Texas SPR Work Program

Annual Performance and Expenditures Report (APER)
State Planning and Research (SPR) Part II

September 1, 2020–August 31, 2021

Certification and Disclaimer Statements

State Planning & Research Program Part II - Research
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In cooperation with:
U.S. Department of Transportation Federal Highway Administration

Research - SPR-0511(221)
Implementation Program - SPR2021(201)

Fiscal Year 2021
(September 1, 2020 – August 31, 2021)

Certification Statement

"I, Kevin Pete, Director, of the Research and Technology Implementation Division (RTI), Texas Department of Transportation (TxDOT), do hereby certify that the State is in compliance with all requirements of 23 U.S.C.505 and its implementing regulations with respect to the research, development, and technology transfer program, and contemplate no changes in statutes, regulations, or administrative procedures which would affect such compliance.

DocuSigned by:
Kevin Pete
D77263CBF1F9429...

1/14/2022

Director

Date

Disclaimer Statement

The FHWA's approval of reports constitutes acceptance of such reports as evidence of work performed but does not imply endorsement of a report's findings or recommendations. This report is prepared for FHWA-funded work and includes appropriate credit references and disclaimer statements. The preparation of this report has been financed in part through grant(s) from the Federal Highway Administration, U.S. Department of Transportation, under the State Planning and Research Program, Section 505 of Title 23, U.S. Code. The contents of this report do not necessarily reflect the official views or policy of the U.S. Department of Transportation.

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Section 1. Annual Report Summary and References

1.1. Approval and Authorization Process

1.1.1 Funding Research—23 CFR 420.115(b)

The Code of Federal Regulations (CFR)—specifically 23 CFR 420.115(b)—says that the federal government is contractually obligated to authorize work funded by the Federal Highway Administration (FHWA) in whole or in part, pursuant to 23 U.S. Code (USC) 106. The CFR requires that appropriate funds be available for the full federal share of the cost of work authorized.

The Texas Department of Transportation (TxDOT) funds research through its Research and Implementation Program, overseen by the TxDOT Research and Technology Implementation Division (RTI). RTI and the Texas state-supported universities conducting the research or implementation executed all project agreements.

RTI provided the fiscal year (FY) 2021 State Planning and Research (SPR) Part II Work Program to the Texas FHWA Division for review and approval. After the FHWA division administrator for the SPR program gave authorization, RTI executed the project agreements.

1.1.2 Reporting Requirements—23 CFR 420.117

The CFR—specifically 23 CFR 420.117—requires that TxDOT issue a report for FHWA approval to continue the agreement between TxDOT and FHWA to carry out statewide transportation planning activities as authorized.

According to 23 CFR 420.117, RTI is responsible for program monitoring and reporting requirements. RTI assigns a team of project managers to monitor the activities and performances of all subrecipients (state-supported universities) to assure that they are managing and performing the work satisfactorily and that they are meeting deadlines.

1.2. Comparison of Actual Performance with Established Goals and Program Overview

1.2.1 Overall Performance

In accordance with 49 CFR 18.40, RTI is fully responsible for managing the day-to-day operations of SPR Part II activities. RTI monitors program activities to assure compliance with applicable federal requirements and attainment of performance goals. Its monitoring covers each project, function, and activity.

In FY 2021, RTI managed one hundred fifty-eight (158) active research projects with 15 universities. Of the 158 projects, one hundred eight (108) remain active projects, forty-seven (47) closed, one (1) cancelled and during this reporting period with two (2) terminating early. Each of these projects met specific agency screening criteria and aligns with TxDOT's organizational strategic goals, which are:

- Maintaining a safe system.
- Connecting Texas communities.
- Addressing congestion.
- Becoming a best-in-class agency.

These projects impacted TxDOT's core transportation function/services, and added value and benefit to TxDOT, participating agencies/external partners, and Texas citizens.

<u>RTI Guidance Documents</u>

RTI executes a Cooperative Research and Implementation Agreement (CRIA) with each university or university system to conduct research projects. Under this CRIA, the university billings for an individual project agreement may exceed the university's fiscal year budget for that individual project agreement by up to 10 percent or $20,000 (whichever is less) without modification of the project agreement. A copy of the CRIA is attached to this report.

RTI has also published the *Research Manual* and the *University Handbook*. These two documents and the CRIA outline the provisions and processes of TxDOT's Research and Implementation Program.

<u>Performance Measures</u>

The performance goal for FY 2021 is an overall 84.5% on-time receipt of project deliverables. This goal aligns with the division's desire to move towards deliverable-based agreements. Analyses at this level also provide insight into where the program can improve in project monitoring efforts. The data provided for the purpose of this report is accurate as of December 1, 2021.

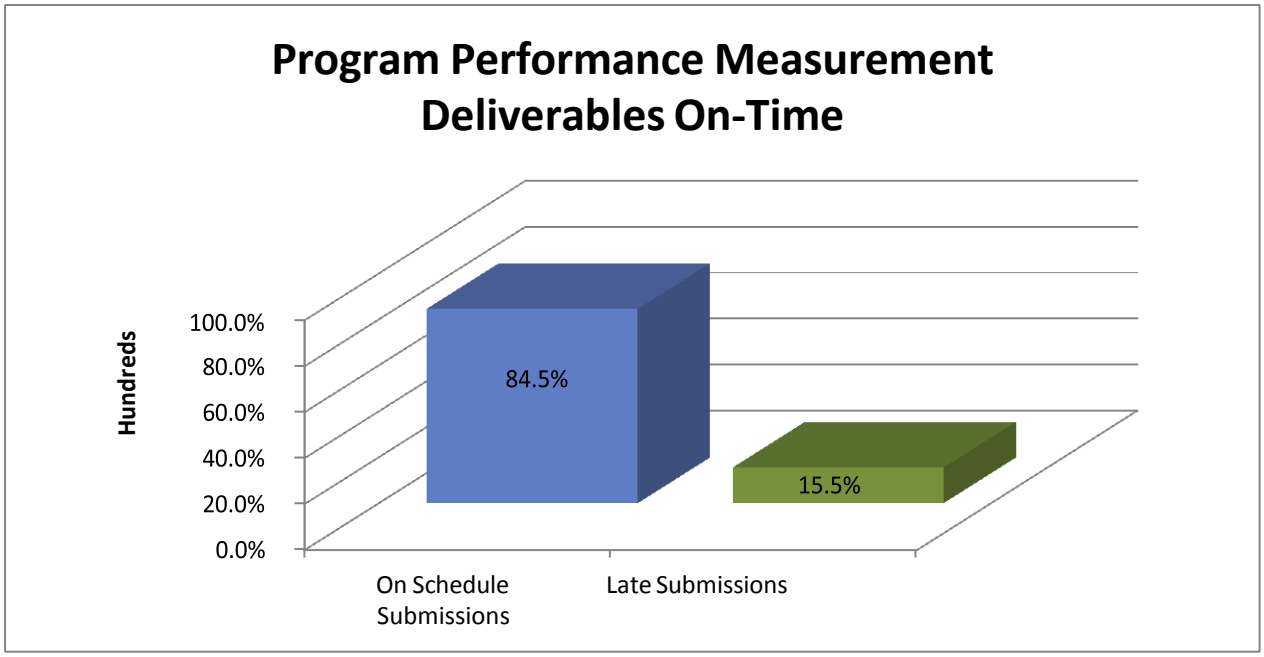

Figure 1. Bar Chart of Deliverables Submitted On-time

Obligation of Funds

Toll or Transportation Development Credits (TDC) are a federal transportation funding tool that can be utilized by states as a means of meeting local and state matching requirements for federal funding.

Table 1. shows how the federal funds appropriated to the Texas SPR II program were obligated.

Table 1. Total Funding Obligated FY21

Program	SPR Program Number	Total Funding Expended FY21	Federal 80%	State 20% TDC
Research Program	SPR 0511 (221)	$23,494,362.63	$18,795,490.10	$4,698,872.53
Implementation Program	SPR 2021(102)	$2,841,672.52	$2,273,338.02	$568,334.50
Total		**$26,336,035.15**	**$21,068,828.12**	**$5,267,207.03**

SPR funds were transferred to other contracting entities during 2021. Table 2. shows how these funds were transferred.

Table 2. Contracting Entities Receiving SPR Funds

Entity That Received SPR Funds	SPR Contribution
National Cooperative Highway Research Program (NCHRP)	$4,641,907.00
Pooled-fund projects, including TxDOT's Transportation Research Board (TRB) dues*	$2,802,378.00

Program	Program Number	Total Funding Obligated FY21	Federal 100%
ADS Demonstration Grant Program	F 2021(463)	$838,024.00	$838,024.00
Total		$838,024.00	$838,024.00

*Additional information is located in Section 2.3 Pooled-Fund Projects

1.2.2 Comparison of Distribution of Funds to Universities and Their Actual Expenditures for the Annual SPR Work Program.

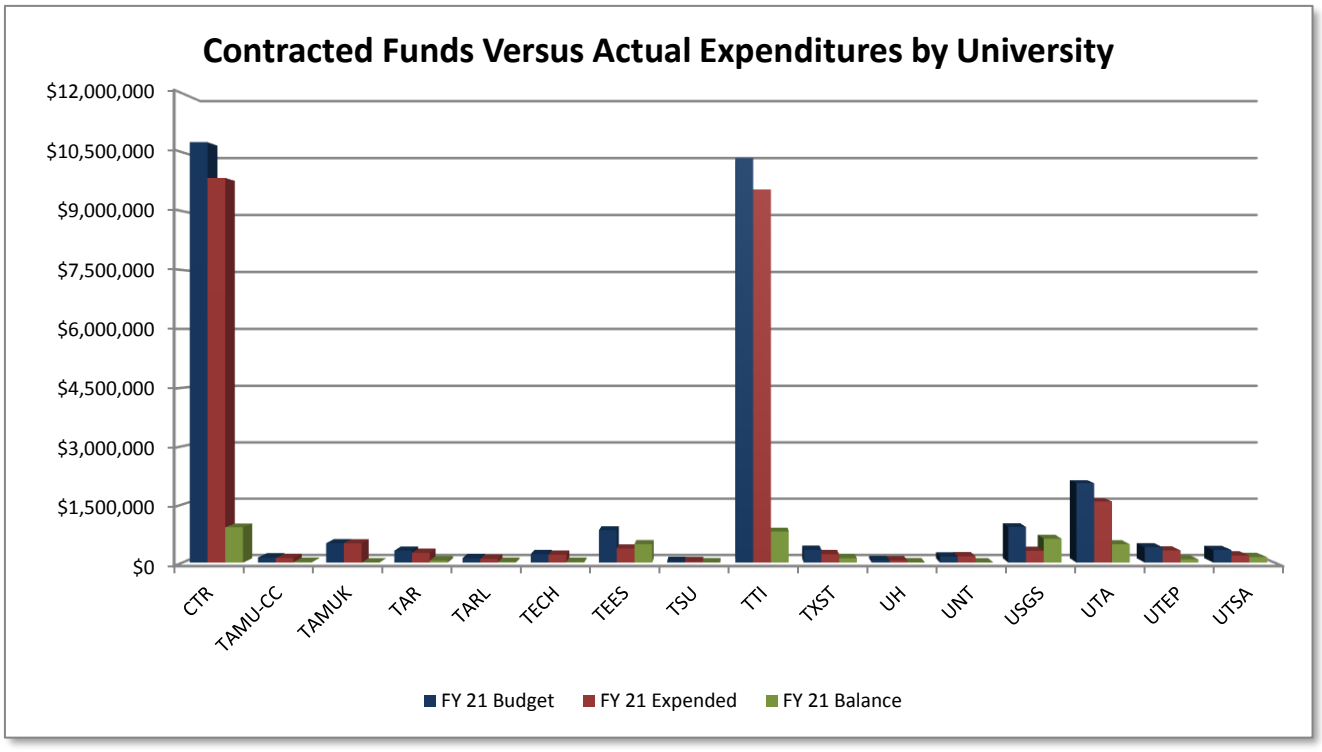

Figure 2. University Contracted Funds versus Actual Expenditures by University.

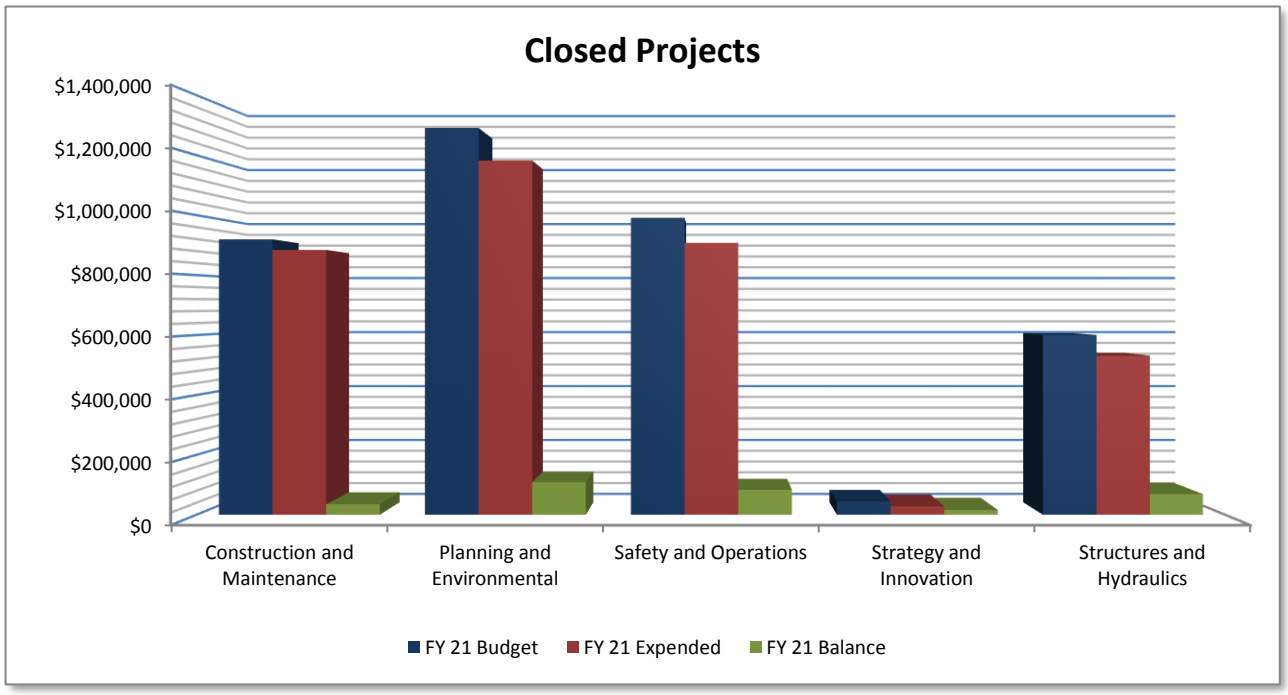

Figure 3. shows the funds budgeted to each research area for closed projects, the funds the universities spent in that area, and the balance.

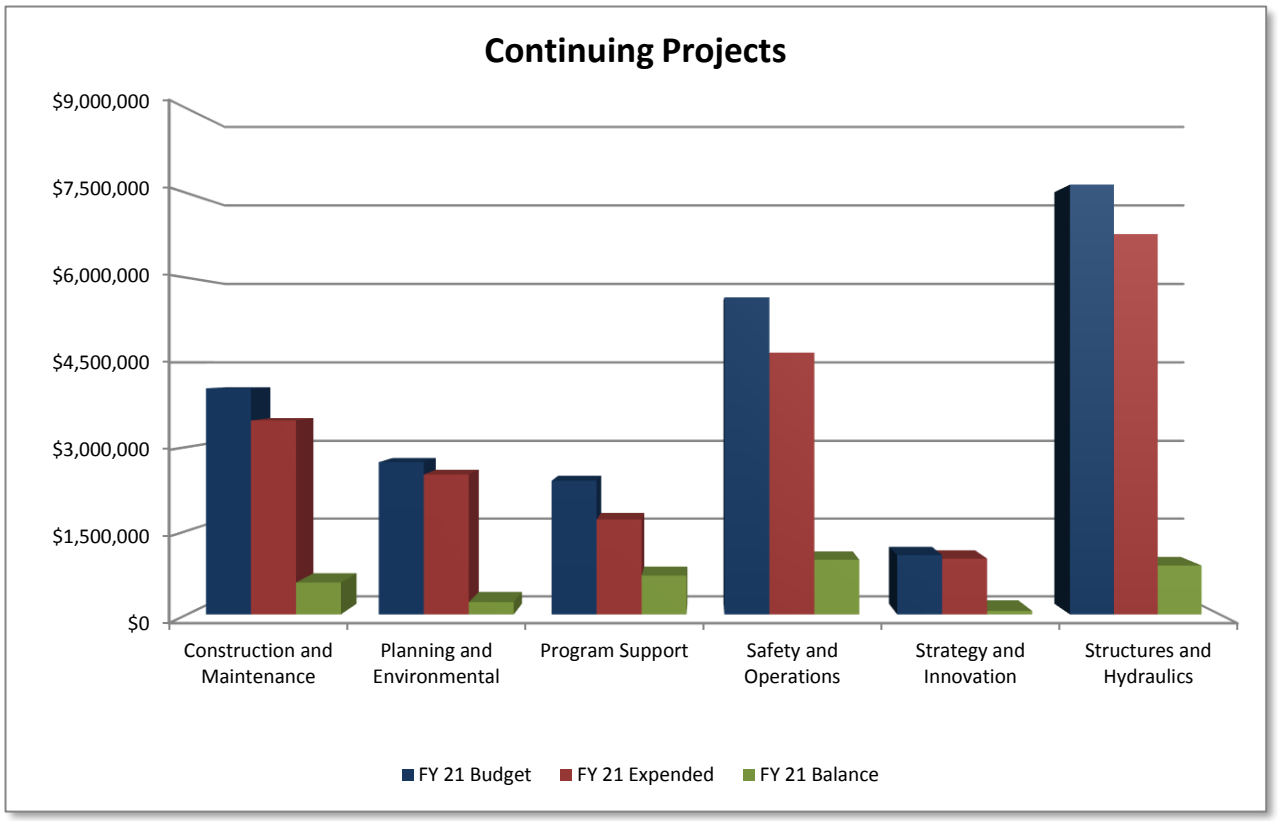

Figure 4. Shows the funds budgeted to each research area for continuing projects, the funds the universities spent in that area, and the balance.

1.2.3 Actual Expenditures

Table 3. Expenditures by Program.

Project	Budgeted	Expended	Balance
Research	$22,336,441.56	$19,742,585.33	$2,259,856.23
Implementation	$1,559,692.35	$1,414,104.80	$145,587.55
Pooled-Fund	$2,250,383.00	$2,250,383.00	$0
Support Projects	$1,937,458.13	$1,473,732.68	$463,725.45
Special Initiative	$1,608,668.11	$693,951.97	$914,716.14
Management and Administration	$1,776,729.00	$1,638,604.27	$138,124.73
Total	**$31,469,372.15**	**$27,213,362.05**	**$4,256,010.10**

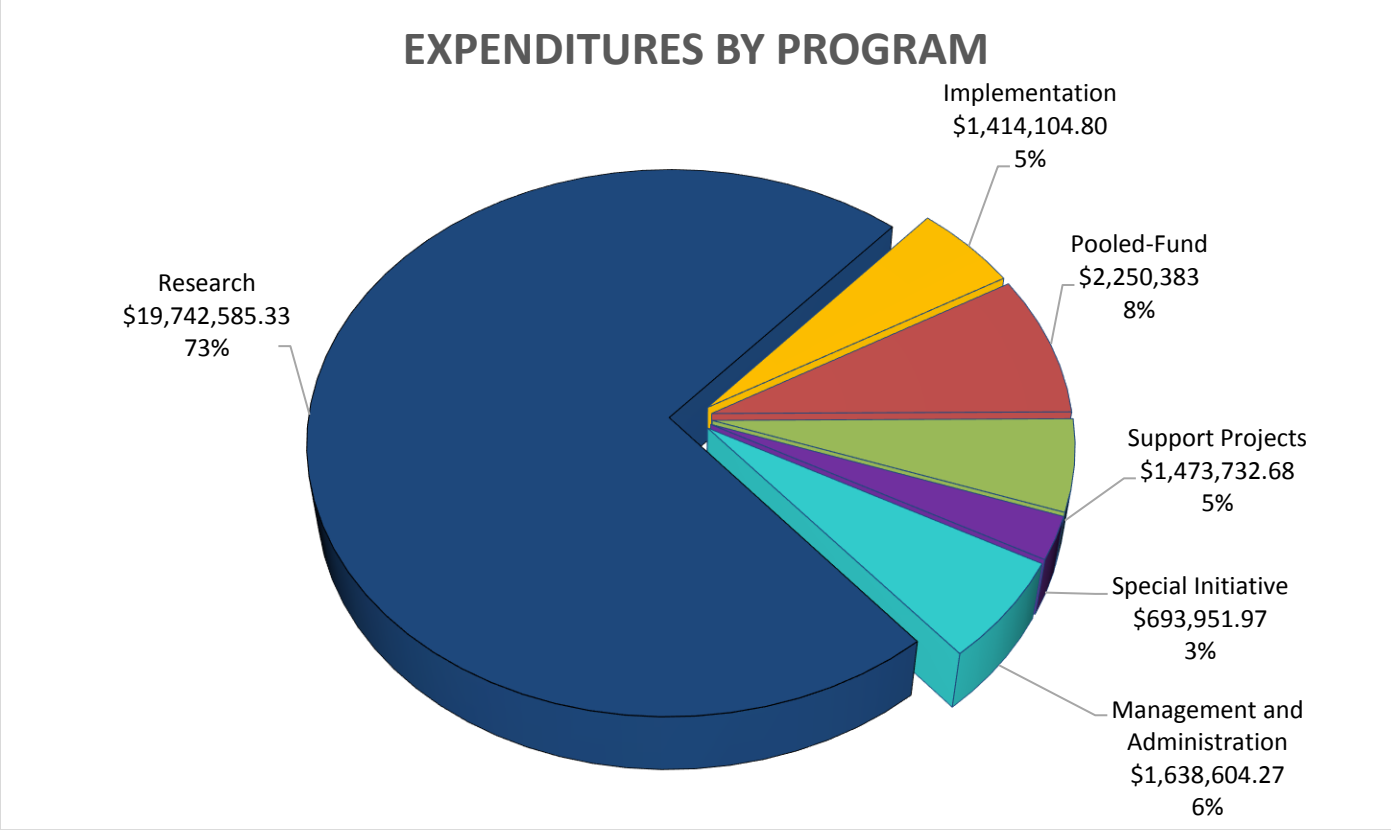

Figure 5. Pie Chart of Expenditures by Program.

Table 4. Expenditures by University.

University	FY '21 Budget	FY'21 Expended	FY'21 Balance
CTR	$10,757,047.92	$9,844,726.22	$912,321.70
TAMU-CC	$131,932.00	$116,236.63	$15,695.37
TAMUK	$500,000.00	$499,707.70	$292.30
TAR	$307,310.75	$252,589.76	$54,720.99
TARL	$115,693.05	$98,047.57	$17,645.48
TECH	$219,207.00	$203,243.40	$15,963.60
TEES	$838,024.00	$362,064.73	$475,959.27
TSU	$38,233.00	$34,214.44	$4,018.56
TTI	$10,353,638.95	$9,551,405.85	$802,233.10
TXST	$331,243.43	$217,737.01	$113,506.42
UH	$60,519.80	$57,834.59	$2,685.21
UNT	$154,555.25	$71,158.24	$83,397.01
USGS	$918,550.00	$302,194.90	$616,355.10
UTA	$2,048,318.89	$1,630,894.58	$417,424.31
UTEP	$394,950.00	$333,239.90	$61,710.10
UTSA	$273,036.11	$193,489.04	$79,547.07
Grand Total	**$27,442,260.15**	**$23,324,374.78**	**$4,117,885.37**

1.3. Acronyms and Abbreviations

Table 5. lists acronyms used in this document and what they stand for.

Table 5. Acronyms.

Acronym	What It Stands for
APER	Annual Performance and Expenditures Report
CFR	Code of Federal Regulations
CRIA	Cooperative Research and Implementation Agreement
CTR	University of Texas at Austin's Center for Transportation Research
FHWA	Federal Highway Administration
FY	Fiscal year
RTI	Research and Technology Implementation Division
SPR	State Planning and Research
SFASU	Stephen F Austin State University
TAR	Texas A&M AgriLife
TAMU-CC	Texas A&M University–Corpus Christi
TAMUK	Texas A&M University–Kingsville

Acronym	What It Stands for
TECH	Texas Tech University's Center for Multidisciplinary Research in Transportation
TEES	Texas A&M Engineering Extension Service
TSU	Texas Southern University
TSUSM	Texas State University–San Marcos
TTI	Texas A&M Transportation Institute
TxDOT	Texas Department of Transportation
UH	University of Houston
UNT	University of North Texas
USC	U.S. Code
UTA	University of Texas at Arlington
UTEP	University of Texas at El Paso
UTRGV	University of Texas Rio Grande Valley
UTSA	University of Texas at San Antonio

1.4. Contact Information

Contact information for RTI personnel.

Table 6. RTI Personnel.

Name	Position Title	Phone Number	Email Address
Kevin Pete	RTI Division Director	512-416-4730	Kevin.Pete@txdot.gov
Phillip Hempel	Portfolio Section Manager	512-416-4731	Phillip.Hempel@txdot.gov
Renee Suaste	Contract Administrator	512-416-4740	Renee.Suaste@txdot.gov
Veronica Tello	Administrative Assistant	512-416-4732	Veronica.Tello@txdot.gov
Susie Duarte	Resource Specialist	512-416-4713	Susie.Duarte@txdot.gov
Ned Mattila	Resource Specialist	512-416-4727	Ned.Mattila@txdot.gov
Barbara Cisneros	Contract Specialist	512-416-4741	Barbara.Cisneros@txdot.gov
Tamara Graham	Contract Specialist	512-416-2065	Tamara.Graham@txdot.gov
Melissa Griffin	Contract Specialist	512-416-4742	Melissa.Griffin@txdot.gov
Joanne Steele	Project Manager	512-416-4657	Joanne.Steele@txdot.gov
Chris Glancy	Project Manager	512-416-4747	Chris.Glancy@txdot.gov
Shelley Pridgen	Project Manager	512-416-4728	Shelley.Pridgen@txdot.gov
Tom Schwerdt	Project Manager	512-416-4748	Tom.Schwerdt@txdot.gov
Wade Odell	Project Manager	512-416-4737	Wade.Odell@txdot.gov
Jade Adediwura	Project Manager	512-416-5061	Jade.Adediwura@txdot.gov
Martin Dassi	Project Manager	512-416-4738	Martin.Dassi@txdot.gov

Table 7. Personnel from Participating Universities.

Name	University	Phone#	Email Address
Ashley Williams	CTR	512-232-3085	CTRmain@engr.utexas.edu
Gail Davis	LAMAR	409-880-8389	gail.davis@lamar.edu
Debbie Danford	TAR	(979) 862-7205	dedanford@ag.tamu.edu
Brent Donham	TAMUC	(903) 886-5321	Brent.donham@tamuc.edu
Mayra Hough	TAMU-CC	(361) 825-3882	mayra.hough@tamucc.edu
Delia L. Garcia	TAMUK	(361) 593-3344	koosr00@tamuk.edu
Barry Lambert	TARL	(254) 968-9104	blambert@tarleton.edu
Kim Harris	TECH	(806) 742-3503	kim.harris@ttu.edu
Natalie Bienski	TEES	(979) 862-5947	nbienski@tamu.edu
Jonathan Dikes	TEEX	(979) 458-6887	jonathan.dikes@teex.tamu.edu
Yi (Grace) Qi	TSU	(713) 313-6809	qiy@tsu.edu
Fengxiang Qiao	TSU	(713) 313-1915	Qiao_fg@tsu.edu
Kay Beauchamp	TSUSM	(512) 245-2102	grants@txstate.edu
Kara Ulibarri	TSUSM	(512) 245-2102	Ku10@txstate.edu
Mary Levien	TTI	(979) 458-1679	m-levien@tamu.edu
Mary Ottinger	UH	(713) 743-9104	maottinger@uh.edu
Beverly Rymer	UH	(713) 743-5773	uhproposals@listserv.uh.edu
Carla McGuire	UNT	(940) 565-3940	proposals@unt.edu

Personnel from Participating Universities Table Continued

Name	University	Phone#	Email Address
Julie Satagaj	UNT	(940) 369-5913	julie.statgaj@unt.edu
William H. Asquith	USGS	(512) 927-3580	wasquith@usgs.gov
Cory Brown	UTEP	(915) 747-5732	cjbrown5@utep.edu
Imad Abdullah	UTEP	(915) 747-8907	emadn@utep.edu
Mari Perez	UTRGV	(956) 665-3002	mari.perez@utrgv.edu
Mohammed Abdel Raheem	UTRGV	(956) 665-2050	mohamed.abdelraheem@utrgv.edu
Liana Ryan	UTSA	(210) 458-6472	Liana.ryan@utsa.edu
Michael Odell	UT-TYLER	(903) 566-7132	modell@uttyler.edu

Point of Contact information for the universities participating in the RTI research program.

1.5. FHWA-Approved Program Revisions

No major program changes or modifications occurred. Only project-level modifications were executed, and those are detailed in the project information templates.

1.6. Reasons for Underruns and Overruns on Budgets

Individual projects have a 10 percent allowance for underruns or overruns as long as they are within the total approved budget for a subrecipient (the university). There were no underruns or overruns that affected the total program budget. All participants complied with the agreements and the budget. These are identified on project templates.

1.6.1 Events and Conditions That Significantly Impacted Projects

During the reporting year, COVID-19 continued to impact projects. The effect varied across the portfolio of projects. Many saw delays in performing tasks such as data collection due to a lack of resources. Other projects required time extensions because of lab closures and limitations due to COVID safety protocols for indoor gathering, traveling in single vehicles and equipment usage scheduling.

We continue to monitor the impact of COVID and remain flexible to meet the goals of each project.

1.7. Deliverables Completed during FY 2021

Project agreements required the universities to submit specific deliverables as outlined in Deliverables Table for FY 2021. In addition, RTI received monthly progress reports for each active project.

Technical memoranda were also required after completion of a work plan task for each active project. If a report or product was due at the end of the task, then no technical memorandum was required.

See Closed Projects for completed projects and their results.

Section 2. Accomplishments and Variances by Projects

2.1 Closed Projects

During FY 2021, RTI monitored fifty (50) active research projects which ended throughout this fiscal year cycle covering September 1. 2020 through August 31, 2021. Of the fifty (50) projects that closed in FY 2021, two (2) were terminated early and one (1) was cancelled.

The objectives of these projects are for the development and application of advanced technology, new knowledge, and improved methods and procedures. Fulfilling these objectives is critical to future TxDOT service quality and operational cost-effectiveness.

This research also:

- Contributes to the high quality of Texas transportation facilities and services.
- Assists the state in meeting needs created by growth and changing technologies.
- Attracts university students working on TxDOT research projects to TxDOT careers upon graduation.
- Ensures that high-quality transportation talent is available in Texas.
- Ensures that transportation research funds are available to Texas universities to maintain the high quality of education at those institutions.

The following are descriptions of projects that closed in FY 2021.

2.1.1 Terminated Projects

Construction and Maintenance

Project Number: 0-6965-01 **University:** UTEP

Project Title: Structural Impacts of Non-Conventional Super Heavy Loads (SHL) on Transportation Infrastructure

Project Start Date: 2/12/2020 **Termination Date:** 5/3/2021

Project Status: Terminated **Total Project Budget:** $66,340.00

RTI Project Manager: Joanne Steele **Researcher:** Reza Ashtiani

Project Objectives: Recent traffic demands and permit issuances reflect an alarming number of Super Heavy Load (SHL) applications in the energy sector and the overweight corridors of Texas. As part of project 0-6965, Receiving Agency developed a database of such demanding axle loads in the Eagle Ford region, and established a mechanistic framework to quantify the structural ramifications of SHLs in the overweight corridors. Some of the recorded axle weights, specifically in Farm to Market roads, are several folds of the permissible axle weight limits in Texas. The highway network in Texas is not designed to withstand such demanding load ing conditions and therefore has incurred unforeseen maintenance and rehabilitation costs associated with premature failure of pavements. Therefore, it is imperative to include SHLs for the design of pavements servicing the corridors with demanding loading conditions.

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$26,000.00	$20,800.00	$5,200.00

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7065 **University:** CTR

Project Title: Develop Innovative Financing Mechanisms in a Fast-Changing Texas Transportation Landscape

Project Start Date: 12/9/2019 **Termination Date:** 5/7/2021

Project Status: Terminated **Total Project Budget:** $206,932.00

RTI Project Manager: Jade Adediwura **Researcher:** Chandra Bhat

Project Objectives: The Performing Agency shall undertake an analysis of the Receiving Agency's ability to fund needed projects by identifying the Receiving Agency's current financing sources and projections.

The Performing Agency shall develop a comprehensive list of alternative financing mechanisms for a detailed analysis for use by the Receiving Agency.

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$89,757.84	$71,806.27	$17,951.57

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Table 8. Totals for Terminated Projects

Financials	FY21 Budget	FY21 Expended	FY21 Balance
Federal 80%	$92,606.27	$91,780.71	$825.56
State 20% TDC*	$23,151.57	$22,945.18	$206.39
Total	**$115,757.84**	**$114,725.89**	**$1,031.95**

2.1.2 Construction and Maintenance

Project Number: 0-6875-03 **University:** TTI

Project Title: Automated and Connected Vehicle (AV/CV) Test Bed to Improve Transit, Bicycle, and Pedestrian Safety - Phase III

Project Start Date: 5/14/2019 **Termination Date:** 8/31/2021

Project Status: Closed **Total Project Budget:** $586,214.75

RTI Project Manager: Wade Odell **Researcher:** Katherine Turnbull

Project Objectives: Crashes involving transit vehicles, bicyclists, and pedestrians are a concern in Texas, especially in urban areas. In research project 0-6875 (hereafter referred to as "Phase I"), the Performing Agency explored the potential for the use of automated and connected vehicle (AV/CV) technology to reduce or eliminate these crashes. The Performing Agency identified concept applications, along with public and private sector partners, and developed a concept of operations plan for designing, testing, piloting, demonstrating, and deploying candidate applications through an AV/CV Test Bed to Improve Transit, Bicycle, and Pedestrian Safety. In research project 0-6875-01 (hereafter referred to as "Phase II"), the Performing Agency designed, developed, and pilot tested the Smart Intersection application using a test bed at the Texas A&M University System (TAMUS) RELLIS Campus proving ground. The Smart Intersection application included a bus equipped with a dedicated short range communication (DSRC) radio automatically communicating with a smart traffic signal and automatically providing a visual and an audio warning to bicyclists and pedestrians. A prototype Android smartphone app was also designed, developed, and pilot tested as part of the pilot test at the RELLIS Campus. In research project 0-6875-03 (hereafter referred to as "Phase III"), the Performing Agency shall deploy the Smart Intersection at George Bush Drive and Penberthy Boulevard in College Station, which is adjacent to the Texas A&M University Campus. The deployment will include southbound buses turning left from Penberthy Boulevard onto George Bush Drive automatically communicating with a smart traffic signal and providing visual and audio warnings to pedestrians and bicyclists waiting to cross the intersection. The Performing Agency shall monitor and evaluate the deployment to assess the technical capabilities of the system and to obtain feedback from pedestrians and bicyclists to the visual and audio warnings.

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
TM3
R1
PSR
June MPR 2021
July MPR 2021

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$207,080.00	$165,664.00	$41,416.00

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-6880 **University:** TTI

Project Title: Full Depth Reclamation in Maintenance Operations Using Emerging Technologies

Project Start Date: 7/24/2015 **Termination Date:** 8/31/2021

Project Status: Closed **Total Project Budget:** $5,075,781.00

RTI Project Manager: Chris Glancy **Researcher:** Tom Scullion

Project Objectives: As documented in the initial project 0-6271, Full Depth Recycling (FDR) is the main approach used all over Texas to rehabilitate thin roadways which are structurally damaged. In the FDR process, the existing surface and base materials are pulverized and mixed together and treated with a stabilizer. The type and amount of stabilizer to add is designed in the laboratory to provide sufficient strength and moisture resistance. The compacted treated base then receives a thin surfacing. This project shall be to identify and use these emerging FDR technologies in maintenance operations of districts to design and construct experimental sections with a range of new stabilizers, most notably cement slurries, foamed asphalt and engineered emulsions. These sections will typically be short distressed high profile roadways in TxDOT districts in which the Performing Agency can work with the TxDOT district lab and construction personnel to design, construct and monitor the experimental FDR sections with these emerging technologies. Guidelines for using these emerging FDR technologies in maintenance operations shall also be developed.

Deliverables:

P12
Workshop Sign-in Sheet: WS-1
Workshop Sign-in Sheet: WS-2
Workshop Sign-in Sheet: WS-3
August MPR 2020
September 2020 MPR
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021

May MPR 2021
June MPR 2021
July MPR 2021
R1
PSR

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$100,000.00	$80,000.00	$20,000.00

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-6966 **University:** CTR

Project Title: Assessment of Test Methods for Supplementary Cementitious Materials

Project Start Date: 9/1/2017 **Termination Date:** 1/31/2021

Project Status: Closed **Total Project Budget:** $465,886.94

RTI Project Manager: Joanne Steele **Researcher:** Maria Juenger

Project Objectives: Supplementary cementitious materials (SCMs) are a critical component of many concrete mixtures, with Class F fly ash being the most widely used in Texas because it reduces concrete cost and improves longterm strength and durability. Increasingly, power plants are blending coals, producing fly ash with potentially different properties than the previously common Class F fly ash from Texas lignite coal. Further, fly ash suppliers can blend fly ashes from different sources and are increasingly interested in reclaiming ashes from landfills and remediating ashes that do not meet specifications. The changing landscape for fly ash demands rigorous testing to ensure that the fly ashes still perform as expected based on their ASTM C618 Class F classification. This project shall evaluate a variety of fly ashes from blended, reclaimed, and remediated sources for chemical and physical characteristics and performance in cement paste, mortar, and concrete mixtures. In addition, since ASTM C618 has been shown to be inadequate for qualifying SCMs, new tests shall be developed and evaluated to characterize the reactivity of SCMs and their performance in concrete.

Deliverables:

September MPR 2020
August MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
TM8.5
TM9
R1
PSR

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$32,874.45	$26,299.56	$6,574.89

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-6985 **University:** TTI

Project Title: Perform Feasibility Study on Use of Innovative Tools and Techniques to Accelerate Pavement Construction

Project Start Date: 9/1/2018 **Termination Date:** 8/31/2021

Project Status: Closed **Total Project Budget:** $480,843.00

RTI Project Manager: Shelley Pridgen **Researcher:** Darlene Goehl

Project Objectives: The Receiving Agency is facing an increase in pavement reconstruction projects over the next 10 years especially with the passage of the Proposition 7 funding. However, most of the roadways needing reconstruction and widening are in the metro areas where traffic handling and user delay costs are a major expense. The Performing Agency shall investigate innovative tools and techniques to accelerate pavement construction. In coordination with the Receiving Agency districts, the Performing Agency shall identify four upcoming major roadway projects (two rigid pavement and two flexible pavement projects), that are scheduled for reconstruction and widening. The Performing Agency shall extensively test these four projects and recommend innovative approaches for district consideration. The Performing Agency shall employ advanced planning tools, such as Construction Analysis for Pavement Rehabilitation Strategies (CA4PRS) to document the optimal construction scheduling and identify time and cost savings. The Performing Agency shall prepare training materials or guidance to include their methodology, testing procedures and other tools used in the selection and design of pavement for candidate

projects. The Performing Agency shall present these findings to the participating districts.

Deliverables:

TM4B
TM6B
Close-Out Webinar
P7
P8
R1
PSR
August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
VoR
June MPR 2021
July MPR 2021

23

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$139,730.00	$111,784.00	$27,946.00

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-6988 **University:** CTR

Project Title: Quantification of the Performance of Preventative Maintenance and Rehabilitation Strategies

Project Start Date: 9/1/2018 **Termination Date:** 2/28/2021

Project Status: Closed **Total Project Budget:** $458,321.40

RTI Project Manager: Joanne Steele **Researcher:** Jorge Prozzi

Project Objectives: TxDOT has implemented Pavement Analyst (PA) in the most ambitious and significant improvement for the management of their highway infrastructure. The implementation of PA has been a great success and some of the benefits are already evident. However, most of the benefits will be realized in the medium-term and long-term by a cost-effective and objective pavement management. Critical to this implementation is a large number of pavement performance models that are used to predict pavement distresses and Condition Score. Current performance models have been inherited from the former PMIS and are not accurate resulting in suboptimal project selection and resource allocation. Current models do not incorporate construction work history and they all respond to the same specification form. These are two significant limitations that make current performance predictions unreliable and inaccurate. In this project, the Performing Agency shall deliver two implementation-ready outcomes: 1) we will calibrate existing models using advanced analytical techniques, incorporating historical data and capturing the effect of maintenance and rehabilitation activities, and 2) we will propose alternative models that do not have the limitations of the current models but that could be directly programmed into PA as easily as the current models. These alternative models will use specification forms that respond to each distress and pavement type.

Deliverables:

VoR
P2
TM5 FINAL to include TMs for Task 5-2 and 5-3
TM6 FINAL
TM7 FINAL
PSR FINAL/P2
R1 FINAL/R2
September MPR 2020
October MPR 2020

November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
August MPR 2020 UH
August MPR 2020

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$98,481.62	$78,785.30	$19,696.32

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-6988 **University:** UH

Project Title: Quantification of the Performance of Preventative Maintenance and Rehabilitation Strategies

Project Start Date: 9/1/2018 **Termination Date:** 2/28/2021

Project Status: Closed **Total Project Budget:** $458,321.40

RTI Project Manager: Joanne Steele **Researcher:** Jorge Prozzi

Project Objectives: TxDOT has implemented Pavement Analyst (PA) in the most ambitious and significant improvement for the management of their highway infrastructure. The implementation of PA has been a great success and some of the benefits are already evident. However, most of the benefits will be realized in the medium-term and long-term by a cost-effective and objective pavement management. Critical to this implementation is a large number of pavement performance models that are used to predict pavement distresses and Condition Score. Current performance models have been inherited from the former PMIS and are not accurate resulting in suboptimal project selection and resource allocation. Current models do not incorporate construction work history and they all respond to the same specification form. These are two significant limitations that make current performance predictions unreliable and inaccurate. In this project, the Performing Agency shall deliver two implementation-ready outcomes: 1) we will calibrate existing models using advanced analytical techniques, incorporating historical data and capturing the effect of maintenance and rehabilitation activities, and 2) we will propose alternative models that do not have the limitations of the current models but that could be directly programmed into PA as easily as the current models. These alternative models will use specification forms that respond to each distress and pavement type.

Deliverables:

VoR
P2
TM5 FINAL to include TMs for Task 5-2 and 5-3
TM6 FINAL
TM7 FINAL
PSR FINAL/P2
R1 FINAL/R2
September MPR 2020

October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
August MPR 2020 UH
August MPR 2020

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$9,955.00	$7,964.00	$1,991.00

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7008 **University:** UTA

Project Title: Advanced Geophysical Tools for Geotechnical Analysis

Project Start Date: 5/29/2019 **Termination Date:** 8/31/2021

Project Status: Closed **Total Project Budget:** $269,523.00

RTI Project Manager: Jade Adediwura **Researcher:** Mohsen Shahandashti

Project Objectives: The TxDOT Geotechnical Manual does not provide guidelines for advanced geophysical subsurface exploration. The objectives of this project are to (1) conduct an overview analysis of the Federal Highway Administration (FHWA) Every Day Counts (EDC)-suggested advanced geophysical tools that are not used (or commonly not used) in Texas, (2) identify and recommend advanced geophysical tools that can improve the Receiving Agency's geotechnical analyses for a variety of applications designed to fit Texas geotechnical and operational environment, (3) develop decision flowcharts to help select recommended methods based on different applications (e.g., investigation of buried utilities, depth of foundations, geological formation, preliminary design parameters such as plasticity index, liquidity index, sulfate content, moisture variations, and forensic evaluations) and operational conditions of different Receiving Agency districts, (4) develop a manual for implementing electrical resistivity profiling for inclusion in a best practices guide or a stand-alone manual, (5) create educational materials, such as brochures and demonstrative videos to train various Receiving Agency workforces (e.g., district engineers, area engineers, maintenance supervisors, and investigation crews), and (6) implement and demonstrate electrical resistivity profiling on five ongoing projects (located in 5 different districts in North, South, East, West, and Center of Texas) to cover for different geotechnical conditions and operational environments and conduct regional training workshops in these districts.

Deliverables:
Video Presentation (VP)
TM7
TM8
VoR
R1A (Draft final report)
PSR
CO Slide

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
R1B (Final Report) and related research manual
June MPR 2021
July MPR 2021
TM4
TM5
VTM (Video Training Material)
EM (Educational Materials)

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$113,980.25	$91,184.20	$22,796.05

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7062 **University:** TTI

Project Title: Synthesis for Quantification of Binder Availability in Recycled Materials

Project Start Date: 11/1/2019 **Termination Date:** 10/31/2020

Project Status: Closed **Total Project Budget:** $64,988.00

RTI Project Manager: Chris Glancy **Researcher:** Amy Epps Martin

Project Objectives: Increasing recycled materials content in asphalt mixtures provides economic and environmental benefits, but each unique materials combination of virgin and recycled materials and additives must be engineered to ensure adequate performance with proper selection of component materials, balanced proportioning, and consideration of recycled binder availability. The design of mixtures with recycled materials often assumes that 100 percent of the recycled binder is available to blend with the virgin binder, and the virgin binder content is reduced accordingly. In reality, when recycled binder availability is less than 100 percent for heavily aged materials, total binder contents are less than optimum from mix design, resulting in dry mixtures with insufficient coating and inadequate durability and cracking performance. In addition, recycled binder availability can be utilized to assess aging state and preclude the use of large quantities of these materials with stiff, brittle binders that contribute negatively to performance even if available. The Performing Agency shall address these concerns and revise the Receiving Agency's Standard and/or Special Specifications to incorporate recycled binder availability as part of mix design and revise the allowable maximum recycled binder ratio (RBR) limits as appropriate in a synthesis project based only on literature and available data.

Deliverables:
R1B
PSR
August MPR 2020
September MPR 2020
October MPR 2020

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$5,022.00	$4,017.60	$1,004.40

Project Number: 0-7077 **University:** TTI

Project Title: Synthesis: Modify Selection Criteria for TxDOT Form 2088, Surface Aggregate Selection Form

Project Start Date: 9/1/2020 **Termination Date:** 8/31/2021

Project Status: Closed **Total Project Budget:** $65,000.25

RTI Project Manager: Tom Schwerdt **Researcher:** Darlene Goehl

Project Objectives: The Performing Agency shall perform a synthesis study focusing on TxDOT's form 2088, "Surface Aggregate Selection Form (WWARP)". The criteria on Form 2088 along with criteria being used by other states and governing agencies that determine friction availability and demand will be investigated. This project shall investigate the factors that affect an agencies management of pavement surface friction to maintain highway safety, while reducing wet surface crashes. The Performing Agency shall conduct a survey with local and nationwide agencies to document experience and performance of their management of pavement surface friction including the criteria used to establish pavement friction availability and demand. The Performing Agency shall compile a report synthesizing the findings of the research.

Deliverables:

September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021
VoR
R1
P1, Close out meeting notes and power point
PSR
TM2
TM3

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$65,000.25	$52,000.20	$13,000.05

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 5-6679-01 **University:** UTEP

Project Title: Implementation of Performance Life of Various HMA Mixes in Texas

Project Start Date: 3/9/2018 **Termination Date:** 4/30/2021

Project Status: Closed **Total Project Budget:** $329,500.00

RTI Project Manager: Wade Odell **Researcher:** Imad Abdallah

Project Objectives: Pavement engineers in Texas subjectively estimate the service lives of various hot-mix asphalt (HMA) mixtures as part of the life-cycle cost analysis considering the staged design and rehabilitation of flexible pavements. In project 0-6679, Performance Life of Various HMA Mixes in Texas, which ended on August 31, 2014, the Performing Agency recommended the performance lives for various dense-graded (conventional) mixtures, stone-matrix asphalts (SMA), permeable friction courses (PFC), performance design mixtures, and other mixtures placed in Texas. A necessary and significant aspect of the approach involved data mining and merging several pavement management databases; i.e., Letting Database, Design and Construction Information System (DCIS), and Pavement Management Information System (PMIS), to obtain mixture longevity data, along with historical PMIS information. The merged database resulted in the development of an online-tool, Performance Life of Mixes in Texas (PERMIT). The longevity data obtained from PERMIT allowed for estimating the probabilistic performance lives of the HMA mixtures through an integrated survivability analysis that considers the historical longevity of mix types, the age of the HMA surface course, distress history-based life predictions, and Receiving Agency personnel perceived service lives. The Performing Agency shall expand PERMIT by incorporating the statewide Site Manager construction data into it. The Performing Agency shall also focus on training Receiving Agency Construction Division and the Receiving Agency district personnel on how to properly use PERMIT to monitor the performance of different mixes, as well as compare their performance with similar mixes regionally to statewide.

Deliverables:

March MPR 2021
April MPR 2021
August MPR 2020
September MPR 2020
October MPR 2020
TM6b
November MPR 2020
December MPR 2020
TM7
January MPR 2021
February MPR 2021
R1

P1-Online Tool User Manual and Supplemental Training Materials (videos, slides and quick start guide)
P2-Online query tool (GUI) to extract data from Permit Web Application

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$51,500.00	$41,200.00	$10,300.00

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 5-6940-01 **University:** TTI

Project Title: Implementation of Portable Weigh-In Motion (WIM) Technology on Texas Highways

Project Start Date: 4/19/2019 **Termination Date:** 8/31/2021

Project Status: Closed **Total Project Budget:** $275,316.00

RTI Project Manager: Wade Odell **Researcher:** Lubinda Walubita

Project Objectives: Due to high costs, there are a limited number of permanent weigh-in-motion (WIM) stations on the Texas highway network, mostly located on interstate highways. As such, it is not feasible to generate accurate load spectra data required for every highway project other than relying on antiquated estimates, even for the 18-kip equivalent single axle loads (ESALs) used in Flexible Pavement System (FPS) designs. The net result is unoptimized designs or poor performing pavement structures with increased maintenance costs or high construction costs due to over-designing, with high overall life cycle costs. Successful statewide implementation and calibration of the mechanistic-empirically (M-E) pavement design methods is also highly dependent on the availability of accurate axle load spectra data, and so is the need for rapid quantification of accurate site-specific traffic data.At a fraction of the cost of permanent WIMs, the portable WIM technology offers a practical alternative or supplement as a cost-effective tool to measure and quantify traffic loading (i.e., volume counts, vehicle class distribution, speed, vehicle weights, ESALs, FPS/M-E inputs) for any given highway site. In research project 0-6940, Develop Systems to Render Mechanistic-Empirical Traffic Data for Pavement Design, portable WIM technology has been successfully explored and demonstrated to accurately measure and collect site-specific traffic data for pavement designs and maintenance or rehabilitation (M/R) purposes in the following Receiving Agency Districts: Brownwood, Bryan, Corpus Christi, Fort Worth, Laredo, and Odessa.

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
P2
P3
R1
PSR
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$80,030.25	$64,024.20	$16,006.05

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 5-6963-01 **University:** TTI

Project Title: Implementation of Seal Coat Binder Rate Adjustments using LiDAR Data

Project Start Date: 5/7/2019 **Termination Date:** 4/30/2021

Project Status: Closed **Total Project Budget:** $216,517.00

RTI Project Manager: Wade Odell **Researcher:** Darlene Goehl

Project Objectives: Seal coats are a very important preventive maintenance method used throughout Texas. Through the preventive maintenance program, about 16,000 lane miles a year are routinely resurfaced with a seal coat by contracts, and about 3,000 lane miles per year of seal coats are placed with state forces. Additionally, seal coats are used in intermediate layers during construction to seal the pavement structure, which is a significant investment of over $300 million annually. For more than 40 years, there has been little change in the design and construction practices, including equipment used to place the binder or aggregate. With little to no changes in design and construction methods, Texas continues to see the same problems reoccurring, such as rock loss, flushing and bleeding. New technologies are being developed that could potentially reduce these types of problems. Recently completed research project 0-6963, Planning the Next Generation of Seal Coat Equipment, found that the mobile LiDAR system shows much promise to remove a significant amount of subjectivity when determining variations in surface conditions. Identification of the surface conditions is needed in order to adjust the seal coat binder rates during construction as the conditions change. The objective of this implementation project is to remove subjectivity from the rate adjustment process which will lead to reduced risk for the Receiving Agency. The Performing Agency shall use LiDAR reflectivity data to describe pavement condition changes through an efficient and effective automated data analysis method. The Performing Agency shall review the projects identified in research project 0-6963 and work with the Bryan District on six projects for the summer 2019 seal coat to identify pavement condition changes and binder rate adjustments. For the 2020 seal coat projects, the Performing Agency shall work with the Bryan District and two additional districts (either Waco, Brownwood, Lufkin or Tyler) to select five projects each. The Performing Agency shall collect data on the selected locations, apply the

algorithm, and provide the district with suggested application rate adjustments.

38

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
TM5
R1
PSR

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$15,664.00	$12,531.20	$3,132.80

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Table 9. Construction and Maintenance Totals For Closed Projects

Financials	Budget	Expended	Balance
Federal 80%	$735,454.26	$707,187.66	$28,266.60
TDC 20%	$183,863.56	$176,796.92	$7,066.64
Total	$919,317.82	$883,984.58	$35,333.24

2.1.3 Planning and Environmental

Project Number: 0-6804 **University:** CTR

Project Title: Life Cycle Cost and Performance of Lightweight Noise Barrier Materials Along Bridge Structures

Project Start Date: 1/29/2013 **Termination Date:** 12/31/2020

Project Status: Closed **Total Project Budget:** $783,649.00

RTI Project Manager: Wade Odell **Researcher:** Manuel Trevino

Project Objectives: The site of this study is on elevated eastbound sections of IH-30, west of downtown Dallas. They are located north of the Kessler Park Neighborhood where the CTR team conducted a major sound project in 2010/2011 on westbound sections of an extensive retaining wall.
Two locations in the Dallas District are segments between Sylvan Avenue and Edgefield Avenue, with an approximate length of 2,500 ft., possessing a concrete sound wall approximately 8-ft. in height. The second segment is from Sylvan Avenue to Beckley Avenue, which has a traditional safety barrier rather than a dedicated concrete reflective sound wall and is approximately 4,000-ft. long. The research team shall evaluate the performance of a light-weight traffic noise wall for both sections which shall extend the height of the existing walls and so both attenuate sound propagation and block the current line of sight from the adjacent neighborhood to the highway.

The CTR team shall conduct a feasibility study using Dallas District staff and industry contacts. This study shall develop the comprehensive work plan needed to answer the issues raised and identify the research components integrate the research activities with the sound wall bidding, construction and maintenance activities which managed separately by the Dallas District. It will allow the subsequent study to capture sound measurements and life cycle impacts at key locations before and after the construction of the lightweight sound walls before fall 2013. The measurement of sound absorption or reflection (depending on the type selected by the Dallas team) needs to be undertaken during regular cycles of weather, including wind and temperature changes, starting in winter 2013.

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
Final R5
PSR2
Updated TM18
Updated TM19

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$40,359.00	$32,287.20	$8,071.80

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-6970 **University:** TTI

Project Title: Daily and Seasonal Movements of Brown Pelicans in the Bahía Grande Wetland Complex

Project Start Date: 9/1/2017 **Termination Date:** 3/31/2021

Project Status: Closed **Total Project Budget:** $517,725.38

RTI Project Manager: Chris Glancy **Researcher:** Andrew Birt

Project Objectives: This project deals with the collection of data to understand and therefore predict the movements of Brown Pelicans in the Bahía Grande Wetland Complex, Texas. The goal of the project is to deliver data and models that the Receiving Agency will use to predict and mitigate pelican mortality events associated with roadways in the region.The Performing Agency shall conduct data collection and develop a model using a strong conceptual framework of pelican mortality risk. This framework involves breaking down the problem into: a) the frequency with which pelicans cross or interact with local roads and bridges; and b) existing, ongoing work that describes the likelihood that mortality events shall occur at specific sites because of bridge/road design and weather events. To accomplish this, the Performing Agency, along with local ornithologists, U.S. Fish and Wildlife Service personnel, scientists, and other interested parties shall capture, band, collect physiological/morphological data, and attach Global Positioning System (GPS) trackers to the birds. The GPS tracking system shall enable the Performing Agency to track individual birds in the region with high resolution; while a distributed citizen science monitoring program shall assemble a complementary database of broader scale pelican activity and movement. The data collection efforts shall be driven by wildlife ecologists specializing in seabird ecology, physiology, and population dynamics. The complimentary data collection methods, undertaken over a two-year period shall provide high-quality data essential for the development of quantitative pelican mortality risk models. The Performing Agency shall develop these risk models which will be useful for predicting current and future pelican mortality, and therefore for developing novel, cost-effective solutions to reduce pelican-road mortality incidents in the region.

Deliverables:

R1B
August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
R1A
PSR

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$81,244.00	$64,995.20	$16,248.80

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7014 **University:** TTI

Project Title: Sequencing and Placement of Noise Walls and Retaining Walls on Complex TxDOT Projects

Project Start Date: 11/1/2019 **Termination Date:** 8/31/2021

Project Status: Closed **Total Project Budget:** $273,983.50

RTI Project Manager: Joanne Steele **Researcher:** Kris Harbin

Project Objectives: Difficulties arise when constructing noise wall and retaining walls due to conflicts with utilities, construction phasing conflicts, and inadequate access. Design manuals and design guides from the Receiving Agency and various other Department of Transportations (DOTs) around the United States mention items to consider during design. These manuals mention utilities and other aspects of construction as potential issues when designing noise and retaining walls but fail to provide details about how to avoid or address these issues. The purpose of the research is to provide guidance on the sequencing and placement of noise walls and sound walls on complex projects. The research includes examining issues such as noise and retaining wall selection, standards and specifications, preferred methods and best practices for sequencing and placement, and design and construction procedures. In addition to the report, the deliverables of the research include a guidebook for the sequencing and placement of design features and recommendations for additions to the Receiving Agency manuals.

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021
TM-5

TM-3
TM-6
P1 - Guidebook
R1
PSR

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$170,228.75	$136,183.00	$34,045.75

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7022 **University:** TAR

Project Title: Evaluating Fall Monarch Butterfly Roadkill Hotspot Incidence and Potential Roadkill Mitigation

Project Start Date: 7/31/2019 **Termination Date:** 8/31/2021

Project Status: Closed **Total Project Budget:** $348,294.75

RTI Project Manager: Joanne Steele **Researcher:** Robert Coulson

Project Objectives: The monarch butterfly (Danaus plexippus) was petitioned for protection under the federal Endangered Species Act in 2014. The listing decision is pending. This action was triggered by the observation that overwintering populations of the eastern migrating monarchs in central Mexico had declined by 82 percent in the 23 years from 1995 to 2018. This rate of decline is compelling evidence that monarch populations have been reduced to the point where persistence of the migratory phenomenon is endangered. Recent research identified that roadkill mortality occurring on Texas roadways is a major mortality factor associated with both the coastal and central flyways used in migration through Texas to the overwintering sites in Mexico. Migrating monarch become more concentrated as they travel south, amplifying the effects of roadkill on populations. Mortality occurs in hotspots associated with landscape and infrastructure features of Texas roadways. Accordingly, this project shall identify hotspot locations, zones, and regions for monarch roadkill mortality and investigate mitigation actions that could be implemented to reduce monarch/vehicle collisions. To accomplish this goal the Performing Agencies shall conduct surveys to identify hotspot locations, correlate hotspot locations with environmental and road infrastructure features, develop maps of roadkill mortality over major Texas highways, and evaluate potential mitigation options.

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021
TM2C
TM4C with zip data
TM2D with zip files
TM4D
TM5C
VOR
VOR
R1
PSR

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$125,530.25	$100,424.20	$25,106.05

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7022 **University:** TTI

Project Title: Evaluating Fall Monarch Butterfly Roadkill Hotspot Incidence and Potential Roadkill Mitigation

Project Start Date: 7/31/2019 **Termination Date:** 8/31/2021

Project Status: Closed **Total Project Budget:** $348,294.75

RTI Project Manager: Joanne Steele **Researcher:** Robert Coulson

Project Objectives: The monarch butterfly (Danaus plexippus) was petitioned for protection under the federal Endangered Species Act in 2014. The listing decision is pending. This action was triggered by the observation that overwintering populations of the eastern migrating monarchs in central Mexico had declined by 82 percent in the 23 years from 1995 to 2018. This rate of decline is compelling evidence that monarch populations have been reduced to the point where persistence of the migratory phenomenon is endangered. Recent research identified that roadkill mortality occurring on Texas roadways is a major mortality factor associated with both the coastal and central flyways used in migration through Texas to the overwintering sites in Mexico. Migrating monarch become more concentrated as they travel south, amplifying the effects of roadkill on populations. Mortality occurs in hotspots associated with landscape and infrastructure features of Texas roadways. Accordingly, this project shall identify hotspot locations, zones, and regions for monarch roadkill mortality and investigate mitigation actions that could be implemented to reduce monarch/vehicle collisions. To accomplish this goal the Performing Agencies shall conduct surveys to identify hotspot locations, correlate hotspot locations with environmental and road infrastructure features, develop maps of roadkill mortality over major Texas highways, and evaluate potential mitigation options.

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021
TM2C
TM4C with zip data
TM2D with zip files
TM4D
TM5C
VOR
VOR
R1
PSR

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$48,406.00	$38,724.80	$9,681.20

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7063 **University:** TAMU-CC

Project Title: Guidance for the Use of UAS During Suboptimal Environmental Conditions

Project Start Date: 1/3/2020 **Termination Date:** 8/31/2021

Project Status: Closed **Total Project Budget:** $655,148.00

RTI Project Manager: Chris Glancy **Researcher:** Cesar Quiroga

Project Objectives: The Receiving Agency uses unmanned aircraft systems (UAS) for various applications in Texas such as highway mapping, bridge inspection, crash site data collection and real-time traffic monitoring. Environmental conditions including wind, rain, mist, smoke, and ambient lighting affect both the flight operations of the UAS aircraft and the quality of the data being collected. However, due to logistics, scheduling, and urgency, UAS flights may need to be performed during suboptimal conditions. To better understand these effects, this research shall address key challenges of UAS operations in suboptimal conditions, provide guidance for UAS flight operations in suboptimal conditions, and recommend settings, procedures and workflows to ensure data quality collected by UAS in suboptimal conditions. This research includes a literature review of the state of the art and the state of the practice, simulation and laboratory tests, preliminary field testing of UAS flight operations and data collection in different suboptimal environmental scenarios, post-flight analytics and assessments, and the development of recommendations and guidance for UAS operations in suboptimal conditions.

Deliverables:
August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021

TMFY21A
TMFY21B
R1A
R1B
PSR
UAS FOM

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$131,932.00	$105,545.60	$26,386.40

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7063 **University:** TTI

Project Title: Guidance for the Use of UAS During Suboptimal Environmental Conditions

Project Start Date: 1/3/2020 **Termination Date:** 8/31/2021

Project Status: Closed **Total Project Budget:** $655,148.00

RTI Project Manager: Chris Glancy **Researcher:** Cesar Quiroga

Project Objectives: The Receiving Agency uses unmanned aircraft systems (UAS) for various applications in Texas such as highway mapping, bridge inspection, crash site data collection and real-time traffic monitoring. Environmental conditions including wind, rain, mist, smoke, and ambient lighting affect both the flight operations of the UAS aircraft and the quality of the data being collected. However, due to logistics, scheduling, and urgency, UAS flights may need to be performed during suboptimal conditions. To better understand these effects, this research shall address key challenges of UAS operations in suboptimal conditions, provide guidance for UAS flight operations in suboptimal conditions, and recommend settings, procedures and workflows to ensure data quality collected by UAS in suboptimal conditions. This research includes a literature review of the state of the art and the state of the practice, simulation and laboratory tests, preliminary field testing of UAS flight operations and data collection in different suboptimal environmental scenarios, post-flight analytics and assessments, and the development of recommendations and guidance for UAS operations in suboptimal conditions.

Deliverables:
August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021

TMFY21A
TMFY21B
R1A
R1B
PSR
UAS FOM

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$187,049.00	$149,639.20	$37,409.80

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7066 **University:** TTI

Project Title: Developing a Small Airport Economic Impact Estimator

Project Start Date: 11/1/2019 **Termination Date:** 10/31/2020

Project Status: Closed **Total Project Budget:** $130,000.00

RTI Project Manager: Joanne Steele **Researcher:** Jeffrey Borowiec

Project Objectives: Knowing the current economic impact of your airport is critical to both airport sponsors and the Receiving Agency. While the Receiving Agency periodically commissions a statewide economic impact study, there is a need for the ability to provide updated or more precise economic impact values to airport sponsors and other stakeholders including the Receiving Agency, city/county officials, airport users, economic development officials, and businesses located on the airport. This is a result of: 1. Some airports not being included in the statewide study (or incomplete information being used); 2. Privacy concerns with respect to the financial/economic data because the airport may only have one business making it identifiable; 3. Changes in an airport's activity levels since the last statewide study was performed; and 4. Airport's desire to have a more detailed analysis than that which is allowed when looking at 300 airports at one time. Having updated and current numbers is important because many local officials use the airport's economic impact values to justify the authorization of grant-matching funds for state and federal airport grants. This allows them to better leverage local funds for airport improvements.

The Performing Agency shall perform a literature review, develop and test an airport economic estimator tool, and create an easy-to-use web-based interface for small airports to input local airport data to determine the economic impact of their airport. The estimator tool will allow airport sponsors to provide airport-specific data if they have it or rely on default numbers, if they are not available, which would be developed and identified by the Performing Agency during this research project. The output will be economic impact values in terms of employment, payroll, and output for the airport, its tenants and businesses, and its visitors as well as the indirect and induced impacts they create.

The Performing Agency shall also develop a User's Guide to explain how to use the estimator tool, what the results are, what they mean, and how the airport sponsors and Receiving Agency can use them.

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$5,900.00	$4,720.00	$1,180.00

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 5-6665-01 **University:** TAMUK

Project Title: TxDOT Native Plant Integration Program for Texas

Project Start Date: 9/1/2018 **Termination Date:** 8/31/2021

Project Status: Closed **Total Project Budget:** $1,500,000.00

RTI Project Manager: Wade Odell **Researcher:** Keith Pawelek

Project Objectives: This implementation project will work to commercialize native seed sources from central and west Texas for TxDOT's use, and develop native seed sources for east Texas and coastal TxDOT Districts. As a result of methods tested in TxDOT research projects 0-4570 and 0-6665, regionally adapted native seed sources of short stature grasses, forbs, and legumes will be developed, commercialized, and made available for TxDOT specification for use on roadsides to meet revegetation mandates throughout Texas. Objectives will include the collection, evaluation increase, and commercialization of seed sources of regionally adapted native seeds. Resulting native seed mixes will enable TxDOT to achieve permanent vegetation cover resulting in timely notice of termination following construction projects. Implementation and use of native seeds will also enable TxDOT to meet current and proposed federal mandates for native plant use on highway rights-of-way throughout Texas. Native seeds made available through this work will also greatly improve TxDOT's ability to restore pollinator plants, including milkweeds, in all regions of the state by ensuring commercial availability of plant centers, and seed sources developed will be commercialized through private seed companies. The project team will work cooperatively with TxDOT Maintenance Division Vegetation Management personnel to development and implement the new standard specification item 164, Seeding for Erosion Control Specifications, that will utilize native seeds made available by the project. The implementation project will enable TxDOT to meet Federal Clean Water Act mandates for erosion control and provide diverse native habitat supporting native plants, pollinators, and wildflowers on roadsides, and to reduce impacts to adjacent private lands throughout Texas.

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021
P1
R1
PSR

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$500,000.00	$400,000.00	$100,000.00

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Table 10. Planning and Environmental Totals for Closed Projects

Financials	Budget	Expended	Balance
Federal 80%	$1,032,519.20	$945,555.05	$86,964.15
State 20% TDC*	$258,129.80	$236,388.76	$21,741.04
Total	**$1,290,649.00**	**$1,181,943.81**	**$108,705.19**

2.1.4 Structures and Hydraulics

Project Number: 0-6905 **University:** UH

Project Title: Performance of Skewed Reinforcing in Inverted-T Bridge Caps

Project Start Date: 1/1/2016 **Termination Date:** 10/31/2020

Project Status: Closed **Total Project Budget:** $855,439.50

RTI Project Manager: Jade Adediwura **Researcher:** Y. L. Mo

Project Objectives: Reinforced concrete inverted-T bridge caps are used extensively in Texas bridges. Many of these bridge structures must be skewed, some in excess of 45 degrees. Faster and easier construction could be obtained if skewed transverse reinforcing steel is utilized. Accordingly, there is a concern that whether using skewed transverse reinforcement shall provide reasonable structural behavior for the skewed inverted-T bridge cap in term of overall cracking occurrence and structural performance. The guidance in current AASHTO code and research of skewed inverted-T bridge caps are only limited to the design of typical normal skewed transverse reinforcement. Therefore, it is necessary to analyze the structural performance of the skewed Inverted-T bridge caps with skewed transverse reinforcement and compare the performance to typical normal transverse reinforcement. The Performing Agency shall conduct the experimental and analytical investigation on the behavior of the skewed Inverted-T bridge caps utilizing skewed transverse reinforcement emphasizing the following three aspects: i) skewed angle ii) detailing of transverse reinforcement and iii) amount of transverse reinforcement. Design provisions of existing design codes, especially AASHTO LRFD code, shall be reevaluated through the experimental approach. Finally, a rational design method shall be established for the skewed Inverted-T bridge caps with skewed transverse reinforcement.

Deliverables:

PSR
TM10
TM11
TM12
TM13
August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
R1B
June MPR 2021

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$9,996.80	$7,997.44	$1,999.36

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-6950 **University:** UTSA

Project Title: Evaluating Bridge Behavior Using Ultra-High Resolution Next-Generation Digital Image Correlation (DIC): Applications in Bridge Inspection and Damage Assessment

Project Start Date: 9/1/2017 **Termination Date:** 12/31/2020

Project Status: Closed **Total Project Budget:** $419,432.00

RTI Project Manager: Tom Schwerdt **Researcher:** Wassim M. Ghannoum

Project Objectives: Due to heavy cost burdens, departments of transportation are increasingly seeking new technologies that can facilitate monitoring their bridge portfolios and reduce the need for costly interventions. Deformation measurements, such as bridge deflections, material strains, and crack progression under load and over time, are at the heart of damage and capacity evaluations for bridges. However, measuring the necessary structural deformations is currently time consuming, requires direct access to the structure, and often suffers from user-bias. Digital Image Correlation (DIC) is a non-contact technology that utilizes specialized digital cameras to deliver high-resolution deformation data between successive images and over large areas of a structure. The technology is advancing rapidly and has recently been proven in laboratory settings to possess the unique ability, amongst competing technologies, to deliver the necessary high-resolution deformation data that can greatly improve the accuracy and reduce the conservatism of structural evaluations. This project shall deliver a state-of-the-art DIC system that can monitor strains and deformations during bridge load testing, as well as monitor damage progression in concrete and steel bridges over time. The system will accelerate and reduce the cost of bridge inspections, while delivering previously inaccessible data for streamlining bridge capacity evaluations and rehabilitation decisions.

Deliverables:

December MPR 2020
WKS
CoM
PSR
FPR
August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$21,997.00	$17,597.60	$4,399.40

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-6953 **University:** CTR

Project Title: Strut-and-Tie Modeling and Design of Drilled Shaft Footings

Project Start Date: 9/1/2017 **Termination Date:** 8/31/2021

Project Status: Closed **Total Project Budget:** $1,155,814.11

RTI Project Manager: Joanne Steele **Researcher:** Oguzhan Bayrak

Project Objectives: The design and detailing of reinforced concrete footings supported by a grid of drilled shafts varies greatly on a state, district, and even municipality basis. The Texas Department of Transportation (TxDOT) has attributed the variations to a lack of guidance and standards for the design of shaft-supported footings. Refinement of the two-dimensional strut-and-tie (STM) provisions of TxDOT Project 0-5253 will provide the guidance necessary for consistent design of three-dimensional column footings. The Performing Agency (PA) shall review at least the following designs and details: 1)Straightforward Design Provisions for Strong, Serviceable Footings: Nodal efficiencyfactors and reinforcement anchorage requirements are to be derived on the basis of largescale testing and analytical studies. It is anticipated that recommended design process will consist of stress checks at singular bearings and anchorage checks at critical locations of the STM. 2) Optimal Strut-and-Tie Models for Common Load Combinations: A set of generalized strutand-tie models are to be developed for the most common load combinations encountered by TxDOT. Empirically based guidance will accompany the generalized strut-and-tie models to ensure the most efficient placement of model elements. Implementation of the three-dimensional STM guidelines developed during TxDOT Project 18-60 will lead to the construction of highly efficient, durable shaft-supported footings across the State of Texas.

Deliverables:

September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
TM5.2
TM6
TM7
TM8
R1
PSR
June MPR 2021
July MPR 2021
TM5.2 (Updated)
TM6 (Updated)
August MPR 2020

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$145,228.14	$116,182.51	$29,045.63

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-6977 **University:** TECH

Project Title: Develop a Generalized Skew Update and Regional Study of Other Measures of Distribution Shape for Texas for Texas Flood Frequency Analyses

Project Start Date: 9/1/2018 **Termination Date:** 8/31/2021

Project Status: Closed **Total Project Budget:** $448,924.15

RTI Project Manager: Martin Dassi **Researcher:** Theodore Cleveland

Project Objectives: This project shall investigate and document generalized (regional) skew coefficients (RegSkew) and other measures of distribution shape in and near Texas. RegSkews, which are derived by procedures integrating sample at-site skew values obtained at many streamgages, are important for peak-streamflow frequency (flood frequency) analyses because of the high sampling variability. The measures of distribution geometry are normally derived from study of USGS instantaneous annual peak streamflow data and ancillary watershed properties. However, identification of applicable time periods of the USGS observational record is complex and critical for execution of this study, and the USGS peak-values database provides only qualitative information to this effect. New RegSkews are therefore needed for hydrologic design because previous studies (nationally c.1982; Texas c.1996) are outdated relative to Federal guidelines (England and others, 2018 [Bulletin 17C]). Future flood frequency analyses will inherently be more reliable and with decreased uncertainties when new RegSkews are used and in particular used with the Expected Moments Algorithm of Bulletin 17C and other settings. Bulletin 17C currently recommends Bayesian generalized least squares (B-GLS) concepts to estimate RegSkews because B-GLS reflects the precision of available estimates, their cross correlations, and the precision of the regional model. This project will report on the results of B-GLS for Texas. The complexity of the Texas flood hydrology, due to a broad spectrum of wide ranging climatic, rural to urban development conditions, and potential flood-flow regulation effects, requires further research of spatial and temporal trends in annual peaks and empirical distributions. Further RegSkew and other measures of distribution shape concepts and methods that incorporate machine learning and generalized additive models will be explored in this project to fully discern probability distribution shape and

prediction for the distal tail estimation of flood frequency. The project will also produce products and training materials suitable for self-training and inclusion in workforce development facilitated training.

Deliverables:

TM5A
TM5B
P6 Training Product, to include a P6 pdf file and pptx training module
VoR
P1
R1/R1A
PSR
August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
R1B
May MPR 2021
June MPR 2021
July MPR 2021

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$13,365.00	$10,692.00	$2,673.00

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-6977 **University:** USGS

Project Title: Develop a Generalized Skew Update and Regional Study of Other Measures of Distribution Shape for Texas for Texas Flood Frequency Analyses

Project Start Date: 9/1/2018 **Termination Date:** 8/31/2021

Project Status: Closed **Total Project Budget:** $448,924.15

RTI Project Manager: Martin Dassi **Researcher:** Theodore Cleveland

Project Objectives: This project shall investigate and document generalized (regional) skew coefficients (RegSkew) and other measures of distribution shape in and near Texas. RegSkews, which are derived by procedures integrating sample at-site skew values obtained at many streamgages, are important for peak-streamflow frequency (flood frequency) analyses because of the high sampling variability. The measures of distribution geometry are normally derived from study of USGS instantaneous annual peak streamflow data and ancillary watershed properties. However, identification of applicable time periods of the USGS observational record is complex and critical for execution of this study, and the USGS peak-values database provides only qualitative information to this effect. New RegSkews are therefore needed for hydrologic design because previous studies (nationally c.1982; Texas c.1996) are outdated relative to Federal guidelines (England and others, 2018 [Bulletin 17C]). Future flood frequency analyses will inherently be more reliable and with decreased uncertainties when new RegSkews are used and in particular used with the Expected Moments Algorithm of Bulletin 17C and other settings. Bulletin 17C currently recommends Bayesian generalized least squares (B-GLS) concepts to estimate RegSkews because B-GLS reflects the precision of available estimates, their cross correlations, and the precision of the regional model. This project will report on the results of B-GLS for Texas. The complexity of the Texas flood hydrology, due to a broad spectrum of wide ranging climatic, rural to urban development conditions, and potential flood-flow regulation effects, requires further research of spatial and temporal trends in annual peaks and empirical distributions. Further RegSkew and other measures of distribution shape concepts and methods that incorporate machine learning and generalized additive models will be explored in this project to fully discern probability distribution shape and

prediction for the distal tail estimation of flood frequency. The project will also produce products and training materials suitable for self-training and inclusion in workforce development facilitated training.

Deliverables:

TM5A
TM5B
P6 Training Product, to include a P6 pdf file and pptx training module
VoR
P1
R1/R1A
PSR
August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
R1B
May MPR 2021
June MPR 2021
July MPR 2021

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$24,200.00	$19,360.00	$4,840.00

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-6977 **University:** UTA

Project Title: Develop a Generalized Skew Update and Regional Study of Other Measures of Distribution Shape for Texas for Texas Flood Frequency Analyses

Project Start Date: 9/1/2018 **Termination Date:** 8/31/2021

Project Status: Closed **Total Project Budget:** $448,924.15

RTI Project Manager: Martin Dassi **Researcher:** Theodore Cleveland

Project Objectives: This project shall investigate and document generalized (regional) skew coefficients (RegSkew) and other measures of distribution shape in and near Texas. RegSkews, which are derived by procedures integrating sample at-site skew values obtained at many streamgages, are important for peak-streamflow frequency (flood frequency) analyses because of the high sampling variability. The measures of distribution geometry are normally derived from study of USGS instantaneous annual peak streamflow data and ancillary watershed properties. However, identification of applicable time periods of the USGS observational record is complex and critical for execution of this study, and the USGS peak-values database provides only qualitative information to this effect. New RegSkews are therefore needed for hydrologic design because previous studies (nationally c.1982; Texas c.1996) are outdated relative to Federal guidelines (England and others, 2018 [Bulletin 17C]). Future flood frequency analyses will inherently be more reliable and with decreased uncertainties when new RegSkews are used and in particular used with the Expected Moments Algorithm of Bulletin 17C and other settings. Bulletin 17C currently recommends Bayesian generalized least squares (B-GLS) concepts to estimate RegSkews because B-GLS reflects the precision of available estimates, their cross correlations, and the precision of the regional model. This project will report on the results of B-GLS for Texas. The complexity of the Texas flood hydrology, due to a broad spectrum of wide ranging climatic, rural to urban development conditions, and potential flood-flow regulation effects, requires further research of spatial and temporal trends in annual peaks and empirical distributions. Further RegSkew and other measures of distribution shape concepts and methods that incorporate machine learning and generalized additive models will be explored in this project to fully discern probability distribution shape and

prediction for the distal tail estimation of flood frequency. The project will also produce products and training materials suitable for self-training and inclusion in workforce development facilitated training.

Deliverables:

TM5A
TM5B
P6 Training Product, to include a P6 pdf file and pptx training module
VoR
P1
R1/R1A
PSR
August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
R1B
May MPR 2021
June MPR 2021
July MPR 2021

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$17,316.20	$13,852.96	$3,463.24

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Structures and Hydraulics

Project Number: 0-7010 **University:** TTI

Project Title: Developing Peak Rate Factor (PRF) Guidance in Hydrologic Modeling

Project Start Date: 7/15/2019 **Termination Date:** 12/31/2020

Project Status: Closed **Total Project Budget:** $149,427.00

RTI Project Manager: Shelley Pridgen **Researcher:** Hatim Sharif

Project Objectives: Hydrologic modeling based on the NRCS dimensionless unit hydrograph uses a standard peak rate factor (PRF) of 484, but the method for developing more appropriate PRF values is complex and cumbersome, and is not commonly used. The most current or common Texas practice is to adjust PRF after initial modeling has been performed as a rough calibration to expected values. This current practice lacks guidance and consistency. Further, changes to PRF values have an effect on the peak flow values and resulting sizes for hydraulic structures. Prior research on appropriate PRF values for Texas has been performed in the past, but a relationship of recommended values for varied watersheds and physiographic regions in Texas was not evident at that time. Additional research is needed to build off prior Texas research and establish solid guidance for a range of reasonable PRF values for all areas of Texas. As an effort towards addressing these challenges, the Performing Agency shall develop a simple, easy–to–use approach for the estimation of peak rate factors and, as needed by the Receiving Agency, related hydrologic modeling tools.

Deliverables:

P5A
P5B
P6A
P6B
R1 (confirm VoR included) draft version
PSR draft version
August MPR 2020
August MPR UTSA 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020

PD1
PD2
PD3
September MPR 2020
October MPR 2020
November MPR TTI 2020
December MPR 2020

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$24,000.00	$19,200.00	$4,800.00

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7010 **University:** UTSA

Project Title: Developing Peak Rate Factor (PRF) Guidance in Hydrologic Modeling

Project Start Date: 7/15/2019 **Termination Date:** 12/31/2020

Project Status: Closed **Total Project Budget:** $149,427.00

RTI Project Manager: Shelley Pridgen **Researcher:** Hatim Sharif

Project Objectives: Hydrologic modeling based on the NRCS dimensionless unit hydrograph uses a standard peak rate factor (PRF) of 484, but the method for developing more appropriate PRF values is complex and cumbersome, and is not commonly used. The most current or common Texas practice is to adjust PRF after initial modeling has been performed as a rough calibration to expected values. This current practice lacks guidance and consistency. Further, changes to PRF values have an effect on the peak flow values and resulting sizes for hydraulic structures. Prior research on appropriate PRF values for Texas has been performed in the past, but a relationship of recommended values for varied watersheds and physiographic regions in Texas was not evident at that time. Additional research is needed to build off prior Texas research and establish solid guidance for a range of reasonable PRF values for all areas of Texas. As an effort towards addressing these challenges, the Performing Agency shall develop a simple, easy–to–use approach for the estimation of peak rate factors and, as needed by the Receiving Agency, related hydrologic modeling tools.

Deliverables:

P5A
P5B
P6A
P6B
R1 (confirm VoR included) draft version
PSR draft version
August MPR 2020
August MPR UTSA 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
PD1

PD2
PD3
September MPR 2020
October MPR 2020
November MPR TTI 2020
December MPR 2020

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$84,000.00	$67,200.00	$16,800.00

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7091 **University:** TTI

Project Title: Synthesis: Rip-Rap for Scour Countermeasures

Project Start Date: 9/1/2020 **Termination Date:** 8/31/2021

Project Status: Closed **Total Project Budget:** $64,999.50

RTI Project Manager: Shelley Pridgen **Researcher:** Jean-Louis Braiud

Project Objectives: Scour often occurs at or adjacent to bridges and is a leading cause of bridge failure. Countermeasures are often used to mitigate scour problems. Riprap is the most common countermeasure for scour mitigation. The word riprap in this project is used to mean stone protection riprap. It is not typical to use riprap as part of the design at bridge piers but rather at the design stage for the protection of bridge abutments. However, if an excessive scour hole develops around the bridge pier then riprap can be used as a repair approach.

The Performing Agency shall address the following key questions in this project. a. Is the use of a filter necessary between the riprap and the native soil? If so, how should the filter (granular or geosynthetic), and the riprap be designed, specified, and placed?What are the differences between dry and underwater installation? b. What is the general stability of slopes with riprap covers? What recommendations need to be made for the slopes to be stable once the riprap cover has been installed?

Deliverables:

September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021
TM2
TM3
TM4

TM5
TM6
R1
PSR
P1

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$64,999.50	$51,999.60	$12,999.90

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7092 **University:** UTA

Project Title: Synthesis: Bridge Deck Drains

Project Start Date: 9/1/2020 **Termination Date:** 8/31/2021

Project Status: Closed **Total Project Budget:** $49,994.25

RTI Project Manager: Jade Adediwura **Researcher:** Mohsen Shahandashti

Project Objectives: The Performing Agency shall compile practical recommendations from an integrated construction, hydraulic, and structural engineering perspective to enhance the implementation of bridge deck drains in Texas bridges. This project shall:
1) synthesize and evaluate existing bridge deck drains
2) recommend appropriate drain types and materials, drain configurations, as well as pipe materials and sizes to minimize the maintenance need of bridge deck drains
3) recommend placement of drain pipes within or external to the bridge structures.
The Performing Agency shall evaluate and compare bridge deck drains based on several criteria, including:
- minimization of maintenance
- aesthetics
- avoidance of hydroplaning
- structural integrity
- minimization of spread
- bicycle safety
- protection of water quality.

Deliverables:
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021
TM2

TM3
TM4
TM5
TM6
R1
PSR

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$49,994.25	$39,995.40	$9,998.85

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 5-6909-01 **University:** CTR

Project Title: Implementation of Field Instrumentation Steel Girder Bridge with Partial Precast Concrete Deck Panels

Project Start Date: 12/23/2020 **Termination Date:** 8/31/2021

Project Status: Closed **Total Project Budget:** $145,190.00

RTI Project Manager: Chris Glancy **Researcher:** Todd Helwig

Project Objectives: The Performing Agencycompleted project0-6909 that focused on the design for deck stress over precast concrete panels (PCPs) in negative moment regions of continuous concrete and steel girders. PCPs have long been used in Texas on precast prestressed concrete girders. The increased use on steel girder systems can lead significant improvements in the economy and efficiency of steel girder systems.The Receiving Agency has a continuous steel bridge in Bastrop County currently under construction in which the contractor desires to use PCPs.The implementation of the 0-6909research applicationshall allow the Performing Agency to gather supporting data demonstrating the performance of the deck reinforcing recommendations.The implementation project shallinstrumentthe bridge deck above two of thesteel girders in the negative moment regionfollowed monitoring of thethe casting of the concrete deck to gather data on the concrete shrinkage strains.The deckshallbe monitored shall include a live load test using4 dump trucks loaded with sand before the bridge is opened to traffic.

Deliverables:

TM2
TM3
A1
TM4
TM5
PSR
R1
P6
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021

June MPR 2021
July MPR 2021

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$145,190.00	$116,152.00	$29,038.00

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Table 11. Structures and Hydraulics Totals for Closed Projects

Financials	Budget	Expended	Balance
Federal 80%	$480,229.51	$424,956.86	$55,272.65
State 20% TDC*	$120,057.38	$106,239.22	$13,818.16
Total	$600,286.89	$531,196.08	$69,090.81

2.1.5 *Safety and Operations*

Project Number: 0-6968 **University:** TTI

Project Title: Roadside Safety Device Analysis, Testing, and Evaluation Program

Project Start Date: 9/1/2017 **Termination Date:** 10/31/2020

Project Status: Closed **Total Project Budget:** $2,312,266.00

RTI Project Manager: Wade Odell **Researcher:** Roger Bligh

Project Objectives: This project provides the Receiving Agency with a mechanism to quickly and effectively address high priority issues related to roadside safety devices. Roadway departure crashes represent over 50% of fatalities on Texas roadways each year. Roadside safety devices shield motorists from roadside hazards such as non-traversable terrain and fixed objects, thereby reducing injuries and fatalities associated with roadway departure crashes. There is a need to develop new or improved roadside safety devices that accommodate a variety of site conditions, placement locations, and a changing vehicle fleet, including motorcycles to further enhance the safety of the motoring public. The second edition of the American Association of State Highway and Transportation Officials (AASHTO) Manual for Assessing Safety Hardware (MASH) published in December 2016 will be used to evaluate the impact performance of the devices developed under this project. This document provides comprehensive procedures for the safety performance evaluation of roadside safety hardware. The MASH design impact vehicle is considered to be more representative than previous guidelines of the large class of light trucks, including sport utility vehicles (SUVs), on Texas roadways.

Deliverables:

R3
PSR
August MPR 2020
September MPR 2020
October MPR 2020

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$16,020.00	$12,816.00	$3,204.00

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-6969 **University:** TTI

Project Title: Traffic Control Device Analysis, Testing, and Evaluation Program

Project Start Date: 9/1/2017 **Termination Date:** 10/31/2020

Project Status: Closed **Total Project Budget:** $1,511,290.00

RTI Project Manager: Wade Odell **Researcher:** Paul Carlson

Project Objectives: This project will provide the Receiving Agency a mechanism to quickly and effectively conduct high priority evaluations of traffic control devices (TCD) including human performance, vehicle technology performance (for sensors used in new vehicles), safety effects, policies, and specifications. The TCD issues to be evaluated in this project may represent new devices or technologies, new applications of an existing device or technology, traffic control device material performance, changes in the Receiving Agency's practices regarding a TCD, or other TCD related needs. Examples of various evaluations include human factors, machine vision performance, safety effects, visibility assessments, and cost/benefit analyses. The activities conducted through this project shall support the development of TCD related policy, standards, guidelines, handbooks, and training. This project is intended to support the Receiving Agency's District needs primarily the Traffic Operations, Maintenance, and Construction Divisions, but also the Engineering Divisions. In each year of the project, TCD issues will be identified and prioritized for investigation. The selected issues shall be evaluated and addressed with a separate work plan, and the results will be presented in with technical memorandums that shall include findings and recommendations that can support the implementation of the new guidelines or policy, as appropriate.

Deliverables:

R3
PSR
August MPR 2020
September MPR 2020
October MPR 2020

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$27,336.00	$21,868.80	$5,467.20

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-6990 **University:** TTI

Project Title: Development of MASH Test Level 3 (TL-3) Compliant Transition between Median Guardrail and Median Concrete Barrier

Project Start Date: 9/1/2018 **Termination Date:** 1/31/2021

Project Status: Closed **Total Project Budget:** $415,732.00

RTI Project Manager: Wade Odell **Researcher:** Akram Abu-Odeh

Project Objectives: The Receiving Agency is moving to implement Manual for Assessing Safety Hardware (MASH) compliant safety hardware. This is a great step forward in terms of enhancing the safety of Texas roadways. The Receiving Agency already has a MASH TL-3 double face guardrail; however, this system does not work alone without end termination or connectivity to other barriers. Most often, a connectivity to a MASH compliant median concrete barrier is needed. The connectivity is the transition section and thus it has to be MASH compliant similar to other components to maintain the MASH compliancy of the overall installation. Hence, there is a safety need for developing a MASH compliant transition between the double face median guardrail and the concrete parapet.

Deliverables:

R1, to include the VoR
PSR
August MPR 2020
VoR
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$101,471.00	$81,176.80	$20,294.20

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-6992 **University:** TTI

Project Title: Traffic Safety Improvements at Low Water Crossings

Project Start Date: 9/1/2018 **Termination Date:** 1/31/2021

Project Status: Closed **Total Project Budget:** $581,328.00

RTI Project Manager: Chris Glancy **Researcher:** Chiara Silvestri Dobrovolny

Project Objectives: Texas has been reported to lead the nation in flood-related deaths, with the majority of deaths caused by motorists attempting to drive through moving water. Motorists might attempt to cross a flooded roadway not realizing its depth or, especially at nighttime during heavy storms that make it difficult to see that flooded road. The report established that it only takes 18-24 inches of moving water to sweep away a truck, and 6 inches to carry away a small car. Many accidents, rescues, and deaths occur at low water crossings, and most accidents occur at night. While it may be impractical to raise or remove all low water crossings across the state, there are low-cost means to better alert the driving public to the risks of low water crossings. The Performing Agency shall investigate low-cost approaches to improve low water crossings, with a focus on easy to install and maintain features, such as: 1) Reflective pavement markings and marker 2) Flood-detection sensors, 3) Active/passive warning devices, an 4) Infrastructure-to-Infrastructure (I2I) and Infrastructure-to-Vehicle (I2V) technologies.

Deliverables:

VoR
P1
R1A (includes TM10)
PSR
P2
August MPR 2020
R1B
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$55,920.00	$44,736.00	$11,184.00

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-6995 **University:** CTR

Project Title: Determine Use of Alternative Retroreflective Pavement Markers (RPMs) on Highways with Centerline Rumble Strips and Winter Weather Pavement Marking Improvements

Project Start Date: 9/1/2018 **Termination Date:** 8/31/2021

Project Status: Closed **Total Project Budget:** $326,509.58

RTI Project Manager: Jade Adediwura **Researcher:** Raissa Ferron

Project Objectives: The use of snow plows in northern Texas frequently results in loss of retroreflective pavement markers (RPMs). The loss of RPMs is not only costly, but also creates unsafe driving conditions during inclement weather. Pavement sections in these districts often use a center-line rumble strip for safety. Traditionally, these rumble strips have precluded the use of metal-encased RPMs (i.e., snow-plowable RPMs). This project evaluates two innovative approaches to arrive at a cost-effective and snow-plowable configuration for roadways containing rumble strips: (i) use of existing commercially available RPMs inset within the trough regions of rumble strips (referred to as rumble inserts) and (ii) use of polymers with reflective beads similar to raised stripes, except inside the rumble strip recess at the appropriate height required for safety (referred to as rumble stripe). The work plan explores variations of both options as well as possible design adjustments to accommodate retro reflection requirements while preventing loss of RPMs due to snow plows. This project evaluates all options for their reflective properties and resistance to the action of snow plows using a full-scale test section. The Performing Agency shall conduct a cost analysis and the results from full-scale testing evaluation shall be used to inform the Receiving Agency of the final recommendations.

Deliverables:

TM FY_2020
R2B
R2A
August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021
PSR
P1

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$131,845.34	$105,476.27	$26,369.07

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-6998 **University:** TTI

Project Title: Work Zone Traffic Engineering Strategies at Flagger Stations and Lane Closures

Project Start Date: 9/1/2018 **Termination Date:** 8/31/2021

Project Status: Closed **Total Project Budget:** $329,250.00

RTI Project Manager: Wade Odell **Researcher:** LuAnn Theiss

Project Objectives: In 2016, Texas had 153 fatal crashes in work zones. Of these 153 crashes, 33 percent were believed to be impacted by work zones and an additional 8 percent could have been impacted by work zones. Thus, the potential exists to prevent 63 work zone crashes per year in the state of Texas. The Receiving Agency has identified two areas where work zone safety could be improved: at flagger stations on two-lane, two-way facilities; and at stationary lane closures on multi-lane facilities. In both of these applications, there are situations where either a slowed or stopped vehicle is hit from behind by another vehicle because of failure to control speed or react in time. Consequently, temporary traffic control solutions are needed that alert approaching drivers in advance of the queue.The objectives of this research are to:(1) Identify and evaluate temporary traffic control devices and/or strategies that could potentially reduce the risk of queue end crashes in work zones, and(2) Develop guidelines for implementation by the Receiving Agency.

R1
PSR
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021

Deliverables:

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$29,250.00	$23,400.00	$5,850.00

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7018 **University:** TSU

Project Title: Development and Enhancement of In Service Performance Evaluation (ISPE) Process for Roadside Safety Devices

Project Start Date: 7/16/2019 **Termination Date:** 7/31/2021

Project Status: Closed **Total Project Budget:** $249,695.00

RTI Project Manager: Wade Odell **Researcher:** Fengxiang Qiao

Project Objectives: The purpose of roadside safety hardware is to reduce the risk of serious and fatal injuries to motorists in advertent road departures. Currently in Texas, the performance criteria of safety hardware, as having being detailed in MASH standards, are solely based on full-scale crash testing evaluation. The Receiving Agency does not have a formalized process to perform in-service performance evaluation (ISPE) of roadside safety features. It is crucial to monitor roadside safety devices on Texas highways to ensure proper functioning after installation. This project shall support the Receiving Agency with setting and evaluating its level of safety risk and use quantitative information in the decision making process.

Deliverables:
R1
PSR
August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
R1
PSR
August MPR 2020
September MPR 2020
October MPR 2020

May MPR 2021
June MPR 2021
July MPR 2021
TM4
TM4
P1

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$38,233.00	$30,586.40	$7,646.60

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7018 **University:** UH

Project Title: Development and Enhancement of In Service Performance Evaluation (ISPE) Process for Roadside Safety Devices

Project Start Date: 7/16/2019 **Termination Date:** 7/31/2021

Project Status: Closed **Total Project Budget:** $249,695.00

RTI Project Manager: Wade Odell **Researcher:** Fengxiang Qiao

Project Objectives: The purpose of roadside safety hardware is to reduce the risk of serious and fatal injuries to motorists in advertent road departures. Currently in Texas, the performance criteria of safety hardware, as having being detailed in MASH standards, are solely based on full-scale crash testing evaluation. The Receiving Agency does not have a formalized process to perform in-service performance evaluation (ISPE) of roadside safety features. It is crucial to monitor roadside safety devices on Texas highways to ensure proper functioning after installation. This project shall support the Receiving Agency with setting and evaluating its level of safety risk and use quantitative information in the decision making process.

Deliverables:
R1
PSR
August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
R1
PSR
August MPR 2020
September MPR 2020
October MPR 2020
May MPR 2021
June MPR 2021
July MPR 2021

TM4
TM4
P1

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$40,568.00	$32,454.40	$8,113.60

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7019 **University:** TTI

Project Title: Development of a MASH Test-Level 4 Compliant Guardrail

Project Start Date: 6/29/2019 **Termination Date:** 2/28/2021

Project Status: Closed **Total Project Budget:** $288,933.00

RTI Project Manager: Wade Odell **Researcher:** Nauman Sheikh

Project Objectives: Currently, there is a lack of public domain Manual for Assessing Safety Hardware (MASH) Test Level 4 (TL-4) guardrail systems, which involves testing the guardrail system with a single unit truck, a pickup truck, and a small passenger sedan. Several corridors in Texas are known to experience a larger percentage of freight and truck traffic. In these corridors, safety of the motoring public can greatly benefit from the use of a MASH TL-4 compliant guardrail system. Some concrete barrier designs are MASH TL-4 compliant; however, being significantly more expensive than metal beam guardrails, these designs are generally very cost prohibitive for large scale implementation. The Receiving Agency desires to develop a metal guardrail system that meets the testing requirement of MASH TL-4, In this project, the Performing Agency shall design and test a MASH TL-4 compliant metal guardrail system. The Performing Agency shall first develop three preliminary design concepts of the guardrail systems that are likely to meet MASH TL-4 requirements. The Project Team will select one of the three concepts for further development. The Performing Agency shall develop full-scale finite element models of the selected system and perform impact simulation under MASH TL-4 conditions. Using the results of these impact simulations, the Performing Agency shall make further improvements to the guardrail design and make recommendations for the final design for crash testing. The Performing Agency shall then construct the guardrail system and perform MASH Test 4-12 (with single unit truck), Test 4-11 (with pickup truck) and Test 4-10 (with small car) to meet the testing requirements for MASH compliance of the new guardrail system.

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
R1
PSR

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$148,571.00	$118,856.80	$29,714.20

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7020 **University:** TTI

Project Title: Develop Guidelines for Work Zone Barrier Use on Freeways

Project Start Date: 7/26/2019 **Termination Date:** 11/30/2020

Project Status: Closed **Total Project Budget:** $150,013.00

RTI Project Manager: Shelley Pridgen **Researcher:** Emira Rista

Project Objectives: Longitudinal continuous barriers are often used in long-term work zones on Texas freeways as a means to protect workers from the travelling public. Although their use provides clear safety benefits, their placement very near or at the edge of the travel lanes and for long stretches, can create difficulties in navigation for certain road users, especially large trucks and emergency personnel. Therefore, a need exists for understanding the state-of-the-practice pertaining to what specific features and factors are being used by work zone designers in positive protection use decision-making. Additionally, various stakeholders input needs to be gathered to determine the key issues these road users are experiencing when navigating through work zones. The objectives of this research are to:1) Conduct a crash investigation to identify crash contributing factors associated with work zone barrier use, 2) Conduct interviews with key construction personnel to identify the state-of-the-practice in barrier use and other design criteria for freeway work zones,3) Conduct interviews with trucking industry and law enforcement representatives to identify these road users perceived difficulties in travelling through various types of work zones with barriers, and 4) Develop a set of guidelines on work zone barrier use for implementation by the Receiving Agency.

Deliverables:

August MPR 2020
September MPR 2020
R1
PSR
VoR with related VoR spreadsheet
TM5
October MPR 2020
November MPR 2020

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$41,188.00	$32,950.40	$8,237.60

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7021 **University:** TTI

Project Title: Develop Enhanced Protection of Median Openings Between Parallel Bridge Structures

Project Start Date: 6/28/2019 **Termination Date:** 7/31/2021

Project Status: Closed **Total Project Budget:** $497,267.75

RTI Project Manager: Martin Dassi **Researcher:** James Kovar

Project Objectives: When divided highways span over a hazard, engineers often design two separate bridges with the ends protected by guardrail installations. However, the opening between the parallel bridge structures may result in a gap in roadside protection. The combination of the sloped median ditch and the approach guardrail can direct errant motorists between the two bridge structures and into the underlying hazard. The risk increases when the spanned hazard is another roadway with motorists traveling below the parallel bridges. Unfortunately, these median openings have resulted in fatal crashes in Texas and across the country. For example, the National Transportation Safety Board has investigated a motorcoach crash between two parallel bridge structures near Loxley, Alabama that resulted in one fatality and 46 injuries. This median opening is a roadside safety issue that deserves further attention. The Performing Agency shall address this safety issue as follows: ○ Develop a median opening protection system (MOPS) that prevents errant motorists from crashing between two parallel bridge structures:

- Identify characteristics of high-risk locations that can benefit from implementation of a MOPS,
- Develop a solution from currently available technologies, and
- Evaluate the MOPS with full-scale crash testing.

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
TM5
R1A (To include VoR, Tm6 and TM7
R1B (Updated R1, to include VoR, Tm6 and TM7
PSR
May MPR 2021
June MPR 2021
July MPR 2021

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$155,965.75	$124,772.60	$31,193.15

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7035 **University:** TTI

Project Title: Examine Trade-Offs Between Center Separation and Shoulder Width Allotment for a Given Roadway Width

Project Start Date: 7/19/2019 **Termination Date:** 8/31/2021

Project Status: Closed **Total Project Budget:** $258,085.00

RTI Project Manager: Tom Schwerdt **Researcher:** Srinivas Geedipally

Project Objectives: The purpose of this project is to provide a practical framework that the Receiving Agency can use to choosebetween cross-sectional design alternatives to optimize operational and safety performanceon rural highways. This framework will incorporatevariables such as traffic volume, heavy vehicle mix, speed, and access point density.Studies have shown that four-lane undivided roadways have poor safety performance compared to four-lane divided and two-lane cross-sections. Four-lane undivided rural highwaysexperience relatively high crash frequencies —especially as traffic volumes increase—resulting in conflicts withhigh-speed opposite-directionvehicles.However, there is not always sufficient space within the available right-of-way to accommodate a traditional four-lane divided cross-section. Some states, including Texas, have started providing a narrowcenterline buffer area that is separated by longitudinal pavement markings. This additional buffer area shifts the lateral placement of vehicles and introduces a greaterphysical separation between approaching vehicles. However, the provision of centerline buffer comes at a cost of reduced lane or shoulderwidths. A better understanding of the benefits of centerseparation, laneand shoulder combinations would provide useful information to designers who make decisions on cross-sections for new and resurfaced roadway segments.The Performing Agency shall collect and analyze data for four-lane sites with centerline buffersand compare their safety and operational performanceswith traditional four-lane undivided sites. Additionally, this research shall quantify the differences in the performance offour-lane undivided highways when compared to other cross-sectionaldesigns. The Performing Agency shall use observed data and simulation to achieve the project objectives.

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
TM3
R1
TM4
TM5
PSR
VoR
May MPR 2021
June MPR 2021
July MPR 2021

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$119,019.00	$95,215.20	$23,803.80

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7046 **University:** TTI

Project Title: Developing Guide Signing for Long Term Work Zones

Project Start Date: 11/1/2019 **Termination Date:** 10/31/2020

Project Status: Closed **Total Project Budget:** $150,000.00

RTI Project Manager: Tom Schwerdt **Researcher:** LuAnn Theiss

Project Objectives: Part 6 of the Texas Manual on Uniform Traffic Control Devices provides standards and guidance for work zone devices, including signing. Section 6F.55 states that temporary guide signs shall have a black legend on an orange background. In 2017, the Receiving Agency issued new standard sheets for Temporary Large Roadside Signs, including details on how to construct crashworthy skids for large guide signs. In practice, a variety of temporary large guide sign designs are seen on long term construction projects on freeways. A variety of fonts, font sizes, sign sizes, route marker plaque designs and text designations, arrow designs, and placement standards are seen. Many of these projects last for multiple years. Suggested sign design and placement recommendations are needed to create uniformity for the traveling public. In addition to freeway guide signs, temporary guide signs on conventional highways are sometimes needed as well. The main benefit of this research will be improved operations thru work zones as drivers will be better able to identify their required exit or turn and maneuver into the correct lane in advance. This will lead to reduced crashes in work zone areas.The objective of this research is to develop recommendations for long term work zone guide sign design and placement to create uniformity for the traveling public.

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020
R1
PSR
P1 (Webinar)

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$20,582.00	$16,465.60	$4,116.40

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7085 **University:** CTR

Project Title: Synthesis: Develop Outdoor Advertising Control Reference Manual for TxDOT

Project Start Date: 9/1/2020 **Termination Date:** 8/31/2021

Project Status: Closed **Total Project Budget:** $64,999.95

RTI Project Manager: Shelley Pridgen **Researcher:** Lisa Loftus Otway

Project Objectives: The control of outdoor advertising (OAC) by the Receiving Agency has been self-assessed to be insufficient to fulfil the federal mandate and places in jeopardy federal funding to the Receiving Agency's highway funds. The control of OAC has a long history, case law, and a strong lobbying community both for and against outdoor advertising signs, which add complexity and nuance in setting out policies for "effective control". To assist in providing guidance on best practices regarding effective control, the Performing Agency shall conduct a synthesis review of the state of the practice in OAC across the U.S. More specifically, the Performing Agency shall conduct a survey of states; conduct targeted interviews and review language, statute and case law to identify policies, regulations and procedures that are effective. The Performing Agency shall also review Texas statutes and regulations, Receiving Agency's internal policies and procedures and the practices of cities delegated authority to control outdoor advertising by the Receiving Agency. The output for this synthesis project shall be a final report with best practices and recommendations to provide a successful model of regulation baseline for program compliance as described in detail below.

Deliverables:

September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021
R1
VOR
COV
VSR
PSR
TM2
TM3
TM4
TM5
TM6
P1 (Reference Manual)

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$64,999.95	$51,999.96	$12,999.99

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Table 12. Safety and Operations Totals for Closed Projects

Financials	FY21 Budget	FY21 Expended	FY 21 Balance
Federal 80%	$792,775.23	$726,064.00	$66,711.23
State 20% TDC*	$198,193.81	$181,516.00	$16,677.81
Total	$990,969.04	$907,580.00	$83,389.04

2.1.6 Strategy and Innovation

Project Number: 0-6999 **University:** CTR

Project Title: Preparing and Utilizing Emerging Technologies and Innovative Research in Transportation

Project Start Date: 9/1/2018 **Termination Date:** 9/30/2020

Project Status: Closed **Total Project Budget:** $899,406.31

RTI Project Manager: Shelley Pridgen **Researcher:** Michael Walton

Project Objectives: To ensure the Receiving Agency remains at the forefront of transportation, the Performing Agency shall organize a cross-functional body of transportation thought leaders and subject matter experts (SMEs), forming a task force dedicated to transportation technology, to equip the Receiving Agency with the essential strategy, innovation, and communication tools. Key deliverables include white papers on critical technologies, an Emerging & Advanced Technology Portfolio, and a Technology Utilization Plan that will serve as the fulcrum between technology discovery and implementation. The Receiving Agency will benefit from insights into industry trends, partnership opportunities, and potential areas for research, as well as strategic deployments, in order to develop its transportation innovation strategy.

Deliverables:

September MPR 2020
TM6.2
PSR
August MPR 2020

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$43,930.11	$35,144.09	$8,786.02

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Table 13. Strategy and Innovations Totals for Closed Projects

Financials	FY21 Budget	FY21 Expended	FY21 Balance
Federal 80%	$35,144.09	$22,463.03	$12,681.06
State 20% TDC*	$8,786.02	$5,615.76	$3,170.26
Total	**$43,930.11**	**$28,078.79**	**$15,851.32**

2.2 Continuing Projects

RTI monitored sixty-one (61) active research projects that are scheduled to continue beyond FY 2021.

The objectives of these projects are for the development and application of advanced technology, new knowledge, and improved methods and procedures. Fulfilling these objectives is critical to future TxDOT service quality and operational cost-effectiveness.

This research also:

- Contributes to the high quality of Texas transportation facilities and services.
- Assists the state in meeting needs created by growth and changing technologies.
- Attracts university students working on TxDOT research projects to TxDOT careers upon graduation.
- Ensures that high-quality transportation talent is available in Texas.
- Ensures that transportation research funds are available to Texas universities to maintain the high quality of education at those institutions.

The following are descriptions of projects that were active in FY 2021 and continue into the next fiscal year(s).

2.2.1 Construction and Maintenance

Project Number: 0-6923 **University:** UTEP

Project Title: Develop Guidelines and Design Program for Hot-Mix Asphalts Containing RAP, RAS, and Other Additives through a Balanced Mix-Design Process

Project Start Date: 6/22/2016 **Termination Date:** 8/31/2022

Project Status: Active **Total Project Budget:** $959,250.00

RTI Project Manager: Tom Schwerdt **Researcher:** Soheil Nazarian

Project Objectives: The Performing agency shall provide the Receiving Agency with an Asphalt Concrete (AC) mix design program and guidelines to determine the optimum recycled asphalt pavement (RAP), recycled asphalt shingles (RAS), and additives content for designing balanced mixes without compromising the quality and performance of the final product. During this project, the Performing Agency shall: 1. Evaluate current mix designs, design processes and guidelines for use of RAP, RAS, and additives on AC mixes in Texas and worldwide to identify weaknesses and strengths of current practices for balanced mix designs involving RAP, RAS, and other additives. 2. Gather laboratory and field performance of sections studied under Research Project 0-6679. These sections are identified as historical and in-service sections (sections to be determined by Receiving Agency) constructed with and without RAP, RAS, and additives. 3. Determine correlation of laboratory results to pavement sections studied under Research Project 0-6679 (chosen by Receiving Agency) using performance indicators from tests such as the overlay tester (OT) and Hamburg wheel tracking device (HWTD) and strength parameters like the Indirect Tensile strength from past research projects to implement a protocol for a balanced cracking and rutting resistant mix containing RAP, RAS, and other additives. 4. Evaluate at least 15mixes used by Receiving Agency through a factorial experiment to assess the influence of RAP, RAS, and additives on the performance of balanced Hot Mix Asphalt (HMA) mixes.
5. Evaluate the feasibility of an AC mix design process that not only consider the raw and recycled materials but also incorporates the structural design of the pavement section to reliably characterize the

performance of the designed AC mix. 6. Develop a design program for Receiving Agency pavement designers and engineers to determine the optimum RAP, RAS, and additive contents on AC mixes with varying aggregate type, asphalt content and grade and (if feasible) structural design of the pavement.

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021
TM12 and Process Training Materials

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$149,450.00	$119,560.00	$29,890.00

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7001 **University:** CTR

Project Title: Utilizing Steel Fibers as Concrete Reinforcement in Bridge Decks

Project Start Date: 5/17/2019 **Termination Date:** 12/31/2022

Project Status: Active **Total Project Budget:** $1,082,759.78

RTI Project Manager: Joanne Steele **Researcher:** Oguzhan Bayrak

Project Objectives: The Performing Agency shall perform work aimed toward the development of steel fiber reinforced concrete (SFRC) mix designs and optimized top mat reinforcement detailing for use in fiber-reinforced cast-in-place (CIP) slabs constructed on top of stay-in-place precast concrete panels (PCP). The findings from this research shall be developed through the performance of targeted SFRC mixture design and material testing activities, numerical modeling activities used to assess SFRC CIP-PCP bridge deck structural performance, and the execution of idealized and full-scale SFRC bridge deck structural testing programs to validate the suitability of the crack control and load carrying abilities of proposed SFRC CIP slab design recommendations.

Deliverables:

TM2.2
August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$292,244.48	$233,795.58	$58,448.90

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7002 **University:** CTR

Project Title: Evaluation of Geogrids for Asphalt Pavement Construction

Project Start Date: 5/14/2019 **Termination Date:** 8/31/2024

Project Status: Active **Total Project Budget:** $1,194,503.05

RTI Project Manager: Jade Adediwura **Researcher:** Jorge Zornberg

Project Objectives: Geogrids have been used in several Receiving Agency Districts to reinforce Hot-Mix Asphalt (HMA) with the objective of minimizing reflective cracking. Recent field evaluations have revealed that polymeric geogrids within HMA resulted in an additional promising benefit; increasing structural capacity and consequently reducing the required thickness of hot-mixoverlays. Despite strong field evidence, important questions remain concerning proper geogrid selection criteria for this new application, what properties to specify, and how to quantify the increased structural capacity. The Performing Agency shall: (1) evaluate different types of polymeric and glass geogrids; (2) instrument field test sections along SH21 to validate constructability and assess long-term field performance; and (3) translate the research findings into practical specifications.

Deliverables:

TM3
August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$240,534.84	$192,427.87	$48,106.97

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7005 **University:** CTR

Project Title: Develop Decision Tree Incorporating Surface Conditions

Project Start Date: 7/31/2019 **Termination Date:** 11/30/2021

Project Status: Active **Total Project Budget:** $349,522.00

RTI Project Manager: Shelley Pridgen **Researcher:** Jorge Prozzi

Project Objectives: Pavement Analyst (PA) has enhanced the effectiveness and efficiency in the planning, construction, and management of the state highway infrastructure. PA helps make informed and objective decisions about maintenance and rehabilitation activities. Historically, these decisions have been based on structural conditions (e.g., condition, ride and/or distress scores). This project shall define and incorporate surface condition elements (i.e., macrotexture, microtexture, friction, skid number, cross-slope, etc.) in the decision trees to improve safety conditions when low levels are detected, particularly in areas that have been identified as problematic.

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021
TM3
TM4
TM5
P1

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$138,619.00	$110,895.20	$27,723.80

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7006 **University:** TTI

Project Title: Design, Construction, and Performance Monitoring of Stabilization of Expansive Soils and Cement

Project Start Date: 4/24/2019 **Termination Date:** 8/31/2023

Project Status: Active **Total Project Budget:** $1,199,145.00

RTI Project Manager: Jade Adediwura **Researcher:** Dar Hao Chen

Project Objectives: The Receiving Agency is actively looking for alternatives to stabilize expansive soils and cement treated bases with polypropylene fiber. Polypropylene fiber, hereafter is referred to as fiber. Many areas in Texas have problems stabilizing expansive soils with traditional stabilizers (i.e. lime, cement, fly ash, or in combination) because of the high levels of sulfates in the soil. Many major pavement failures have occurred due to lime/cement induced sulfate heaves. In addition, reflection cracks from cement treated bases have been reported in numerous projects. Expansive soils have caused extensive pavement heaves, bumps and longitudinal cracks. The repetitive shrinking and swelling is responsible for the development of cracks, heaves and bumps on Texas roads. Roadway surface cracks allow water intrusion which degrades underlying pavement layers, and prematurely fails the pavement structure. Surface heaves and bumps are a driver safety issue. Cracks, heaves, and bumps are extremely expensive to repair over the life of the pavement, and it would be more economical and safer to the public to mitigate their occurrences during construction. Previous research results indicate that the fiber-reinforced cement treated bases has shown to increase performance. Significant improvements in both shear and compressive strengths, as well as flexibility, have been reported in fiber reinforced soils and fiber reinforced cement treated bases. Also, fiber reinforced clays and sands were able to reduce volumetric shrinkage strains and swell pressures. It is expected that these types of improvements would directly mitigate the aforementioned distresses. There are huge potential benefits of applying polypropylene fiber to stabilize expansive soils and cement treated bases to (1) increase strength, (2) reduce shrinkage potential, (3) reduce chemical stabilizer content, and (4) increase flexibility/ductility. There is a critical need to incorporate fiber in the Receiving Agency's "Modification and Stabilization of Soils and Base for Use in Pavement Structures" guidelines. Therefore, this study will develop appropriate laboratory test methods to evaluate mix designs for (1) fiber reinforced cement treated

base, (2) fiber reinforced clay, and (3) fiber reinforced sandy soil. In addition, this study will provide assistances to Receiving Agency Districts to develop optimum fiber application rates and establish specifications and construction QC/QA plans for uniform mixing. The Performing Agency shall conduct laboratory tests to determine optimum fiber application rates for cement treated base and 6 different subgrade soils: (1) PI < 15, (2) 15 ≤ PI < 35, (3) PI ≥ 35, (4) sulfate concentration > 3000 ppm but ≤ 8000 ppm, (5) sulfate concentration > 8000 ppm, and (6) organics content exceeds 1%. Over the last few years, the Receiving Agency has successfully constructed several Full Depth Recycling (FDR) sections with foamed asphalt using innovative reclaiming equipment. One key issue that the Performing Agency shall address in this study is an evaluation of the mix technologies that ensure fibers are mixed uniformly in the field. The Performing Agency shall use the Wirtgen Reclaimer as the initial device for mixing fibers into the material being stabilized. The Performing Agency shall progress to other common construction equipment and processes to achieve the optimum mixing results. This study shall investigate innovative Nondestructive Testing (NDT) tools to (1) assist site characterization, (2) select candidate test sections, (3) identify sampling locations, (4) provide input on mix design process, (5) provide Input during QC/QA process, and (6) monitor field performance of the test section. The Performing Agency shall document the optimal construction techniques and identify time and cost savings.

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021
TM-2
TM-3
TM-5

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$283,174.25	$226,539.40	$56,634.85

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7025 **University:** TTI

Project Title: Develop Surface Aggregate Classification of Reclaimed Asphalt Pavement

Project Start Date: 6/28/2019 **Termination Date:** 4/30/2022

Project Status: Active **Total Project Budget:** $377,280.00

RTI Project Manager: Tom Schwerdt **Researcher:** Fujie Zhou

Project Objectives: The use of Surface Aggregate Classification A (SAC-A) aggregates has increased significantly to over 1.9 million tons annually to meet the friction demand of pavements. The challenge to the Receiving Agency, is to develop specifications, methods, and means to conserve our existing SAC-A resources. The goal of this project is to determine if potential exists to conserve SAC-A resources by adding friction value to reclaimed asphalt pavements (RAP) while not having any detrimental effects with mix quality. This project will synthesize the state-of-the practice for use of RAP in surface mixes and associated skid resistance and durability. This project will also evaluate field test sections to identify how RAP affects skid resistance. Furthermore, this project will select and characterize multiple RAPs and then evaluate the impact of different RAP types and amount on both skid resistance and durability of different types asphalt mixes. Based on the results of both laboratory and field works, this project will develop SAC rating for RAP and guidelines for using RAP in surface mixes. To foster technology transfer, this project will develop a training presentation and perform two (2) workshops to the Receiving Agency engineers.

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021

TM3
TM4
TM5

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$137,765.00	$110,212.00	$27,553.00

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7026 **University:** TECH

Project Title: Optimizing Reinforcing Steel in 12-inch and 13-inch Continuously Reinforced Concrete Pavement (CRCP)

Project Start Date: 8/14/2019 **Termination Date:** 8/31/2022

Project Status: Active **Total Project Budget:** $501,031.00

RTI Project Manager: Joanne Steele **Researcher:** Moon Won

Project Objectives: The distresses observed lately in thick CRCP sections in Texas are quite different from typical distress types that have long been recognized in CRCP – namely punchouts and spalling. The new distress type is characterized by segmentation of slabs at transverse cracks, generally under the wheel paths. Forensic investigations conducted to identify the cause(s) of those distresses indicate delamination of the slab at the depth of longitudinal steel. It appears that thicker slabs with longitudinal steel placed at mid-depth of the slab result in longer transverse crack spacing, which increases warping stresses. The increased warping stresses in concrete induce horizontal cracking at the steel depth, and wheel loading applications in this area cause segmentation of the upper half of concrete slabs, resulting in serious distresses. This project shall investigate the mechanism of this distress type, and develop optimum steel designs. The investigation shall consist of evaluating structural responses of CRCP through theoretical analyses as well as field experiments where various steel designs (different steel depths for one-mat and configurations for two-mat) are employed. The results of data analyses from both mechanistic analyses and field experiments will be used to develop optimum steel designs in CRCP.

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021

July MPR 2021
ITM-3
TM-3

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$175,675.00	$140,540.00	$35,135.00

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7027 **University:** TTI

Project Title: Accelerating Mix Designs for Base Materials

Project Start Date: 7/10/2019 **Termination Date:** 10/31/2023

Project Status: Active **Total Project Budget:** $689,885.00

RTI Project Manager: Martin Dassi **Researcher:** Stephen Sebesta

Project Objectives: Stabilization of roadway or stockpile materials allows for enhancing strength and stiffness properties of pavement base layers to meet structural requirements in a cost-effective and sustainable manner. Historically, stabilization mixture design criteria relied on compressive strength results and, depending on the treatment and test method, could take nearly a month to complete. Additionally, the different treatments currently require different preparation, curing, and acceptance criteria. This project will develop a harmonized accelerated design procedure for base materials with the objective of producing an acceptable design recommendation within seven (7) days. This project will include stabilizer types such as cement, lime, lime-fly-ash, asphalt emulsion, and foamed asphalt, and will focus on rapid test turnaround time, lab curing techniques to rapidly simulate cured field conditions, inclusion of moisture susceptibility in the mix design, and performance-related design criteria. This project will develop recommended harmonized test procedures, suggested specification modifications as applicable, and perform training workshops.

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021
TM3
TM4

P2 Test Procedure and Specifications

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$126,869.25	$101,495.40	$25,373.85

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7028 **University:** CTR

Project Title: Capitalizing on Construction Records to Identify Relationships between Construction and Long-Term Project Performance

Project Start Date: 9/1/2019 **Termination Date:** 12/31/2021

Project Status: Active **Total Project Budget:** $367,510.80

RTI Project Manager: Tom Schwerdt **Researcher:** Zhanmin Zhang

Project Objectives: As part of its quality control and quality assurance (QC/QA) process, Receiving Agency maintains pavement-related data in several databases: mixture design and QC/QA data in SiteManager (SMGR); construction, bid, and project related information in the Design and Construction Information System (DCIS); pavement performance history in the Pavement Management Information System (PMIS); and maintenance activities in Compass or Maintenance Management Information System (MMIS). Even though a significant amount of data and information are available in these databases, the effect of material design factors and QC/QA efforts on the long-term project performance is not well understood. The primary objective of this project is to investigate the relationship between the Receiving Agency's material design specifications, QC/QA effort, and long-term pavement performance. The Performing Agency shall first extract relevant data from the Receiving Agency databases and integrate them into an efficient internal working database for conducting analyses under this research. Various data analysis techniques shall be employed to explore relationships between the construction records and pavement performance. Findings from the data analysis shall be validated through site visits and discussions with local experts from the Receiving Agency. Finally, recommendations and modifications shall be developed for the Receiving Agency to improve its existing construction practices.

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021
TM3
TM4

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$156,406.10	$125,124.88	$31,281.22

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7031 **University:** CTR

Project Title: Develop Efficient Prediction Model of Highway Friction on an Annual Basis on Texas Network

Project Start Date: 9/27/2019 **Termination Date:** 12/31/2021

Project Status: Active **Total Project Budget:** $348,740.00

RTI Project Manager: Shelley Pridgen **Researcher:** Jorge Prozzi

Project Objectives: Texas roads see a significant number of wet-weather crashes; therefore, ensuring adequate skid resistance (skid number) is of utmost importance for public safety. Recent laser technology allows quick, efficient, and high-resolution skid resistance measurement. However, contractors collect macrotexture only in terms of mean profile depth—a poor predictor of skid. Consequently, Receiving Agency personnel have to collect the additional skid data necessary, covering about 33% of the network on an annual basis (approximately 50% of the Interstate System and 25% of the non-Interstate system). This project shall develop an instrument that can collect high-resolution surface profiles to determine macrotexture and microtexture under different conditions and on different surface types. This information will be used to develop equations to predict friction and skid numbers with a high degree of accuracy. This instrument shall be able to collect data at highway speed, allowing accurate texture data collection on the entire network on an annual basis. Because this instrument will be small enough to attach to any surveying vehicle, texture data can be collected as part of other operations, eliminating the need for an independent data collection effort. This will provide not only savings but also enhance operational safety.

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021

June MPR 2021
July MPR 2021
TM3

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$134,527.00	$107,621.60	$26,905.40

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7057 **University:** CTR

Project Title: Develop Guidelines for Precoating Aggregates of Seal Coat

Project Start Date: 12/23/2019 **Termination Date:** 8/31/2022

Project Status: Active **Total Project Budget:** $391,695.64

RTI Project Manager: Tom Schwerdt **Researcher:** Amit Bhasin

Project Objectives: The Performing Agency shall examine the factors related to precoating of aggregates that influence the quality of seal coats, and use this information to provide guidelines for the Receiving Agency's engineers.

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021
TM2
TM3

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$155,096.96	$124,077.57	$31,019.39

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7058 **University:** CTR

Project Title: Development of a Performance Related Test for Designing Seal Coats

Project Start Date: 1/13/2020 **Termination Date:** 8/31/2022

Project Status: Active **Total Project Budget:** $391,695.67

RTI Project Manager: Tom Schwerdt **Researcher:** Amit Bhasin

Project Objectives: The Performing Agency shall conduct literature review, identify and/or develop test methods for seal coat material compatibility and establish testing protocols, and propose final test method and acceptance criteria.

Deliverables:

TM2
TM3
August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$154,918.21	$123,934.57	$30,983.64

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7060 **University:** CTR

Project Title: Measuring Faulting on Jointed Concrete Pavements

Project Start Date: 12/17/2019 **Termination Date:** 8/31/2022

Project Status: Active **Total Project Budget:** $499,769.03

RTI Project Manager: Jade Adediwura **Researcher:** Jorge Prozzi

Project Objectives: On an annual basis, the Receiving Agency collects most of its required distress information through a contracted vendor. However, faulting, one of the essential distresses, is estimated from longitudinal profile data, which is neither reliable nor accurate enough for establishing performance measures. Recent reforms enacted by MAP-21 (Moving Ahead for Progress in the 21st Century Act) include transitioning to a performance-based program, including establishing national performance goals for Federal-aid highway programs. The FAST Act (Fixing America's Surface Transportation Act) continues this performance management approach, within which states invest resources in projects that collectively shall make progress toward national goals. The FAST Act shortens the timeframe for states and metropolitan planning organizations to make progress toward meeting performance targets under the National Highway Performance Program and clarifies the significant progress timeline for the Highway Safety Improvement Program performance targets. It is under this framework that the Performing Agency shall develop a reliable measurement system to identify, measure, and calculate faulting on all jointed concrete pavements(JCP). In particular, this project has the objective of developing a system to collect and verify faulting data of JCP in an accurate manner at highway speeds during daylight conditions. This project shall deliver end products to meet a TRL Level 8.

Deliverables:

TM3
TM4
August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$195,175.77	$156,140.62	$39,035.15

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7061 **University:** CTR

Project Title: Optimizing Laboratory Curing Conditions for Hot Mix Asphalt to Better Simulate Field Behavior

Project Start Date: 12/9/2019 **Termination Date:** 1/31/2023

Project Status: Active **Total Project Budget:** $900,499.16

RTI Project Manager: Tom Schwerdt **Researcher:** Soheil Nazarian

Project Objectives: The Performing Agencies shall investigate existing and novel laboratory methods to determine protocols that simulate the two critical aging states needed to design an asphalt mixture to resist rutting and cracking, and provide information on how curing effects the physical and engineering performance of binders and mixtures.The Performing Agencies shall provide findings that can be used to cure asphalt mixtures as their rutting and cracking resistance is being evaluated as a part of a mix design process (e.g.,as in the case of a balanced mix design).

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021
ITM4
TM4
TM5

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$123,447.85	$98,758.28	$24,689.57

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7061 **University:** UTEP

Project Title: Optimizing Laboratory Curing Conditions for Hot Mix Asphalt to Better Simulate Field Behavior

Project Start Date: 12/9/2019 **Termination Date:** 1/31/2023

Project Status: Active **Total Project Budget:** $900,499.16

RTI Project Manager: Tom Schwerdt **Researcher:** Soheil Nazarian

Project Objectives: The Performing Agencies shall investigate existing and novel laboratory methods to determine protocols that simulate the two critical aging states needed to design an asphalt mixture to resist rutting and cracking, and provide information on how curing effects the physical and engineering performance of binders and mixtures.The Performing Agencies shall provide findings that can be used to cure asphalt mixtures as their rutting and cracking resistance is being evaluated as a part of a mix design process (e.g.,as in the case of a balanced mix design).

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021
ITM4
TM4
TM5

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$168,000.00	$134,400.00	$33,600.00

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7064 **University:** TTI

Project Title: Use of Tamper Bar Paver to Place Thick Lift Asphalt Concrete Pavement (ACP)

Project Start Date: 12/6/2019 **Termination Date:** 6/30/2022

Project Status: Active **Total Project Budget:** $412,634.00

RTI Project Manager: Tom Schwerdt **Researcher:** Bryan Wilson

Project Objectives: Asphalt concrete placement specifications have maximum allowable lift thicknesses to ensure adequate mixture compaction. When the design thickness exceeds this limit, placement must be phased in multiple lifts, creating other problems:

- Increased construction time, traffic exposure, and traffic disruption
- Potentially worse performance from poor stiffness/bonding at the lift interface. In 2018, an Atlanta District contractor experimented with a tamper bar paver for single-lift placement of Superpave Type C at four (4) to six (6) inches thick. Both the top and bottom of the lift had acceptable air void contents. Further study of tamper bar pavers for thick-lift construction is warranted. The Performing Agency shall:
  1) Review the literature for performance of tamper bar pavers in thick-lift placement and recommended maximum lift-thicknesses.
  2) Develop a field-based testing plan that considers different construction scenarios, paver types, number of lifts, total thickness, tamper bar settings, and roller patterns.
  3) Construct test sections and evaluate in-place air voids with traditional methods and innovative methods like full-coverage Ground Penetrating Radar (GPR) based density testing and Computed Tomography (CT) X-ray scanning. Also evaluate pavement profile roughness, and stiffness and cracking performance of cores.
  4) Statistically analyze the data.
  5) Develop guidelines for the use of tamper bar pavers, highlighting best practices and limitations.

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021
TM4

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$131,235.00	$104,988.00	$26,247.00

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7070 **University:** CTR

Project Title: Develop Guidelines and Best Practices for Bonding Hot-Mix Asphalt Portland Cement Concrete Pavement

Project Start Date: 9/1/2020 **Termination Date:** 8/31/2022

Project Status: Active **Total Project Budget:** $310,076.62

RTI Project Manager: Tom Schwerdt **Researcher:** Amit Bhasin

Project Objectives: Asphalt overlaid on concrete pavements can result in bond failures that are likely due to one or more factors (e.g. properties of the tack coat, application rate of the tack coat, the type and texture of the concrete layer). The goal of this study is to identify, develop, and validate a test method that can be used on a routine basis to screen and/or field-test the quality of the bond between the asphalt and the concrete layer; use the method to evaluate the impact of various factors on the performance of the bond including but not limited to type of tack coat or membrane, application rate, surface texture (including cost-effective and innovative ways to prepare concrete surfaces), surface moisture, and concrete material type; and propose guidelines for future selection of surface preparation techniques and materials that meet the requirements for adequate bonding at the interlayer surfaces. The work plan builds on expertise from the areas of concrete and asphalt pavements and materials. The work plan also includes forensic analysis of recent failures and evaluation of future sites, as well as detailed analytical and numerical modeling of different scenarios to reinforce the findings and deliverables from this study.

Deliverables:
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021

TM2
TM3

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$129,734.73	$103,787.78	$25,946.95

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7070 **University:** UTSA

Project Title: Develop Guidelines and Best Practices for Bonding Hot-Mix Asphalt Portland Cement Concrete Pavement

Project Start Date: 9/1/2020 **Termination Date:** 8/31/2022

Project Status: Active **Total Project Budget:** $310,076.62

RTI Project Manager: Tom Schwerdt **Researcher:** Amit Bhasin

Project Objectives: Asphalt overlaid on concrete pavements can result in bond failures that are likely due to one or more factors (e.g. properties of the tack coat, application rate of the tack coat, the type and texture of the concrete layer). The goal of this study is to identify, develop, and validate a test method that can be used on a routine basis to screen and/or field-test the quality of the bond between the asphalt and the concrete layer; use the method to evaluate the impact of various factors on the performance of the bond including but not limited to type of tack coat or membrane, application rate, surface texture (including cost-effective and innovative ways to prepare concrete surfaces), surface moisture, and concrete material type; and propose guidelines for future selection of surface preparation techniques and materials that meet the requirements for adequate bonding at the interlayer surfaces. The work plan builds on expertise from the areas of concrete and asphalt pavements and materials. The work plan also includes forensic analysis of recent failures and evaluation of future sites, as well as detailed analytical and numerical modeling of different scenarios to reinforce the findings and deliverables from this study.

Deliverables:

September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021

TM2
TM3

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$25,000.00	$20,000.00	$5,000.00

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7072 **University:** TXST

Project Title: Improve Data Quality for Automated Pavement Distress Data Collection

Project Start Date: 9/8/2020 **Termination Date:** 8/31/2023

Project Status: Active **Total Project Budget:** $449,720.00

RTI Project Manager: Jade Adediwura **Researcher:** Feng Wang

Project Objectives: Accuracy and precision issues associated with the reliability of the existing automated and semi-automated pavement condition data collection methods have existed since inception with the Receiving Agency. This research shall develop data quality assurance guidelines for the Receiving Agency to improve the quality of automated pavement condition data. The three components in the research are the development of an audit sampling method, a set of consistency check criteria for pre-analysis of new data, and data quality criteria in acceptance of new data. A pilot study for a selected Receiving Agency District shall be completed with the developed guidelines to evaluate the effectiveness of the proposed data quality assurance procedures for data quality improvement.

Deliverables:

TM2
TM3
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$36,009.43	$28,807.54	$7,201.89

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7073 **University:** CTR

Project Title: Improving Testing Requirements in Item 300 Of TxDOT Standard Specifications

Project Start Date: 9/1/2020 **Termination Date:** 8/31/2023

Project Status: Active **Total Project Budget:** $580,000.00

RTI Project Manager: Tom Schwerdt **Researcher:** Amit Bhasin

Project Objectives: The Receiving Agency's standard specification Item 300, Asphalts, Oils, and Emulsions, includes more than 48 different test procedures or conditioning procedures for asphalt concrete (AC) graded binders (12), cutbacks (8), emulsified binders (17), and performance-graded (PG) binders (11) used in different pavement construction and maintenance applications. This does not include testing requirements for recycling agents, crack sealants, or asphalt rubber binder. The Receiving Agency regularly performs many of these tests for quality management or quality assurance purposes. This test schedule presents a challenge for the binder lab in terms of maintaining test procedures, acquiring and maintaining test equipment, calibrating equipment, and training personnel. Some specification tests are legacy tests that once were the state-of-the-art and thought to be related to asphalt binder performance. Many of these legacy tests are not used in more recently developed specifications, as other tests are now available and may be more indicative of performance. This project seeks to review the Receiving Agency's Item 300 binder specifications and tests for relevance; determine whether they assess safety, performance, or constructability; and take into account accuracy, efficiency, and environmental considerations. The project shall also make recommendations for changes.

Deliverables:

TM1
TM2
TM3
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$97,548.83	$78,039.06	$19,509.77

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7073 **University:** TTI

Project Title: Improving Testing Requirements in Item 300 Of TxDOT Standard Specifications

Project Start Date: 9/1/2020 **Termination Date:** 8/31/2023

Project Status: Active **Total Project Budget:** $580,000.00

RTI Project Manager: Tom Schwerdt **Researcher:** Amit Bhasin

Project Objectives: The Receiving Agency's standard specification Item 300, Asphalts, Oils, and Emulsions, includes more than 48 different test procedures or conditioning procedures for asphalt concrete (AC) graded binders (12), cutbacks (8), emulsified binders (17), and performance-graded (PG) binders (11) used in different pavement construction and maintenance applications. This does not include testing requirements for recycling agents, crack sealants, or asphalt rubber binder. The Receiving Agency regularly performs many of these tests for quality management or quality assurance purposes. This test schedule presents a challenge for the binder lab in terms of maintaining test procedures, acquiring and maintaining test equipment, calibrating equipment, and training personnel. Some specification tests are legacy tests that once were the state-of-the-art and thought to be related to asphalt binder performance. Many of these legacy tests are not used in more recently developed specifications, as other tests are now available and may be more indicative of performance. This project seeks to review the Receiving Agency's Item 300 binder specifications and tests for relevance; determine whether they assess safety, performance, or constructability; and take into account accuracy, efficiency, and environmental considerations. The project shall also make recommendations for changes.

Deliverables:

TM1
TM2
TM3
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$100,000.00	$80,000.00	$20,000.00

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7074 **University:** CTR

Project Title: Increase the Allowable Content of Recycled Crushed Concrete Fine Aggregate in Class P Concrete

Project Start Date: 9/1/2020 **Termination Date:** 8/31/2022

Project Status: Active **Total Project Budget:** $298,500.00

RTI Project Manager: Jade Adediwura **Researcher:** Kevin J. Folliard

Project Objectives: Over 140 million tons of recycled concrete aggregate (RCA) are produced in the United States per year, and this material has been used in a host of transportation infrastructure applications, including fills, embankments, bases, subbases, and concrete pavements. Currently, Receiving Agency limits the maximum amount of recycled crushed concrete fine aggregate (RCFA) allowed in Class P paving concrete to 20% (by mass replacement of virgin sand). However, this limit is somewhat arbitrary, and in fact, much higher replacement levels have been used successfully by Receiving Agency and other state highway agencies in the past. The goal of this project is to evaluate the key technical and construction-related issues that potentially limit the RCFA content in new concrete pavements, and based on laboratory and field evaluations, provide recommendations on maximum RCFA contents. This shall be accomplished by performing a thorough review of literature and current practice, conducting a comprehensive laboratory investigation, and constructing and monitoring new pavement sections containing higher amounts of RCFA. Based on the findings from this project, recommendations shall be made to revise existing Receiving Agency recommended practice and specifications to potentially allow for RCFA contents above the current 20 percent threshold.

Deliverables:

TM2
TM3A
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$143,590.38	$114,872.30	$28,718.08

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7075 **University:** TTI

Project Title: Determine the Influence of Thermal Segregation on Current Asphalt Mixtures

Project Start Date: 9/1/2020 **Termination Date:** 8/31/2023

Project Status: Active **Total Project Budget:** $439,970.00

RTI Project Manager: Martin Dassi **Researcher:** Tom Scullion

Project Objectives: Thermal segregation during asphalt mixture construction can identify areas that become low density. These low-density areas generally exhibit reduced pavement life. While the general methods for measuring thermal segregation remained relatively unchanged since their implementation, the asphalt mixture types and design methods underwent significant modifications in the last 10 years. The Performing Agency shall evaluate the significance of thermal segregation with current generation asphalt mixes. The Performing Agency shall perform validation and, if appropriate, develop modified thermal segregation criteria based on the consequences of thermal segregation on current asphalt mixes. The Performing Agency shall provide guidance on what frequency of thermal segregation constitutes a recurring issue. The Performing Agency shall make sure current thermal profile requirements properly align with current generation asphalt mixes and construction practices.

Deliverables:

TM2
TMFY21A
TMFY21B
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$57,206.00	$45,764.80	$11,441.20

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7076 **University:** TTI

Project Title: Develop Laboratory Mix Design of Full Depth Reclamation (FDR) Projects Using Foamed Asphalt Binder and Emulsified Asphalt

Project Start Date: 9/1/2020 **Termination Date:** 8/31/2024

Project Status: Active **Total Project Budget:** $885,286.25

RTI Project Manager: Joanne Steele **Researcher:** Tom Scullion

Project Objectives: Full depth reclamation (FDR) is a cost-effective recycling strategy that reuses both asphalt bound and unbound granular materials. FDR was implemented in Texas in the early 1990s in the Bryan and Lubbock Districts. In the past five years, the Receiving Agency has implemented FDR using either foamed asphalt or emulsions. The current specification allows for 4-inch diameter by 2-inch height specimens or 6-inch diameter by 3.75-inch height specimens to be tested, with identical acceptance criteria for both sample sizes. This practice has raised concern regarding the effect of sample size on the indirect tensile (IDT) strength because larger specimens have shown lower IDT strength compared to 4-inch diameter specimens regardless of material source, binder type, binder content, or conditioning procedure. The Performing Agency shall evaluate the strength differences between the two specimen sizes and provide acceptance criteria revisions, as appropriate. In addition, the effect of testing temperature is critical with regard to IDT strength of FDR specimens. Therefore, the Performing Agency shall evaluate the specimens at various testing temperatures and recommend a target temperature to substitute the more general test conditions currently specified. The Performing Agency shall validate the revised criteria by evaluating the performance of selected field projects.

Deliverables:

TM2
TM3
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$200,113.25	$160,090.60	$40,022.65

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 5-4829-05 **University:** CTR

Project Title: Implementation of Geosynthetic-stabilized Roadways for Base Course Reduction: Field Monitoring and Design Recommendations

Project Start Date: 5/2/2018 **Termination Date:** 8/31/2022

Project Status: Active **Total Project Budget:** $737,818.96

RTI Project Manager: Jade Adediwura **Researcher:** Jorge Zornberg

Project Objectives: The Performing Agency shall conduct this implementation project, supporting the ongoing reconstruction of segments of IH10 near San Antonio. The Receiving Agency shall use geogrid stabilization to aid in design of roadway sections allowing for reduced base course thickness. The Performing Agency shall support the design, construction, monitoring and data interpretation of pavement test sections to be constructed in IH10 using multiple geogrid products.

Deliverables:
FY'21 TMA
FY'21 TMB
August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$99,186.87	$79,349.50	$19,837.37

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 5-6674-01 **University:** TTI

Project Title: Statewide Implementation of New Binder Selection Catalog and New Binder Performance Tests

Project Start Date: 6/18/2019 **Termination Date:** 8/31/2022

Project Status: Active **Total Project Budget:** $424,999.75

RTI Project Manager: Joanne Steele **Researcher:** Fujie Zhou

Project Objectives: The Performing Agency shall assist Receiving Agency with implementing the new binder selection catalog developed in research project 0-6674-01 and to expand the existing statewide binder properties database with new binder performance tests. The Performing Agency shall implement the new binder selection catalog in five (5) Receiving Agency Districts, including, but not limited to Amarillo, Dallas, Austin, Bryan, and Paris. In each Receiving Agency District, the Performing Agency shall work with Receiving Agency District design engineers and laboratory staff to design a mix with the binders in the new catalog and construct and monitor selected test sections in each Receiving Agency District. The Performing Agency shall then use the data generated in these test sections to develop and teach implementation workshops for Receiving Agency District design engineers in a minimum of five (5) Receiving Agency Districts. The Performing Agency shall present the results at the Receiving Agency's annual Construction Conference or Short Course.

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021

Deliverables:

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$124,999.50	$99,999.60	$24,999.90

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 5-6839-01 **University:** TTI

Project Title: Implementation of Pavement Rehabilitation and Design Strategy for Heavy Loads in Energy Development Areas

Project Start Date: 5/6/2019 **Termination Date:** 2/28/2022

Project Status: Active **Total Project Budget:** $300,000.25

RTI Project Manager: Martin Dassi **Researcher:** Fujie Zhou

Project Objectives: The Performing Agency shall assist the Receiving Agency's Pavement Analysis and Design Branch to provide support to Receiving Agency Districts requiring pavement designs in areas known to experience a high volume of overloaded trucks. The Performing Agency shall perform the following support activities-1)Compare the advanced design recommendations with those obtained using traditional methods (FPS21) and 2)Complete at least five (5) projects for various impacted Receiving Agency Districts around Texas, including, but not limited to Laredo, Corpus Christi, Odessa and Austin. In each of these designs, the Performing Agency shall use realistic load spectra along with advanced materials characterization data and the performance prediction models developed and partially validated in the research studies. The Performing Agency shall use the data generated in the five (5) projects to develop and teach implementation workshops for Receiving Agency District designers. The Performing Agency shall teach training schools in a minimum of four (4) Districts and have the results readily available for presentation at the Receiving Agency Annual Construction and Maintenance Conferences.

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$104,999.75	$83,999.80	$20,999.95

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 5-6910-01 **University:** TECH

Project Title: Implementation of Concrete Overlay Evaluation and Design

Project Start Date: 5/21/2019 **Termination Date:** 8/31/2022

Project Status: Active **Total Project Budget:** $148,168.25

RTI Project Manager: Tom Schwerdt **Researcher:** Moon Won

Project Objectives: The primary tasks in this implementation project are to train Receiving Agency Staff (1) to evaluate existing Portland Cement Concrete (PCC) pavements and develop appropriate optimum overlay strategies and (2) to conduct early-age performance evaluations of PCC overlays. This implementation project also includes the development of training materials and other documents that shall be used to modify the PCC overlay portion of TxDOT Pavement Manual. The Receiving Agency has many miles of concrete pavement that have already passed or are approaching the end of their design lives, which will require some form of rehabilitation in the near future. The PCC overlay design program developed under previous research project #0-6910 represents significant improvements over existing PCC overlay design programs, primarily because the new program is based on the "mechanistic" condition of the existing pavement, not "visual condition" of the pavement. The findings from this implementation project shall help the Receiving Agency deploy cost-effective pavement rehabilitation programs.

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$30,167.00	$24,133.60	$6,033.40

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 5-6925-01 **University:** CTR

Project Title: Implementation of improved Performance Grade (PG) of Asphalt Binders

Project Start Date: 9/1/2019 **Termination Date:** 4/30/2022

Project Status: Active **Total Project Budget:** $292,470.00

RTI Project Manager: Tom Schwerdt **Researcher:** Amit Bhasin

Project Objectives: The Performance Agency shall work with the Materials and Test Division of the Receiving Agency to sample and test binders from several different existing road sections that have been in service for a few years across the state. The Performing Agency shall also provide assistance to the Receiving Agency in terms of identifying appropriate test equipment to conduct the test, demonstrating the method and assisting lab technicians to run the test in the long-term as needed, and provide spreadsheets that facilitate analysis from test data to obtain parameters of interest.

Deliverables:
August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021
Interim Report

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$128,091.25	$102,473.00	$25,618.25

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Table 14. Construction and Maintenance Totals for Continuing Projects

Financials	Budget	Expended	Balance
Federal 80%	$3,231,828.56	$2,775,203.00	$456,625.56
State 20% TDC*	$807,957.14	$693,800.75	$114,156.39
Total	$4,039,785.70	$3,469,003.75	$570,781.95

2.2.2 RTI Strategy and Innovation Projects

Project Number: 0-7033 **University:** CTR

Project Title: Defining Operational Design Domains (ODDs) for the Safe Blending of Levels 0-4 Connected and Autonomous Vehicles (CAVs) in the Traffic Stream

Project Start Date: 9/1/2019 **Termination Date:** 8/31/2022

Project Status: Active **Total Project Budget:** $643,665.00

RTI Project Manager: Joanne Steele **Researcher:** Kristie Chin

Project Objectives: This project explores the establishment of a robust Operational Design Domain (ODD) framework for automated driving systems. The project will use a hybrid policy and technical process to define, prioritize, and simulate and test ODDs for autonomous driving.

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021
TM7.1
TM7.2
TM7.3

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$214,216.87	$171,373.50	$42,843.37

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7034 **University:** CTR

Project Title: Exploring the Use of Artificial Intelligence to Leverage TxDOT Data for Enhanced Corridor Management and Operations

Project Start Date: 8/1/2019 **Termination Date:** 8/31/2023

Project Status: Active **Total Project Budget:** $608,862.28

RTI Project Manager: Joanne Steele **Researcher:** Natalia Ruiz Juri

Project Objectives: This project will develop a thorough understanding of the concrete and tangible benefits that artificial intelligence (AI) may offer to the Receiving Agency when considering the vast volumes of data currently collected and will explore emerging planning and operations applications. A twofold research approach will provide both a broad, high-level summary of the state of the art/practice in AI and its relevance to the Receiving Agency, and an in-depth analysis of one or two selected applications. The review of the state of the art will include a literature and data survey and creation of a prospectus summarizing the techniques and tools relevant to the Receiving Agency given data availability and planning/operation priorities. For the use cases, the Performing Agency will consider applications involving system performance estimation and system control using Markov and non-Markov decision processes. After completing a preliminary research phase, the Performing Agency will host a workshop for the Receiving Agency and its partners to demonstrate the explored concepts and collect feedback to inform the model application and testing. Project deliverables will include a comprehensive report, including a quantitative and qualitative evaluation of the selected use cases, and access to the datasets and code-base used in this project.

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021
P2
TM 4
TM 6
P3 to include input and output zip files
P4 and P4 source code zip file
TM7.1
TM7.2
TM7.3
TM12

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$153,008.85	$122,407.08	$30,601.77

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7080 **University:** UTSA

Project Title: Develop Roadway and Parking Design Criteria to Accommodate Automated and Autonomous Vehicles

Project Start Date: 9/1/2020 **Termination Date:** 1/31/2023

Project Status: Active **Total Project Budget:** $344,148.86

RTI Project Manager: Joanne Steele **Researcher:** Hatim Sharif

Project Objectives: Automated vehicles (AVs) are predicted to be available for public use within a decade or so. Adequate planning is needed for optimally designing infrastructure to accommodate autonomous vehicles. This includes pick-up/drop-off lanes, changes in parking infrastructure, and changes in roadway design that should be cost-efficient and accommodate vehicles that will drive themselves safely. This study shall conduct research into the best practices for accommodating AVs in the scenario of a mix of AVs and traditional vehicles on the roadway until the state of full automation in all vehicles. This research has two important objectives: (1) propose updates to the Receiving Agency's roadway design standards, given the emerging landscape of autonomous vehicles, and (2) research and model changes in standards of lane widths, parking requirements (including new types of parking infrastructure), lane designations, and other roadway design elements to determine the most efficient outcomes. The two goals will help making Texas ready for the transition phase from human driven vehicles to automated future.

Deliverables:

September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021
TM2
TM3

TM4
TM5
TM6

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$140,144.11	$112,115.29	$28,028.82

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7081 **University:** CTR

Project Title: Understanding the Impact of Autonomous Vehicles on Long-Distance Travel Mode and Destination Choice in Texas

Project Start Date: 9/1/2020 **Termination Date:** 8/31/2022

Project Status: Active **Total Project Budget:** $366,199.64

RTI Project Manager: Martin Dassi **Researcher:** Kara Kockelman

Project Objectives: As autonomous vehicles (AVs) become increasingly available over coming years, their travel, trade, emissions, cost, and other implications need to be anticipated across Texas. Prior studies predict AVs dominating U.S. passenger travel between 100 and 500 miles (one-way) and freight ton-miles over 300 miles. With network vehicle-miles travelled (VMT) predicted to rise by over 25% (as many Texas air travelers shift to shared AVs, others extend their current ground-trip distances, and still others begin more trip-making), this work shall gather new data to simulate year by year changes in freight and passenger flows across Texas and the nation for all competing modes, including a close look at airport access costs. Coupled with other trends (like population growth and aging), the Performing Agency shall anticipate impacts on airline ticket sales, railway freight, and traffic volumes by light and heavy-duty vehicles, near and long term, across emerging technologies, policies and cost scenarios. Project deliverables shall enable state and local practitioners to directly extend and update their planning models and predictions, with focus on longer-distance trip-making. As required, TRL Level 5 shall be readily achieved, with the work's final model development achieving TRL between 6 and 8.

Deliverables:

TM2
TM3
TM4
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$179,983.46	$143,986.77	$35,996.69

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7094 **University:** TXST

Project Title: Determine Evacuation Planning Design for Disaster Resilience

Project Start Date: 9/2/2020 **Termination Date:** 8/31/2022

Project Status: Active **Total Project Budget:** $220,819.00

RTI Project Manager: Wade Odell **Researcher:** Feng Wang

Project Objectives: When a disaster occurs, the victims in the affected area will evacuate to the shelters of nearby cities. There are interactions between transportation network services and evacuation capabilities between different cities in Texas, especially in the mega-regions of the Texas Triangle and the Gulf Coast. The evacuation demands of vulnerable populations are not considered, and the vulnerability analysis of the regional transportation infrastructure network is not considered to optimize evacuation strategies.

This project takes advantage of social media data to analyze the movement behavior of different types of evacuees in detail and combines multiple data sources to identify the evacuation origin and destination distribution of vulnerable populations in these mega-regions.The Performing Agency shall analyze the vulnerability of the transportation infrastructure network in the study areas and identify critical road segments that are significantly affected during the evacuation process. From the perspective of the evacuation destinations, the Performing Agency shall optimize evacuation route plans and design traffic control strategies for different types of evacuees.

Deliverables:

September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021

TM2
TM3
TM4
TM5
TM6

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$108,897.00	$87,117.60	$21,779.40

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-9904-17/15512 **University:** CTR

Project Title: TX Alliance IAC

Project Start Date: 9/1/2017 **Termination Date:** 12/31/2021

Project Status: Active **Total Project Budget:** $1,928,560.72

RTI Project Manager: Shelley Pridgen **Researcher:** C. Michael Walton

Project Objectives: Texas Department of Transportation - Research and Technology Implementation Division is in need of administrative support to coordinate collaboration among stakeholders across the state in order to address local, regional and state mobility challenges. The Performing Agency shall be responsible for coordination of the Texas Innovation Alliance Team, which initiated from the USDOT's Smart City Challenge, was solidified at the Texas Mobility Summit in December 2016, and serves as an outgrowth of the Texas Technology Task Force. Key objectives are to bring together local and state public agencies, research institutions and affiliates, and policymakers into a discussion focused on community, collaboration and choice, which shall include, but not be limited to, the following: Key objectives shall include, but are not limited to: Enhance the Network – The Performing Agency shall position the Receiving Agency to collaborate with stakeholders to develop an agenda for action, broker shared challenges with outcome-driven solutions, and strengthen the ability for Texas to compete for federal funding. Leveraging Resources - Maximize the impact of the Receiving Agency's investment by coordinating investments and advancing the deployment, adoption, and scaling of solutions. Share Lessons Learned- The Performing Agency shall work with the Receiving Agency to share lessons learned and initiatives across the state in real-time.

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021
TM21
TM22
TM23
TM24
TM25
TM26
R5: Transition Plan

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$268,201.00	$214,560.80	$53,640.20

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Table 15. Strategy and Innovation Totals for Continuing Projects

Financials	Budget	Expended	Balance
Federal 80%	$851,561.03	$799,941.74	$51,619.29
State 20% TDC*	$212,890.26	$199,985.43	$12,904.83
Total	**$1,064,451.29**	**$999,927.17**	**$64,524.12**

2.2.3 Planning and Environmental

Project Number: 0-6837-03 **University:** TTI

Project Title: Assessment of Innovative and Automated Freight Systems and Development of Evaluation Tools - Phase III

Project Start Date: 6/13/2019 **Termination Date:** 8/31/2022

Project Status: Active **Total Project Budget:** $2,331,767.00

RTI Project Manager: Wade Odell **Researcher:** Curtis Morgan

Project Objectives: In research project 0-6837 (Phase I), the Performing Agency conducted a comprehensive review of innovative and automated freight strategies and technologies (S/T) used worldwide. The Performing Agency initially identified a total of 57 different S/T from this review. In consultation with the Receiving Agency, the Performing Agency selected nine S/T areas, that could improve future freight distribution in Texas, to advance to research project 0-6837-01 (Phase II). In Phase II, the Performing Agency conducted an analysis which used the Systematic Technology Reconnaissance, Evaluation, and Adoption Methodology (STREAM) process from National Cooperative Highway Research Program Report 750, Volume 3, to evaluate each S/T's effectiveness. In Project 0-6837-03 (Phase III), the Performing Agency shall evaluate innovative strategic freight operational changes and technology applications recommended by the Receiving Agency at the conclusion of Phase II to ensure continued timely flow of commercial freight through the Texas transportation system. Phase III was planned to consist of seven distinctive project activities based upon the results of Phases I & II of the project. The activities advanced for Phase III research were selected by the Receiving Agency and address four of the nine freight S/T areas that were examined during Phase II. The selected S/T areas are: 1) Port Area Intelligent Transportation Systems (ITS) 2) Separation of Trucks from Automobiles/Truck-Only Infrastructure 3) Truck Parking Information 4) Border Advanced Traveler Information. Multiple Port Area ITS-related activities were chosen while the other three S/T areas produced one activity each. Phase III examines freight traffic changes near seaports after ITS equipment implementation, communication of rail blockages at a port entrance to approaching trucks, modeling of truck-only lane impacts within a major freight corridor, truck parking-

related sensing and communication at existing Receiving Agency rest areas, and border crossing enhancement through coordinated information exchange. Each Phase III activity has independent utility and furthers implementation goals of the Texas Freight Mobility Plan (TFMP).

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021
TM2C
TM3C
TM4C
TM5C

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$645,397.50	$516,318.00	$129,079.50

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-6973 **University:** TARL

Project Title: Predictive Mapping of Potentially Listed Rare Plant Species

Project Start Date: 6/6/2018 **Termination Date:** 10/31/2021

Project Status: Active **Total Project Budget:** $312,801.12

RTI Project Manager: Martin Dassi **Researcher:** Hemanta Kafley

Project Objectives: Predictive models for spatial distributions have been effective tools for managing variety of organisms that respond to various environmental factors. However, predicting distribution of rare plant species has been formidable for several reasons, including 1) Paucity of data on presence; 2) Lack of data on "true absence"; 3) Paucity of data in general for each species; 4) Issues associated with the accuracy of available data, and; 4) challenges in identifying predictive models to predict spatial distribution given the circumstances mentioned above. The Performing Agency shall collate data on 17 identified rare plant species in Texas from multiple sources including databases, herbarium collections, and citizen science data, aggregate the data within the defined grid units across Texas, identify environmental predictors that may explain species distributions, and adopt appropriate statistical predictive models to predict rare plant species spatial distribution. This project shall compare the models based on ecological niche factor analysis, generalized linear models (GLM) with pseudo absences, ordination techniques such as the Principal Component Analysis (PCA) or the canonical counterpart of the PCA, or other available techniques depending on the data obtained on the candidate species, to develop the most appropriate predictive spatial distribution models for all the candidate rare plant species.

Deliverables:

TM7B
TM8A
TM7C
TM7D
R1A
TM8B
August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$115,693.05	$92,554.44	$23,138.61

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7010-01 **University:** TTI

Project Title: Developing Peak Rate Factor (PRF) Guidance in Hydrologic Modeling

Project Start Date: 6/23/2021 **Termination Date:** 12/31/2021

Project Status: Active **Total Project Budget:** $79,915.25

RTI Project Manager: Shelley Pridgen **Researcher:** Hatim Sharif

Project Objectives: The current Texas practice in Peak Rate Factor (PRF) calculation is to adjust PRF after initial Hydrologic modeling, based on the NRCS dimensionless unit hydrograph, has been performed as a rough calibration to expected values. Changes to PRF values have an effect on the peak flow values and the resulting sizes for hydraulic structures. Recommended PRF values for varied watersheds and physiographic regions in Texas was not previously taken into account. The Performing Agencies shall complement the work of Project 0-7010 by performing additional tasks including data collection and analysis to establish solid guidance for a range of reasonable PRF values for different hydro-physiographic provinces of Texas based on the distribution of observed PRF values.

Deliverables:

P2
P3 and calculations spreadsheet
June MPR 2021 UTSA
July MPR UTSA 2021
June MPR 2021 TTI
July MPR TTI 2021

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$2,575.00	$2,060.00	$515.00

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7010-01 **University:** UTSA

Project Title: Developing Peak Rate Factor (PRF) Guidance in Hydrologic Modeling

Project Start Date: 6/23/2021 **Termination Date:** 12/31/2021

Project Status: Active **Total Project Budget:** $79,915.25

RTI Project Manager: Shelley Pridgen **Researcher:** Hatim Sharif

Project Objectives: The current Texas practice in Peak Rate Factor (PRF) calculation is to adjust PRF after initial Hydrologic modeling, based on the NRCS dimensionless unit hydrograph, has been performed as a rough calibration to expected values. Changes to PRF values have an effect on the peak flow values and the resulting sizes for hydraulic structures. Recommended PRF values for varied watersheds and physiographic regions in Texas was not previously taken into account. The Performing Agencies shall complement the work of Project 0-7010 by performing additional tasks including data collection and analysis to establish solid guidance for a range of reasonable PRF values for different hydro-physiographic provinces of Texas based on the distribution of observed PRF values.

Deliverables:

P2
P3 and calculations spreadsheet
June MPR 2021 UTSA
July MPR UTSA 2021
June MPR 2021 TTI
July MPR TTI 2021

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$31,395.00	$25,216.00	$6,179.00

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7023 **University:** TAR

Project Title: Determining Downstream Ecological Impacts of Sediment Derived from Bridge Construction

Project Start Date: 9/1/2019 **Termination Date:** 3/31/2022

Project Status: Active **Total Project Budget:** $313,569.13

RTI Project Manager: Jade Adediwura **Researcher:** Habib Ahmari

Project Objectives: Sediment release from bridge construction may change the sediment regime of the receiving streams, causing habitat degradation downstream of bridges. One of TxDOT's responsibilities is to address potential effects on aquatic species listed under the federal Endangered Species Act. As sedentary, bottom-dwelling filter feeders, mussels are susceptible to habitat destabilization activities such as bridge construction. Several Texas freshwater mussel species are expected to be added to list of the U.S. Endangered Species Act. To date, guidelines for determining the areas within streams that are likely to be impacted by bridge construction are not well supported by empirical data. Nor is a predictive model available to quantify such effects, and to provide information required for habitat suitability assessment. The Performing Agencies shall develop a predictive tool and validate its performance in the field. The objectives of this project are to: 1) develop a predictive model that can be used to estimate the quantity, size, and accumulation depths of sediment derived from bridge construction; 2) evaluate the model predictions of a bridge construction site by collecting field data; 3) obtain the FHWA Technology Readiness Level 7; and 4) create educational materials, user manuals, and demonstrative videos, to train the Receiving Agency's workforce.

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021

June MPR 2021
July MPR 2021
TM3B
TM3C Parts I and II

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$33,147.50	$26,518.00	$6,629.50

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7023 **University:** UTA

Project Title: Determining Downstream Ecological Impacts of Sediment Derived from Bridge Construction

Project Start Date: 9/1/2019 **Termination Date:** 3/31/2022

Project Status: Active **Total Project Budget:** $313,569.13

RTI Project Manager: Jade Adediwura **Researcher:** Habib Ahmari

Project Objectives: Sediment release from bridge construction may change the sediment regime of the receiving streams, causing habitat degradation downstream of bridges. One of TxDOT's responsibilities is to address potential effects on aquatic species listed under the federal Endangered Species Act. As sedentary, bottom-dwelling filter feeders, mussels are susceptible to habitat destabilization activities such as bridge construction. Several Texas freshwater mussel species are expected to be added to list of the U.S. Endangered Species Act. To date, guidelines for determining the areas within streams that are likely to be impacted by bridge construction are not well supported by empirical data. Nor is a predictive model available to quantify such effects, and to provide information required for habitat suitability assessment. The Performing Agencies shall develop a predictive tool and validate its performance in the field. The objectives of this project are to: 1) develop a predictive model that can be used to estimate the quantity, size, and accumulation depths of sediment derived from bridge construction; 2) evaluate the model predictions of a bridge construction site by collecting field data; 3) obtain the FHWA Technology Readiness Level 7; and 4) create educational materials, user manuals, and demonstrative videos, to train the Receiving Agency's workforce.

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021

June MPR 2021
July MPR 2021
TM3B
TM3C Parts I and II

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$107,771.00	$86,216.80	$21,554.20

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7024 **University:** TTI

Project Title: Assessing Ozone Impacts on Electric Vehicle (EV) Adoption in Texas

Project Start Date: 11/1/2019 **Termination Date:** 6/30/2023

Project Status: Active **Total Project Budget:** $510,772.00

RTI Project Manager: Shelley Pridgen **Researcher:** Reza Farzaneh

Project Objectives: Plug-in Electric vehicles (PEVs) are expected to overtake conventional vehicles by mid-2030s. PEVs have considerably lower tailpipe pollutant emissions which react with each other and form ground-level ozone, a criteria pollutant known to be harmful to human health and the environment. However, when the overall wheel-to-well emissions are considered, characterizing the net impact of PEVs on ozone is a complex task that involves capturing the influence of factors such as PEV technology, energy sources of electricity generation, and location and time of electricity generation. The Performing Agency shall use the most recent available data and methods to develop forecasts of changes in ground-level-ozone as a result of PEV activities in three non-attainment areas of Texas (Houston, Dallas-Fort Worth, and San Antonio) for multiple scenarios representing different plausible changes in key influence factors by years 2023 and 2028. The Performing Agency shall develop a series of scenarios for PEV activity levels, energy sources, and charging profiles. The Performing Agency shall then estimate the changes in emissions from PEVs and power generation by location and time. The Performing Agency shall use the Environmental Protection Agency's (EPA) Community Multi-scale Air Quality Model (CMAQ) photochemical modeling along with Texas-specific emission inputs prepared and used by the Texas Commission on Environmental Quality (TCEQ) to estimate hourly levels of ground-level ozone in the study areas.

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021
TM-3-Pre final version
TM-4 DRAFT version
P1

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$161,480.75	$129,184.60	$32,296.15

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7037 **University:** TTI

Project Title: Develop Models for Freight Flows and Commercial Travel Patterns within Texas Urban Regions

Project Start Date: 3/3/2020 **Termination Date:** 8/31/2023

Project Status: Active **Total Project Budget:** $1,654,330.00

RTI Project Manager: Jade Adediwura **Researcher:** Curtis Morgan

Project Objectives: This project will use a phased work plan to develop a freight model within one or more urban areas of the state of Texas using the most current state of the practice methods and data sources. The Performing Agency shall produce a freight model through an interactive and iterative process by the Performing Agency, Receiving Agency, and Metropolitan Planning Organizations (MPO) partners using the concept of first creating a "minimum viable product" as used in commercial software development. Key initial steps to this process will be investigation of similar recent freight modeling efforts in the United States (U.S.), early identification of freight model requirements for both Receiving Agency and local/regional planning efforts, selection of the type/function of model that will address those requirements, and an assessment of data availability and of any fatal flaws that might be encountered. The Performing Agency shall then work cooperatively with the selected MPO partner to build and implement a state-of -the practice model that can be iteratively improved over time as additional data or methods emerge. Training for model users and an ongoing, web-based forum for users to share insights and questions are also part of the work plan. Reporting of results and transferability to diverse MPOs are other key features of the project.

Deliverables:

TM2B
TM3
TM4
August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$453,582.00	$362,865.60	$90,716.40

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7053 **University:** TTI

Project Title: Quantify the Valuation of Right-of-Way

Project Start Date: 11/1/2019 **Termination Date:** 7/31/2022

Project Status: Active **Total Project Budget:** $321,353.00

RTI Project Manager: Jade Adediwura **Researcher:** Edgar Kraus

Project Objectives: The Receiving Agency manages over one (1) million acres of right-of-way, which is used by a variety of third parties to install facilities such as utilities, saltwater pipelines, and small cell nodes. Third parties include common carriers, who install facilities for public use, and private parties, who install facilities for private use. Common carriers access the right-of-way via permit, for which the Receiving Agency does not have the authority to charge a fee. Private parties lease the right-of-way, and the associated fees are intended to cover administrative costs and the value of the right-of-way. This research shall develop a valuation framework to assess the value of the right-of-way for leases of various longitudinal distances and durations. The research shall also assess whether common carriers are violating their permits by installing additional facilities and leasing them to private parties. The research shall document instances where violations occur and identify companies that are common carriers and lease facilities that were installed by permit.

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
TM5
TM6

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$78,400.00	$62,720.00	$15,680.00

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7054 **University:** CTR

Project Title: Integration of Stated Preference and Revealed Preference Methods in Regional Travel Survey Programs

Project Start Date: 12/9/2019 **Termination Date:** 8/31/2022

Project Status: Active **Total Project Budget:** $376,600.48

RTI Project Manager: Tom Schwerdt **Researcher:** Chandra Bhat

Project Objectives: The Performing Agency (PA) shall (1) identify state-of-the-art stated preference (SP) techniques, (2) develop a guidebook that explains the factors to consider when designing an integrated revealed preference (RP)-SP survey, (3) recommend to the Receiving Agency the SP components that may be appended to existing surveys to enhance their use for long-term travel forecasts, and (4) provide a proof of concept by conducting a pilot survey as well as applying a combined RP-SP modeling framework for a specific context.

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021
TM4
TM5
TM6
P2
VOR

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$154,256.35	$123,405.08	$30,851.27

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7055 **University:** CTR

Project Title: Creating a Resilient Port System in Texas: Assessing and Mitigating Extreme Weather Events

Project Start Date: 1/14/2020 **Termination Date:** 12/31/2021

Project Status: Active **Total Project Budget:** $307,156.75

RTI Project Manager: Joanne Steele **Researcher:** Zhanmin Zhang

Project Objectives: Extreme weather events, such as hurricanes and tropical storms, pose considerable challenges to the Texas port system. Given the economic and strategic significance of the Texas port system, ensuring its resilience against such hazards is essential. Although resilience is a vague concept defined differently by different entities, the specific aspects of port system resilience need to be identified and incorporated in resilience enhancement programs. Moreover, achieving optimal resilience of port systems requires a thorough understanding of the port network functions, identification of port infrastructure vulnerabilities, and quantification of resultant risks.

The Performing Agency shall undertake a holistic analysis of the current resilience capabilities of the Texas port system and suggest measures to improve them. The Performing Agency shall identify vulnerabilities of various port infrastructure components and supporting infrastructure.

The Performing Agency shall also quantify the physical and economic risks of port disruptions and develop metrics linking the characteristics of extreme events to associated risks. The Performing Agency shall evaluate the resilience of the port system with due consideration to aspects concerning port system operations and its capability for restoration and recovery. The Performing Agency shall provide resilience enhancement recommendations for immediate implementation based on the study findings.

Deliverables:

TM4
TM5
TM6
TM7
TM8
August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$152,340.75	$121,872.60	$30,468.15

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7056 **University:** TTI

Project Title: Development of a Web-Based Airport Rates and Charges Model

Project Start Date: 3/3/2020 **Termination Date:** 10/31/2021

Project Status: Active **Total Project Budget:** $259,000.00

RTI Project Manager: Shelley Pridgen **Researcher:** Jeffrey Borowiec

Project Objectives: Charging market rates and fees for airport facilities and services is critical for putting an airport on the path to self-sufficiency. Charging market rates for airport leases and rents is also a grant assurance and compliance requirement. However, many airports have rates and charges that are below market rates and do not have a mechanism in place for knowing what they should charge for the facilities and services at their airport. This research will provide airports with a strategy to increase airport revenue, rely less on state and federal funds, and help reduce non-aeronautical use of hangars.

The Performing Agency shall perform a literature review, develop a rates and charges survey, administer the survey, and analyze the results. The Performing Agency shall use this data from the survey to develop a rates and charges model that will provide users with the ability to better understand what their fee structure should look like based on a variety of input variables including geographic location, airport type, airport size, and activity level. The output will be a series of averages or ranges of rates and charges for various hangar types and sizes, fuel flow fees, and other facilities/charges found on airport property for both aeronautical and non-aeronautical use.

The rates and charges model developed from this research will allow airport sponsors, the Receiving Agency, and other stakeholders, including airport businesses, tenants, aircraft owners, and city/county officials, to gain a better understanding of what their area's market rates are and what they should be charging at a particular airport. Many smaller airports do not have the staff expertise to ascertain market rates; this model will help them do that. For those airports with some expertise or capability in this area, this model will provide some additional information and assurance that their rates are appropriate.

The Performing Agency shall create an easy-to-use web-based interface allowing users to select criteria best matching their airport. The model will then use these criteria to provide comparable rates and charges for similar facilities and services. The Performing Agency shall also develop a User's Guide to explain how to use the rates and charges model, what the results are, what they mean, and how the airport sponsors and Receiving Agency can use them.

Deliverables:

TM3
TM4
TM5
P1
P2
P3
August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$170,000.50	$136,000.40	$34,000.10

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7071 **University:** CTR

Project Title: Evaluate Geophysical Methods to Detect Underground Voids

Project Start Date: 9/1/2020 **Termination Date:** 1/31/2023

Project Status: Active **Total Project Budget:** $328,525.12

RTI Project Manager: Joanne Steele **Researcher:** Loukas F. Kallivokas

Project Objectives: Construction delays and costly change orders can occur when subsurface voids are unexpectedly encountered on transportation projects. Unfortunately, voids and caves are common in the karst geology beneath two of the four most populated metropolitan areas in Texas (Austin and San Antonio). This project shall assist in assessment of subsurface conditions by investigating and testing the most promising surface-deployed geophysical imaging methods that can be used to identify voids. First, the Performing Agency shall perform a thorough literature review of imaging methods such as Ground Penetrating Radar (GPR), Electrical Resistivity Tomography (ERT), Multi-channel Analysis of Surface Waves (MASW), and Full Waveform Inversion (FWI) of stress waves to investigate their strengths, weaknesses, and applicability to the clay-over-limestone karst geology of central Texas. Second, the Performing Agency shall conduct 2D/3D imaging synthetic and field trial tests using each of the most promising methods, the latter at two sites chosen by the Receiving Agency where the subsurface is known to include voids. Third, the Performing Agency shall evaluate the performance of each method considering its accuracy, cost, advantages, and limitations. Fourth, based on our findings, the Performing Agency shall recommend a strategy that will be most useful for identifying voids on infrastructure projects.

Deliverables:

TM1
TM3
TM4
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021

May MPR 2021
June MPR 2021
July MPR 2021

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$120,769.87	$96,615.90	$24,153.97

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7078 **University:** TAR

Project Title: Assessing Efficacy of Toad Exclusion Fencing (TEF) To Prevent Herpetofauna, With an Emphasis on Houston Toad, From Entering Construction Zones

Project Start Date: 10/29/2020 **Termination Date:** 8/31/2022

Project Status: Active **Total Project Budget:** $490,356.85

RTI Project Manager: Shelley Pridgen **Researcher:** Robert Coulson

Project Objectives: The Houston toad (Anaxyrus houstonensis) (HT) is a federally endangered species (USDI FWS 1970). Effective mitigation measures against incidental take of the HT during construction, such as Receiving Agency's specification for Amphibian and Reptile Exclusion Fence (AREF) must be implemented to reduce the risk of toad mortality or injury. The AREF should also be evaluated for effectiveness of potential Receiving Agency use in protecting other herptiles, specifically the federally threatened Louisiana Pine Snake (LPS, Pituophis ruthveni). Currently, the Receiving Agency is using geotextile fencing materials for AREF, but this AREF has not been tested for efficacy in excluding HT and other herpetofauna. In addition to testing the current Receiving Agency geotextile AREF, the project shall test specially designed amphibian wildlife fencing from Animex Fencing (AMX T40/1015), and Ertec (EF30F). The barrier efficacy (percent fence crossings), materials cost, installation efficiency, and field durability for all three types of AREF for excluding HT and LPS shall be determined, as well as their ability to facilitate herptile escape if they become trapped in construction zones or roadways (percent fence escapes). The Performing Agencies shall conduct trials with Gulf Coast toads (Incilius nebulifer) (GCT) as a proxy species for the HT and corn snakes (CS, Pantherophis guttatus) as a proxy for LPS. The Performing Agencies shall conduct experiments in both a controlled outdoor campus facility and along roadways in a field environment. The Performing Agencies shall provide results of the testing and trials of AREF and cost comparisons (including estimated installation costs) and practical considerations.

Deliverables:

October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021
TM4A
TM5A
TM5B

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$148,633.00	$118,906.40	$29,726.60

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7078 **University:** TTI

Project Title: Assessing Efficacy of Toad Exclusion Fencing (TEF) To Prevent Herpetofauna, With an Emphasis on Houston Toad, From Entering Construction Zones

Project Start Date: 10/29/2020 **Termination Date:** 8/31/2022

Project Status: Active **Total Project Budget:** $490,356.85

RTI Project Manager: Shelley Pridgen **Researcher:** Robert Coulson

Project Objectives: The Houston toad (Anaxyrus houstonensis) (HT) is a federally endangered species (USDI FWS 1970). Effective mitigation measures against incidental take of the HT during construction, such as Receiving Agency's specification for Amphibian and Reptile Exclusion Fence (AREF) must be implemented to reduce the risk of toad mortality or injury. The AREF should also be evaluated for effectiveness of potential Receiving Agency use in protecting other herptiles, specifically the federally threatened Louisiana Pine Snake (LPS, Pituophis ruthveni). Currently, the Receiving Agency is using geotextile fencing materials for AREF, but this AREF has not been tested for efficacy in excluding HT and other herpetofauna. In addition to testing the current Receiving Agency geotextile AREF, the project shall test specially designed amphibian wildlife fencing from Animex Fencing (AMX T40/1015), and Ertec (EF30F). The barrier efficacy (percent fence crossings), materials cost, installation efficiency, and field durability for all three types of AREF for excluding HT and LPS shall be determined, as well as their ability to facilitate herptile escape if they become trapped in construction zones or roadways (percent fence escapes). The Performing Agencies shall conduct trials with Gulf Coast toads (Incilius nebulifer) (GCT) as a proxy species for the HT and corn snakes (CS, Pantherophis guttatus) as a proxy for LPS. The Performing Agencies shall conduct experiments in both a controlled outdoor campus facility and along roadways in a field environment. The Performing Agencies shall provide results of the testing and trials of AREF and cost comparisons (including estimated installation costs) and practical considerations.

Deliverables:

October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021
TM4A
TM5A
TM5B

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$107,253.85	$85,803.08	$21,450.77

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7079 **University:** TTI

Project Title: Establish TxDOT Transportation Resilience Planning Scorecard and Best Practices

Project Start Date: 9/1/2020 **Termination Date:** 8/31/2022

Project Status: Active **Total Project Budget:** $499,999.75

RTI Project Manager: Joanne Steele **Researcher:** Ali Mostafavi

Project Objectives: More frequent extreme weather events and natural hazards call for improving resilience of the nation's transportation infrastructure. Recognizing this, the recent Federal Highway Bill has specified requirements for improving disaster resilience. In particular, the State of Texas has experienced a growing number of hurricanes and flooding events impacting its transportation infrastructure over the past two decades. In order to better integrate and operationalize resiliency in transportation planning for the Receiving Agency, this project shall create foundational knowledge and tools for planning and decision making. Accordingly, the Performing Agency shall: (1) evaluate of the current state of practice, needs, gaps, and priorities related to transportation resilience through surveying various state and local stakeholders, (2) employ analytical and data-driven methods to implement vulnerability and resilience assessments on the state road networks, (3) develop a transportation resilience scorecard to inform current and future transportation resilience planning efforts, (4) identify transportation resilience best practices and measures to objectively improve transportation resilience, (5) present research outcomes in a guide document for the Receiving Agency and other local transportation agencies, and (6) provide transportation resilience training through a workshop and three webinars.

Deliverables:

September 2020 MPR
October 2020 MPR
November 2020 MPR
December 2020 MPR
January 2021 MPR
February 2021 MPR
March 2021 MPR
April 2021 MPR
May 2021 MPR
June 2021 MPR

July 2021 MPR
TM2
TM1 FY End TM

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$245,355.50	$196,284.40	$49,071.10

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Table 16. Planning and Environmental Total for Continuing Projects

Financials	Budget	Expended	Balance
Federal 80%	$2,182,994.30	$2,005,993.38	$177,000.91
State 20% TDC*	$545,748.57	$501,498.35	$44,250.23
Total	**$2,728,051.62**	**$2,507,491.73**	**$220,559.89**

2.2.4 Structures and Hydraulics

Project Number: 0-6872-01 **University:** TTI

Project Title: Use of Geothermal Energy for De-icing Approach Pavement Slabs and Bridge Decks - Phase II

Project Start Date: 10/9/2020 **Termination Date:** 6/30/2023

Project Status: Active **Total Project Budget:** $737,866.69

RTI Project Manager: Shelley Pridgen **Researcher:** Xinbao Yu

Project Objectives: De-icing using geothermal energy can provide the Receiving Agency with a better alternative than the existing method of using deicing with sands and/or salts. This research project shall explore the potential for retrofitting bridges with a hydronic pipe geothermal heating system and achieve Technology Readiness Levels (TRL) level 6 through prototype demonstration in a relevant environment. At the end of the project, the geothermal deicing technology shall be ready for prototype demonstration in an operational environment (TRL level 7).

Deliverables:

October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
TM2
TM3
TM4
TM5
TM6
October MPR 2020
TM8
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$70,169.60	$56,135.68	$14,033.92

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-6872-01 **University:** UTA

Project Title: Use of Geothermal Energy for De-icing Approach Pavement Slabs and Bridge Decks - Phase II

Project Start Date: 10/9/2020 **Termination Date:** 6/30/2023

Project Status: Active **Total Project Budget:** $737,866.69

RTI Project Manager: Shelley Pridgen **Researcher:** Xinbao Yu

Project Objectives: De-icing using geothermal energy can provide the Receiving Agency with a better alternative than the existing method of using deicing with sands and/or salts. This research project shall explore the potential for retrofitting bridges with a hydronic pipe geothermal heating system and achieve Technology Readiness Levels (TRL) level 6 through prototype demonstration in a relevant environment. At the end of the project, the geothermal deicing technology shall be ready for prototype demonstration in an operational environment (TRL level 7).

Deliverables:

October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
TM2
TM3
TM4
TM5
TM6
October MPR 2020
TM8
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$96,259.27	$77,007.42	$19,251.85

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-6936 **University:** CTR

Project Title: Development of Integral/Semi-integral Abutments for TxDOT bridges

Project Start Date: 9/1/2016 **Termination Date:** 8/31/2023

Project Status: Active **Total Project Budget:** $1,049,627.10

RTI Project Manager: Jade Adediwura **Researcher:** Jorge Zornberg

Project Objectives: While the use of integral and semi-integral bridge abutments has reportedly been increasing nationwide, their construction in Texas has remained limited. These systems have been reported to minimize the costs associated with the installation, maintenance, and repair of bridge deck joints and bearings. In addition, they have the potential to minimize the "bump at the end of the bridge," which results in reduced maintenance costs. Although this technology has not been widely adopted in Texas, a reassessment of its potential cost and performance benefits is timely. This requires assessment of key design and construction aspects, including the characteristics of common soils in Texas, the details typically adopted for foundation, superstructure, and substructure, and the local pavement standards. Accordingly, this project proposes to assess the use of this technology in Texas by producing: (1) a review of US and international practices, as well as of existing data, to assess the applicability to conditions prevailing in Texas, (2) a thorough evaluation of structures already constructed in Texas, as well as of an integral bridge that will be constructed in 2016 in Texas by FHWA Federal Lands, and (3) a set of design details for using this technology in Texas conditions.

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021

FY'21 TMA
FY'21 TMB

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$123,730.73	$98,984.58	$24,746.15

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-6958 **University:** TTI

Project Title: Developing Performance Specification for High Performance Concrete

Project Start Date: 9/1/2017 **Termination Date:** 4/30/2022

Project Status: Active **Total Project Budget:** $742,586.00

RTI Project Manager: Tom Schwerdt **Researcher:** Anol Mukhopadhyay

Project Objectives: In the past, achieving high strength was considered by the Receiving Agency as the main design criteria to formulate high performance concrete. The Receiving Agency considers mix design options 1-4 in item 421 as high performance concrete (HPC) and these options were developed for ASR mitigation and not for other durability aspects. Very little work has been done to determine if these options are adequate to provide long-term durability often needed when HPC is specified. The main objective of this study is to develop performance specification for high performance concrete in order to ensure high performance in terms of durability. The Performing Agency will conduct a combination of both field investigation and laboratory study in order to achieve this objective. The Performing Agency shall use both conventional and innovative new lab testing methods to determine the key performance characteristics (i.e., prescribing acceptable limits of permeability, shrinkage, surface resistivity, and chloride ingress - basis for developing performance specification) followed by developing specific prescriptive requirements in order to formulate wide varieties of prescriptive mixes that can meet the durability requirements matching with different exposure conditions. A combined approach of relating mix design parameters, lab based durability test results, mechanical properties, structural dimensions, climatic conditions, and / exposure conditions through suitable service life prediction model and predicting will be used to ensure long term durability (at least 75 years) for the HPCs in typical aggressive environments. This will lead to develop performance- and prescriptive-based concrete specifications for HPC. This could potentially encourage contractors to effectively use these fine-tuned prescriptive HPC mixtures without the need of conducing additional long duration testing and ensure making long lasting durable concrete and save taxpayers' dollars.

Deliverables:

P3A
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021
August MPR 2020

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$159,850.00	$127,880.00	$31,970.00

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-6982 **University:** TTI

Project Title: Utilization of UHPC Bridge Superstructures in Texas

Project Start Date: 9/1/2018 **Termination Date:** 8/31/2022

Project Status: Active **Total Project Budget:** $1,410,992.75

RTI Project Manager: Tom Schwerdt **Researcher:** Mary Beth Hueste

Project Objectives: The Receiving Agency has led the nation in developing innovative bridge design and construction solutions for decades through its strong research and development programs. This project aims to extend this progressive tradition. The use of ultra-high performance concrete (UHPC) in Texas bridges has the potential of producing substantial improvements to bridge construction. For example, the recent Malaysian experience with UHPC proved the fact that bridge superstructure weight can be reduced by 40 percent. For long-span bridges, such self-weight reductions can result in significant design and construction benefits. Within this context, this projects aims to identify the applications in which the use of UHPC can be leveraged to develop new structural systems.

The three major technical objectives of this research are outlined in the project statement as follows-1) Conduct an analytical feasibility study to identify the material properties for which a nonproprietary UHPC mixture design should be developed to deliver the optimal design benefits, 2) Develop a nonproprietary concrete mixture design to meet the needs identified in Technical Objective1 and, 3) Conduct experiments (full-scale and material-level) to study long-term mechanical properties (for example tensile creep) in an effort to eliminate or minimize the use of ordinary reinforcing bars in UHPC applications.

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021
TM5

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$394,751.00	$315,800.80	$78,950.20

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Structures and Hydraulics

Project Number: 0-7011 **University:** CTR

Project Title: Evaluation of Seamless Bridges

Project Start Date: 7/19/2019 **Termination Date:** 8/31/2023

Project Status: Active **Total Project Budget:** $810,497.00

RTI Project Manager: Joanne Steele **Researcher:** Todd Helwig

Project Objectives: Conventional bridges use expansion joints to accommodate movements primarily caused by temperature changes in the bridge superstructure. However, water and contaminants that pass through the joints tend to accelerate deterioration of girders, bearings and substructure elements. The seamless bridge concept, which was first developed in Australia, eliminates the use of expansion joints between the bridge deck and the continuously reinforced concrete pavement (CRCP). Implementation of this technology has been reported to delay deterioration of bridge elements and totally eliminates the need for routine joint maintenance. In this project, the Research Team shall conduct fundamental and applied research techniques to develop comprehensive design guidelines for implementing seamless bridge technology in Texas. The primary goals of the project include the following: (a) characterize the interaction between CRCP in a transition slab and different base materials with and without bond breakers utilizing full-scale experiments, (b) develop modeling techniques to analyze the structural response of seamless bridge systems, develop guidelines for determining the optimal length of the transition slab and corresponding reinforcing steel, (d) identify design issues associated with the use of a seamless connection for standard bridge structures, and monitor the field performance of a bridge constructed using a seamless transition.

Deliverables: TM3.2A
Int. TMA (interim update for ongoing tasks)
August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021

February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021
July MPR Excel format 2021
TM3.2A Word format

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$234,732.50	$187,786.00	$46,946.50

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7012 **University:** CTR

Project Title: Development of Non-Fracture Critical Steel Box Straddle Caps

Project Start Date: 7/9/2019 **Termination Date:** 10/31/2022

Project Status: Active **Total Project Budget:** $989,286.00

RTI Project Manager: Martin Dassi **Researcher:** Todd Helwig

Project Objectives: Steel box straddle caps are commonly utilized in congested urban environments when intersecting roadways do not permit conventional piers. The high strength-to-weight ratio of steel makes the straddle caps efficient from a construction and performance perspective; however, the members are categorized as fracture-critical, necessitating more stringent design requirements and biennial hands-on inspections—creating significant long-term costs. The Performing Agency shall develop details that allow the straddle box caps to be classified as redundant members, removing the fracture-critical designation on the caps. The study shall not only target on new construction, but also evaluate methods of retrofitting existing caps to develop desired redundancy. The Performing Agency shall investigate the use of prestressing tendons/bars to provide redundancy to the steel box straddle caps. The methods of research include full-scale laboratory testing consisting of fatigue loading to initiate cracks and fracture tests under static loading on post-tensioned straddle box caps. Computational models shall be used to develop a comprehensive design methodology for system redundant straddle caps that are non-fracture-critical. The systems developed shall create significant benefits in both the life-cycle economy and long-term performance of steel straddle caps.

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021
TM5
TM FY21

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$367,637.00	$294,109.60	$73,527.40

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7013 **University:** TTI

Project Title: Performance and Improvement of Texas Poor Boy Continuous Bridge Deck Details

Project Start Date: 6/28/2019 **Termination Date:** 8/31/2023

Project Status: Active **Total Project Budget:** $727,298.00

RTI Project Manager: Martin Dassi **Researcher:** Anna Birely

Project Objectives: The majority of bridges in Texas are constructed with girders as simple spans. A simple-span deck requires expansion joints which are sources for maintenance and durability issues. To avoid this, continuous decks are an attractive option, however cracks may develop. The Receiving Agency uses a detail that intentionally forms cracks, referred to as the "Texas Poor Boy" detail. Despite a four decade history of such detailing, a comprehensive evaluation of performance of this detailing has not been conducted.

The Performing Agency shall conduct a multi-tiered survey to identify the performance of the current "Poor Boy" continuous bridge deck details within different environments (high ADT, high rainfall, or high deicing salt zones), as well as a literature and state-of-the practice survey to establish the detailing and expected performance of alternative connection designs. Using the results of these surveys, the Performing Agency shall develop candidate modifications to the current poor-boy details for new construction and candidate details for rehabilitation of existing bridges. The Performing Agency shall use modeling and full-scale experimental tests to assess the performance of the recommended details. The Performing Agency shall use the results of modeling and experimental to make final recommendations for design methodologies and details.

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR with related specimen drawing 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021
TM3
TM4

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$183,561.00	$146,848.80	$36,712.20

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7015 **University:** CTR

Project Title: Analyze Shear Capacity of Texas Standard Prestressed Beams from Strut-and-Tie Models of Beam Ends

Project Start Date: 7/17/2019 **Termination Date:** 10/31/2021

Project Status: Active **Total Project Budget:** $399,736.00

RTI Project Manager: Joanne Steele **Researcher:** Oguzhan Bayrak

Project Objectives: Article 5.7.3.2 of AASHTO LRFD includes design guidance for sections near supports. This AASHTO design provision, i.e., the 0.18 f ′c limit, has been put in place to ensure that the complicated nature of stresses are accounted for while transferring the forces in the B-region to the simply supported ends of pretensioned girders. The 0.18 f ′c shear stress limit can be exceeded if load transfer into the supports can be justified by appropriate strut and tie models (STMs). Bridge designers find these STMs to be difficult to create. For Tx-Girders near their span limit, the bottom flange is nearly full of prestressing steel, and the web will have harped strands over a significant height. For U-beams, X-beams, slab beams, decked slab beams, and box beams, there will be many debonded strands to different lengths in addition to strands bonded over the entire beam length. This project aims to create a series of STMs for the end regions of Tx-Girders, U-beams, box beams, X-beams, slab beams, and decked slab beams. These STMs will be used to study the interaction between shear, flexure, and the anchorage of longitudinal tie(s) with the ultimate goal of deriving simplified shear stress limits.

Deliverables:
TM2
TM4
TM5
TM6
TM7
August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021

April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$174,652.00	$139,721.60	$34,930.40

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7016 **University:** CTR

Project Title: Develop Guidance for Structural Behavior of Tall Haunches in TxDOT Beam and Girder Bridge

Project Start Date: 7/10/2019 **Termination Date:** 10/31/2022

Project Status: Active **Total Project Budget:** $990,349.00

RTI Project Manager: Martin Dassi **Researcher:** Eric Williamson

Project Objectives: Deck haunches are commonly used onboth prestressed concrete and structural steel girder bridges. The haunch isthe area between the top of a bridgegirder and the bottom of the concrete deck. Haunch geometry can be influenced by a variety of factors. A primary function of the haunch is tomaintain a uniform deck thickness. Haunches are often needed to account for camber and cross-slope.Due to unusual geometric situations or design errors, beam and girder bridges sometimes require tall haunches, which calls into question the overall constructability and horizontal shear transfer between the girders and the deck. To date, no testing has been conducted to ensure the effectiveness of currentTxDOT detailing practices. The proposed project will develop guidelines for analyzing and designing haunches having different heightsand reinforcement detailing. The research will include full-scale laboratory testing ofa wide range of haunch detailsforboth prestressed concrete and structural steelgirder bridges. Detailed computational models will alsobe developed. Aparametric studywill represent the range of dimensions encountered for the vast majority of Texas bridges.Haunch analysis, design, and detailing guidelines will be provided at the conclusion of this project.

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021

July MPR 2021
TM3
TM FY21
TM3B

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$338,265.00	$270,612.00	$67,653.00

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7017 **University:** TXST

Project Title: Use of Rapid Setting Hydraulic Cement (RSHC) for Structural Applications

Project Start Date: 7/3/2019 **Termination Date:** 8/30/2022

Project Status: Active **Total Project Budget:** $465,000.00

RTI Project Manager: Martin Dassi **Researcher:** Federico Aguayo

Project Objectives: The goal of this project is to determine feasibility of using rapid setting cements as a cost effective solution for structural applicationsin Texas, specifically in bridge structural componentsand decks. The Performing Agency, or "research team", will(1) synthesize relevant information available on rapid cements in published (and unpublished) literature, (2) conduct a survey of domestically available and structurally feasible rapid setting cements for use in TxDOT bridge deck construction, (3) perform a comprehensive experimental evaluation covering a range of fresh and hardened material propertiesfor calcium sufloaluminate (CSA) cement, calcium aluminate cement (CAC), Type III cement,and combinations of all three,(4)verify and demonstrate adequate performance characteristic and durability performance based on laboratory testing,(5) correlate performance characteristics with material and placement costs (6) and develop guidelines and specification for implementation of rapid setting cements for bridge structures and decks in Texas.

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021
TM FY21A
TM FY21B

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$186,337.00	$149,069.60	$37,267.40

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7038 **University:** TTI

Project Title: Develop Bridge Weigh-in-Motion Approach to Measure Live Loads on Texas Highways

Project Start Date: 10/21/2019 **Termination Date:** 10/31/2022

Project Status: Active **Total Project Budget:** $414,611.00

RTI Project Manager: Martin Dassi **Researcher:** Keith Pawelek

Project Objectives: The primary objective for bridge weigh-in-motion (B-WIM) systems is to characterize the truck loading on a given corridor. B-WIM (compared to pavement weigh-in-motion) is potentially less disruptive to traffic, more durable, more economical, safer to install and able to produce accurate traffic data. This project aims to realize these potential advantages through the development of a B-WIM system that includes extensive experimental testing. The system shall identify the truck gross weight, axles (weights, number and spacing), speed and vehicle classification. A secondary objective of B-WIM is to evaluate the bridge itself. The Performing Agency shall develop an approach to identify bridge parameters such as distribution factors, percent composite action, dynamic impact factor, and stress cycles from B-WIM data. The Performing Agency shall include site-specific load ratings on the final bridge evaluations. The overall purpose of B-WIM is to aid the Receiving Agency with future decisions. The major technical objectives of this research are to: 1. Develop and finalize the B-WIM approach through preliminary experimental testing. 2. Select three (3) bridges to install B-WIM systems along crucial corridors. 3. Install the B-WIM system along three (3) in-service bridges, which includes calibration of each setup. 4. Conduct traffic data analysis and a validation study. 5. Perform an evaluation of each in-service bridge.

Deliverables:
August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021

May MPR 2021
June MPR 2021
July MPR 2021
TM-4
ITM-5
ITM-6

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$136,083.00	$108,866.40	$27,216.60

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7039 **University:** CTR

Project Title: Development of Knowledge in the Application of Strut-and-Tie Modeling

Project Start Date: 12/16/2019 **Termination Date:** 12/31/2022

Project Status: Active **Total Project Budget:** $999,908.86

RTI Project Manager: Martin Dassi **Researcher:** Oguzhan Bayrak

Project Objectives: The Performing Agency shall fill knowledge gaps in the 2017 AASHTO LRFD Bridge Design Specifications including but not limited to:
1. Strength of nodes in which tension fields in three orthogonal direction are present.
2. Stress concentrations observed at curved bar nodes (locations where the reinforcing bars change direction) can be critical. The tighter the radius of the bend, the higher these stresses are. Development of design recommendations for this special class of CTT nodes has not yet occurred in the U.S., due to lack of supporting test data.
3. Triaxial confinement benefits offered by confining reinforcement have not been researched and codified.
4. AASHTO LRFD Bridge Design Specifications limit the spacing of crack control reinforcing to d/4 or 12 in, i.e., “d/4 limit”. This limit can be relaxed, if supported by experimental evidence.

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021
TMFY21

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$364,425.19	$291,540.15	$72,885.04

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7040 **University:** TTI

Project Title: Evaluation of Corrosion Prevention and Mitigation Approaches Used On Texas Bridges

Project Start Date: 12/1/2019 **Termination Date:** 11/30/2023

Project Status: Active **Total Project Budget:** $856,909.50

RTI Project Manager: Tom Schwerdt **Researcher:** Stefan Hurlebaus

Project Objectives: Corrosion of steel has been causing millions of dollars of loss in infrastructure to the state of Texas. The use of corrosion-resistant reinforcement in concrete structures and painting of steel elements have been the most common mitigation strategies. In addition, the use of weathering steel, metalizing on steel and concrete elements, and cathodic protection (sacrificial anode) have also been applied on the Receiving Agency bridges. The performances of different approaches vary with different bridges in different geographic areas; i.e., cold, arid, and humid districts. It is imperative for the Receiving Agency to have a decision tool to conduct effective corrosion prevention for new construction and corrosion mitigation for effective maintenance.The project objectives are to (1) conduct a synthesis of worldwide field investigations of the performance of corrosion mitigation, (2) perform field evaluations statewide to investigate the effectiveness of corrosion mitigation instrumented in the past, and to (3) perform lab tests, as necessary, to verify findings and to obtain a better understanding of corrosion mitigation approaches.

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021
ITM3

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$224,195.50	$179,356.40	$44,839.10

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7041 **University:** CTR

Project Title: Develop NextGen Texas Bridge Decks

Project Start Date: 12/9/2019 **Termination Date:** 5/31/2023

Project Status: Active **Total Project Budget:** $1,066,698.18

RTI Project Manager: Martin Dassi **Researcher:** Oguzhan Bayrak

Project Objectives: The Performing Agency shall conduct a comprehensive experimental and analytical investigation to develop appropriate design criteria for using partial-depth precast panels that can span the full width of bridge superstructure. The Performing Agency shall develop and validate a precast deck panel system with wire trusses that will integrate with precast panel practices in Texas. The Performing Agency shall study the behavior of full-scale bridge superstructure models under design loads, typical overloads, and at ultimate conditions. The Performing Agency shall develop and test standard details for partial-depth deck panels in the laboratory for use in the Receiving Agency's standards for bridges constructed in Texas. The Performing Agency shall provide design guidelines that reflect the knowledge developed during the course of the project's experimental and analytical investigations.

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021
TM2
TMFY21

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$365,015.00	$292,012.00	$73,003.00

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7042 **University:** CTR

Project Title: Use of Larger Diameter Shear Studs for Composite Steel Bridges

Project Start Date: 12/17/2019 **Termination Date:** 12/31/2022

Project Status: Active **Total Project Budget:** $980,914.60

RTI Project Manager: Jade Adediwura **Researcher:** Michael Engelhardt

Project Objectives: Efficient steel bridge girder design makes use of composite action between the concrete bridge deck and the steel girders. Shear studs welded to the girder top flange provide the critical link between the deck and girders. Satisfying AASHTO fatigue requirements normally leads to a very large number of shear studs, which makes placing partial-depth precast panels extremely difficult and results in a safety hazard for workers during erection or early construction stages. Using larger-diameter shear studs shall significantly reduce the number of studs required on composite steel girders. This project focuses on the feasibility of using shear stud diameters greater than 7/8 inch for composite steel bridge construction, and the development of design guidelines for evaluating the static and fatigue strength of larger diameter shear studs. The Performing Agency shall perform:
1. laboratory testing using push-out or similar specimens to obtain data to evaluate both the static strength and fatigue strength of larger diameter shear studs.
2. large-scale composite beam tests and associated computational studies to provide an evaluation of the performance of composite steel bridge girders with larger diameter shear studs.

Deliverables:
August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021

TM3
TM4
TM5

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$343,109.96	$274,487.97	$68,621.99

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7068 **University:** UTA

Project Title: Identify and Analyze Inundated Bridge Superstructures in High Velocity Flood Events

Project Start Date: 10/21/2019 **Termination Date:** 10/31/2021

Project Status: Active **Total Project Budget:** $223,742.50

RTI Project Manager: Martin Dassi **Researcher:** Habib Ahmari

Project Objectives: Bridges are designed to withstand flood and debris loads; however, it is reported that 53% of bridge failures in the US are caused by hydraulic events, including floods, scour, debris, and drifts. The Receiving Agency's design policy requires shear keys in stream crossings based on a freeboard 100-year flood level. The design policy is not applicable to bridges with significant stream velocity and debris in 25- and 50-year floods.

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
TM4
TM5
R1A

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$101,477.75	$81,182.20	$20,295.55

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7088 **University:** CTR

Project Title: Develop Closure Joint Materials Specification and Evaluate Performance for Side-By-Side Accelerated Bridge Construction (ABC) Superstructure Systems

Project Start Date: 9/1/2020 **Termination Date:** 8/31/2023

Project Status: Active **Total Project Budget:** $778,500.00

RTI Project Manager: Martin Dassi **Researcher:** Kevin J. Folliard

Project Objectives: The Performing Agency shall develop, investigate, and implement optimized concrete mixtures to be used in closure pour connections between precast elements in side-by-side accelerated bridge construction (ABC) superstructure systems. The Performing Agency shall:

- Involve the use of innovative materials and mixture proportions that are intended to provide high early strengths to facilitate accelerated bridge construction, while ensuring that good long-term durability is also achieved.
- Develop mixtures including rapid-setting, fiber-reinforced concrete (RSFRC) and ultra-high-performance concrete (UHPC).
- Evaluate in the laboratory (materials and full-scale structural testing) and on outdoor exposures to fully characterize the critical fresh, hardened, structural, and durability properties that are need for closure pour connections.
- Select for full-scale implementation and monitoring in ABC projects scheduled for construction in the Amarillo, Bryan, and Dallas Districts based on the findings of the literature review and laboratory/exposure site tests, candidate RSFRC and UHPC mixtures.
- Develop a suite of mixtures by developing a wide range of mixtures with varying rheological properties, strength gain characteristics, and toughness values from which the Receiving Agency may select for any given closure pour connection.

Deliverables:

September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021
TM2
TMFY21

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$245,722.95	$196,578.36	$49,144.59

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7089 **University:** CTR

Project Title: Develop and Validate Precast Column Solutions for Texas Bridges

Project Start Date: 9/1/2020 **Termination Date:** 8/31/2023

Project Status: Active **Total Project Budget:** $991,199.72

RTI Project Manager: Jade Adediwura **Researcher:** Oguzhan Bayrak

Project Objectives: The Performing Agency shall develop and validate practical standard designs and connection details for precast concrete columns. The Performing Agency shall provide the following:

- Develop cost-effective bridge column solutions employing precast solid sections and precast hollow sections with a cast-in-place (CIP) core.
- Characterize the composite behavior between precast elements and CIP concrete in precast shell columns and socket connections.
- Conduct large-scale laboratory tests to validate the constructability and structural performance of the proposed precast column systems and connections.
- Develop design guidelines and draft specifications for implementation of precast columns in Texas bridges.

Deliverables:

September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021
TM2
TM3

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$269,145.46	$215316.37	$53,829.09

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7090 **University:** CTR

Project Title: Evaluate the Deployment of High Strength Reinforcing Steel in Texas

Project Start Date: 9/1/2020 **Termination Date:** 8/31/2023

Project Status: Active **Total Project Budget:** $999,898.30

RTI Project Manager: Martin Dassi **Researcher:** Oguzhan Bayrak

Project Objectives: The Performing Agency shall:

- Demystify the use of high strength reinforcing steel in Texas bridge design in Phase 1. This shall be accomplished through examination of Texas bridge components and systems. Phase 1 shall address where and when it makes sense to use high strength reinforcing, what benefits can be realized, who else is using high strength reinforcing and how they are using it.
- Supplement Phase 1 through a series of analytical and experimental test programs covering a wide range of structural bridge components in Phase 2. This shall include realistically scaled structural testing in combination with numerical modeling to address data gaps related to serviceability performance and ultimate strength behavior.

Deliverables:

October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021
TM2
TM5
TMFY21

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$226,833.27	$181,466.62	$45,366.65

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7093 **University:** CTR

Project Title: Develop Refined Design Methods for Lean-On Bracing

Project Start Date: 9/1/2020 **Termination Date:** 8/31/2023

Project Status: Active **Total Project Budget:** $980,000.00

RTI Project Manager: Martin Dassi **Researcher:** Todd Helwig

Project Objectives: The Performing Agencies shall instrument and conduct field monitoring of bridges with lean-on bracing identified in Task 3. The monitoring shall include bridges under construction and also completed bridges subjected to controlled loading using trucks to better understand the behavior described in Tasks 2, 4 and 7. The Performing Agencies shall carry out parametric Finite Element Analyses (FEA) along with the field monitoring and develop improved guidelines to facilitate widespread use of lean-on bracing applications in Texas bridges.

Deliverables:

September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021
TM2
TM3
TM3 and 4A combined
TMFY21

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$150,000.00	$120,000.00	$30,000.00

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7093 **University:** TTI

Project Title: Develop Refined Design Methods for Lean-On Bracing

Project Start Date: 9/1/2020 **Termination Date:** 8/31/2023

Project Status: Active **Total Project Budget:** $980,000.00

RTI Project Manager: Martin Dassi **Researcher:** Todd Helwig

Project Objectives: The Performing Agencies shall instrument and conduct field monitoring of bridges with lean-on bracing identified in Task 3. The monitoring shall include bridges under construction and also completed bridges subjected to controlled loading using trucks to better understand the behavior described in Tasks 2, 4 and 7. The Performing Agencies shall carry out parametric Finite Element Analyses (FEA) along with the field monitoring and develop improved guidelines to facilitate widespread use of lean-on bracing applications in Texas bridges.

Deliverables:

September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021
TM2
TM3
TM3 and 4A combined
TMFY21

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$95,000.00	$76,000.00	$19,000.00

Project Number: 0-7095 **University:** CTR

Project Title: Evaluate Improved Streamflow Measurement at TxDOT Bridges

Project Start Date: 9/1/2020 **Termination Date:** 8/31/2023

Project Status: Active **Total Project Budget:** $6,381,589.00

RTI Project Manager: Shelley Pridgen **Researcher:** David R. Maidment

Project Objectives: The Receiving Agency maintains 30,000 bridges, some of which have been threatened by flooding, especially during the past four years. Better information on forecast flood inundation would help anticipate bridge and road flooding; inform decisions before, during, and after flooding; and help deploy resources for bridge inspection after flooding is over. The National Weather Service began in August 2016 operating a National Water Model, continually providing real-time forecasting on 190,000 miles of Texas streams and rivers. This project shall establish and maintain a Receiving Agency Flood Monitoring Network that consists of 80 gauges—60 new gauges installed as part of this project and 20 existing gauges installed as part of a previous Receiving Agency project. The new gauges shall be located in watersheds as defined by the USGS or TWDB, selected to provide a range of observation on main stem and tributary rivers and on soil and slope conditions in Texas river and coastal basins, and shall be complementary to existing observation networks. Observational data from the gauges and flood forecast information shall be made accessible through a Receiving Agency Flood Forecast System and Operational Data Website.

Deliverables:

September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021
TM3Q1

TM3Q2
P4A
TM3Q3
P6B1
TM2
TM3Q4

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$1,728,999.21	$1,383,199.37	$345,799.84

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7095 **University:** USGS

Project Title: Evaluate Improved Streamflow Measurement at TxDOT Bridges

Project Start Date: 9/1/2020 **Termination Date:** 8/31/2023

Project Status: Active **Total Project Budget:** $6,381,589.00

RTI Project Manager: Shelley Pridgen **Researcher:** David R. Maidment

Project Objectives: The Receiving Agency maintains 30,000 bridges, some of which have been threatened by flooding, especially during the past four years. Better information on forecast flood inundation would help anticipate bridge and road flooding; inform decisions before, during, and after flooding; and help deploy resources for bridge inspection after flooding is over. The National Weather Service began in August 2016 operating a National Water Model, continually providing real-time forecasting on 190,000 miles of Texas streams and rivers. This project shall establish and maintain a Receiving Agency Flood Monitoring Network that consists of 80 gauges—60 new gauges installed as part of this project and 20 existing gauges installed as part of a previous Receiving Agency project. The new gauges shall be located in watersheds as defined by the USGS or TWDB, selected to provide a range of observation on main stem and tributary rivers and on soil and slope conditions in Texas river and coastal basins, and shall be complementary to existing observation networks. Observational data from the gauges and flood forecast information shall be made accessible through a Receiving Agency Flood Forecast System and Operational Data Website.

Deliverables:
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021
TM3Q1

TM3Q2
P4A
TM3Q3
P6B1
TM2
TM3Q4

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$894,350.00	$715,480.00	$178,870.00

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 5-6652-01 **University:** CTR

Project Title: Shear Behavior of Spliced Post-Tensioned Girders with Ungrouted Tendons

Project Start Date: 5/14/2019 **Termination Date:** 5/31/2022

Project Status: Active **Total Project Budget:** $428,142.42

RTI Project Manager: Joanne Steele **Researcher:** Oguzhan Bayrak

Project Objectives: The objective of this Implementation Project is to test the implementation of the previously developed research products for cases in which ducts are not grouted or are filled with flexible fillers such as wax. By conducting targeted tests on Receiving Agency spliced girders with ungrouted tendons, the implementation of the previously developed design expressions to such cases shall be accomplished. The calibration of shear capacity reduction factors that consider the influence of duct size and duct material shall be necessary. The case of ungrouted tendons is pertinent to intermediate construction stages before bridges are completed or in cases where Receiving Agency may consider using fillers that have not been tested or used previously.

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$155,998.98	$124,799.18	$31,199.80

Project Number: 5-6950-01 **University:** UTSA

Project Title: Implementation of Evaluating Bridge Behavior Using Ultra High-Resolution Digital Imaging Correlation (DIC)

Project Start Date: 7/1/2021 **Termination Date:** 8/31/2022

Project Status: Active **Total Project Budget:** $83,176.25

RTI Project Manager: Tom Schwerdt **Researcher:** Wassim M. Ghannoum

Project Objectives: The recently developed Civil Infrastructure Vision (CIV) system, under Project 0-6950), now allows the Receiving Agency to conduct bridge or culvert load testing in house at a fraction of the cost of hiring an outside contractor to conduct the load test. Additional training is needed for Receiving Agency'semployees that will be using the system from the Performing Agency team that developed the system. The Performing Agency shall evaluate/load rate up to 10 bridges between July1, 2021 and August 31, 2022 in coordination with TxDOT Bridge Division (BRG). Bridges shall be statewide and selected by BRG, with the first currently planned for Waco District (WAC). The Receiving Agency employees shallbe trained in the Digital Image Correlation (DIC) system hands-on during the load testing.Following the Implementation BRG shall be able to perform this testing inhouse, with per-bridge costs reduced to little more than travel expenses. The Receiving Agency owns the fully functional DIC system developed on Project 0-6950 and shall require training/experience to properly utilize it.This project was just selected for the 2021 AASHTO High Value Research Award, the "Sweet 16".

Deliverables: July MPR 2021

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$22,413.75	$17,931.00	$4,482.75

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Table 17. Structures and Hydraulics Totals for Continuing Projects

Financials	Budget	Expended	Balance
Federal 80%	$6,122,172.10	$5,420,337.50	$701,834.60
TDC 20%	$1,530,543.02	$1,355,084.37	$175,458.65
Total	**$7,652,715.12**	**$6,775,421.87**	**$877,293.25**

2.2.5 Safety and Operations

Project Number: 0-6994 **University:** TTI

Project Title: Develop a Retrofit Design for Guard Fence System to Enhance Motorcycle Safety

Project Start Date: 9/1/2018 **Termination Date:** 4/30/2022

Project Status: Active **Total Project Budget:** $740,871.00

RTI Project Manager: Wade Odell **Researcher:** Chiara Silvestri Dobrovolny

Project Objectives: Motorcyclists are among the most vulnerable users of the road system and the appropriate design of roadside safety systems plays an important role in the severity of motorcycle crashes.Data show that from 2004, the number of fatalities related to motorcycle impact against safety barriers was greater than the number of fatalities recorded from the impact of passenger car users against same roadside safety devices.

Although there are no guidelines addressing proper test and use of motorcycle retrofit barriers, there is a need to develop an appropriately designed guardrail system retrofit to address motorcycle-rider fatalities associated with barrier impacts, which can happen with the rider being either in a sliding or upright position. The Performing Agency shall consider such a retrofit system for placement on appropriate high speed roadways at locations that are more likely to be associated with motorcycle impact fatalities and severe injuries. The Performing Agency shall develop an appropriate motorcycle- friendly retrofit guard fence system for evaluation to determine its compliance with the 2016 Manual for Assessing Safety Hardware (MASH), per Federal Highway Administration (FHWA) requirement.

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
TM8 Stand alone
March MPR 2021

April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$109,638.00	$87,710.40	$21,927.60

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7004 **University:** TTI

Project Title: Improve System Emergency Response Performance in the Houston District Using Connected Vehicle Technology

Project Start Date: 7/18/2019 **Termination Date:** 12/31/2022

Project Status: Active **Total Project Budget:** $468,058.50

RTI Project Manager: Wade Odell **Researcher:** Hongmin Zhou

Project Objectives: Emergency response services play a vital role in saving lives and minimizing property damage when major events or incidents happen. The Dedicated Short Range Communication (DSRC) and Bluetooth Low Energy (BLE) technologies have the potential to improve the efficiency and roadway safety related to emergency management services. The primary objective of this project is to develop and test DSRC- and BLE-based prototype systems for enhancing emergency preemption and notification. Another objective is to provide the Receiving Agency with guidelines for implementing DSRC and BLE technologies for supporting emergency response services. To this end, the Performing Agency shall: (1) Identify methodologies for improving emergency vehicle signal preemption in a connected environment; (2) Develop and test prototype DSRC-based and BLE-based systems to broadcast Signal Phase and Time (SPaT) messages, Emergency Vehicle Alerts (EVAs), and other notifications to emergency vehicles and other roadway users in the vicinity; (3) Enhance signal preemption performance; (4) Assist the Receiving Agency in implementing the prototype systems at selected Houston field sites; and (5) Identify anticipated cost and benefit of the connected emergency response system. The key products of the project include DSRC and BLE prototype systems that operate with the Receiving Agency's infrastructure and guidelines for implementing the system.

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021

April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021
TM4A
DD-1A

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$120,005.25	$96,004.20	$24,001.05

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7007 **University:** CTR

Project Title: Weather-Responsive Management Strategies

Project Start Date: 6/3/2019 **Termination Date:** 5/31/2022

Project Status: Active **Total Project Budget:** $588,583.08

RTI Project Manager: Wade Odell **Researcher:** Chandra Bhat

Project Objectives: Weather-responsive management and maintenance strategies are innovative approaches to traffic operations management and roadway maintenance that mitigate the effects of adverse weather on the transportation system. Desired outcomes of these strategies include reduced weather-related vehicle crashes, decreased delays, improved mobility, and environmental benefits. This project shall demonstrate a strategy to improve safety and reliability to reduce costs and improve dissemination of information to travellers via roadway ice maintenance and traffic operations integrations. The demonstrated strategy leverages mobile and connected vehicle data, as well as weather-related data sources, to closely track Receiving Agency ice prevention and response activities, public driving patterns, and regional precipitation. The outcome is to optimize the application of anti-icing agent and ice removal activities, as well as to inform travellers of road conditions and treatment progress. With this demonstration, this project enhances the value of current and future strategy implementation by showcasing data archiving and analysis processes that fit within the Receiving Agency IT architecture and cybersecurity model, actionable choices presented through decision support systems, better public awareness through relevant information dissemination strategies, system robustness through data quality checking, and better understanding through performance metrics. All of these elements are critical for any well-developed weather-responsive management and maintenance strategy.

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
TM5
TM6
TM7
P1 with 2 Appendices
P2
June MPR 2021
July MPR 2021

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$151,174.06	$120,939.25	$30,234.81

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7009 **University:** TTI

Project Title: Implementation of Automated Traffic Signal Performance Measures

Project Start Date: 8/8/2019 **Termination Date:** 8/31/2022

Project Status: Active **Total Project Budget:** $389,603.00

RTI Project Manager: Wade Odell **Researcher:** Srinivasa Sunkari

Project Objectives: Based on the concept of "what gets measured gets managed," Automated Traffic Signal Performance Measures (ATSPMs) use a suite of performance measures, data collection and data analysis tools to support objectives and performance based approaches to traffic signal operations, maintenance, management and design. ATSPMs provide the data that the Receiving Agency needs to adopt an objectives-driven, performance-based approach to managing traffic signal operations. In this project, Performing Agency shall conduct a review the state of practice related to the implementation and use of ATSPMs to enhance traffic signal performance. The Performing Agency shall then compare and contrast the use and implementation requirements of a minimum of three ATSPM software suites commonly available to the Receiving Agency. Based on this assessment, the Performing Agency shall develop prototype data-analysis techniques and tools to assist the Receiving Agency identify strategies and techniques for enhancing traffic signals. The Performing Agency shall use the lessons learned and results of the assessment to develop recommendations and guidelines for the Receiving Agency Districts on deploying and using ATSPMs to assess and improve traffic signal performance and operations.

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April; MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021

TM4
TM3B

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$126,278.00	$101,022.40	$25,255.60

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7029 **University:** TTI

Project Title: Evaluation of the Performance of Rumble Strips on Pavements Where Seal Coats Have Been Applied

Project Start Date: 7/10/2019 **Termination Date:** 2/28/2022

Project Status: Active **Total Project Budget:** $353,647.25

RTI Project Manager: Shelley Pridgen **Researcher:** Bryan Wilson

Project Objectives: The repeated application of seal coats on pavements with rumble strips may reduce the effectiveness of the rumble strips to alert drivers of inadvertent lane departures. The goal of this project is to determine how many layers of seal coat can be applied on a pavement with rumble strips before rumble strip performance and, consequently, driver safety is compromised. The Proposing Agency shall: 1) Review the literature for rumble strip performance thresholds for safety specifically relating to noise and vibration. 2) Develop a field-based testing plan using a statistical D-optimal design methodology. The plan will either be a before-after design of several projects scheduled for seal coat construction, or a repeated measures design of a few projects with controlled application and testing of multiple seal coat applications. Rumble strip location, seal coat grade, vehicle type, and speed are also considered. 3) Identify test sections according to the plan. 4) Measure interior noise and vibration for sections before and after seal coat application. Also measure texture with a laser profiler on select sections. 5) Determine how many seal coats result in an unacceptable drop in rumble strip performance. 6) Develop guidelines for the application of seal coat over existing rumble strips.

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$117,342.25	$93,873.80	$23,468.45

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7036 **University:** TTI

Project Title: Use of Roundabouts and Innovative Intersection Designs at High-Speed Intersections in Texas

Project Start Date: 8/6/2019 **Termination Date:** 7/31/2022

Project Status: Active **Total Project Budget:** $499,968.50

RTI Project Manager: Wade Odell **Researcher:** Marcus Brewer

Project Objectives: Rural high-speed roads continue to see increasedvolumes statewide. Traditionally,those roads might beconverted to limited-access highways under the speeds and volumes seen today, but that level of systematic conversion is not feasible. As a result, there are numerous at-grade access points on rural high-speed roads that introduce potentialoperational delays and safety concerns. Traditional at-grade intersections may not efficiently accommodate the demands increasingly found in many locations across Texas, particularly with increases in oversize/overweight (OSOW) vehicle volumes in some areas. Newer alternatives, such as modern roundabouts and innovative intersection designs, may be more suitable to improve safety and operations at many locations; however, guidance is needed toidentify suitable alternatives and develop appropriate design details for specificintersections.The Performing Agency shall investigate the operational and safety benefits of modern roundabouts and selected innovative intersection designs for high-speed locations, as well as best practices for designingthese intersection alternatives. In this project, the Performing Agency shall compile proven results from these designs in other states and collect and analyze operational and safety data within Texas to develop design guidance that the Receiving Agency can use to implement roundabout designs that accommodate OSOW vehicles and innovative intersections that provide appropriate access in rural areas.

Deliverables:
August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021

May MPR 2021
June MPR 2021
July MPR 2021

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$206,478.25	$165,182.60	$41,295.65

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7043 **University:** TTI

Project Title: Addressing Bicyclist Safety through the Development of Crash Modification Factors for Bikeway Facilities

Project Start Date: 11/5/2019 **Termination Date:** 4/30/2022

Project Status: Active **Total Project Budget:** $328,913.50

RTI Project Manager: Tom Schwerdt **Researcher:** Bahar Dadashova

Project Objectives: According to the Receiving Agency's Crash Record Information System (CRIS) database, there have been 26,148 crashes involving bicyclists (pedalcyclists) from 2010 to 2018 in Texas, resulting in 2,885 fatalities and suspected serious injuries (KA), and 22,937 non-incapacitating and possible injuries (BC). Overall, bicycle crashes as well as fatal and suspected serious injury crashes involving bicyclists have been on the rise. This trend could continue increasing partly due to the increasing demographics of millennials and the active population in major metroplex areas and energy sector corridor. Bicyclist safety concerns exist not only in cities and metropolitan areas but for the overall state highway network as well. On-system highways are usually in better condition than local roads in terms of riding surface, shoulder presence, driveway spacing, etc. hence more bicyclists use these roadways for training, recreational, and even commuting purposes. This shift, on the other hand, has very daunting safety implications; it is estimated that 33% of all bicyclist fatalities occur on state highways.

In this project, the Performing Agency shall develop crash reduction factors for bikeway facilities implemented on Texas roadways to assess their safety and economic effectiveness. Bikeway facilities include but are not limited to bike lanes, buffered bike lanes, advisory bike lanes, through bike lanes, sharrows (shared bike lanes), two-way cycle tracks, protected bike lanes and so on. This research will address the development of crash reduction factors for target crash types where sufficient bicycle facility information and crash information is available. To enable future cost-benefit assessments, the research will include an estimate of service life, installation, and maintenance costs of such facilities.

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021
TM-4
TM-4A

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$135,315.50	$108,252.40	$27,063.10

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7044 **University:** TTI

Project Title: Considerations for "Super 3" Cross-Section in High-Volume Rural Corridors with Turning Traffic

Project Start Date: 1/2/2020 **Termination Date:** 4/30/2022

Project Status: Active **Total Project Budget:** $338,945.00

RTI Project Manager: Wade Odell **Researcher:** Kay Fitzpatrick

Project Objectives: Rural high-speed two-lane roads continue to see increased volumes statewide. Traditionally, those roads might be converted to limited-access divided four-lane highways under the speeds and volumes seen today, but that level of systematic conversion is not feasible in every location. The Super 2 concept is being used across the state to provide passing opportunities and increase capacity on rural two-lane roads, but passing lanes are a treatment for through vehicles and do not address the needs of turning vehicles. As a result, there are numerous at-grade access points on rural high-speed roads that introduce potential operational delays and safety concerns, which may be compounded if passing lanes are added in locations with generators of large volumes of turning traffic.

The Performing Agency shall investigate the operational and safety benefits of intersection turning treatments on two-lane and Super 2 corridors, as well as best practices for designing these treatments. In this project, the Performing Agency shall use existing conditions on two-lane and Super 2 corridors with and without intersection turning treatments to develop computer simulation models for evaluating the effectiveness of such treatments on operations and safety. The Performing Agency shall use the evaluation results to updated guidelines that the Receiving Agency can use to implement turning treatments on sections in or near passing lanes.

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021
TM4

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$215,138.75	$172,111.00	$43,027.75

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7045 **University:** UTA

Project Title: Analyze the Use of Green Pavement Markings – Intersection Safety for Non-Motorized Users

Project Start Date: 5/26/2020 **Termination Date:** 5/31/2022

Project Status: Active **Total Project Budget:** $299,695.00

RTI Project Manager: Wade Odell **Researcher:** Katie Kam

Project Objectives: More communities are using green to delineate at intersections where cyclists should wait at a traffic signal, start a left turn, or cross the roadway. In 2011, the Federal Highway Administration issued a memo giving interim approval (IA-14) for the optional use of green colored pavement for bike lanes as a traffic control device for inclusion in the Manual on Uniform Traffic Control Devices (MUTCD).

The FHWA indicated that they found the green to be successful for bicycle applications because cyclists felt safer and drivers felt more aware that cyclists may be present. In addition, the National Association of City Transportation Officials (NACTO) included green pavement in their Bikeway Design Guide. The Receiving Agency has requested research into the safety and behavioral implications of using green colored pavement and their performance to help inform an agency opinion on their use in Texas communities and possible inclusion in the Texas MUTCD.

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021

TM2 with related TM spreadsheet and
GIS zip file link
TM2 V2/TM3

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$178,089.00	$142,471.20	$35,617.80

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7047 **University:** TTI

Project Title: Establish Guidelines for Designing Auxiliary Lanes on Frontage Roads

Project Start Date: 12/1/2019 **Termination Date:** 6/30/2022

Project Status: Active **Total Project Budget:** $330,627.00

RTI Project Manager: Shelley Pridgen **Researcher:** Ioannis Tsapakis

Project Objectives: Auxiliary Lanes (ALs) are used on frontage roads to help facilitate safe weaving, merging, and diverging traffic movements to and from the frontage roads at and between freeway ramp terminals. They help balance the trafficloadand provide transitions, vehicle storage, acceleration/deceleration to and from driveways, turnaround lanes,and interchange approaches and departures. Acceleration and deceleration lanes, climbing lanes, and right-and left-turn lanes are examples of AL types that can serve different purposes. There is limited guidance for designing ALs on frontage roadsat and between freeway ramp terminals. The goal of this project is to identify gaps in existing guidelines and develop design criteria for ALs on frontage roads. To address this goal the Performing Agency shall: a) review the literature and the state of practice in Texas; b) determine the conditions under which a certain typeof AL designimproves traffic operations; and c) conduct safety analyses to identify influential factors and develop crash prediction models that practitioners can use to determinehow the addition ofan AL with certain characteristics can affect safety.

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021
P1

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$137,883.25	$110,306.60	$27,576.65

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7048 **University:** CTR

Project Title: Identify Risk Factors that Lead to Increase in Fatal Pedestrian Crashes and Develop Countermeasures to Reverse Trend

Project Start Date: 12/17/2019 **Termination Date:** 12/31/2021

Project Status: Active **Total Project Budget:** $360,131.65

RTI Project Manager: Shelley Pridgen **Researcher:** Kara Kockelman

Project Objectives: The Performing Agency shall assemble a suite of relevant data sets across the State to deliver both aggregate and highly disaggregate analyses of pedestrian-crash data, reflecting exposure pattern variations by site and city, county and region, roadway and intersection design decisions, local economic and demographic conditions, climate and context.Using traditional econometric and artificial intelligence methods the Performing Agency shall anticipate which factors are at play in fatal and severe pedestrian crashes and identify all factors that increase such risks, in order to deliver a suite of cost-effective countermeasures and treatments to dramatically reverse the rise in pedestrian deaths across Texas.

Deliverables:
August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021
TM3
TM4
TM5

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$219,657.03	$175,725.62	$43,931.41

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7049 **University:** TTI

Project Title: Improving and Communicating Speed Management Practices

Project Start Date: 12/20/2019 **Termination Date:** 6/30/2022

Project Status: Active **Total Project Budget:** $446,016.25

RTI Project Manager: Shelley Pridgen **Researcher:** Kay Fitzpatrick

Project Objectives: Speed limits are among the most visible and routinely enforced traffic control devices motorists encounter in their everyday driving. They are also associated with safety in a broad range of forums, from neighborhood residents concerned with their children's safety to national safety agencies calling into question the rationale for speed limit setting procedures used by the vast majority of engineering practitioners. Given this high degree of exposure and scrutiny, speed limits – and the practices and procedures used to develop them, inform drivers, and help enforcement of them – must be appropriate for their environment, defensible from an engineering and legal perspective, and comprehensible to the full range of mobility and safety stakeholders. In short, speed limits are a highly complex engineering, human factors, and political issue belied by the simplicity of a black-on-white, two-digit regulatory sign.

This research work plan is designed to increase the profession's understanding of the fundamental relationships between posted and operating speed, develop consistent procedures for the establishment of posted speed limits and the use of technologies to increase driver awareness and comprehension, and provide content to support external and internal Receiving Agency dialog about speed limits and their development for all roadway environments. Historical procedures for posted speed limit setting based on 85th percentile speed will be leveraged for their utility, where appropriate, but revised to current practice based on sensitivity to roadway characteristics and driving environment context.

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021
TM4A
TM3B

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$246,793.00	$197,434.40	$49,358.60

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7050 **University:** CTR

Project Title: Improving the identification of curve-related crashes in the crash records information system (CRIS)

Project Start Date: 3/20/2020 **Termination Date:** 5/31/2022

Project Status: Active **Total Project Budget:** $209,041.00

RTI Project Manager: Jade Adediwura **Researcher:** Zhanmin Zhang

Project Objectives: About 38,000 fatal crashes occur every year in the United States, of which 25 percent are curverelated.

According to Federal Highway Administration, the average crash rate for horizontal curves is about three times that of other highway segment types. Curves also play a significant role in Texas. From 2010 to 2017, about 9 percent of all crashes and 22 percent of fatal crashes were curve-related. However, a recent analysis revealed that Crash Records Information System (CRIS) may substantially misclassify curve-related crashes. The CRIS variables missed about one-third of curve-related motorcycle crashes. In addition, the degree of misclassification appears to vary by crash severity. Consequently, the role of curves and their safety impact are underestimated.

Therefore, there is a need for better identification of curve-related crashes, methods for better understanding curve characteristics and their impact on crash risk and severity.

In this research project, the Performing Agency shall conduct comprehensive literature syntheses and critical review of curve-related crashes in CRIS; develop an effective methodological procedure that will be tested for improved identification of curve-related crashes and curve characteristics by using a small sample of data from databases such as the Geospatial Roadway Inventory Database (GRID), Texas roadway geometry, and CRIS database; and evaluate the performance of the developed procedure and analyze CRIS curve-related crash data to diagnose the reason of misclassification.

Deliverables:

TM2
TM3
TM4
August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$104,969.00	$83,975.20	$20,993.80

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7051 **University:** TTI

Project Title: Develop a Real-Time Decision Support Tool for Rural Roadway Safety Improvements

Project Start Date: 12/3/2019 **Termination Date:** 1/31/2022

Project Status: Active **Total Project Budget:** $300,000.00

RTI Project Manager: Shelley Pridgen **Researcher:** Subasish Das

Project Objectives: Roadway departure and speeding related crashes are the dominant types of crashes on rural roadways. As a result, the Texas Strategic Highway Safety Plan (SHSP) has identified them as two of the seven research emphasis areas for 2017-2022. Conventional crash risk analysis typically omits real-time speed, real-time volume, and weather data, significantly limiting safety predictive methods. To mitigate this research gap, the following three national databases can be combined: (1) National Performance Management Research Data Set (NPMRDS) with passenger and freight travel time data sets for the National Highway System (NHS) and other roadways; (2) Travel Monitoring Analysis System (TMAS) data with traffic volume data through both temporary traffic counting and continuous traffic counting programs; and (3) Real-time weather data from the National Oceanic and Atmospheric Administration (NOAA).Rural traffic crashes account for a disproportionate number of fatalities in comparison to urban crashes. In 2017, 53 percent of Texas crash fatalities occurred on rural roadways. Further research is necessary to reduce rural roadway crashes and allocate resources for rural roadway safety improvements, particularly research focusing on the SHSP areas of emphasis, including roadway departure and speeding-related crashes. The findings of such research should be integrated into TxDOT's future vision plans.To achieve the project goals, the Performing Agency shall leverage ongoing staff leadership and engagement with research from both the Rural Speed Safety Project for USDOT Safety Data Initiative (SDI) as well as the National Cooperative Highway Research Program (NCHRP 17-76). This research will provide updated safety performance functions for rural roadways and a decision support tool for exploring crash risk at both segment and segment-temporal levels.

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021
TM4
P2 Decision Support Tool, to include P2 Tech Memo, online tool, data and source code

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$153,199.00	$122,559.20	$30,639.80

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7052 **University:** TTI

Project Title: Evaluation of Surface Mounted Median Guardrail

Project Start Date: 2/1/2020 **Termination Date:** 1/31/2022

Project Status: Active **Total Project Budget:** $336,813.00

RTI Project Manager: Wade Odell **Researcher:** Nauman Sheikh

Project Objectives: Concrete median barriers are very commonly used in areas that have high Average Daily Traffic (ADT) or where there is higher chance of vehicle intruding into opposing lanes due to curves or other geometric features. Concrete barriers are generally expensive to construct and a metal rail median guardrail has the potential to reduce this cost. In a lot of urban and high traffic volume roadways, a median with soil is not available. This limits the use of existing guardrail systems since they require metal posts that are embedded in soil. The Performing Agency's approach aims to develop a metal rail median guardrail that can be mounted directly on concrete pavement. Such a design will allow the Receiving Agency to protect opposing traffic in a lot of areas where it was previously cost prohibitive to do so with concrete median barriers.

The Performing Agency shall develop a concept of surface mounted guardrail that shall meet the Manual for Assessing Safety Hardware (MASH) testing requirements for Test Level (TL) 3. The Performing Agency shall mature this concept through a series of component level dynamic impact testing and finite element (FE) simulation. The Performing Agency shall develop a full system model of the guardrail and perform vehicle impact simulations to determine the likelihood of the design to meet MASH testing requirements. As a final step, the Performing Agency shall conduct MASH Test 3-11 and Test 3-10 with a pickup truck and a small passenger car, respectively, to verify the performance of the new surface mounted guardrail design.

Deliverables:

TM3
TM4
August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$206,051.00	$164,840.80	$41,210.20

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7059 **University:** TTI

Project Title: Develop Guidelines for Inspection, Repair, and Use of Portable Concrete Barrier

Project Start Date: 11/1/2019 **Termination Date:** 5/31/2022

Project Status: Active **Total Project Budget:** $403,450.75

RTI Project Manager: Tom Schwerdt **Researcher:** Chiara Silvestri Dobrovolny

Project Objectives: The Manual for Assessing Safety Hardware (MASH) Implementation agreement allows State Transportation Agencies to continue the use of Portable Concrete Barriers (PCBs) manufactured on or before December 31, 2019 and successfully tested to NCHRP Report 350 or the 2009 edition of MASH, throughout their normal service life. Damage to the precast barriers can occur in transit, in storage, or due to vehicular impact. Often damage to the connections occurs, cracks in the barrier, corners broken and many other forms of damage can be sustained by the barrier. No federal guidance, however, has been developed to determine life expectancy for PCBs. There is a need to develop a guideline addressing the type and extent of barrier damage that would constitute replacement of the segment. To meet the research objective, the Performing Agency shall document best practices with respect to management of repairing or replacing PCB segments and utilize a combination of engineering evaluation, dynamic component testing and full-scale crash testing to develop guidelines to assist in developing a process to determine the useful service life. Defining the service life of PCBs is important to reduce the risk of inferior unsafe barriers being used on Texas roadways.

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021
TM-4
TM-5

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$132,809.75	$106,247.80	$26,561.95

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7067 **University:** TTI

Project Title: Enhancing Freeway Safety Prediction Models

Project Start Date: 1/1/2020 **Termination Date:** 12/31/2021

Project Status: Active **Total Project Budget:** $275,000.00

RTI Project Manager: Shelley Pridgen **Researcher:** Mike Pratt

Project Objectives: Safety prediction models have been developed for urban freeway segments in Texas and elsewhere to apply to cross sections up to 10 lanes wide. These models are documented resources such as the Receiving Agency's Roadway Safety Design Workbook and the Highway Safety Manual (HSM), and applied in several spreadsheet-based analysis tools. These tools are acknowledged in the Project Development Process Manual and have been used by various district personnel, particularly in the evaluation of project alternatives or analysis of design exceptions. However, additional research is needed to address knowledge gaps as well as to develop updated local calibration factors for the models. Specifically, safety prediction models do not exist for 12-lane freeway segments or freeway segments with managed lanes (such as high-occupancy-vehicle or high-occupancy-toll lanes).This research project shall develop new safety prediction models for 12-lane freeway segments and segments with managed lanes, and also derive local calibration factors for models for urban freeway segments with 4-10 lanes. The project shall also develop an analysis tool to help practitioners implement the new models to facilitate analysis of complex urban freeway configurations, such as cases where an urban freeway widening project requires challenging tradeoffs between narrowing lanes or inside or outside shoulders.

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021

June MPR 2021
July MPR 2021
TM3
TM4A
TM4B

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$155,797.00	$124,637.60	$31,159.40

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7082 **University:** TTI

Project Title: Evaluate Attachments to Concrete Barrier Systems to Deter Pedestrians

Project Start Date: 9/1/2020 **Termination Date:** 8/31/2022

Project Status: Active **Total Project Budget:** $436,762.25

RTI Project Manager: Shelley Pridgen **Researcher:** Chiara Silvestri Dobrovolny

Project Objectives: Concrete rigid barriers are used in medians to separate traffic, and on the roadside to shield hazards from motorists and motorists from hazards. These barriers need to demonstrate crashworthiness through full-scale testing per American Association of State Highway and Transportation Officials (AASHTO) Manual for Assessing Safety Hardware (MASH). Attachments may be deployed on top of concrete barriers due to various reasons, including deterring pedestrians from crossing highways. Such hardware attachments, however, have not been investigated to MASH standards. Previous crash tests under MASH high-speed impact conditions highlighting the propensity for vehicles to climb and intrude into the area where these attachments might be deployed. Therefore, the Performing Agency suspects that impacting vehicles will likely interact with hardware attached to concrete barriers. The AASHTO Roadside Design Guide (RDG) does not provide guidance for attaching hardware on top of barriers. Although limited research has investigated the crashworthiness of sign supports on top of concrete barriers, continuous systems that could be used to deter pedestrian crossings have not been investigated to MASH standards. The Performing Agency shall evaluate attachment to the top of concrete barriers to determine if devices suitable for deterring pedestrian crossing are MASH compliant. Additionally, guidance will be provided for the selection and attachment of these systems on top of concrete barriers.

Deliverables:

TM2
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$50,633.25	$40,506.60	$10,126.65

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7083 **University:** TTI

Project Title: Develop Highway Safety Manual (HSM) Safety Performance Functions (SPFs) and Calibration Factors for Texas

Project Start Date: 9/1/2020 **Termination Date:** 8/31/2022

Project Status: Active **Total Project Budget:** $309,753.75

RTI Project Manager: Jade Adediwura **Researcher:** Srinivas Geedipally

Project Objectives: This project shall calibrate the Highway Safety Manual (HSM) Safety Performance Functions (SPFs) for conditions in Texas. SPFs are equations that are used in project-level decision making for estimating the average crash frequency for existing conditions, alternatives to existing conditions, or proposed new roadways. Agencies also use SPFs to identify sites with promise, which are locations that may benefit the most from a safety treatment. SPF calibration is needed because most of the existing HSM SPFs were developed for states other than Texas. The calibration is conducted to account for differences in crash reporting procedures and thresholds, driver and animal population, and weather conditions.

Deliverables:
TM2
TMFY21A
TMFY21B
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$153,889.75	$123,111.80	$30,777.95

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7084 **University:** UNT

Project Title: Develop Improved Methods for Eliminating Striping on Roadway Surfaces

Project Start Date: 9/1/2020 **Termination Date:** 8/31/2023

Project Status: Active **Total Project Budget:** $288,000.75

RTI Project Manager: Tom Schwerdt **Researcher:** Maurizio Manzo

Project Objectives: The Performing Agency shall evaluate the most effective methods for stripe removal to include but not limited to a fully working prototype laser system to remove pavement marking stripes from roadways. A vehicle used for the routine road striping job shall be adapted to host a diode-pumped YAG laser at 1064 nm wavelength and beam delivery together with a passive insulation system. Preliminary laboratory testing shall be made to adjust laser' parameters such as laser fluence, pulse width, and repetition rate on specimens marked with current standard materials: thermoplastics, water-based paint, and preformed tape. Surface integrity after the use of the laser system shall be checked with methods including but not limited to Raman spectroscopy technique and photographs taken at different angles (to check for scarring) in a laboratory setting before the in-situ testing. The laser system shall be deployed and used on various marked pavements to collect data (photogrammetry) which shall be documented in a geodatabase, analyzed via Matlab Image Processing Toolbox. In addition, this project shall explore a synthesis study on the existing methods of removing striping from roadways used in Texas and elsewhere, and examine and compare these removal methods with the proposed laser technique on different roadway surfaces to determine the most effective methods for pavement marking removals.

Deliverables:
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021

July MPR 2021
TM2

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$154,555.25	$123,644.20	$30,911.05

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7086 **University:** TTI

Project Title: Roadside Safety Device Analysis, Testing, and Evaluation Program

Project Start Date: 9/1/2020 **Termination Date:** 10/31/2023

Project Status: Active **Total Project Budget:** $2,307,324.75

RTI Project Manager: Wade Odell **Researcher:** Roger Bligh

Project Objectives: Roadway departure crashes are the most common type of crash in Texas. These crashes represent over 45 percent of all fatal crashes and 34 percent of all serious injury crashes. Texas data shows that there were 9,560 fatal and 30,766 serious injury roadway departure crashes from 2010-2016. Roadside safety devices shield motorists from roadside hazards such as non-traversable terrain and fixed objects, thereby reducing injuries and fatalities associated with roadway departure crashes. To improve the safety of the motoring public, there is a need to develop new or improved safety devices that accommodate a variety of site conditions, placement locations, and a changing vehicle fleet. The Performing Agency shall provide the Receiving Agency with a mechanism to quickly and effectively address high priority issues related to roadside safety devices. The Performing Agency shall provide results in new and improved safety features that minimize the consequences of vehicles leaving the road and reduce injuries and fatalities associated with roadway departure crashes. The Performing Agency shall develop roadside safety devices to meet the 2016 edition of the American Association of State Highway and Transportation Officials (AASHTO) Manual for Assessing Safety Hardware (MASH) roadside safety criteria, to address the continuing trend of larger vehicles in the statewide vehicle fleet.

Deliverables:

September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021

R1

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$750,000.50	$600,000.40	$150,000.10

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7087 **University:** CTR

Project Title: Develop Standards for Temporary Concrete Median Barrier in Flood-Prone Areas

Project Start Date: 9/1/2020 **Termination Date:** 8/31/2022

Project Status: Active **Total Project Budget:** $485,096.38

RTI Project Manager: Wade Odell **Researcher:** Chiara Silvestri Dobrovolny

Project Objectives: Portable concrete median barriers are used in work zones to prevent serious cross-median crashes and vehicle penetration in work zones. These barriers are used on highways to provide positive containment of vehicles and to reduce maintenance and repair needs. When implemented in flood-prone areas, portable concrete median barriers can act as a dam for flood waters until the damming of water causes the barrier to displace and break, as recently occurred in the Houston and Beaumont Districts during severe storms. These situations required significant repair before the highways could be reopened and the level of safety for motorists restored. Any required barrier maintenance or repair increases risk to maintenance personnel and can result in significant congestion if a lane closure is required. There is a need to develop and evaluate an appropriate portable concrete median barrier in compliance with the 2016 edition of the American Association of State Highway and Transportation (AASHTO) Manual for Assessing Safety Hardware (MASH) Test Level (TL-3) for implementation in flood-prone areas. To meet this objective, the Performing Agencies shall design such a barrier to accommodate passage of flood water, to decrease risk to motorists, and to reduce level of damage to the highway.

Deliverables:

March MPR CTR 2021
April MPR 2021 CTR
May MPR CTR 2021
June MPR 2021 CTR
July MPR 2021 CTR
TM2
TM3
September MPR 2020
October MPR 2020
February MPR CTR 2021

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$105,554.50	$84,443.60	$21,110.90

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7087 **University:** TTI

Project Title: Develop Standards for Temporary Concrete Median Barrier in Flood-Prone Areas

Project Start Date: 9/1/2020 **Termination Date:** 8/31/2022

Project Status: Active **Total Project Budget:** $485,096.38

RTI Project Manager: Wade Odell **Researcher:** Chiara Silvestri Dobrovolny

Project Objectives: Portable concrete median barriers are used in work zones to prevent serious cross-median crashes and vehicle penetration in work zones. These barriers are used on highways to provide positive containment of vehicles and to reduce maintenance and repair needs. When implemented in flood-prone areas, portable concrete median barriers can act as a dam for flood waters until the damming of water causes the barrier to displace and break, as recently occurred in the Houston and Beaumont Districts during severe storms. These situations required significant repair before the highways could be reopened and the level of safety for motorists restored. Any required barrier maintenance or repair increases risk to maintenance personnel and can result in significant congestion if a lane closure is required. There is a need to develop and evaluate an appropriate portable concrete median barrier in compliance with the 2016 edition of the American Association of State Highway and Transportation (AASHTO) Manual for Assessing Safety Hardware (MASH) Test Level (TL-3) for implementation in flood-prone areas. To meet this objective, the Performing Agencies shall design such a barrier to accommodate passage of flood water, to decrease risk to motorists, and to reduce level of damage to the highway.

Deliverables:

September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR CTR 2021
April MPR 2021 CTR
May MPR CTR 2021
June MPR 2021 CTR
July MPR 2021 CTR
TM2
TM3
September MPR 2020
October MPR 2020
February MPR CTR 2021
March MPR TTI 2021
April MPR 2021 TTI
May MPR TTI 2021
June MPR 2021 TTI
July MPR 2021 TTI

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$109,897.00	$87,917.60	$21,979.40

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7096 **University:** TTI

Project Title: Traffic Control Device Analysis, Testing and Evaluation Program

Project Start Date: 9/1/2020 **Termination Date:** 8/31/2023

Project Status: Active **Total Project Budget:** $1,585,988.75

RTI Project Manager: Wade Odell **Researcher:** Melissa Finley

Project Objectives: Traffic control devices (TCDs) are the primary means of communicating highway information to road users. The design, application, and maintenance of TCDs are under constant transformation as new technologies, methodologies, and policies are introduced. The Performing Agency shall provide the Receiving Agency a mechanism to quickly and effectively conduct high priority evaluations of issues related to TCDs. The TCD issues to be evaluated in this project could represent new devices or technologies, new applications of an existing device or technology, TCD material performance, changes in the Receiving Agency's practices regarding a TCD, or other TCD related needs. Examples of various evaluations include human factors, machine vision performance, safety and operational effects, visibility assessments, and cost effectiveness analyses. The activities conducted through this project shall support the development of TCD related policy, specifications, guidelines, handbooks, and training.

September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021
R1

Deliverables:

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$515,812.50	$412,650.00	$103,162.50

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-7098 **University:** TTI

Project Title: Determine Drainage Basin Mapping and Estimation Of Hydroplaning

Project Start Date: 8/1/2020 **Termination Date:** 8/31/2022

Project Status: Active **Total Project Budget:** $284,899.50

RTI Project Manager: Wade Odell **Researcher:** Charles Gurganus

Project Objectives: Research project 0-6896, Proper Selection of Ride Quality Pay Adjustment Schedule and Re-Evaluation, used mobile LiDAR to map surface features of the highway network. Many of these surface features included drainage related elements such as ditch depth, ditch slope, and paved surface area drainage mapping. During the project, a method was developed to use the mapped drainage basins to calculate water film thickness and subsequently estimate hydroplaning potential using formulas from literature.

With drainage basin information, the Receiving Agency can identify roadway sections with geometry that could have poor wet weather performance. Using the surface measurements from mobile LiDAR, the Receiving Agency can home in on the exact location of the poor geometry and craft a solution that is more precise and specifically targets the geometric attributes that need to be improved. In addition, because mobile LiDAR can be collected at the network level, this provides the Receiving Agency the opportunity to be proactive and address poor geometric conditions that can lead to wet weather crashes, even if they do not currently exist.

Deliverables:

August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021

TM2
TM3 with Google Earth kmz file
TM4

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$155,852.50	$124,682.00	$31,170.50

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Safety and Operations

Project Number: 0-7099 **University:** TEES

Project Title: AVA: Automated Vehicles for All

Project Start Date: 1/26/2021 **Termination Date:** 8/31/2025

Project Status: Active **Total Project Budget:** $7,063,787.00

RTI Project Manager: Tom Schwerdt **Researcher:** Reza Langari

Project Objectives: USDOT awarded federal funds to Texas A&M Engineering Experiment Station (TEES) to take the lead on and subcontract with George Washington University, University of California at Davis, University of Illinois at Urbana-Champaign to study and test the safe integration of automated driving systems on rural Texas roadways for the purpose of the Automated Driving System Demonstration Grants program. TxDOT through RTI will help foster these efforts in partnership with FHWA and govern reimbursement of this project, in a separate Grant Subrecipient Agreement with TEES. All necessary Grant documents that outline the details of this agreement have been completed and attached.

Deliverables:

Kick-off meeting
PMP
DMP 2021
Project Evaluation Plan
Quarterly Progress Report Q1 2021
Quarterly Progress Report Q2 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$838,024.00	$670,419.20	$167,604.80

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 5-6996-01 **University:** UTA

Project Title: Snowplow Operations Management System

Project Start Date: 2/10/2020 **Termination Date:** 4/30/2022

Project Status: Active **Total Project Budget:** $250,571.25

RTI Project Manager: Joanne Steele **Researcher:** Mohsen Shahandashti

Project Objectives: Performing Agency shall create a Snowplow Operations Management System to (1) collect and display live feed of images from cameras mounted on winter operation vehicles, (2) collect and store current and forecasted ambient temperature data, (3) predict road surface temperatures for the next five days and identify roads with probable icing hazards, (4) develop an easy-to-use map-based ArcGIS exinterface showing the live feed of camera images, ambient temperatures, road surface temperatures, and probable icing road segments for safe and efficient operation of snowplows.
The project shall be performed for the Receiving Agency's Wichita Falls District. The Performing Agency shall also prepare and present a schedule and cost analysis for implementing the proposed Snowplow Operations Management System in TxDOT districts beyond the Wichita Falls district

TM3
TM4
August MPR 2020
September MPR 2020
October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021

Deliverables:

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$101,451.00	$81,160.80	$20,290.20

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Table 18. Safety and Operations Totals for Continuing Projects

Financials	Budget	Expended	Balance
Federal 80%	$4,521,830.67	$3,738,614.50	$783,216.18
State 20% TDC*	$1,130,457.67	$934,653.62	$195,804.04
Total	$5,652,288.34	$4,673,268.12	$979,020.22

2.2.6 RTI Program Support

Project Number: 0-6974 **University:** TTI

Project Title: Digital Publication and Outreach Services in Support of Research

Project Start Date: 7/11/2018 **Termination Date:** 8/31/2022

Project Status: Active **Total Project Budget:** $902,668.50

RTI Project Manager: Phillip Hempel **Researcher:** Kelly West

Project Objectives: The Performing Agency shall produce Video Summary Report's (VSRs) for the Receiving Agency which summarize transportation research and implementation projects.Additionally, the Performing Agency shall also produce outreach materials for the Receiving Agency that will be transportation research related material and may include additional related subjects of interest.

Deliverables:

Year 4 - TM3 2021
VSRs Year 4. Total of 24 required
August Production Tracking List 2020
September MPR 2020
October MPR & VSR Production Tracking List 2020
November MPR & Production Tracking List 2020
December MPR & Production Tracking List 2020
February MPR & Production Tracking 2021
March MPR & Production Tracking 2021
April MPR 2021 & Distribution, Production, Planning and Scripting
May MPR & VSR FY21 Production Tracking, VSR FY21-22 Scripting and Planning and VSR FY21 Distribution for May 2021
June MPR & VSR FY21 Production Tracking, VSR FY21-22 Scripting and Planning and VSR FY21 Distribution for June 2021
January MPR & FY21 VSR Production Tracking
September Tracking List 2020
October VSR Planning and Scripting FY21-22

July MPR & VSR FY21 Production Tracking, VSR FY21-22 Scripting and Planning and VSR FY21 Distribution for July 2021
August MPR 2020

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$251,130.75	$200,904.60	$50,226.15

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-6999-21 **University:** CTR

Project Title: Texas Technology Task Force (TTTF)

Project Start Date: 10/23/2020 **Termination Date:** 9/30/2022

Project Status: Active **Total Project Budget:** $924,066.00

RTI Project Manager: Shelley Pridgen **Researcher:** N/A

Project Objectives: The Texas Department of Transportation (TxDOT) needs support to manage the Texas Technology Task Force (TTTF). The Performing Agency shall be responsible for coordination of the TTTF. Authorized by Texas's 83rd Legislature General Appropriations Bill, S.B. No. 1, Item 44, VII-31, the Texas Department of Transportation (TxDOT) established the TTTF in 2013 to enhance its vision for the future of Texas' transportation systems. The TTTF began with a core knowledge group of transportation experts and has grown into a successful program that is responsible for managing the Emerging Technology Portfolio, publishing white papers on critical topics, delivering strategic plans such as the Technology Utilization Plan,developing communication strategies, and conducting TTTF meetings with in-depth technical analysis. Key objectives shall include, but are not limited to: • Maintaining a core knowledge group and network of subject matter expertise • Identifying emerging technologies and analyzing potential impacts • Developing key strategies to integrate critical technologies into the Texas transportation systemScope: The Performing Agency manages the Texas Technology Task Force, a strategic advisory body to TxDOT focused on conducting technology discovery, assessing the benefits and barriers to emerging technology adoption, and publishing strategic recommendations.

Deliverables:

October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021
TM1.1
TM2.1
TM3.1
TM4.1 to include 4.1 Business Readiness Guide and separate WPs 4.1_1, 4.1_2, 4.1_3 and 4.1_4
TM5.1
R1
TM7.1
P1

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$458,513.00	$366,810.40	$91,702.60

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 0-9902-21 **University:** CTR

Project Title: CTR Research Library Services

Project Start Date: 9/1/2020 **Termination Date:** 8/31/2022

Project Status: Active **Total Project Budget:** $794,681.44

RTI Project Manager: Renee Suaste **Researcher:** Kevyn Barnes

Project Objectives: The Performing Agency shall provide publishing services, library information services, and collection management to support the federally-funded State Planning and Research Part II (SPR II) Work Program managed by the Receiving Agency's Research and Technology Implementation Division (RTI). The Performing Agency shall provide the facilities, technical oversight, and trained professional, technical, and clerical staff needed to respond to the Receiving Agency's research information needs and to update, preserve, and facilitate public access to the collection of published resources contained in the Receiving Agency's transportation research library (hereinafter referred to as "TxDOT Research Library"). The U.S. Department of Transportation (USDOT) Public Access Plan ensures public access to unclassified publications and digital data sets arising from the USDOT's research and development funding, which includes the SPR Part II Work Program (hereinafter referred to as "Research Program"). The Performing Agency shall support transparency and longterm stewardship of Research Program results by providing online public access to Research Program information, performing services that ensure the Receiving Agency follows USDOT Public Access Plan guidelines, and serving as the Receiving Agency's official repository for all Research Program deliverables.

Deliverables:

Next Gen Digital Library Plan
September Research Digest 2020
October Research Digest 2020
November Research Digest 2020
December Research Digest 2020
January Research Digest 2021
February Research Digest 2021
March Research Digest 2021
April Research Digest 2021
May Research Digest 2021
June Research Digest 2021
July Research Digest 2021
August Research Digest 2021
September Research Digest 2021

September MPR 2021
October Research Digest 2021
October MPR 2021
November Research Digest 2021
November MPR 2021
December Research Digest 2021
December Digest VSR 2021
December MPR 2021
January Research Digest 2022
January MPR 2022
February Research Digest 2022
February MPR 2022
March Research Digest 2022
March MPR 2022
April Research Digest 2022
April MPR 2022
May Research Digest 2022
May MPR 2022
June Research Digest 2022
June MPR 2022
July Research Digest 2022
July MPR 2022
August Research Digest 2022
August MPR 2022

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$404,347.21	$323,477.77	$80,869.44

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Project Number: 5-7097-21 **University:** UTA

Project Title: Texas Local Technical Assistance Program (LTAP)

Project Start Date: 9/30/2020 **Termination Date:** 8/31/2023

Project Status: Active **Total Project Budget:** $3,823,487.48

RTI Project Manager: Shelley Pridgen **Researcher:** Debra Dehn

Project Objectives: The Local Technical Assistance Program (LTAP) is a nationwide effort financed by the Federal Highway Administration and individual state departments of transportation. Its purpose is to translate into understandable terms the best available technology and practices for roadways, bridges, bicycle and pedestrian facilities, and public transportation for city and county roadway and transportation personnel. The Texas Local Technical Assistance Program (TxLTAP) operated by the Performing Agency and is sponsored by the Receiving Agency and the Federal Highway Administration (FHWA).

TxLTAP is focused on preserving and enhancing the local road system by delivering quality training and technical assistance to local city and county road agencies in Texas. The training provided through this program shall increase the performance of the transportation workers in Texas by ensuring they conduct their duties in a safe, efficient, environmentally sound and cost-effective manner. This program shall also allow city and county agencies to maximize benefits from their often limited fiscal and staffing resources. Through training geared to local government circumstances, customized technical assistance, advice provided at events, and a library of resources, TxLTAP provides relevant and impactful information focused on road and bridge/culvert maintenance, the use of traffic control devices, and other techniques to promote traffic safety.

Deliverables:

October MPR 2020
November MPR 2020
December MPR 2020
January MPR 2021
February MPR 2021
March MPR 2021
April MPR 2021
May MPR 2021
June MPR 2021
July MPR 2021
Newsletter 3.3
Newsletter 3.1

Newsletter 3.2
TxSTIC Meeting 13.1
Newsletter 3.4
TxSTIC Meeting 13.2
TxSTIC Meeting 13.3

Financials:	FY21 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$1,281,980.17	$1,025,584.14	$256,396.03

*Non-Federal Match provided by Transportation Development Credits (TDCs)

Table 19. RTI Program Support Totals for Continuing Projects

Financials	Budget	Expended	Balance
Federal 80%	$1,916,776.90	$1,360,361.78	$556,415.73
State 20% TDC*	$479,194.23	$340,089.69	$139,104.54
Total	$2,395,971.13	$1,700,451.47	$695,519.66

2.3 Pooled-Fund Projects

Pooled-fund projects are for planning, research, development, or technology transfer project activities administered by FHWA and are supported by two or more participants. These projects address an issue of significant or widespread interest related to highway, public, or intermodal transportation. The research is intended to address a new area or provide information that will complement or advance previous investigations of the subject matter.

As 23 CFR 420.205 describes, "To promote effective use of available resources, the State DOTs are encouraged to cooperate with other State DOTs, the FHWA, and other appropriate agencies to achieve RD&T objectives established at the national level and to develop a technology transfer program to promote and use those results. This includes contributing to cooperative RD&T programs such as the NCHRP, the TRB, and transportation pooled fund studies as a means of addressing national and regional issues and as a means of leveraging funds."

Pooled-fund projects are a very effective means of leveraging precious research funds. Table 20 shows the pooled-fund projects that Texas participates in.

Table 20. FY 2021 Pooled-Fund Projects.

The following are project descriptions of the pooled-fund projects.

Project	Name	Study Number	Lead State	Project Dates	Texas 2021
8-8417	Center for the Aging Infrastructure: Steel Bridge Research, Inspection, Training and Education Engineering Center - SBRITE	TPF-5(281)	Indiana Department of Transportation	2020 - 2021	$50,000.00
8-8453	Roadside Safety Research for MASH Implementation	TPF-5(343)	Washington State Department of Transportation	2016 - 2023	$50,000.00
8-8455	Develop and Support Transportation Performance Management Capacity	TPF-5(326)	Rhode Island Department of Transportation	2017 - 2022	$283,000.00
8-8456	Transportation Management Center Pooled Fund Study	TPF-5(319)	Federal Highway Administration	2016 - 2022	$50,000.00
8-8458	Connecting the DOTs: Implementing ShakeCast Across Multiple State Departments of	TPF-5(357)	California Department of Transportation	2017 - 2022	$15,000.00
8-8460	Evaluating New Technologies for Roads Program Initiatives in Safety and Efficiency -	TPF-5(359)	Michigan Department of Transportation	2017 - 2021	$40,000.00
8-8461	Pavement Surface Properties Consortium - A Research Program at the Virginia Smart	TPF-5(345)	Virginia Department of Transportation	2017 - 2021	$20,000.00
8-8462	Clear Roads Phase II	TPF-5(353)	Minnesota Department of Transportation	2017 - 2021	$25,000.00
8-8463	Building Information Modeling (BIM) for Bridges and Structures	TPF-5(372)	Iowa Department of Transportation	2018 - 2022	$20,000.00
8-8465	Autonomous Maintenance Technology (AMT)	TPF-5(380)	Colorado Department of Transportation	2018 - 2022	$25,000.00
8-8470	Improve pavement surface distress and transverse profile data collection and analysis, Phase II	TPF-5(399)	Federal Highway Administration	2019 - 2024	$20,000.00
8-8473	Pavement Structural Evaluation with Traffic Speed Deflection Devices (TSDDs)	TPF-5(385)	Virginia Department of Transportation	2019 - 2022	$109,000.00
8-8475	Institute for Trade and Transportation Studies (ITTS)	TPF-5(390)	Mississippi Department of Transportation	2018 - 2023	$39,800.00

Project	Name	Study Number	Lead State	Project Dates	Texas 2021
8-8479	Connected Vehicle Pooled Fund Study	TPF-5(389)	Virginia Department of Transportation	2019 - 2022	$50,000.00
8-8481	Development of Criteria to Assess the Effects of Pack-out Corrosion in Built-up Steel Members	TPF-5(436)	Indiana Department of Transportation	2019 - 2022	$40,000.00
8-8482	Smart Work Zone Deployment Initiative (FY20-FY24)	TPF-5(438)	Iowa Department of Transportation	2020 - 2024	$25,000.00
8-8484	EconWorks - Improved Economic Insight	TPF-5(456)	Arkansas Department of Transportation	2020 - 2024	$4,000.00
8-8486	Technology Transfer Concrete Consortium (FY20-FY24)	TPF-5(437)	Iowa Department of Transportation	2020 - 2024	$8,000.00
8-8487	No Boundaries Transportation Maintenance Innovations	TPF-5(441)	Colorado Department of Transportation	2020 - 2025	$10,000.00
8-8488	Transportation Research and Connectivity (librarian toolkit / knowledge networking / information condition / analysis of resources / digitization efforts / ADA support)	TPF-5(442)	Oklahoma Transportation	2020 - 2022	$25,000.00
8-8489	Structural Behavior of Ultra-High-Performance Concrete	TPF-5(468)	Federal Highway Administration	2020 - 2022	$25,000.00
8-8490	Traffic Safety Culture - Phase 2	TPF-5(444)	Montana Department of Transportation	2020 - 2024	$50,000.00
8-8491	National Accessibility Evaluation Phase II Access Across America	TPF-5(455)	Minnesota Department of Transportation	2021 - 2025	$40,000.00
8-8492	Automated Vehicle Research Program	TPF-5(453)	Ohio Department of Transportation	2021 - 2025	$50,000.00
8-8493	Developing and Calibrating Fragmental Rockfall Models using Physics Engines	TPF-5(459)	Washington State Department of Transportation	2020 - 2023	$30,000.00
8-8495	Traffic Analysis, Modeling, and Simulation	TPF-5(458)	Federal Highway Administration	2020 - 2023	$20,000.00

Project	Name	Study Number	Lead State	Project Dates	Texas 2021
8-8497	High Performance Computational Fluid Dynamics (CFD) Modeling Services for Highway Hydraulics	TPF-5(446)	Federal Highway Administration	2020 - 2023	$15,000.00
8-8499	Road Usage Charge West	TPF-5(451)	Oregon Department of Transportation	2020 - 2025	$25,000.00
8-8500	Assessment and Repair of Prestressed Bridge Girders Subjected to Over-Height Truck Impacts (OHTI)	TPF-5(462)	Missouri Department of Transportation	2020 - 2022	$45,000.00
8-8501	Infrastructure to Support Advanced Autonomous Aircraft Technologies	1513	Ohio Department of Transportation	2021 - 2023	$175,000.00
8-8502	Hydrologic and Hydraulic Software Enhancements (SMS, WMS, Hydraulic Toolbox, and HY-8)	TPF-5(464)	Federal Highway Administration	2020 - 2024	$10,000.00
8-8503	Railroad Crossing Signal Technology and Implementation Solutions Pooled Fund	1509	Washington State Department of Transportation	2021	$25,000.00
8-8504	Traffic Control Device (TCD) Consortium (3)	TPF-5(447)	Federal Highway Administration	2020 - 2022	$25,000.00
8-8505	Determining the in-place strength of concrete using piezoelectric based sensors	TPF-5(471)	Indiana Department of Transportation	2021 - 2023	$25,000.00
8-8506	Pavement Surface Properties Consortium: Phase III - Managing the Pavement Properties for Improved Safety	TPF-5(463)	Virginia Department of Transportation	2021 - 2025	$20,000.00
8-8507	Bridge Deck Preservation Portal	TPF-5(474)	Iowa Department of Transportation	2021 - 2022	$30,000.00
8-8508	Soil and Erosion Testing Services for Bridge Scour Evaluations	TPF-5(461)	Federal Highway Administration	2021 - 2025	$15,000.00
8-8509	Research Project Tracking System	TPF-5(467)	Kentucky Transportation Cabinet	2021	$3,500.00
8-8510	Demonstration to Advance New Pavement Technologies Pooled Fund	TPF-5(478)	Federal Highway Administration	2021 - 2025	$10,000.00

Project	Name	Study Number	Lead State	Project Dates	Texas 2021
8-8511	Integration of New Traffic Signal Actuation Concepts using Enhanced Detector Information	TPF-5(483)	Iowa Department of Transportation	2021 - 2023	$33,000.00
8-8512	Accelerated Performance Testing on the 2021 NCAT Pavement Test Track with MnROAD Research Partnership	TPF-5(469)	Alabama Department of Transportation	2021 - 2023	$640,083.00
8-8513	Building Information Modeling (BIM) for Infrastructure	TPF-5(480)	Iowa Department of Transportation	2021 - 2025	$30,000.00
Grand Total					$2,250,383.00

Project Number: 8-8417

Study Number: TPF-5(281)

Project Title: Center for the Aging Infrastructure: Steel Bridge Research, Inspection, Training and Education Engineering Center - SBRITE

Lead Agency: Indiana Department of Transportation

Status: Contract Signed

Project Objectives: The objective is to develop the Steel Bridge Research, Inspection, Training, and Education Engineering Center (S-BRITE Engineering Center) focused on existing steel highway bridges. This National Center will be the first of its kind and will become the leading education, training, research, and engineering center related to all aspects affecting the existing aging steel bridge and structure inventory. Although the Center will be focused on highway bridges, it will also support stakeholders of steel railroad bridges as well as steel ancillary structures, such as lighting towers and sign supports. The Center will contribute to improved asset management decisions for DOTs, FHWA, and other partners relative to existing steel bridge inventory. This impact will be realized by ensuring existence of the following:

- High quality inspection data
- Advanced predictive models
- Improved management decisions
- Timely and effective execution

This will be accomplished by providing solutions to the following:

- inspection reliability issues
- inadequate technical expertise
- training and education opportunities for students and professionals
- short-term and long-term research needs

Once the center is successfully operational, other materials and systems, such as concrete, presstressed, and post-tensioned structures may be added.

Financials:	Year	Commitment
TxDOT	2020 - 2021	$50,000.00

Project Number: 8-8453

Study Number: TPF-5(343)

Project Title: Roadside Safety Research for MASH Implementation

Lead Agency: Washington State Department of Transportation

Status: Cleared by FHWA

Project Objectives: The objective of the Roadside Safety Pooled Fund Program is to provide a cooperative approach to conducting research on roadside safety hardware. Emphasis will be placed on assisting State DOTs with their implementation of MASH and addressing other roadside safety needs of common interest.

Another objective of this pooled fund research to provide each participating state an opportunity to send a representative to an annual meeting to collaborate with other state DOT safety engineers to assess best practices, new regulatory issues, risk management strategies, and other matters pertaining to roadside safety. Participation in this meeting is funded through the state's annual program contribution.

Financials:	Year	Commitment
TxDOT	2016 - 2023	$50,000.00

Project Number: 8-8455

Study Number: TPF-5(326)

Project Title: Develop and Support Transportation Performance Management Capacity Development Needs for State DOTs

Lead Agency: Rhode Island Department of Transportation

Status: Cleared by FHWA

Project Objectives: The focus of this pooled fund project will be to research and assess training and educational needs of contributing members, develop and deliver training, and to facilitate the sharing and retention of performance management best practices. Funding will be used to:

`• Identify Gaps in TPM Knowledge, Skills and Abilities—Conduct a needs analysis for learning and capacity development of contributing members resulting in a short and long-term capacity building roadmap;

• Develop and Deliver Learning and Capacity Development Resources—Develop training and educational material to meet the gaps identified in the knowledge, skills and abilities;

• Establish a TPM Information Clearinghouse—The TPM Information Clearinghouse will be used to showcase PM best practices, foster collaboration, and serve as a repository for PM resources; and

• Support Knowledge Transfer Among Pooled Fund States

Specifically this pooled fund will:

Guide the prioritization of needs for determining training and other educational support for contributing members:

1. Provide and promote communication and information sharing among member States related to learning and capacity development needs in the areas of performance management and provide input on research topics.
2. Develop framework and roadmap for addressing learning and capacity development needs.
3. Identify learning and capacity development resources needed to support the development of PM skills.
4. Develop online and/or blended training courses and materials that are suitable for a wide variety of audiences such as State Departments of Transportation (State DOTs), Metropolitan Planning Organizations (MPOs), Public Transit Providers, and local governments.

5. Support a TPM Information Clearinghouse which will serve as a repository for TPM best practices and other resource information to assist states, MPO's and local government with learning about TPM and their implementation of TPM.

Financials:	Year	Commitment
TxDOT	2017 - 2022	$283,000.00

Project Number: 8-8456

Study Number: TPF-5(319)

Project Title: Transportation Management Center Pooled Fund Study

Lead Agency: Federal Highway Administration

Status: Cleared by FHWA

Project Objectives: The goal of the TMC PFS is to assemble regional, state, and local transportation management agencies and the Federal Highway Administration (FHWA) to (1) identify human-centered and operational issues; (2) suggest approaches to addressing identified issues; (3) initiate and monitor projects intended to address identified issues; (4) provide guidance and recommendations and disseminate results; (5) provide leadership and coordinate with others with TMC interests; and (6) promote and facilitate technology transfer related to TMC issues nationally.

Financials:	Year	Commitment
TxDOT	2016 - 2022	$50,000.00

Project Number: 8-8458

Study Number: TPF-5(357)

Project Title: Connecting the DOTs: Implementing ShakeCast Across Multiple State Departments of Transportation for Rapid Post-Earthquake Response

Lead Agency: California Department of Transportation

Status: Cleared by FHWA

Project Objectives: This collaborative effort will bring participating DOTs into full ShakeCast operation for post-earthquake assessment of state and local bridge inventories. The project will provide a mechanism to actively engage representatives from state DOTs with the common interests in implementing and expanding the application of ShakeCast technologies to improve emergency response capabilities.

Financials:	Year	Commitment
TxDOT	2017 - 2022	$15,000.00

Project Number: 8-8460

Study Number: TPF-5(359)

Project Title: Evaluating New Technologies for Roads Program Initiatives in Safety and Efficiency - ENTERPRISE (PHASE II)

Lead Agency: Michigan Department of Transportation

Status: Cleared by FHWA

Project Objectives:
1. Investigate and promote ITS approaches and technologies that are compatible with other national and international ITS initiatives.
2. Support the individual ITS program plans of ENTERPRISE participants.
3. Provide a mechanism to support multi-state and international project cooperation and technical information interchange.
4. Facilitate the formation of public-private partnerships for appropriate program activities.
5. Pursue emerging ITS project opportunities in areas of interest to the group.
6. Provide test beds in a variety of environments and locations for emerging ITS technologies.
7. Identify common needs within the group and proceed with appropriate technical activities.

Financials:	Year	Commitment
TxDOT	2017 - 2021	$40,000.00

Project Number: 8-8461

Study Number: TPF-5(345)

Project Title: Pavement Surface Properties Consortium - A Research Program at the Virginia Smart Road Phase II

Lead Agency: Virginia Department of Transportation

Status: Cleared by FHWA

Project Objectives: The main objective of the pooled-fund program of research has been to conduct applied research focused on enhancing the level of service provided by the roadway transportation system by optimizing pavement surface characteristics.

Phase I of the study included regular verification and validation of the participant's equipment, opportunities for technology transfer, and the accumulation of a significant body of knowledge on the measurement of pavement surface properties. Practical and tangible results were documented and disseminated though a large number of publications listed in the Phase 1 Outcomes (see study Documents).

Examples of technologies that were evaluated as part of this program include high-friction surfaces (HFS) and Continuous Friction Measuring Equipment (CFME). HFS treatments have been adopted as a low-cost countermeasure as part of the Every-day-Counts FHWA program. CFME's are currently being used to support the development of a new generation of friction management programs.

Phase II of the program continues to support the member's effort to produce high-quality surface properties measurements but focuses on supporting the enhancing and adoption of emerging friction and macrotexture measurement technologies and the integration of these measurements into the next generation of pavement asset management systems. The focus will be on developing and deploying asset management approaches and tools that help improve the safety of our road networks by reducing the number of crashes and related fatalities. It will also seek participation of industry through the pooled-fund or an industrial affiliate program.

Financials:	Year	Commitment
TxDOT	2017 - 2021	$20,000.00

Project Number: 8-8462

Study Number: TPF-5(353)

Project Title: Clear Roads Phase II

Lead Agency: Minnesota Department of Transportation

Status: Cleared by FHWA

Project Objectives: Objectives of the new phase of the Clear Roads Pooled Fund project will include:

- Conduct structured field testing and evaluation across a range of winter conditions and different highway maintenance organizational structures to assess the practical effectiveness, ease of use, optimum application rates, barriers to use, durability, safety, environmental impact, and cost-effectiveness of innovative materials, equipment, and methods for improved winter highway maintenance.
- Conduct research that explores the use of innovative materials, equipment, and processes that will promote environmentally sustainable winter maintenance operations.
- Conduct cost-benefit analyses to ensure that new technologies, materials, or methods contribute to operational efficiency.
- Investigate state agency uses of performance measures for winter operations and develop management tools that support effective analysis and reporting of the measures.
- Establish industry standards and develop performance measures for evaluating and utilizing new materials and technologies.
- Support technology transfer by developing and disseminating practical field guides and training curriculum to promote the results of research projects.
- Support the exchange of information and ideas among state agencies via peer exchanges, impromptu internal surveys, and collaborative research efforts that provide opportunities for winter maintenance specialists to share experiences related to winter maintenance.
- Conduct national surveys to compile and document agency practices on the latest operational issues (for example salt shortages, level of service requirements, or other "hot button" issues).
- Conduct quicker turnaround, lower cost, synthesis projects to investigate the latest research and practices on pressing winter maintenance topics.

- Coordinate with the Aurora Pooled Fund (http://www.aurora-program.org/) to enhance the impact, and avoid duplication, of winter road weather research.
- Promote public education and outreach related to winter maintenance and winter driving safety.

Financials:	Year	Commitment
TxDOT	2017 - 2021	$25,000.00

Project Number: 8-8463

Study Number: TPF-5(372)

Project Title: Building Information Modeling (BIM) for Bridges and Structures

Lead Agency: Iowa Department of Transportation

Status: Contract Signed

Project Objectives: The pooled fund project will provide the primary funding mechanism for AASHTO SCOBS T-19 to perform the duties of governance and stewardship of BIM for Bridges and Structures.

Financials:	Year	Commitment
TxDOT	2018 - 2022	$20,000.00

Project Number: 8-8465

Study Number: TPF-5(380)

Project Title: Autonomous Maintenance Technology (AMT)

Lead Agency: Colorado Department of Transportation

Status: Cleared by FHWA

Project Objectives: The mission of this study is to support and promote collaborative research efforts in the field of autonomous technologies in work zone applications, with the goal of improving the safety, efficiency and quality of work efforts, along with providing better solutions and valuable lessons learned for the integration of new technologies to further these goals. The participation of many transportation related agencies in this study furthers the cooperation in this industry, leading to improved future development of beneficial technologies and improved sharing of information and lessons learned. This is intended to further safety, efficiency, and quality of work done in this field for all relevant agencies.

Financials:	Year	Commitment
TxDOT	2018 - 2022	$25,000.00

Project Number: 8-8470

Study Number: TPF-5(399)

Project Title: Improve pavement surface distress and transverse profile data collection and analysis, Phase II

Lead Agency: Federal Highway Administration

Status: Cleared by FHWA

Project Objectives: Improve the Quality of Pavement Surface Distress and Transverse Profile Data Collection and Analysis by assembling SHAs, the FHWA, and industry representatives to:

- Identify data collection integrity and quality issues
- Identify data analysis needs
- Suggest approaches to addressing identified issues and needs

Based on this information, the SHAs and the FHWA will:

- Initiate and monitor projects intended to address identified issues and needs
- Disseminate results
- Assist in solution deployment

Financials:	Year	Commitment
TxDOT	2019 - 2024	$20,000.00

Project Number: 8-8473

Study Number: TPF-5(385)

Project Title: Pavement Structural Evaluation with Traffic Speed Deflection Devices (TSDDs)

Lead Agency: Virginia Department of Transportation

Status: Cleared by FHWA

Project Objectives: The objective of the proposed pooled-fund project is to establish a research consortium focused on providing participating agencies guidelines on how to specify collection and use data collected with TSDDs for network- and project-level (if feasible) pavement management applications. Specific tasks within this multi-year program will be developed in cooperation with the consortium participants. In addition, the consortium will also provide participating agencies with a mechanism to conduct pilot demonstration testing in their respective networks.

Financials:	Year	Commitment
TxDOT	2019 - 2022	$109,000.00

Project Number: 8-8475

Study Number: TPF-5(390)

Project Title: Institute for Trade and Transportation Studies (ITTS)

Lead Agency: Mississippi Department of Transportation

Status: Cleared by FHWA

Project Objectives: The purpose of ITTS is to support member states in developing their competitive advantages to capture and quantify trade opportunities and economic benefits through improved transportation planning, investments, collaboration, and operations.

Financials:	Year	Commitment
TxDOT	2018 - 2023	$39,800.00

Project Number: 8-8479

Study Number: TPF-5(389)

Project Title: Connected Vehicle Pooled Fund Study

Lead Agency: Virginia Department of Transportation

Status: Cleared by FHWA

Project Objectives:

- To provide technology transfer to state, local, and international transportation agencies as well as vehicle Original Equipment Manufacturers (OEMs) in preparing for the deployment of connected vehicle infrastructure and to provide input to the AASHTO Connected and Automated Vehicle working group, USDOT Connected Vehicle Program, and other national initiatives.
- To establish a multi-phase program to facilitate research, field demonstration, evaluation, and technology transfer of connected vehicle infrastructure, vehicles, and applications.
- To aid transportation agencies and OEMs in justifying and promoting the large scale use of connected vehicle environment and applications through modeling, development, engineering, and planning activities.

Financials:	Year	Commitment
TxDOT	2019 - 2022	$50,000.00

Project Number: 8-8481

Study Number: TPF-5(436)

Project Title: Development of Criteria to Assess the Effects of Pack-out Corrosion in Built-up Steel Members

Lead Agency: Indiana Department of Transportation

Status: Contract Signed

Project Objectives: Objectives and Impact
The objectives of the proposed pooled-fund study are as follows:
1) To develop AASHTO ready specifications for the evaluation of the effects of pack-out corrosion in built-up steel tension, compression, and flexural members.
2) Provide guidance on the need for repairs and corrosion rates that can be expected in various environments in order to assist owners in programming when repairs may need to be made.
3) Identify the most effective methods of repairs and provide suggesting verbiage that could be used when preparing special provisions for repairs.
4) Develop several case-study examples, including calculations that will be used for training users on the methodologies to be developed. It is anticipated that the research team will host a number of webinars or on-site training sessions to ensure technology transfer and implementation.
5) The impact of this study is obvious considering there is no such quantitative guidance available at present. The results of the work will allow owners to accurately assess the effects of this form of corrosion on various limits states (e.g., strength, fatigue, buckling, etc.) in built-up steel members. Both flexural and truss-type members will be studied. The ability to program repairs based on data-driven models allows for the best possible use of limited maintenance funds and safely extend the life of the existing inventory.

Financials:	Year	Commitment
TxDOT	2019 - 2022	$40,000.00

Project Number: 8-8482

Study Number: TPF-5(438)

Project Title: Smart Work Zone Deployment Initiative (FY20-FY24)

Lead Agency: Iowa Department of Transportation

Status: Contract Signed

Project Objectives: This program represents an on-going effort among cooperating states' DOTs, the FHWA, universities, and industry to evaluate new products and conduct related research focused on the enhancement of safety and mobility in highway work zones. Over 100 studies and evaluations have been completed since the inception of the SWZDI and final reports are posted in the Smart Work Zone Deployment Initiative web site at https://swzdi.intrans.iastate.edu/.

Financials:	Year	Commitment
TxDOT	2020 - 2024	$25,000.00

Project Number: 8-8484

Study Number: TPF-5(456)

Project Title: EconWorks - Improved Economic Insight

Lead Agency: Arkansas Department of Transportation

Status: Cleared by FHWA

Project Objectives: The focus of this pooled fund project will be to support transportation planners with a better understanding of the economic impact of transportation projects by continuing the overall operation, maintenance and improvement to the EconWorks website, and completing and adding additional case studies to provide more robust economic analysis.

Financials:	Year	Commitment
TxDOT	2020 - 2024	$4,000.00

Project Number: 8-8486

Study Number: TPF-5(437)

Project Title: Technology Transfer Concrete Consortium (FY20-FY24)

Lead Agency: Iowa Department of Transportation

Status: Contract Signed

Project Objectives: The goal of the TTCC is to:

- Identify needed research priorities by region
- Provide a forum for technology exchange between participants
- Develop and fund technology transfer materials
- Provide on-going communication of research needs faced by state agencies to the FHWA, industry, and CP Tech Center
- Provide technical leadership for concrete related national initiatives to advance state-of-the-art construction and material practices

It is anticipated that this consortium would become the national forum for state involvement in the technical exchange needed for collaboration and new initiatives and provide tactical strategies and solutions to issues identified by the member states.

Financials:	Year	Commitment
TxDOT	2020 - 2024	$8,000.00

Project Number: 8-8487

Study Number: TPF-5(441)

Project Title: No Boundaries Transportation Maintenance Innovations

Lead Agency: Colorado Department of Transportation

Status: Cleared by FHWA

Project Objectives: Through this pooled fund project, the Colorado Department of Transportation (CDOT) will work with other State Departments of Transportation (DOTs) to facilitate the transfer of knowledge of promising non-snow and ice maintenance innovations and technologies. This project provides a forum for State DOTs to share their maintenance innovations with each other, support technology transfer activities and develop marketing and deployment plans for selected innovations through bi-annual 2-3 day peer exchange meetings at various locations selected by participating members. Resources will be provided for the transfer of knowledge and experience of various innovations that includes travel, training and other technology transfer activities.

It is anticipated that this consortium will become the national forum for state involvement in the technical exchange needed for collaboration and new initiatives, and be a forum for advancing the application and benefit of research technologies. In addition, the project will create a searchable database or warehouse where innovations and research done relating to highway maintenance can be found and showcased. State participation in this process will be through the pooled fund. FHWA, industry and others will be invited to participate in the project discussions and activities.

Workshops will continue to be provided for the states participating in the pooled fund project. This project will help DOTs to save time and money by not investing in the same research that has already been performed by other state DOTs. Rather than having each DOT identify and conduct research separately, DOTs can work collectively through this pooled fund project.

The Colorado DOT will serve as the lead state for the execution of the pooled fund project described in this proposal. The Colorado DOT will handle all administrative duties associated with the project.

Financials:	Year	Commitment
TxDOT	2020 - 2025	$10000

Project Number: 8-8488

Study Number: TPF-5(442)

Project Title: Transportation Research and Connectivity (librarian toolkit / knowledge networking / information condition / analysis of resources / digitization efforts / ADA support)

Lead Agency: Oklahoma Transportation

Status: Cleared by FHWA

Project Objectives: To support coordinated development of transportation libraries as well as research organizations without dedicated libraries, the following objectives will be undertaken. These objectives will be accomplished through member activities and partnerships with professional groups such as the Transportation Research Board (TRB) Library and Information Science for Transportation Committee (LIST), the Special Libraries Association (SLA) Transportation Division, and the National Transportation Knowledge Network (NTKN). Completed projects will be stored permanently at the NTKN and the National Transportation Library (NTL) for public use and will be completed within the three-year span of the pooled fund study. The specific objectives are listed below:

1. Develop a toolkit of recommendations and best practices for transportation research organizations that do not have a transportation librarian.
2. Partner with the NTKN to analyze effectiveness of libguides, identify gaps in coverage, and survey the needs of DOTs.
3. Develop a white paper analyzing the current condition of transportation information infrastructure, including review of pertinent knowledge management resources.
4. Develop a cooperative digitization project among members, in partnership with the NTL, to convert copies of older materials to digital formats, as well as providing ADA compliance support for digital documents.
5. Enhance communication between group members (hold annual pooled fund meeting in conjunction with the AASHTO RAC conference).

Financials:	Year	Commitment
TxDOT	2020 - 2022	$25,000.00

Project Number: 8-8489

Study Number: TPF-5(468)

Project Title: Structural Behavior of Ultra-High Performance Concrete

Lead Agency: Federal Highway Administration

Status: Cleared by FHWA

Project Objectives: The objective of the proposed project is to develop knowledge pertinent to the structural performance of ultra-high performance concrete (UHPC). This knowledge will be of significant value as the AASHTO Committee on Bridges and Structures considers the use of UHPC-class materials in highway bridges and structures.

Financials:	Year	Commitment
TxDOT	2020 - 2022	$25,000.00

Project Number: 8-8490

Study Number: TPF-5(444)

Project Title: Traffic Safety Culture - Phase 2

Lead Agency: Montana Department of Transportation

Status: Cleared by FHWA

Project Objectives: Only through the growth of a positive safety culture can significant and sustainable reductions in crash fatalities and serious injuries be achieved. Towards that end, this pooled fund program will:
(1) conduct research to identify solutions to specific culture-based traffic safety problems, taking advantage of the implementation opportunities to improve traffic safety;
(2) develop resources to enhance understanding and application of traffic safety culture strategies; and
(3) provide technology transfer of best practices in traffic safety culture strategies.

Financials:	Year	Commitment
TxDOT	2020 - 2024	$50,000.00

Project Number: 8-8491

Study Number: TPF-5(455)

Project Title: National Accessibility Evaluation Phase II Access Across America

Lead Agency: Minnesota Department of Transportation

Status: Contract Signed

Project Objectives: This project has two main objectives. First, it will create a new, national Census block-level accessibility dataset that can be used by partners in local transportation system evaluation, performance management, planning, and research efforts. Second, it will produce and publish a series of annual reports describing accessibility to jobs by auto, transit, and biking in metropolitan areas across America.

Accessibility Dataset
This project will create a national Census-block level dataset describing accessibility to jobs from locations across the county, updated annually. Accessibility calculations will rely on detailed travel time calculations for both driving and transit, which will be implemented using commercially-available GPS-based speed measurements, published transit schedules, and detailed bike and pedestrian networks. Each Access Across America partner will have direct digital access to the accessibility datasets covering the jurisdictions of all partners.

Annual Report
The annual Access Across America series of annual reports will provide summaries of the detailed accessibility datasets for the 50 largest metropolitan areas across America. These will be released to national and local media outlets and supported by publicity and communications efforts. Partners will be recognized in the report for their sponsorship and support.

Optional Goals
The accessibility evaluation tools and expertise developed in this project can also support optional goals for interested agencies:
1. Include destinations from local data sources - Local destination datasets from your organization can be included in the annual accessibility calculations. Cost: $5,000.00

2. Accessibility Data Workshop - Researchers can lead an on-site or remote workshop to provide transportation agency staff hands-on experience with accessibility data and training on accessibility concepts. Cost: $5,000.00
3. Scenario Evaluation - Using annual accessibility data as a baseline, researchers can develop an accessibility evaluation of highway, transit, bike, or pedestrian scenarios based on planning data from your organization. Cost varies with scenario complexity and objectives.

Financials:	Year	Commitment
TxDOT	2021 - 2025	$40,000.00

Project Number: 8-8492

Study Number: TPF-5(453)

Project Title: Automated Vehicle Research Program

Lead Agency: Ohio Department of Transportation

Status: Cleared by FHWA

Project Objectives: Through this pooled fund, the Ohio Department of Transportation (ODOT) will work with federal and state departments of transportation to establish multiple projects to research vehicle-roadway interaction including data failures and mitigation methods, identify and define standards, and encourage interoperability across state borders.

Financials:	Year	Commitment
TxDOT	2021 - 2025	$50,000.00

Project Number: 8-8493

Study Number: TPF-5(459)

Project Title: Developing and Calibrating Fragmental Rockfall Models using Physics Engines

Lead Agency: Washington State Department of Transportation

Status: Cleared by FHWA

Project Objectives: The objectives of the research work are to:
1. Develop a field data collection methodology to observe rockfall events, generated by scaling projects. Develop a detailed database of rockfall events, collected and analyzed from DOT rock slope scaling projects, and utilize this database to define ranges of input parameters needed to simulate rockfalls.
2. Build a user interface with the selected physics engine to permit model self-calibration based on observations, and generate numerous simulations providing probabilistic output data. Define and produce useable metrics such as runout distance for a defined % of the volume, bounce height and energy etc.
3. Determine the basis for decisions related to goodness of fit of simulations, and simulate many known rockfall events to define appropriate ranges of input parameters to generate realistic fragmental rockfall models for different geological settings and slope condition states.
4. Simulate the interaction between falling fragments and the underlying slope, considering geology, geometry and whether the blocks will be impacting outcropping rock, talus, soil, and possibly vegetation, to refine the fragmentation model.

Financials:	Year	Commitment
TxDOT	2020 - 2023	$30,000.00

Project Number: 8-8495

Study Number: TPF-5(458)

Project Title: Traffic Analysis, Modeling, and Simulation

Lead Agency: Federal Highway Administration

Status: Cleared by FHWA

Project Objectives: The Traffic Analysis, Modeling, and Simulation (TAMS) PFS is intended to serve as a forum and provide an opportunity for the participants to identify, address, and collectively tackle key issues and challenges that are common among public agencies in conducting, managing, and/or approving traffic analysis and simulation studies. The TAMS PFS will address key technical and programmatic traffic analysis issues through the investigation and development of best practices, lessons learned, and recommended guidelines or methodologies. The TAMS PFS will also provide an opportunity to facilitate the interaction, sharing of information, and exchange of knowledge with a broader audience to advance and improve upon the current state-of-the-practice related to the usage, management, and/or approval of traffic analysis and simulation tools.

The goal of this study is to improve the state-of-the-practice in traffic analysis, modeling, and simulation to enable public agencies to make the best possible transportation investment decisions based upon high-quality traffic analyses. The objectives of this study are to assemble federal, state, regional, and local agencies to: 1) identify challenges and issues common among those responsible for conducting, managing, and/or approving traffic analysis and simulation studies; 2) suggest approaches to address identified challenges; 3) initiate and monitor projects intended to address identified challenges and issues; 4) develop and disseminate noteworthy practices, recommendations, and results; and 5) promote and facilitate technology transfer related to traffic analysis and simulation issues nationally.

Financials:	Year	Commitment
TxDOT	2020 - 2023	$20,000.00

Project Number: 8-8497

Study Number: TPF-5(446)

Project Title: High Performance Computational Fluid Dynamics (CFD) Modeling Services for Highway Hydraulics

Lead Agency: Federal Highway Administration

Status: Cleared by FHWA

Project Objectives: The objective of these pooled funds is to provide research and analysis for a variety of highway hydraulics projects managed or coordinated by State DOTs; to provide and maintain a high performance Computational Fluid Dynamics (CFD) computing environment for application to highway hydraulics infrastructure and related projects; and to support and seek to broaden the use of CFD among State Department of Transportation employees.

Financials:	Year	Commitment
TxDOT	2020 - 2023	$15,000.00

Project Number: 8-8499

Study Number: TPF-5(451)

Project Title: Road Usage Charge West

Lead Agency: Oregon Department of Transportation

Status: Cleared by FHWA

Project Objectives:

- Explore the technical and operational feasibility of a multi-jurisdictional road usage charge system.
- Investigate public and key decision maker criteria for acceptance and share experience and lessons learned to foster positive outcomes.
- Develop standards and protocols for how road use charges could best be collected and remitted among the various jurisdictions.
- Develop preliminary operational concepts for how a multi-jurisdictional road usage charge system could be administered.
- Develop a model for regional cooperation and interoperability that can be used in the Western region and potentially across North America.
- Engage the automotive manufacturing and technology sector to encourage the ability for mileage reporting to occur in conjunction with other products and services the sector provides in the marketplace.
- Share knowledge to maximize the preparedness for and efficiency of policy and program development for road usage charging among the members.

Financials:	Year	Commitment
TxDOT	2020 - 2025	$25,000.00

Project Number: 8-8500

Study Number: TPF-5(462)

Project Title: Assessment and Repair of Prestressed Bridge Girders Subjected to Over-Height Truck Impacts (OHTI)

Lead Agency: Missouri Department of Transportation

Status: Contract Signed

Project Objectives: Vehicle impact is one of the major causes for bridge collapse in the U.S. The overarching goal of this project is to assess the damage to and repair of bridge girders due to the over-height truck impact using comprehensive experimental testing and analytical models. In particular, this project aims to determine:

- The remaining carrying capacity of bridge girders damaged due to over-height truck impact which will allow stakeholders (e.g., DOT engineers) to prioritize girders needing repairs.
- Determine the carrying capacity of the damaged girders after being repaired using different repair measures. The repaired beams will be investigated under static and fatigue loads to determine their capacities.

Financials:	Year	Commitment
TxDOT	2020 - 2022	$45,000.00

Project Number: 8-8501

Study Number: 1513

Project Title: Infrastructure to Support Advanced Autonomous Aircraft Technologies

Lead Agency: Ohio Department of Transportation

Status: Solicitation Posted

Project Objectives: Market Assessment
Strategic Roadmap Research and Development
Implementation
Research Effectiveness and Document Plans for Full Implementation

Financials:	Year	Commitment
TxDOT	2021 - 2023	$175,000.00

Project Number: 8-8502

Study Number: TPF-5(464)

Project Title: Hydrologic and Hydraulic Software Enhancements (SMS, WMS, Hydraulic Toolbox, and HY-8)

Lead Agency: Federal Highway Administration

Status: Cleared by FHWA

Project Objectives: This Transportation Pooled Fund (TPF) project will:
1. Enhance the capabilities of the four FHWA sponsored software programs and ensure they remain consistent with the latest FHWA technical reference documents.
2. Update the software user manual documentation.
3. Make new software versions publicly available.
4. Develop and deploy technology transfer materials and workshops to test and demonstrate new software content and features.
5. Inform users of the availability of new software versions and features through website postings, email notifications, newsletter articles, conference presentations, and other avenues.

Financials:	Year	Commitment
TxDOT	2020 - 2024	$10,000.00

Project Number: 8-8503

Study Number: 1509

Project Title: Railroad Crossing Signal Technology and Implementation Solutions Pooled Fund

Lead Agency: Washington State Department of Transportation

Status: Solicitation Posted

Project Objectives: The objective of this pooled fund is to initiate a research project to determine whether there is an opportunity to reduce conflicts at railroad grade crossings using smart technology. These conflicts occur between railroads, pedestrians and motorists. The intent is to improve signals and signage, barriers, warnings to autonomous vehicles, LIDAR, digital imaging, etc. resulting in improved safety, and also potentially address rerouting of emergency and other vehicles. The pooled fund will be closed on completion of this project.

Financials:	Year	Commitment
TxDOT	2021	$25,000.00

Project Number: 8-8504

Study Number: TPF-5(447)

Project Title: Traffic Control Device (TCD) Consortium (3)

Lead Agency: Federal Highway Administration

Status: Cleared by FHWA

Project Objectives: This project is being created to re-new the contract for Pooled Fund Project TPF-5(316). All new Funding Commitments will need to be made on the Pooled Fund Website to this new project and all new funds will be transferred to the Lead State/Agency by the partners. The Lead State/Agency will have the responsibility for Receiving, Obligating, Expending, and Balancing the funding for this project.

To assemble a consortium composed of regional, State, local entities, appropriate organizations and the FHWA to 1) establish a systematic procedure to select, test, and evaluate approaches to novel TCD concepts as well as incorporation of results into the MUTCD; 2) select novel TCD approaches to test and evaluate; 3) determine methods of evaluation for novel TCD approaches; 4) initiate and monitor projects intended to address evaluation of the novel TCDs; 5) disseminate results; and 6) assist MUTCD incorporation and implementation of results.

Financials:	Year	Commitment
TxDOT	2020 - 2022	$25,000.00

Project Number: 8-8505

Study Number: TPF-5(471)

Project Title: Determining the in-place strength of concrete using piezoelectric based sensors

Lead Agency: Indiana Department of Transportation

Status: Contract Signed

Project Objectives: The aim of this project is to develop a reliable in-situ sensing method to evaluate the concrete properties for determining optimal traffic opening time of patching job or new construction with fly ash or other supplementary cementitious materials. This goal will be achieved by using piezoelectric sensors coupled with electromechanical impedance (EMI) analyzers to determine the very early age properties of concrete (i.e. Stiffness, setting time, hydration, etc.). This novel method will address the deficiency of current testing methods for determining traffic opening, for instance extensive calibration of maturity test and inefficiency of flexural strength test.

The impact of this study can be revolutionary as it does not require any conventional mechanical testing and expensive and heavy test setups in the field. It only requires commercially available piezoelectric sensors (~$10 per sensor) and a portable EMI analyzer for data analysis and interpretation. There is no need for calibration for each different mix design. The associated benefits of using this novel non-destructive sensing method include 1) determining optimal traffic opening time based on reliable data of concrete properties; 2) reducing pre-mature failure of concrete pavement, bridge deck, patching, and other concrete structures; 3) enabling significant cost and schedule savings in construction projects due to reduced testing samples and testing time; and 4) reducing construction worker safety issues and jobsite accident rates in construction zones.

Financials:	Year	Commitment
TxDOT	2021 - 2023	$25,000.00

Project Number: 8-8506

Study Number: TPF-5(463)

Project Title: Pavement Surface Properties Consortium: Phase III - Managing the Pavement Properties for Improved Safety

Lead Agency: Virginia Department of Transportation

Status: Cleared by FHWA

Project Objectives: The mission of the Surface Properties Consortium has been to conduct applied research focused on enhancing the level of service provided by the roadway transportation system by optimizing pavement surface characteristics.

Phase I [TPF-5(141)] included regular verification and validation of the participants' equipment, opportunities for technology transfer, and the accumulation of a significant body of knowledge on the measurement of pavement surface properties. Phase II [TPF-5(345)] continued to support the members' effort to produce high-quality surface properties measurements, but focused mainly on emerging friction and macrotexture measurement technologies and the integration of these measurements into the next generation of pavement asset management systems. Practical and tangible results were well documented and disseminated.

The focus of Phase III will be on continuing to support the implementation of asset management approaches and tools that help improve the safety of our road networks by reducing the number of crashes and related fatalities. It will represent a concerted effort to bring pavement design and evaluation experts together with maintenance and safety professionals to maximize the contribution of the pavement community Towards Zero Deaths on US highways. It will also seek participation of industry through the pooled-fund or an industrial affiliate program.

Financials:	Year	Commitment
TxDOT	2021 - 2025	$20,000.00

Project Number: 8-8507

Study Number: TPF-5(474)

Project Title: Bridge Deck Preservation Portal

Lead Agency: Iowa Department of Transportation

Status: Cleared by FHWA

Project Objectives: The objective of the BDPP development phase is to provide a cloud based web tool hosted on the InfoBridge website that meets, or exceeds, the engineering based functionality outlined in the previously mentioned BDPP Framework Report. The BDPP will standardize the bridge deck maintenance process by assisting engineers with the logical selection of maintenance actions. The BDPP will create a set of maintenance action scenarios based on cost effective bridge deck implemented at the most efficient point in the life cycle of individual assets and integrate a fully functional bridge deck preservation portal programmed in accordance with the framework developed in Phase 1 to be hosted on the FHWA LTBPP InfoBridge website (https://infobridge.fhwa.dot.gov/).

Financials:	Year	Commitment
TxDOT	2021 - 2022	$30,000.00

Project Number: 8-8508

Study Number: TPF-5(461)

Project Title: Soil and Erosion Testing Services for Bridge Scour Evaluations

Lead Agency: Federal Highway Administration

Status: Cleared by FHWA

Project Objectives: The objective of these pooled funds is to provide and/or support soil and erosion testing services for bridge projects over water crossings managed or coordinated by State DOTs, to provide technical assistance to design, fabricate, and install erosion testing devices to support and seek to broaden the use of erosion testing devices among State Department of Transportations, and to compile and analyze the collected soil and erosion testing data in a broader research effort to more accurately estimate reliable scour design depths given the soil conditions and hydraulic load during a given storm event.

Financials:	Year	Commitment
TxDOT	2021 - 2025	$15,000.00

Project Number: 8-8509

Study Number: TPF-5(467)

Project Title: Research Project Tracking System

Lead Agency: Kentucky Transportation Cabinet

Status: Cleared by FHWA

Project Objectives: Develop common functional requirements, a software solution and maintenance of the software solution for a Research Program Tracking System to be used by multiple DOTs

Financials:	Year	Commitment
TxDOT	2021	$3,500.00

Project Number: 8-8510

Study Number: TPF-5(478)

Project Title: Demonstration to Advance New Pavement Technologies Pooled Fund

Lead Agency: Federal Highway Administration

Status: Cleared by FHWA

Project Objectives: This pooled fund seeks to support and showcase the implementation of innovative pavement technologies, products, and processes by State DOTs by leveraging of Federal investments with State DOT partnerships.

Financials:	Year	Commitment
TxDOT	2021 - 2025	$10,000.00

Project Number: 8-8511

Study Number: TPF-5(483)

Project Title: Integration of New Traffic Signal Actuation Concepts using Enhanced Detector Information

Lead Agency: Iowa Department of Transportation

Status: Cleared by FHWA

Project Objectives: The objective of this research is to develop field-tested methods of integrating vehicle trajectory data into actuated signal control that can be directly implemented in traffic signal controllers. This research will identify the practical requirements and limitations of establishing trajectory-assisted actuated signal control. The findings will be developed into a resource toolkit that will permit implementation and further development of the methods conceived during the course of the research.

Financials:	Year	Commitment
TxDOT	2021 - 2023	$33,000.00

Project Number: 8-8512

Study Number: TPF-5(469)

Project Title: Accelerated Performance Testing on the 2021 NCAT Pavement Test Track with MnROAD Research Partnership

Lead Agency: Alabama Department of Transportation

Status: Cleared by FHWA

Project Objectives: The primary objectives of the pooled fund project described herein will be:
1. Constructing experimental pavements on the existing 1.7-mile NCAT test oval and the MnROAD mainline bypass that are representative of in-service roadways on the open transportation infrastructure;
2. Applying accelerated performance truck traffic after construction for the duration of the 3-year research cycle;
3. Assessing/comparing the functional and structural field performance of trafficked sections on a regular basis via surface and subsurface measures;
4. Validating/calibrating new and existing methodologies for analysis and design using pavement surface condition, pavement load response, precise traffic and environmental logging, and cumulative damage;
5. Correlating field results with laboratory data for both mix and structural performance; and
6. Answering practical questions posed by research sponsors through formal (i.e., reports and technical papers) and informal (e.g., one-on-one responses to sponsor inquiries) technology transfer. For example, can pavement thickness be reduced as a result of the addition of premium mix additives, and if so does the thickness reduction offset the additional cost of construction?

Financials:	Year	Commitment
TxDOT	2021 - 2023	$640,083.00

Project Number: 8-8513

Study Number: TPF-5(480)

Project Title: Building Information Modeling (BIM) for Infrastructure

Lead Agency: Iowa Department of Transportation

Status: Cleared by FHWA

Project Objectives: The pooled fund serves as the mechanism for stakeholders to work collaboratively to advance BIM for Infrastructure. This will involve building off the foundational work that was charted out in the BIM National Strategic Work Plan, with emphasis on increasing coordination and awareness of BIM technologies and activities.

This pooled fund will coordinate with efforts of TPF-5(372) focusing on BIM for Bridges and Structures.

Financials:	Year	Commitment
TxDOT	2021 - 2025	$30,000.00

3.1 Research Management and Administration

RTI performs the following management and administrative activities.

Project Number: 0-50

Project Title: Research Management and Administration

Project Objectives: RTI provides administrative oversight for support functions including budgeting, purchasing, contract administration, legislative analysis, mapping, and the SPR Work Program.

Planned Activities: Develop, implement, and monitor the division's biennium budget.

1. Develop, implement, and monitor the SPR Work Program, ensuring that all requirements of 23 CFR 420, 2 CFR 200, and other applicable federal and state statutes and regulations are followed.

    a. Prepare and submit the proposed 2022 SPR Work Program to FHWA.

    b. Prepare and submit the 2021 Annual Performance and Expenditures Report (APER) to FHWA.

    c. Hold quarterly status meetings with FHWA to report on the 2022 SPR Work Program.

    d. Prepare and submit amendments to the 2022 SPR Work Program as needed.

2. Administer and ensure that all the division's agreements/contracts are approved, procured, monitored, and closed out in accordance with the provisions of 2 CFR 200. In addition, this function ensures that program monitoring and reporting requirements of FHWA planning and research funds are in compliance with 23 CFR 420.117.

Financials	Budget	Expended	Balance
Division Travel	$70,590.00	$102.96	$70,487.04
Salary	$1,706,139.00	$1,638,501.31	$67,637.69
Total RTI Division Program Management	$1,776,729.00	$1,638,604.27	$138,124.73

End of Report