Date:** 7/31/2024

Identify Quarter:	Identify Period of Performance:	Identify Quarterly Report Submittal Deadline:
Quarter 4	4/1/22 - 6/30/22	7/30/22

Project Schedule Status:

- ☒ **On Schedule**
- ☐ **On Approved Revised Schedule**
- ☐ **Ahead of Schedule**
- ☐ **Behind Schedule**

Progress:

Task	Total Budget	% work Completed This Quarter	Expenses This Quarter	Total % of Task Completed	Remaining Budget
1. Project Planning and Correspondence	$13,939.00	25.1	$3,356.00	34.1	$8,824.00
2. Design and Analysis	$59,224.00	57.0	$33,785.00	67.2	$19,454.00
3. Full-Scale Crash / Bogie Testing	$122,413.00	0	$0.00	0	$122,413.00
4. Reporting and Project Deliverables	$29,295.00	0	$0.00	0	$29,295.00
5.					
6.					
7.					
8.					
9.					

Progress and Accomplishments this Quarter:

(Provide an informative summary of tasks/activities that occurred this quarter includes meetings, work plan status, significant progress, etc.)

Previously, the researchers developed a series of potential retrofit concepts to improve the system performance. These concepts were reviewed in terms of their pros and cons, including crash performance, cost, and installation ease. MwRSF presented the concepts to the sponsors and surveyed the sponsors regarding their preferred concepts for further development. Feedback from the survey identified the preferred concept as a saddle cap attached to the PCB connection pin that spans the barrier joint.

In this quarter, MwRSF has continued development of the simulation models for analyis and development of the preferred concept. Preliminary models of the retrofit system were developed.

Circumstances Affecting Project, Scope, or Budget:

(Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints, along with recommended solution to those problems.)

None

The COVID-19 pandemic and business responses may play a factor in future efforts. MwRSF has not been shut down and is still working, but much of the personnel has transitioned to working remotely, as has much of the country during this time of social distancing. This major shift in regular work operations may lead to delays and inefficiencies as well as other unforeseen hurdles. Additionally, changes to businesses outside of MwRSF may lead to possible delays in material acquisition. MwRSF will continue to make progress on this research in the most effective manner possible moving forward.

Anticipated Work Next Quarter:

In the next quarter, MwRSF will continue efforts on a simulation model of the retrofit anchored PCB system and evaulated its initial performance and potential design changes.

Total Percentage of Project Completion:

19.8%

Pooled Fund
Research Project Quarterly Progress Report

Date: 7/30/2022 **Project Number:** TPF-5(430) Suppl#17 - RPFP-21-CONC-3

Project Title: MASH TL-3 Portable Barrier System

Principal Investigator: Faller, Bielenberg, et al.

Principal Contact Information Email: rbielenberg2@unl.edu **Phone:** (402) 472-9064

Project Start Date: 7/1/2021 **Project Completion Date:** 7/31/2024

Identify Quarter:	Identify Period of Performance:	Identify Quarterly Report Submittal Deadline:
Quarter 4	April 2021 - June 2021	7/30/22

Project Schedule Status:

- ☒ **On Schedule**
- ☐ **On Approved Revised Schedule**
- ☐ **Ahead of Schedule**
- ☐ **Behind Schedule**

Progress:

Task	Total Budget	% work Completed This Quarter	Expenses This Quarter	Total % of Task Completed	Remaining Budget
1. Project Planning and Correspondence	$33,717.00	10.8	$3,625.00	18.9	$27,337.00
2. Design and Analysis	$81,642.00	15.1	$12,309.00	18.3	$66,703.00
3. Reporting and Project Deliverables	$32,937.00	0	$0.00	0	$32,937.00
4.					
5.					
6.					
7.					
8.					
9.					

Progress and Accomplishments this Quarter:

(Provide an informative summary of tasks/activities that occurred this quarter includes meetings, work plan status, significant progress, etc.)

In this quarter, MwRSF continued simulation of the preferred barrier concept with a focus on limiting barrier damage during MASH TL-3 impacts. Various reinforcement schemes were applied.

Circumstances Affecting Project, Scope, or Budget:

(Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints, along with recommended solution to those problems.)

None

The COVID-19 pandemic and business responses may play a factor in future efforts. MwRSF has not been shut down and is still working, but much of the personnel has transitioned to working remotely, as has much of the country during this time of social distancing. This major shift in regular work operations may lead to delays and inefficiencies as well as other unforeseen hurdles. Additionally, changes to businesses outside of MwRSF may lead to possible delays in material acquisition. MwRSF will continue to make progress on this research in the most effective manner possible moving forward.

Anticipated Work Next Quarter:

In the next quarter, MwRSF will continue analysis of the staggered, interlocking PCB concept. This will include simulation of revised designs to improve the structural integrity and additonal analysis of segment length and tolerance variations if time allows.

Total Percentage of Project Completion:

14.4%

Research Project Quarterly Progress Report

Date: 7/27/2022 **Project Number:** TPF-5(430) Suppl. #18, RPFP-21-AGT-1

Project Title: Approach Guardrail Transition Behind Elevated Sidewalk

Principal Investigator: Faller, Pajouh, Bielenberg, Lechtenberg, Rosenbaugh, Steelman, and Stolle

Principal Contact Information Email: srosenabugh2@unl.edu **Phone:** (402) 472-9324

Project Start Date: 7/1/2021 **Project Completion Date:** 7/31/2024

Report Period: **Due Date:**

- ☐ Quarter 1 (July 1 – September 30) — October 31
- ☐ Quarter 2 (October 1 – December 31) — January 31
- ☐ Quarter 3 (January 1 – March 31) — April 30
- ☒ Quarter 4 (April 1 – June 30) — July 31

Project Schedule Status:

- ☒ **On Schedule**
- ☐ **On Approved Revised Schedule**
- ☐ **Ahead of Schedule**
- ☐ **Behind Schedule**

Progress:

Task	Total Budget	% work Completed This Quarter	Expenses This Quarter	Total Expenses to Date	Total % of Task Completed	Remaining Budget
1. Planning and CAD	$27,125	100%	$237	$3,033	5%	$24,092
2. Design and Analysis	$87,468	0%	$0	$2,000	2%	$85,468
3. Reporting and Project Deliverables	$31,548	0%	$0	$0	0%	$31,548
4.						
5.						
6.						
7.						
8. Total	$146,141	-	$237	$5,033	3%	$141,108

Progress and Accomplishments this Quarter:

(Provide an informative summary of tasks/activities that occurred this quarter includes meetings, work plan status, significant progress, etc.)

This project is on hold waiting for the vehicle and tire models get updated as part of NCHRP 22-39.

A project update presentation was given at the annual meeting of the Midwest Pooled Fund members in April of 2022.

Circumstances Affecting Project, Scope, or Budget:

(Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints, along with recommended solution to those problems.)

The budget numbers presented herein include labor charges through June 2022.

This project was proposed and budgeted with the understanding that the vehicle and tire models had to be updated as part of a different project prior to conducting simulated crash tests as part of this project. As such, the project was put on hold in 2021 and early 2022.

The COVID-19 pandemic and business responses may play a factor in future efforts. MwRSF has not been shut down and is still working, but much of the personnel has transitioned to working remotely, as has much of the country during this time of social distancing. This major shift in regular work operations may lead to delays and inefficiencies as well as other unforeseen hurdles. Additionally, changes to businesses outside of MwRSF may lead to possible delays in material acquisition. MwRSF will continue to make progress on this research in the most effective manner possible moving forward.

Anticipated Work Next Quarter:

The literature review will be completed and the state survey will be sent out. Work to create and validate the models for the simulation effort may be started.

Total Percentage of Project Completion:

3%

Research Project Quarterly Progress Report

Date: 7/27/2022 **Project Number:** TPF-5(430) Suppl. #19, RPFP-21-AGT-3

Project Title: Guidelines for Flaring AGTs, Phase III

Principal Investigator: Faller, Pajouh, Bielenberg, Lechtenberg, Rosenbaugh, Steelman, and Stolle

Principal Contact Information Email: srosenabugh2@unl.edu **Phone:** (402) 472-9324

Project Start Date: 7/1/2021 **Project Completion Date:** 7/31/2024

Report Period: **Due Date:**

- ☐ Quarter 1 (July 1 – September 30) — October 31
- ☐ Quarter 2 (October 1 – December 31) — January 31
- ☐ Quarter 3 (January 1 – March 31) — April 30
- ☒ Quarter 4 (April 1 – June 30) — July 31

Project Schedule Status:

- ☒ **On Schedule**
- ☐ **On Approved Revised Schedule**
- ☐ **Ahead of Schedule**
- ☐ **Behind Schedule**

Progress:

Task	Total Budget	% work Completed This Quarter	Expenses This Quarter	Total Expenses to Date	Total % of Task Completed	Remaining Budget
1. Planning and CAD	$4,705	0%	$0	$0	0%	$4,705
2. Design and Analysis	$109,854	0%	$0	$0	0%	$109,854
3. Reporting and Project Deliverables	$6,748	0%	$0	$0	0%	$6,748
4.						
5.						
6.						
7.						
8. Total	$121,307	-	$0	$0	0%	$121,307

Progress and Accomplishments this Quarter:

(Provide an informative summary of tasks/activities that occurred this quarter includes meetings, work plan status, significant progress, etc.)

Work on this project, Phase III, has yet to begin as the research efforts are still being conducted on the previous phase of this project – see project TPF-5(430)_Supplement 3 for details on Phase II efforts of the Flared AGT research project.

Circumstances Affecting Project, Scope, or Budget:

(Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints, along with recommended solution to those problems.)

The budget numbers presented herein include labor charges through June 2022.

The COVID-19 pandemic and business responses may play a factor in future efforts. MwRSF has not been shut down and is still working, but much of the personnel has transitioned to working remotely, as has much of the country during this time of social distancing. This major shift in regular work operations may lead to delays and inefficiencies as well as other unforeseen hurdles. Additionally, changes to businesses outside of MwRSF may lead to possible delays in material acquisition. MwRSF will continue to make progress on this research in the most effective manner possible moving forward.

Anticipated Work Next Quarter:

Work on this project will begin once Phase II of this project has been completed.

Total Percentage of Project Completion:

0%

Pooled Fund
Research Project Quarterly Progress Report

Date: 5/12/2022 **Project Number:** TPF-5(430) Suppl. #20, RPFP-21-SIGN-1

Project Title: Breakaway Systems for Ground Mounted, Large Steel Sign Support Structures

Principal Investigator: Faller, Asadollahipajouh, Bielenberg, Holloway, Lechtenberg, Rosenbaugh, Steelman, Stolle

Principal Contact Information Email: joshua.steelman@@unl.edu **Phone:** (402) 472-1972

Project Start Date: 7/1/2021 **Project Completion Date:** 7/31/2024

Identify Quarter:	Identify Period of Performance:	Identify Quarterly Report Submittal Deadline:
Quarter 4	4/1/22 - 6/30/22	7/31/22

Project Schedule Status:

- ☒ **On Schedule**
- ☐ **On Approved Revised Schedule**
- ☐ **Ahead of Schedule**
- ☐ **Behind Schedule**

Progress:

Task	Total Budget	% work Completed This Quarter	Expenses This Quarter	Total % of Task Completed	Remaining Budget
1. Project Plan/Corresp, Lit search, survey	$21,681.00	0%	$0.00	0%	$21,681.00
2. Sign Configuration Analysis & Selection	$28,702.00	0%	$0.00	0%	$28,702.00
3. Research Report & Deliverables	$27,357.00	0%	$0.00	0%	$27,357.00
4.					
5.					
6.					
7.					
8.					
9. Total	$77,740.00	0%	$0.00	0%	$77,740.00

Progress and Accomplishments this Quarter:

(Provide an informative summary of tasks/activities that occurred this quarter includes meetings, work plan status, significant progress, etc.)

None

Circumstances Affecting Project, Scope, or Budget:

(Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints, along with recommended solution to those problems.)

None

The COVID-19 pandemic and business responses may play a factor in future efforts. MwRSF has not been shut down and is still working, but much of the personnel has transitioned to working remotely, as has much of the country during this time of social distancing. This major shift in regular work operations may lead to delays and inefficiencies as well as other unforseen hurdles. MwRSF will continue to make progress on this research in the most effective manner possible moving forward.

Anticipated Work Next Quarter:

Initiate literature review

Total Percentage of Project Completion:

0%

Pooled Fund
Research Project Quarterly Progress Report

Date: 7/30/2022 **Project Number:** TPF-5(430)-Suppl #21, RPFP-21-POLE-1

Project Title: NDOT Breakaway Pole Research (Wisconsin)

Principal Investigator: Faller, Bielenberg, Pajouh, Holloway, Lechtenberg, Rosenbaugh, Steelman, Stolle

Principal Contact Information Email: mojdeh.pajouh@unl.edu **Phone:** (402) 472-0920

Project Start Date: 7/1/2021 **Project Completion Date:** 7/31/2024

Identify Quarter:	Identify Period of Performance:	Identify Quarterly Report Submittal Deadline:
Quarter 4	April 1 - June 30	July 31, 2022

Project Schedule Status:

- ☒ **On Schedule**
- ☐ **On Approved Revised Schedule**
- ☐ **Ahead of Schedule**
- ☐ **Behind Schedule**

Progress:

Task	Total Budget	% work Completed This Quarter	Expenses This Quarter	Total % of Task Completed	Remaining Budget
1. Project Planning and Correspondence	$66,665.00	23.57%	$15,710.00	36.75%	$42,167.00
2. Design and Analysis	$162,291.00	0	$0.00	0	$162,291.00
3. Reporting and Project Deliverables	$40,509.00	0	$0.00	0	$40,509.00
4.					
5.					
6.					
7.					
8.					
9. Total	$269,455.00	5.83%	$15,710.00	6.94%	$244,967.00

Progress and Accomplishments this Quarter:

(Provide an informative summary of tasks/activities that occurred this quarter includes meetings, work plan status, significant progress, etc.)

In the past quarter, a survey was designed and sent to the Midwest Pooled Fund state members. The survey aimed to collect the slip base pole configurations commonly used by the state DOTs. The complete responses were collected from 13 state DOTs.

Circumstances Affecting Project, Scope, or Budget:

(Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints, along with recommended solution to those problems.)

The COVID-19 pandemic and business responses may play a factor in future efforts. MwRSF has not been shut down and is still working, but much of the personnel has transitioned to working remotely, as has much of the country during this time of social distancing. This major shift in regular work operations may lead to delays and inefficiencies as well as other unforseen hurdles. Additionally, changes to businesses outside of MwRSF may lead to possible delays in material acquisition. MwRSF will continue to make progress on this research in the most effective manner possible moving forward.

The project costs presented herein only include labor charges through June 30, 2022.

Anticipated Work Next Quarter:

In the next quarter, the research team will review the survey responses and identify the most common and critical slip base configurations for further numerical and analytical analysis. Next, CAD drawings for potential critical configurations will be initiated for LS-DYNA computer simulations.

Total Percentage of Project Completion:

6.94%

Pooled Fund
Research Project Quarterly Progress Report

Date: 7/30/2022 **Project Number:** TPF-5(430) Suppl#22 / RPFP-21-CONSULT

Project Title: Annual Consulting Services Support

Principal Investigator: Faller, Bielenberg, et al.

Principal Contact Information Email: rbielenberg2@unl.edu **Phone:** (402) 472-9064

Project Start Date: 7/1/2021 **Project Completion Date:** 7/31/2024

Identify Quarter:	Identify Period of Performance:	Identify Quarterly Report Submittal Deadline:
Quarter 4	April 2022 - June 2022	7/30/22

Project Schedule Status:

- ☒ **On Schedule**
- ☐ **On Approved Revised Schedule**
- ☐ **Ahead of Schedule**
- ☐ **Behind Schedule**

Progress:

Task	Total Budget	% work Completed This Quarter	Expenses This Quarter	Total % of Task Completed	Remaining Budget
1. Project Planning and Correspondence	$61,446.00	7.1	$4,375.00	7.1	$57,071.00
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					

Progress and Accomplishments this Quarter:

(Provide an informative summary of tasks/activities that occurred this quarter includes meetings, work plan status, significant progress, etc.)

This project allows MwRSF to be a valuable resource for answering questions with regard to roadside safety issues. MwRSF researchers and engineers are able to respond to issues and questions posed by the sponsors during the year. Major issues discussed with the States have been documented in our Quarterly Progress Reports and all questions and support are accessible on a MwRSF Pooled Fund Consulting web site.

In the past quarter MwRSF has responded to a series of state inquiries. The Quarterly Progress Report summarizing these responses has been attached to this document. The summary will also be available for download at the recently completed MwRSF Pooled Fund Consulting web site - http://mwrsf-qa.unl.edu/

We are continuing to work with and improve the MwRSF Pooled Fund Consulting web site as our experience with it grows. We would ask that all Pooled Fund member states use the new site from this point forward for their inquiries and to contact us with any issues they experience with the web site.

The summary of the consulting effort for this quarter is attached with the progress update.

Circumstances Affecting Project, Scope, or Budget:

(Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints, along with recommended solution to those problems.)

The COVID-19 pandemic and business responses may play a factor in future efforts. MwRSF has not been shut down and is still working, but much of the personnel has transitioned to working remotely, as has much of the country during this time of social distancing. This major shift in regular work operations may lead to delays and inefficiencies as well as other unforseen hurdles. Additionally, changes to businesses outside of MwRSF may lead to possible delays in material acquisition. MwRSF will continue to make progress on this research in the most effective manner possible moving forward

Anticipated Work Next Quarter:

MwRSF will continue to answer questions and provide support to the sponsors during the upcoming quarter.

We would ask that all questions be submitted through the web site so that they can be answered and archived therein.

http://mwrsf-qa.unl.edu/

Total Percentage of Project Completion:
7.1

Research Project Quarterly Progress Report

Date: 7/30/2022 **Project Number:** TPF-5(430) – Suppl. #10 – FY20-WISC-1-MGS SLOPE HALF POST 1Q 2020

Project Title: MASH 2016 TL-3 Evaluation of the MGS with Half Post Spacing and 7-ft Posts Adjacent to Sl

Principal Investigator: R. Bielenberg and R. Faller,

Principal Contact Information Email: rbielenberg2@unl.edu **Phone:** (402) 472-9064

Project Start Date: 1/16/2020 **Project Completion Date:** 12/31/2022

Report Period: **Due Date:**

- ☐ Quarter 1 (July 1 – September 30) ---------- October 31
- ☐ Quarter 2 (October 1 – December 31)---------- January 31
- ☒ Quarter 3 (January 1 – March 31) ---------- April 30
- ☒ Quarter 4 (April 1 – June 30)---------- July 31

Project Schedule Status:

- ☐ **On Schedule**
- ☒ **On Approved Revised Schedule**
- ☐ **Ahead of Schedule**
- ☐ **Behind Schedule**

Progress:

Task	Total Budget	% work Completed This Quarter	Expenses This Quarter	Total % of Task Completed	Remaining Budget
1. Project Planning and Correspondence	$10,490.00	0.0%	$0.00	81.2%	$1,968.00
2. Full-Scale Crash Testing	$193,277.00	7.0%	$13,596.00	79.7%	$39,171.00
3. Reporting and Project Deliverables	$16,441.00	0.0%	$0.00	0.0%	$16,441.00
4.					
5.					
6.					
7.					
8.					
9.					

Progress and Accomplishments this Quarter:

(Provide an informative summary of tasks/activities that occurred this quarter includes meetings, work plan status, significant progress, etc.)

In this quarter, MwRSF continued analysis and documentaion of the full-scale testing conducted previously, and made progress on the final report. Results from the full-scale testing were presented at the Midwest Pooled Fund Program Annual Meeting.

Circumstances Affecting Project, Scope, or Budget:

(Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints, along with recommended solution to those problems.)

Note that the original start date for the project was listed as October of 2019 with an end date in the 3Q of 2021 (Sept. 30, 2021). Authorization of for the project was not received until January 2020, so the end date has been pushed back accordingly to end of December 2021.

Currently, the full-scale testing has been delayed due to its status in the MwRSF testing que. COVID-19 has reduced avaiable staff at the outdoor test facility, created increased employee leave, and created material procurement issues. These issues have created a backlog of testing ath the facility. MwRSF is trying our best to resolve the test backlog, but delays are currently expected for most projects. We will continue to update the status of the full-scale testing and its effect on the overall project timeline.

Due to the delays noted above, MwRSF has requested and received an NCE to extend the project end date to 12/31/2022

Anticipated Work Next Quarter:

In the next quarter, MwRSF anticipates working towards the completion of the summary report for the project. MwRSF will also review the results of the full-scale crash test and develop recommendations for any needed transtions to the stiffened MGS installation adjacent to slopes.

Total Percentage of Project Completion:
73.9%

Pooled Fund
Research Project Quarterly Progress Report

Date: 7/31/2022 **Project Number:** TPF-5(430) Suppl. #15, RPFP-21-MPFW

Project Title: Midwest Pooled Fund Website

Principal Investigator: Faller, Asadollahipajouh, Bielenberg, Holloway, Lechtenberg, Rosenbaugh, Stolle

Principal Contact Information Email: kpolivka2@unl.edu **Phone:** (402) 472-9070

Project Start Date: 7/1/2021 **Project Completion Date:** 7/31/2024

Identify Quarter:	Identify Period of Performance:	Identify Quarterly Report Submittal Deadline:
Quarter 4	4/1/22 - 6/30/22	7/31/22

Project Schedule Status:

- ☒ **On Schedule**
- ☐ **On Approved Revised Schedule**
- ☐ **Ahead of Schedule**
- ☐ **Behind Schedule**

Progress:

Task	Total Budget	% work Completed This Quarter	Expenses This Quarter	Total % of Task Completed	Remaining Budget
1. Website Develop, Populate, and Host	$18,573.00	1%	$308.00	6%	$17,117.00
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9. Total	$18,573.00	1%	$1,456.00	6%	$17,117.00

Progress and Accomplishments this Quarter:

(Provide an informative summary of tasks/activities that occurred this quarter includes meetings, work plan status, significant progress, etc.)

Continue maintenance, repair, and upkeep of the website. Update research hub with new completed projects.

Circumstances Affecting Project, Scope, or Budget:

(Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints, along with recommended solution to those problems.)

This is continuation funding until the funds from Project No.: RPFP-20-PFCHS – TPF-5(430) Supplement #7, Project Title: Pooled Fund Center for Highway Safety have been exhaused.

The COVID-19 pandemic and business responses may play a factor in future efforts. MwRSF has not been shut down and is still working, but much of the personnel has transitioned to working remotely, as has much of the country during this time of social distancing. This major shift in regular work operations may lead to delays and inefficiencies as well as other unforseen hurdles. MwRSF will continue to make progress on this research in the most effective manner possible moving forward.

Anticipated Work Next Quarter:

Troubleshooting and fixing any issues that have occurred during the transition. Continue maintenance, repair, and upkeep of the website. Update research hub with new completed projects.

Total Percentage of Project Completion:

6%

Pooled Fund
Research Project Quarterly Progress Report

Date: 7/30/2022 **Project Number:** TPF-5(430) Suppl. #24, RPFP-21-LS-DYNA

Project Title: LS-DYNA Modeling Enhancement Support

Principal Investigator: Faller, Bielenberg, et al.

Principal Contact Information Email: rbielenberg2@unl.edu **Phone:** (402) 472-9064

Project Start Date: 7/1/2021 **Project Completion Date:** 7/31/2024

Identify Quarter:	Identify Period of Performance:	Identify Quarterly Report Submittal Deadline:
Quarter 4	April 22 - June 22	7/30/22

Project Schedule Status:

- ☒ **On Schedule**
- ☐ **On Approved Revised Schedule**
- ☐ **Ahead of Schedule**
- ☐ **Behind Schedule**

Progress:

Task	Total Budget	% work Completed This Quarter	Expenses This Quarter	Total % of Task Completed	Remaining Budget
1. LS-DYNA Modeling Enhancement	$43,823.00	15.7	$6,894.00	16.5	$36,562.00
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					

Progress and Accomplishments this Quarter:

(Provide an informative summary of tasks/activities that occurred this quarter includes meetings, work plan status, significant progress, etc.)

In this quarter, MwRSF researcher used the LS-DYNA funding to investigate the use of new soil modeling techniques. These new soil modeling techniques may allow for improved modeling of different post shapes and embedements depths. This work was condcuted to support RPFP-20-MGS-2 which was in investigating reduced guardrail post embemdent over culvert and other structures.

Circumstances Affecting Project, Scope, or Budget:

(Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints, along with recommended solution to those problems.)

None

Anticipated Work Next Quarter:

MwRSF will continue to use the LS-DYNA funds to support modeling needs in ongoing Midwest Pooled Fund Projects. This may include the following.

1. MwRSF has recently done an extensive amount of research in advance soil modeling techniques for use in modeling dynamic post in soil interactions. These models have been primarily developed on a component level. Research is needed to more fully developed these advanced soil modeling techniques and incorporate them into existing roadside hardware models to improve our model fidelity and allow improved investigation of soil parameters effects on roadside hardware such as post embedment, slopes, and other factors.
2. MwRSF has recently developed advanced steel fracture parameters for the GISSMO material failure command in LS-DYNA. This allows users to relate the stress state of the material to the failure strain in order to aid in predicting failure under multiple types of loading conditions. To date, the research in this area has focused mainly on the simulation of coupon samples used to develop the failure parameters. Research is needed to incorporate this steel failure methodology into existing guardrail and roadside hardware models.
3. MwRSF sees a need for advancement in concrete modeling methods. Currently several concrete material models exists and previous research at MwRSF has investigated the material models themselves. However, further research is needed to investigate the incorporation of reinforcing steel and in the concrete material and ensuring effective load transfer through the reinforcing steel. Additional investigation of bonding and development of the reinforcement is needed as well.
4. Vehicle model improvements are a constant need for Midwest Pooled Fund research efforts. Currently needed vehicle model improvements include more refined tire models, enhanced suspension models with suspension failure, and upgrades to existing TL-4 single unit truck and TL-5 tractor-trailer models.

It is anticipated that summary reports on the soil modeling and AGT modeling will be completed. Additonal work may also occur on the new tire models.

Total Percentage of Project Completion:
16.5%

Research Project Quarterly Progress Report

Date: 7/30/2022 **Project Number:** TPF-5(430) Suppl. 12 – FY20-WY-1-GATE: MASH 2016 Th 3

Project Title: Evaluation of Drop-Arm Road Closure Gate

Principal Investigator: R. Bielenberg and R. Faller,

Principal Contact Information Email: rbielenberg2@unl.edu **Phone:** (402) 472-9064

Project Start Date: 2/26/2020 **Project Completion Date:** 9/30/2022

Report Period: **Due Date:**

- ☐ Quarter 1 (July 1 – September 30) ---------- October 31
- ☐ Quarter 2 (October 1 – December 31)---------- January 31
- ☐ Quarter 3 (January 1 – March 31) ---------- April 30
- ☒ Quarter 4 (April 1 – June 30)---------- July 31

Project Schedule Status:

- ☐ **On Schedule**
- ☒ **On Approved Revised Schedule**
- ☐ **Ahead of Schedule**
- ☐ **Behind Schedule**

Progress:

Task	Total Budget	% work Completed This Quarter	Expenses This Quarter	Total % of Task Completed	Remaining Budget
1. Project Planning and Correspondence	$17,507.00	5.2%	$910.00	43.5%	$9,886.50
2. Design and Analysis	$10,862.00	0.0%	$0.00	75.1%	$2,708.34
3. Full-Scale Crash Testing	$185,441.00	0.0%	$0.00	43.6%	$104,527.00
4. Reporting and Project Deliverables	$16,147.00	0.0%	$0.00	0.0%	$16,147.00
5.					
6.					
7.					
8.					
9.					

Progress and Accomplishments this Quarter:

(Provide an informative summary of tasks/activities that occurred this quarter includes meetings, work plan status, significant progress, etc.)

Following the failure of the ffirst full-scale crash test of the system, WYDOT was presented with several options for moving forward.

1. WYDOT can choose continue moving forward with the higher speed tests. If those tests pass, they could choose to self-certify the road closure gate based on limited concerns for occupant risk in the low-speed test. This may not be the optimal path to take, but it has been chosen by some states. As such, I wanted to list it as an option.
2. MwRSF can suggest modifying the system to alleviate the windshield penetration and rerun test no. 3-60. Several options exist, including modifying the metal plate extension used for the gate arm guide U-bolt attachment to be shorter, have rounded edges, or to flare back the corners. These changes could reduce the potential for windshield penetration significantly. One could also consider redesign of the gate arm guide attachment to a c-clamp or other design that does not create the same windshield hazard. Design and retesting of the modified system would likely require additional funding at some point to complete the test matrix.
3. WYDOT could terminate the effort – although this may leave one without a crashworthy gate system.

WYDOT has indicated that they prefer option 2. MwRSF submitted an updated project budget and scope to WYDOT in 4Q 2021 and is currently awaiting approval to proceed.

Circumstances Affecting Project, Scope, or Budget:

(Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints, along with recommended solution to those problems.)

Currently, material shipping delays and delays to the overall MwRSF test que have put the project behind schedule. MwRSF will attempt to continue to meet the proposed schedule to the degree possible.

Currently, the full-scale testing has been delayed due to its status in the MwRSF testing que. COVID-19 has reduced avaiable staff at the outdoor test facility, created increased employee leave, and created material procurement issues. These issues have created a backlog of testing ath the facility. MwRSF is trying our best to resolve the test backlog, but delays are currently expected for most projects. We will continue to update the status of the full-scale testing and its effect on the overall project timeline.

Due to these delays, MwRSF has requested and received an NCE until 9/30/2022.

As noted previously, the failure of test no. WRCG-1 required revision of the scope and budget for the project. MwRSF revised these items and provided them to WYDOT for approval. MwRSF has not yet received approval to continue on this research effort.

Anticipated Work Next Quarter:

In the next quarter, MwRSF will await approval to proceed based on the revised project scope. Once approval is obtained. MwRSF will work on development of design modifications and re-testing of the gate system.

Total Percentage of Project Completion:
42.0%