Texas SPR Work Program

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

September 1, 2021–August 31, 2022

Certification and Disclaimer Statements

State Planning & Research Program Part II - Research
Texas Department of Transportation
Research and Technology Implementation Division
125 E. 11TH Street
Austin, Texas 78701
Phone (512) 416-4730
EMAIL: RTIMAIN@TXDOT.GOV

In cooperation with:
U.S. Department of Transportation Federal Highway Administration

Research - SPR-0511(222)
Implementation Program – SPR2022(023)

Fiscal Year 2022
(September 1, 2021 – August 31, 2022)

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
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12/27/2022

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) 2022 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 2022, RTI managed one hundred forty-three (143) active research projects with 19 universities. Of the 143 projects, ninety-two (92) remain active projects, fifty-one (51) closed, zero (0) cancelled and during this reporting period with one (1) 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.

RTI Guidance Documents

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.

Performance Measures

The performance for FY 2022 is an overall 75.4% on-time receipt of project deliverables. Analyses at this level also provides insight into where the program can improve in project monitoring efforts. The data provided for the purpose of this report is accurate as of November 8, 2022.

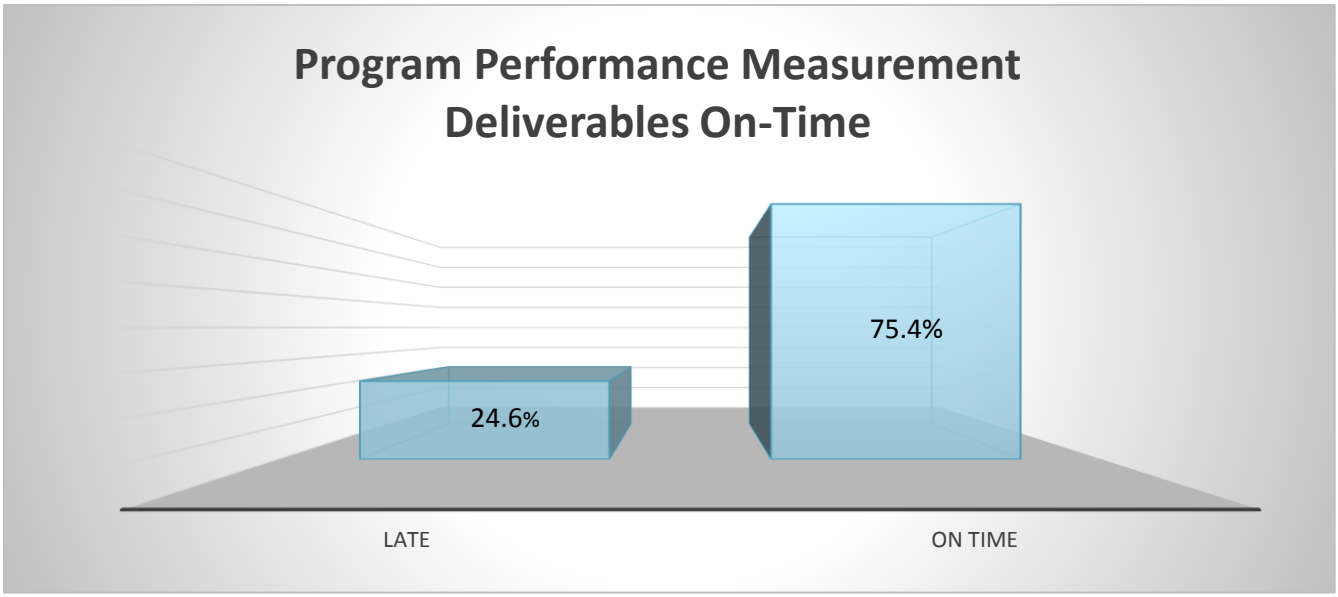

Figure 1. Bar Chart of Deliverables Submitted On-time

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 FY22

Program	SPR Program Number	Total Funding Expended FY22	Federal 80%	State 20% TDC
Research Program	SPR 0511 (222)	$24,715,213.05	$19,772,170.44	$4,943,042.61
Implementation Program	SPR 2022(023)	$2,280,321.14	$1,824,256.91	$456,064.23
Total		**$26,995,534.19**	**$21,596,427.35**	**$5,399,106.84**

SPR funds were transferred to other contracting entities during 2022. 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)	$5,334,244.00
Pooled-fund projects, including TxDOT's Transportation Research Board (TRB) dues*	$3,051,283.00

Program	Program Number	Total Funding Obligated FY22	Federal 100%
ADS Demonstration Grant Program	F 2021(463)	$2,141,365.00	$2,141,365.00
Total		$2,141,365.00	$2,141,365.00

Program	SPR Program Number	Total Funding Obligated FY22	Federal 100%
Pooled Fund	TPF-5(482)	$72,654.25	$72,654.25
Total		$72,654.25	$72,654.25

Program	SPR Program Number	Total Funding Obligated FY22	Federal 80%	State 20% TDC
STIC Incentive	F 2022(240)	$32,635.00	$26,108.00	$6,527.00
Total		$32,635.00	$26,108.00	$6,527.00

Program	SPR Program Number	Total Funding Obligated FY22	Federal 80%	State 20% TDC
Innovation	SPR 2022(946)	$330,000.00	$264,000.00	$66,000.00
Total		$330,000.00	$264,000.00	$66,000.00

*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.

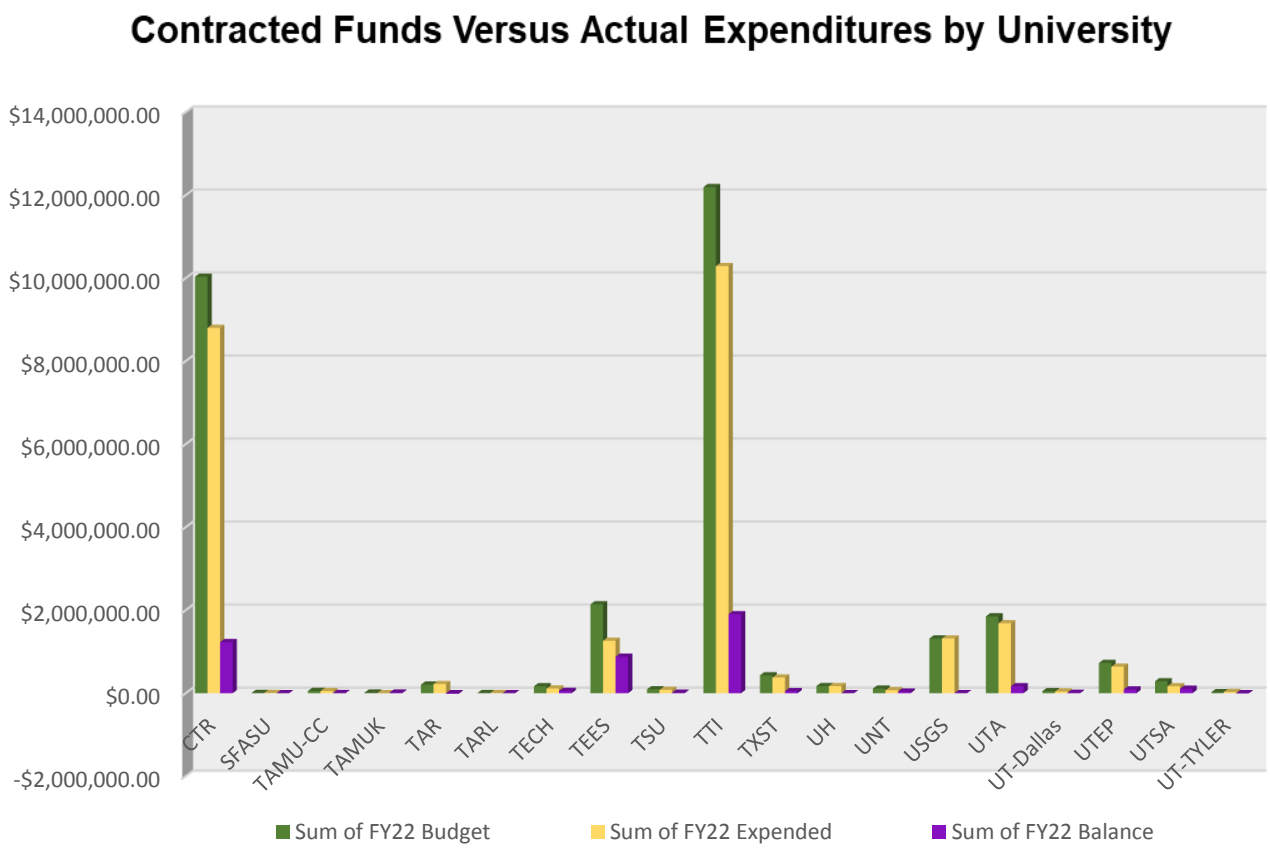

Figure 2. University Contracted Funds versus Actual Expenditures by University.

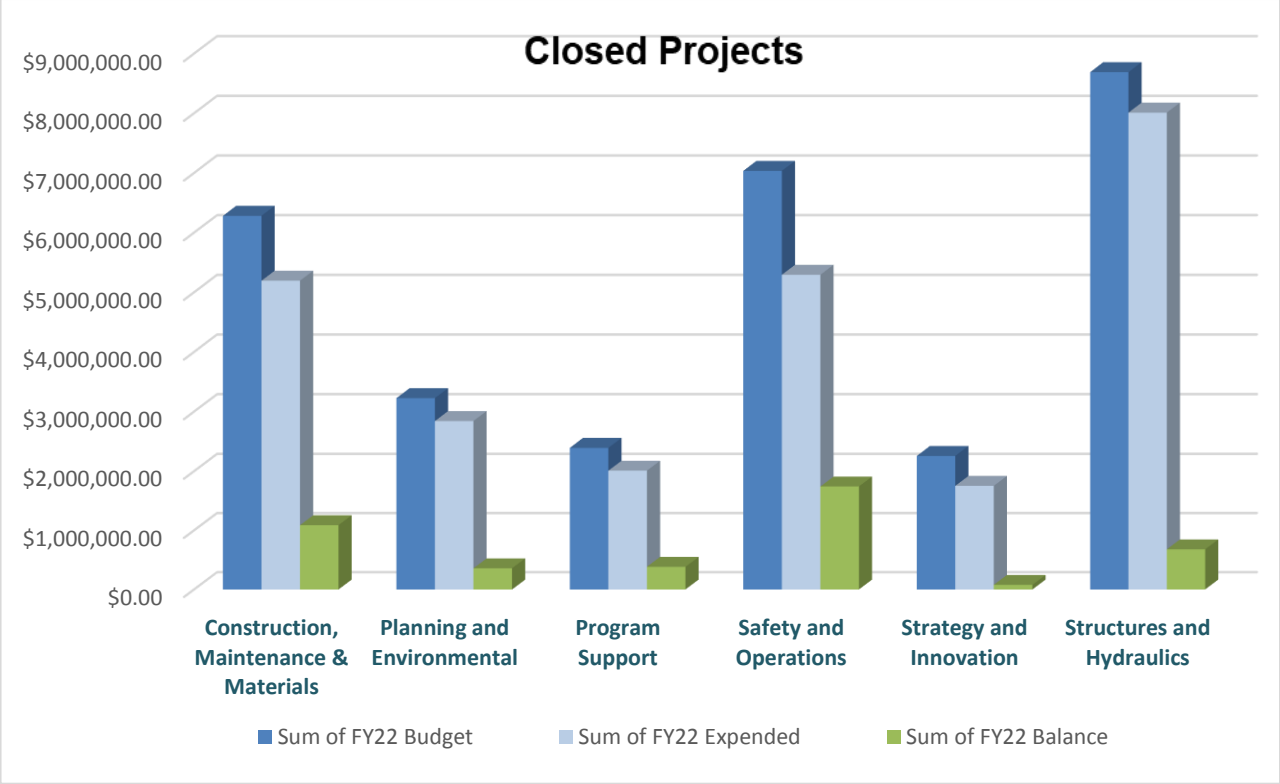

Figure 3. Shows the funds budgeted to each research area for closed projects, the funds the universities spent in that area, and the balance.

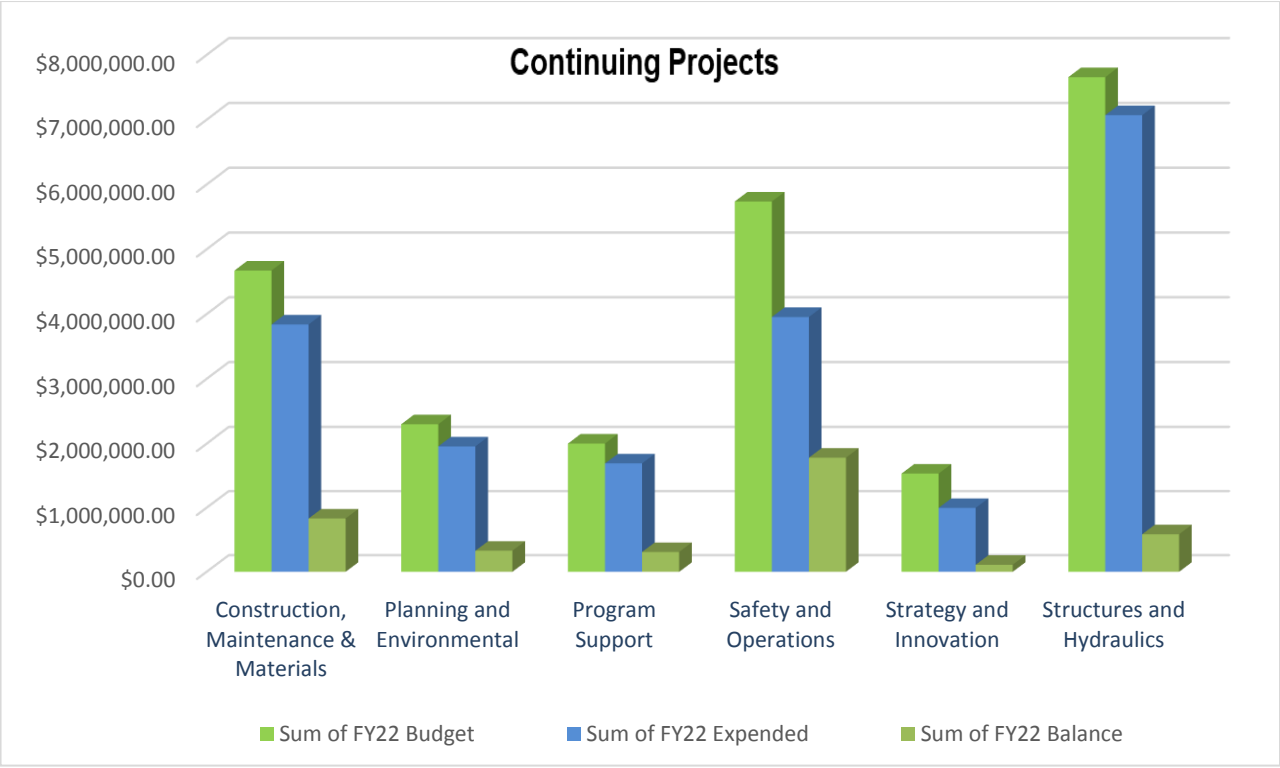

Figure 4. Shows the funds budgeted to each research area for continuing projects, the funds the universities spent in that area, and the balance.

1.2.3 Actual Expenditures

Table 3. Expenditures by Program for FY 2022

Project	Budgeted	Expended	Balance
Research	$23,677,518.07	$21,125,088.67	$2,552,429.37
Implementation	$1,030,975.97	$924,894.79	$106,081.18
Pooled-Fund	$2,403,633	$2,403,633.00	$0
Support Projects	$2,392,329.40	$2,007,588.99	$384,740.41
Special Initiative	$2,780,095.00	$2,197,998.98	$582,096.02
Management and Administration	$1,714,416.00	$1,838,110.77	-$123,694.77
Total	**$33,998,967.44**	**$30,497,315.20**	**$3,501,652.21**

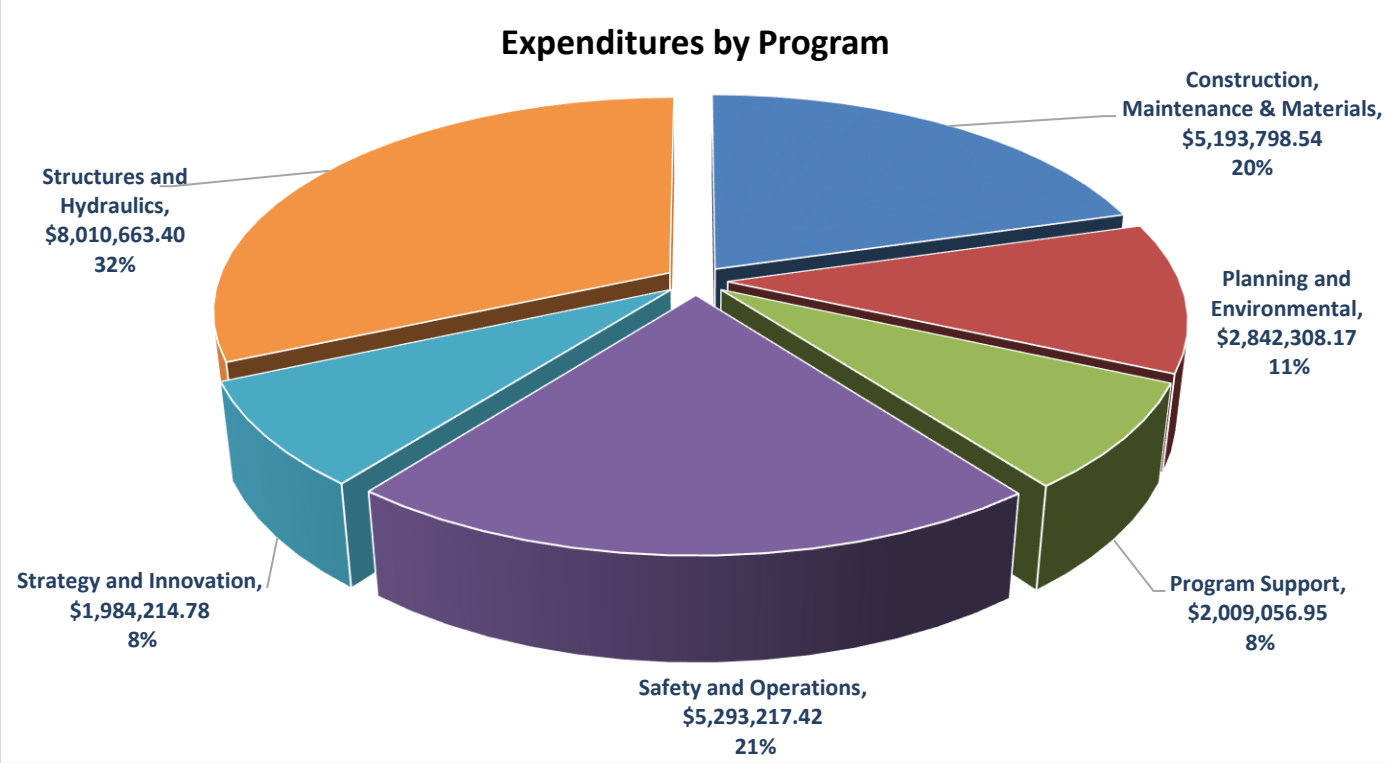

Figure 5. Pie Chart of Expenditures by Program.

Table 4. Expenditures by University.

University	FY '22 Budget	FY'22 Expended	FY'22 Balance
CTR	$10,032,146.88	$9,091,810.20	$940,336.68
SFASU	$5,341.91	$5,065.75	$276.16
TAMU-CC	$55,856.25	$52,026.23	$3,830.02
TAMUK	$13,400.00	$0.00	$13,400.00
TAR	$207,040.63	$221,154.46	-$14,113.83
TARL	$3,939.02	$3,939.02	$0.00
TECH	$166,646.75	$112,841.96	$53,804.79
TEES	$2,141,365.00	$1,713,699.45	$427,665.55
TSU	$92,648.65	$82,134.90	$10,513.75
TTI	$12,192,842.05	$10,490,354.62	$1,702,487.43
TXST	$430,602.71	$380,194.75	$50,407.96
UH	$170,901.25	$170,901.24	$0.01
UNT	$111,518.00	$72,332.81	$39,185.19
USGS	$1,316,800.00	$1,316,800.00	$0.00
UTA	$1,851,030.59	$1,682,489.78	$168,540.81
UT-Dallas	$49,647.25	$39,572.57	$10,074.68
UTEP	$727,595.00	$638,434.61	$89,160.39
UTSA	$287,599.00	$168,796.11	$118,802.89
UT-Tyler	$23,997.50	$13,022.97	$10,974.53
Grand Total	**$29,880,918.44**	**$26,255,571.43**	**$3,625,347.01**

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
TARL	Tarleton State University

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
TXST	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
USGS	U.S. Geological Survey
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
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	TXST	(512) 245-2102	grants@txstate.edu
Kara Ulibarri	TXST	(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
Emily Lace Michael Odell	UT-DALLAS UT-TYLER	(972) 883-4572 (903) 566-7132	emily.lacy@utdallas.edu 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 FY 2022 reporting year, the portfolio of projects was impacted by market changes affecting supply and demand and, in some cases, directly by COVID-19. This resulted in projects requiring time extensions where needed, due to delays in shipping and receiving of supplies.

We continue to monitor the impacts to the Program and remain flexible to meet the goals of each project.

1.7. Deliverables Completed during FY 2022

Project agreements required the universities to submit specific deliverables as outlined in Deliverables Table for FY 2022. 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 2022, RTI monitored fifty-one (51) active research projects which ended throughout this fiscal year cycle covering September 1, 2021 through August 31, 2022. Of the fifty-one (51) projects that closed in FY 2022, one (1) terminated early.

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 2022.

2.1.1 Terminated Projects

Strategy and Innovation

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: Terminated **Total Project Budget:** $271,385.00

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.

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$162,488.00	$129,990.40	$32,497.60

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

Table 8. Totals for Terminated Project

Financials	FY22 Budget	FY22 Expended	FY22 Balance
Federal 80%	$129,990.40	$129,990.10	$0.30
State 20% TDC*	$32,497.60	$32,497.52	$0.08
Total	**$162,488.00**	**$162,487.62**	**$0.38**

2.1.2 Construction, *Maintenance and Materials*

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: Closed **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 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
TM11
TM13
R1 (2nd)
PSR (2nd)
P1

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$145,450.00	$116,360.00	$29,090.00

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

Construction, Maintenance and Materials

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: Closed **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: R1 & VOR

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$58,877.00	$47,101.60	$11,775.40

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

Construction, Maintenance and Materials

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: Closed **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:
R1B: Research Report
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$80,000.25	$64,000.20	$16,000.05

*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: Closed **Total Project Budget:** $526,031.00

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 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
TM-4

TM-5
VOR
R1
PSR
TM-6

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$152,546.75	$122,037.40	$30,509.35

*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: Closed **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 2021
September MPR 2021
October MPR 2021
November MPR 2021
TM5
VOR
PSR
R1
December MPR 2021

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$44,956.36	$35,965.09	$8,991.27

*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: Closed **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 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
TM4
TM5
P1
P2
P3
TM6

P4
P5
P6
R1
PSR

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$40,273.00	$32,218.40	$8,054.60

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

Construction, Maintenance and Materials

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: Closed **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 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
TM4
TM5
R1 Draft (to include Guidelines and Acceptance deliverable)
PSR
Guidelines & Acceptance
R1 Final

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$184,477.30	$147,581.84	$36,895.46

*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: Closed **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:
TM4
TM5
R1 Draft
PSR
R1 Final
August MPR 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
Guidelines & Acceptance

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$174,061.93	$139,249.54	$34,812.39

*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:** 8/31/2022

Project Status: Closed **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 disruptio- 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: PSR
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$106,977.00	$85,581.60	$21,395.40

*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: Closed **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:
August MPR 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
TM1

TM4
TM5
TM6
TM7
TM8
R1A
PSR
R1B

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$130,341.89	$104,273.51	$26,068.38

*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: Closed **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:
August MPR 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
TM1
TM4

TM5
TM6
TM7
TM8
R1A
PSR
R1B

Financials:	FY22 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: 0-7101 **University:** TTI

Project Title: Synthesis for Best Practices for 4-Year Pavement Management Plans

Project Start Date: 9/1/2021 **Termination Date:** 8/31/2022

Project Status: Closed **Total Project Budget:** $64,882.00

RTI Project Manager: Chris Glancy **Researcher:** Charles Gurganus

Project Objectives: The Performing Agency shall perform a synthesis study focusing on best practices for developing 4-Year Pavement Management Plans (PMPs). Successful 4-year PMPs help provide the traveling public with a safe, comfortable, and reliable roadway network. Developing, initiating and performing a 4-Year PMP requires working across multiple levels within the Receiving Agency. Expert knowledge of the maintenance area serves as a foundation.

The PMPs must support statewide goals, regularly driven by pavement management data and reports housed in Pavement Analyst (PA). District's maintenance sections that successfully meet the needs of its roadways, while also improving statewide performance metrics in a fiscally constrained environment succeed in developing effective 4-year PMPs. The Performing Agency's primary goal of this project is to capture and communicate the practices of these successful districts.

Deliverables:
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
R1
PSR
TM2
TM3
TM4

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$64,882.00	$51,905.60	$12,976.40

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

Project Number: 0-7109 **University:** TTI

Project Title: Synthesis for Best Practices for Preventive Maintenance Preparatory Work

Project Start Date: 9/1/2021 **Termination Date:** 8/31/2022

Project Status: Closed **Total Project Budget:** $64,611.75

RTI Project Manager: Chris Glancy **Researcher:** Darlene Goehl

Project Objectives: The synthesis study shall focus on pavement preparatory work performed before preventive maintenance (PM) surfacing contracts with the goal of answering, "What work needs to be performed to the roadway before a new surface is placed?"

Preparatory work performed by in-house maintenance forces or maintenance contracts may include crack sealing, fog seal, repairs, milling, and level-up and should be performed well in advance of the PM contract. Both flexible and rigid pavements may require work in advance of a PM contract. Seal coats or thin overlays are typical PM surfacing projects. The synthesis shall investigate best practices, factors that affect materials selected, factors that affect repair decisions, timing of preparatory work and the effects of the repair procedures and materials on the life of the new surface based on the preparatory work performed.

Deliverables:

September MPR 2021

October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
R1
PSR
TM2
TM3

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$64,611.75	$51,689.40	$12,922.35

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

Project Number: 0-7135 **University:** TSU

Project Title: Synthesis of Best Application and Verification Practices for Long-Life Pavement Markings

Project Start Date: 9/1/2021 **Termination Date:** 8/31/2022

Project Status: Closed **Total Project Budget:** $64,993.77

RTI Project Manager: Chris Glancy **Researcher:** Fengxiang Qiao

Project Objectives: The long-term performance, number, and variability of pavement marking materials and specifications depend on the ability to meet both day and night functionality on roadways, as well as on other characteristics such as surface topography, AADT, truck volume, regional weather conditions, and maintenance operations. To control the amount of pavement marking material applied on both liquid and thermoplastic marking applications has a direct bearing on the pavement marking's longevity and life-cycle costs. This project shall synthesize best case examples of quality control of longitudinal, lane-line liquid and thermoplastic pavement marking applications. The Performing Agency shall scan practices across the United States and other countries focusing on:

- Types of markings materials used and reasons for their use on different pavement types, including application thickness, quality control approaches and methods, including verifying selected thickness or quantity of markings
- Types of specifications used, recommended language, and issues associated with each specification
- Application rate verification in the field; i.e., thickness, volume, or rate
- Equipment ability to measure quantity of marking applied and modifications to existing equipment
- How markings are paid for; i.e., subsidiary, by volume, or by length.

Deliverables: **September MPR 2021**

October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022

June MPR 2022
July MPR 2022
TM2
TM3
TM4
TM5
P6
R1
PSR

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$64,993.77	$51,995.02	$12,998.75

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

Construction, Maintenance and Materials

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: Closed **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.

Deliverables: July MPR 2022

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$140,000.25	$112,000.20	$28,000.05

*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:** 8/31/2022

Project Status: Closed **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:
PSR
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
R1B Research Report
P2-V2 Presentation Materials
P3-V2 Instructor's Guide
P4-V2 Student Handbook
March MPR 2022
April MPR 2022

May MPR 2022
June MPR 2022
July MPR 2022

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$60,000.00	$48,000.00	$12,000.00

*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: Closed **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 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
TM1
P1
TM2
P2
P3
R1
PSR

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$73,000.00	$58,400.00	$14,600.00

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

Table 9. Construction, Maintenance and Materials Totals For Closed Projects

Financials	Budget	Expended	Balance
Federal 80%	$1,288,359.40	$1,084,078.92	$204,280.48
TDC 20%	$ 322,089.85	$271,019.73	$51,070.12
Total	**$1,610,449.25**	**$1,355,098.65**	**$255,350.60**

2.1.3 Planning and Environmental

Project Number: 0-6701-01 **University:** TTI

Project Title: Planning and Environment Linkages (PEL) Guidance

Project Start Date: 9/1/2021 **Termination Date:** 1/31/2022

Project Status: Closed **Total Project Budget:** $9,976.00

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

Project Objectives: The Receiving Agency's Research and Technology Implementation (RTI) Division funded research project 0-6701 in FY 2012 to investigate potential methods of linking transportation planning in Texas with the environmental clearance process required of the National Environmental Policy Act (NEPA). The study approach and findings were documented in a research report (0-6701-1) and a guidance document entitled Texas Department of Transportation (TxDOT) Resource for Linking Planning with Project Planning in Support of NEPA (0-6701-P1).

The Performing Agency shall:

(1) Conduct structured interviews with the Receiving Agency's planning and environmental subject matter experts, five of the state's Metropolitan Planning Organizations (MPOs), and up to five State Departments of Transportation that pioneered Planning and Environmental Linkages (PEL) in FY 2012 to determine the need for updated/new PEL Guidance given that 0-6701-P1 was developed a decade ago as well as the Receiving Agency's participation in the NEPA Assignment program under 23 U.S.C. 327 and the Memorandum of Understanding with FHWA originally dated December 16, 2014 and renewed on December 9, 2019 (Phase 1) and,

(2) Update 0-6701-P1 if the interviews reveal the need for updated/additional guidance (Phase 2).

Phase 2 will only be conducted if the Phase I interviews reveal the need for updated/additional guidance. The scope of services and budget for Phase 2 will be finalized in consultation with the Receiving Agency based on the outcome of Phase 1.

Deliverables: TM2
PSR

R1
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$9,976.00	$7,980.80	$1,995.20

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

Planning and Environmental

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: Closed **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: October MPR 2021
PSR

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$3,939.02	$3,151.22	$ 787.80

*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:** 3/31/2022

Project Status: Closed **Total Project Budget:** $87,915.25

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:
P4
PSR
R1
August MPR 2021 UTSA
September MPR 2021 UTSA
October MPR 2021
November MPR 2021
December MPR 2021
August MPR 2021 TTI
September MPR 2021 TTI
January MPR 2022
February MPR 2022
March MPR 2022
P5

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$41,425.25	$33,140.20	$8,285.05

*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:** 3/31/2022

Project Status: Closed **Total Project Budget:** $87,915.25

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:
P4
PSR
R1
August MPR 2021 UTSA
September MPR 2021 UTSA
October MPR 2021
November MPR 2021
December MPR 2021
August MPR 2021 TTI
September MPR 2021 TTI
January MPR 2022
February MPR 2022
March MPR 2022
P5

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$11,828.75	$9,463.00	$2,365.75

*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: Closed **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:
October MPR 2019
August MPR 2021
R1A
PSR
R1B
September MPR 2021
October MPR 2021
November MPR 2021
TM4 Demonstrate prototype in relevant environment
December MPR 2021
January MPR 2022

February MPR 2022
March MPR 2022

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$31,151.50	$24,921.20	$6,230.30

*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: Closed **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:
October MPR 2019
August MPR 2021
R1A
PSR
R1B
September MPR 2021
October MPR 2021
November MPR 2021
TM4 Demonstrate prototype in relevant environment
December MPR 2021
January MPR 2022

February MPR 2022
March MPR 2022

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$9,900.63	$7,920.50	$1,980.13

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

Planning and Environmental

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: Closed **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:
R1B
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$66,286.00	$53,028.80	$13,257.20

*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: Closed **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 2021
P3
R1
PSR
CO
COV
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
TM8
TM9
TM10
TM11
P4 Workshop

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$186,785.03	$149,428.02	$37,357.01

*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: Closed **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:
TM9
TM10
VOR
PSR
P1
P2
R1

August MPR 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$39,482.50	$31,586.00	$7,896.50

*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: Closed **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:

R1
PSR
August MPR 2021
September MPR 2021
October MPR 2021

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$7,999.50	$6,399.60	$1,599.90

*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: Closed **Total Project Budget:** $518,731.85

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:
August MPR 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021

January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
R1
PSR
TM2A
TM2C
TM2B
TM3A
TM3B
TM4B
TM5C

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$197,140.00	$157,712.00	$39,428.00

*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: Closed **Total Project Budget:** $518,731.85

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:
August MPR 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021

January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
R1
PSR
TM2A
TM2C
TM2B
TM3A
TM3B
TM4B
TM5C

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$65,705.00	$52,564.00	$13,141.00

*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: Closed **Total Project Budget:** $499,999.75

RTI Project Manager: Joanne Steele **Researcher:** Ali Mostafavi

Project Objectives: 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.

Deliverables:
August 2021 MPR
September 2021 MPR
October 2021 MPR
November 2021 MPR
December 2021 MPR
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
TM4
P3
P4
TM5
P5
P2
P6
R1
PSR
P1
TM3

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$254,644.25	$203,715.40	$50,928.85

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

Table 10. Planning and Environmental Totals for Closed Projects

Financials	Budget	Expended	Balance
Federal 80%	$741,010.74	$707,770.48	$33,240.26
State 20% TDC*	$185,252.69	$176,942.62	$8,310.07
Total	**$926,263.43**	**$884,713.10**	**$41,550.33**

2.1.4 Program Support

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: Closed **Total Project Budget:** $794,681.44

RTI Project Manager: Tom Schwerdt **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 Programmanaged 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 ensurespublic accessto 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 andlong-term 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:
P1
P2
P3
P4
P5
P6
Research Digest - Special Edition (August)
Research Digest - September 2021
Research Digest - October 2021
Research Digest - November 2021
Research Digest - December 2021

Research Digest - January 2022
Research Digest - February 2022
Research Digest - March 2022
Research Digest - April 2022
Research Digest - May 2022
Research Digest - June 2022
Research Digest - July 2022
August MPR 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$390,334.23	$312,267.38	$78,066.85

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

Table 11. Program Support Totals for Closed Projects

Financials	Budget	Expended	Balance
Federal 80%	$312,267.38	$253,081.62	$59,185.76
State 20% TDC*	$78,066.85	$63,270.41	$14,796.44
Total	$390,334.23	$316,352.03	$73,982.20

2.1.5 Structures and Hydraulics

Project Number: 0-6953-01 **University:** CTR

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

Project Start Date: 10/6/2021 **Termination Date:** 6/30/2022

Project Status: Closed **Total Project Budget:** $85,505.60

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

Project Objectives: Design recommendations developed during the course of TxDOT Project 0-6953 provided much needed guidance when establishing three-dimensional strut-and-tie models for the design of drilled shaft supported footings. The Performing Agency shall expand on the original five load cases examined in 0-6953 and develop strut-and-tie models for two additional biaxial load cases which are very common in everyday design and bridge construction and for which no STM guidance is explicitly provided. Development of strut-and-tie models for the additional biaxial cases shall provide much needed insight when implementing STM in design for complex load scenarios and will significantly enhance the confidence when using the STM provisions.

Deliverables:
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
TM2: Strut-and-Tie Modeling Guidelines for Biaxial Load Combinations R1
PSR

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$85,505.60	$68,404.48	$17,101.12

*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:** 10/31/2022

Project Status: Closed **Total Project Budget:** $1,526,978.50

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 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
VoR
March MPR 2022

April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
R1
July MPR 2022
R1

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$388,715.00	$310,972.00	$77,743.00

*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: Closed **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:
R1
PSR
August MPR 2021
September MPR 2021
October MPR 2021

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$12,133.00	$9,706.40	$2,426.60

*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: Closed **Total Project Budget:** $414,611.00

RTI Project Manager: Martin Dassi **Researcher:** Matthew Yarnold

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 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022

March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
TM-5
TM-6
TM-7
R1A
P1
July MPR 2022

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$138,568.00	$110,854.40	$27,713.60

*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: Closed **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:
PSR
R1B
August MPR 2021
September MPR 2021
October MPR 2021

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$9,630.00	$7,704.00	$1,926.00

*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: Closed **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:
TM3
TM4
R1
PSR
August MPR 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$47,654.00	$38,123.20	$9,530.80

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

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: Closed **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 shall be 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:
August MPR 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
R1
PSR

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$60,762.50	$48,610.00	$12,152.50

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

Table 12. Structures and Hydraulics Totals for Closed Projects

Financials	Budget	Expended	Balance
Federal 80%	$594,374.48	$539,072.74	$55,301.74
State 20% TDC*	$148,593.62	$134,768.19	$13,825.43
Total	$742,968.10	$673,840.93	$69,127.17

2.1.6 Safety and Operations

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: Closed **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:
P1 Workshop
WS1 Participant List
P2 Draft Specification
R1
PSR
August MPR 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022

April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$134,774.75	$107,819.80	$26,954.95

*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:** 5/31/2022

Project Status: Closed **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 2021
TM5
TM6
P1
P2
P3
R1
PSR
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022

March MPR 2022
April MPR 2022
May MPR 2022

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$75,000.00	$60,000.00	$15,000.00

*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: Closed **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 2021
September MPR 2021
October MPR 2021
TM-6
TM-7
P1
P2
R1
PSR

November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
June MPR 2022
July MPR 2022

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$147,103.75	$117,683.00	$29,420.75

*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: Closed **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 2021
September MPR 2021
October MPR 2021

TM-6
R1
PSR
P1 (Webinar)
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$67,698.50	$54,158.80	$13,539.70

*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: Closed **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 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
TM5
R1
PSR

January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$59,108.75	$47,287.00	$11,821.75

*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: Closed **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 2021
September MPR 2021 and Appendix 1
October MPR 2021
November MPR 2021
December MPR 2021
R1
P1
PSR

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$57,850.97	$46,280.78	$11,570.19

*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:** 8/31/2022

Project Status: Closed **Total Project Budget:** $501,006.00

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 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
TM4B

P1 Pamphlet
P2 Video
R1
PSR
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
TM6

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$160,846.50	$128,677.20	$32,169.30

*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: Closed **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:
TM5
TM6
TM7
TM8
VoR
P1
R1
PSR

Close-Out Video (COV)
August MPR 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$43,293.00	$34,634.40	$8,658.60

*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: Closed **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 2021
September MPR 2021
October MPR 2021
November MPR 2021

P3 Guidelines Document
P4 Workshop Materials
R1
PSR
December MPR 2021
January MPR 2022

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$16,854.00	$13,483.20	$3,370.80

*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: Closed **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:
PSR
R1
August MPR 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$85,290.00	$68,232.00	$17,058.00

*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:** 8/31/2022

Project Status: Closed **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 2021
TM-6
TM-7
TM-8
R1
P1 (Webinar) draft
PSR draft
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022

February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
P1, V2
PSR, V2

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$99,909.25	$79,927.40	$19,981.85

*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:** 6/30/2022

Project Status: Closed **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 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
R1
PSR
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022

May MPR 2022
June MPR 2022

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$27,062.00	$21,649.60	$5,412.40

*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: Closed **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:
TM3
TM4
TM5
R1
PSR
P1: Spreadsheet Tool
P2: Webinar Presentation
August MPR 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$155,864.00	$124,691.20	$31,172.80

*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: Closed **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 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022

R1
PSR

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$78,662.25	$62,929.80	$15,732.45

*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: Closed **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.

Deliverables:
TM5
TM6
IPR1
PSR2
August MPR 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
TM7

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$88,246.50	$70,597.20	$17,649.30

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

Table 13. Safety and Operations Totals for Closed Projects

Financials	FY22 Budget	FY22 Expended	FY 22 Balance
Federal 80%	$1,038,051.38	$1,076,891.26	-$38,839.88
State 20% TDC*	$259,512.84	$269,222.81	-$9,709.97
Total	$1,297,564.22	$1,346,114.07	-$48,549.85

2.1.7 Strategy and Innovation

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: Closed **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:
R1
PSR
TM5
TM6
TM7
TM8
P1: Executive Guide
P2: Instruction Materials
August MPR 2021
September MPR 2021
October MPR 2021

November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$186,216.18	$148,972.94	$37,243.24

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

Project Number: 0-7125 **University:** TTI

Project Title: Expand Applications for Texas Connected Freight Corridor

Project Start Date: 9/1/2021 **Termination Date:** 10/31/2022

Project Status: Closed **Total Project Budget:** $100,000.00

RTI Project Manager: Tom Schwerdt **Researcher:** Nick Wood

Project Objectives: The Texas Connected Freight Corridors (TCFC) system is a connected and automated vehicle (CAV) environment that seeks to improve safety and mobility for the Texas Triangle – consisting of the Austin, Dallas/Fort Worth, Houston, San Antonio, and Laredo metropolitan regions. The TCFC project is a baseline effort to develop and deliver six initial applications for use by vehicle fleets. The deployed applications include advanced travel information systems (ATIS), queue warning, work zone warning, wrong-way driving, road weather warning, and freight signal priority. The Performing Agency shall expand the initial TCFC system by considering additional CAV applications for inclusion and consideration. The Performing Agency shall review existing CAV efforts and pursuits, survey key stakeholders, assess the effectiveness and financial feasibility, and outline the next steps for procurement and implementation. The project goal is to develop an implementation framework that expands the TCFC system through additional applications and extended geographic reach. The effort will help to incentivize participation, as having more vehicles improves the overall effectiveness of the CAV environment in Texas.

Deliverables:
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
TM2
TM3
PSR

R1

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$98,219.50	$78,575.60	$19,643.90

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

Project Number: 0-7126 **University:** CTR

Project Title: Synthesis on Automated Pedestrian Data Collecting Techniques and Applications in Transportation Planning, Design and Management

Project Start Date: 9/1/2021 **Termination Date:** 8/31/2022

Project Status: Closed **Total Project Budget:** $65,000.00

RTI Project Manager: Tom Schwerdt **Researcher:** Kenneth Perrine

Project Objectives: Cities in the United States have been experiencing a significant increase in the number of pedestrian fatalities, even as the increased intensity of pedestrian movement. Thus, there is a critical need for accurate, reliable, and comprehensive information about pedestrian travel movements to support planning, design, and management of pedestrian infrastructure as part of a larger regional surface transportation system. In this project, the Performing Agency shall undertake a comprehensive literature review on the state-of-the-art and the state-of-the-practice of automated pedestrian detection techniques. Additional insights shall be solicited from nationwide surveys and interviews. The outcome is an assessment of the different automated data collection methods, including well established and emerging artificial intelligence (AI)- and sensor-based technologies, to evaluate their appropriateness and efficacy in different environments and for supporting data collection and usage efforts. In addition to generating a research report, the Performing Agency shall provide the Receiving Agency with a decision support system that compiles information gathered through the literature review, survey, interviews, and trainings while integrating economic analyses. The practical support tool shall be structured to directly and seamlessly feed into the Receiving Agency's strategic planning and design efforts and enhance current operations.

Deliverables:
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022

July MPR 2022
TM2
TM3
TM4
P1 Decision support system
R1 Research Report
VoR (Included in the R1)
PSR
CO
VSR

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$65,000.00	$52,000.00	$13,000.00

*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: Closed **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 2021
TM27
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
TM28

Financials:	FY22 Total Budget	100% Federal
Contract Total	$211,936.00	$211,936.00

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

Table 14. Strategy and Innovations Totals for Closed Projects

Financials	FY22 Budget	FY22 Expended	FY22 Balance
Federal 80%	$449,097.34	$477,692.62	-$28,595.28
State 20% TDC*	$112,274.34	$119,423.16	-$7,148.82
Total	$561,371.68	$597,115.78	-$35,744.10

2.2 Continuing Projects

RTI monitored ninety-two (92) active research projects that are scheduled to continue beyond FY 2022.

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 2022 and continue into the next fiscal year(s).

2.2.1 *Construction, Maintenance and Materials*

Project Number: 0-6674-03 **University:** TTI

Project Title: Automated IDEAL Cracking and Rutting Tests

Project Start Date: 9/1/2021 **Termination Date:** 8/31/2023

Project Status: Active **Total Project Budget:** $370,637.25

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

Project Objectives: The objective of this project is to complete the design and construction of the automated test system and to deliver an automated IDEAL cracking and rutting test system working unit to the Receiving Agency's MTD lab. The automated test system, includes (1) specimen rapid cooling unit, (2) auto-air void measurement unit, (3) specimen conditioning unit for both room and high temperature, (4) automation arm unit, and (5) automated IDEAL cracking test (IDEAL-CT), IDEAL rutting test (IDEAL-RT), and indirect tensile (IDT) strength test unit, and (6) waste disposal unit. This automated test system shall shorten test time and improve lab safety, test efficiency and accuracy.

The Performing Agency shall work closely with the Receiving Agency to build one automated lab test system. The Performing Agency shall conduct comprehensive parallel comparison with the standard (manual) test system to ensure that the automated test results align with the current standard tests. The Performing Agency shall develop a user manual for the automated test system. Additionally, the Performing Agency shall provide training and demonstrations to Receiving Agency lab technicians after delivering the automated test system.

Deliverables:
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
TM2

Financials:	TMFY22 FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$197,637.25	$158,109.80	$39,527.45

*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:
TM4
TM3.2
August MPR 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$283,141.15	$226,512.92	$56,628.23

*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:
TM5
August MPR 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
TMFY22A
TMFY22B

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$167,031.38	$133,625.10	$33,406.28

*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:** 8/31/2024

Project Status: Active **Total Project Budget:** $1,730,912.76

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 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
VoR

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$434,216.50	$347,373.20	$86,843.30

*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 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
ITMFY22
TMFY22

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$164,733.75	$131,787.00	$32,946.75

*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:** 2/28/2023

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:
TM5
VOR
August MPR 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022

May MPR 2022
June MPR 2022
July MPR 2022

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$127,510.21	$102,008.17	$25,502.04

*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:** $900,498.56

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 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
ITM6A
ITM6B
TM6
ITM7
TM7

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$139,996.00	$111,996.80	$27,999.20

*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:** $900,498.56

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 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
ITM6A
ITM6B
TM6
ITM7
TM7

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$172,000.00	$137,600.00	$34,400.00

*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:
TM4
P4
TM5
P5
TM6
P6A
P6B
August MPR 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$166,318.71	$133,054.97	$33,263.74

*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:** $580,030.00

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:
TM4
August MPR 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022

March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$89,477.08	$71,581.66	$17,895.42

*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:** $580,030.00

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:
TM4
August MPR 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022

March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022

Financials:	FY22 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:** 8/31/2023

Project Status: Active **Total Project Budget:** $357,000.00

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:
VoR
Close-Out Video
August MPR 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022

June MPR 2022
July MPR 2022

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$154,909.62	$123,927.70	$30,981.92

*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:
TMFY22A
August MPR 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
TMFY22B

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$213,173.75	$170,539.00	$42,634.75

*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:
August MPR 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022

July MPR 2022
TM3 V2

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$205,023.25	$164,018.60	$41,004.65

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

Project Number: 0-7102 **University:** CTR

Project Title: Develop Models for Field Performance of Friction and Skid Number

Project Start Date: 9/1/2021 **Termination Date:** 2/28/2024

Project Status: Active **Total Project Budget:** $471,872.25

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

Project Objectives: The Receiving Agency's Maintenance Division has recently implemented a comprehensive and more powerful pavement management system known as Pavement Analyst (PA). The new system is capable of prioritizing maintenance and rehabilitation (M&R) activities for different time horizons based on a series of decision trees that account for current distress levels, scores, traffic, location, environment, etc. The decision trees incorporate new variables, such as skid and texture which are correlated to the number of wet weather crashes. Controlling these variables shall significantly improve the safety of the Texas highway network. There are no current models for the prediction of skid or texture that can be used on Pavement Analyst. The existing models are based on laboratory characterization and the exponential decay rate is estimated from laboratory performance. The objective of this research project is to develop a performance model to predict pavement skid number as a function of time, for use in the Receiving Agency's pavement management system, i.e. Pavement Analyst. The Performing Agency shall develop models that account for field prediction of skid and texture, to be incorporated into Pavement Analyst and to aid in the selection of optimal M&R activities. These models shall also account for treatment type: PM, LRhb, MRhb, and HRhb.

Deliverables:
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
TM2

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$176,460.69	$141,168.55	$35,292.14

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

Project Number: 0-7103 **University:** TTI

Project Title: Investigating Prime versus Curing: Where, When and Why

Project Start Date: 9/1/2021 **Termination Date:** 11/30/2024

Project Status: Active **Total Project Budget:** $525,000.25

RTI Project Manager: Martin Dassi **Researcher:** Darlene Goehl

Project Objectives: The objective of this research project is to determine where, when, and why a prime or cure is needed for a pavement layer. Materials such as prime coats, curing materials, seal coats, and tack coat are typically considered non-structural, but integral to the pavement structure. Some materials can be used for multiple purposes: prime, bond or help cure; however, the rates and timing of use may change depending on why the material is being used. Guidance is needed to help designers, inspectors and construction personnel understand the materials and where, when, and why to use them.

The Performing Agency shall develop guidelines for prime and curing through a series of laboratory and field testing and develop tests and procedures to determine the best materials for a prime, cure or a combination. These guidelines shall aid decision makers in determining whether a prime, cure or bonding material is needed, and where, when and why to design and use the appropriate materials.

Deliverables:
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
TM2
TM3
TM4A

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$163,245.00	$130,596.00	$32,649.00

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

Project Number: 0-7104 **University:** TTI

Project Title: Establish Performance-Based Acceptable Lab-Molded Density Range for Mix Design and QC/QA

Project Start Date: 9/1/2021 **Termination Date:** 4/30/2025

Project Status: Active **Total Project Budget:** $829,999.25

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

Project Objectives: Lab-molded density of asphalt mixes is a critical factor for laboratory mix design, plant production, and field performance. Current mix design and production quality control and quality assurance (QC/QA) are developed around a fixed lab-molded density of 96 percent. Adherence to a fixed lab-molded density is not only one of the main factors leading to drier, more crack susceptible mixes where low asphalt binder content is often caused by balancing high lab-molded density values at plant production, but it also impacts the implementation of the Balanced Mix Design approach. Furthermore, various field test sections designed with densities ranging from 96.5 to 98 percent were previously constructed in different areas of Texas, and they performed well in the field with no observed rutting problems. Thus, the objective of this project is to establish an acceptable range of lab-molded densities for laboratory mix design and production QC/QA testing. To achieve the objective, the Performing Agencies shall review the literature, conduct extensive laboratory performance tests, construct test sections and monitor their performance, and finally recommend an acceptable range of lab-molded density based on all the information and data collected.

Deliverables:
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
TM2A
TM2B

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$118,643.75	$94,915.00	$23,728.75

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

Project Number: 0-7104 **University:** UTEP

Project Title: Establish Performance-Based Acceptable Lab-Molded Density Range for Mix Design and QC/QA

Project Start Date: 9/1/2021 **Termination Date:** 4/30/2025

Project Status: Active **Total Project Budget:** $829,999.25

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

Project Objectives: Lab-molded density of asphalt mixes is a critical factor for laboratory mix design, plant production, and field performance. Current mix design and production quality control and quality assurance (QC/QA) are developed around a fixed lab-molded density of 96 percent. Adherence to a fixed lab-molded density is not only one of the main factors leading to drier, more crack susceptible mixes where low asphalt binder content is often caused by balancing high lab-molded density values at plant production, but it also impacts the implementation of the Balanced Mix Design approach. Furthermore, various field test sections designed with densities ranging from 96.5 to 98 percent were previously constructed in different areas of Texas, and they performed well in the field with no observed rutting problems. Thus, the objective of this project is to establish an acceptable range of lab-molded densities for laboratory mix design and production QC/QA testing. To achieve the objective, the Performing Agencies shall review the literature, conduct extensive laboratory performance tests, construct test sections and monitor their performance, and finally recommend an acceptable range of lab-molded density based on all the information and data collected.

Deliverables:
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
TM2A
TM2B

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$85,000.00	$68,000.00	$17,000.00

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

Project Number: 0-7105 **University:** TTI

Project Title: Measuring Seal Coat Rate Field Adjustments

Project Start Date: 9/1/2021 **Termination Date:** 11/30/2024

Project Status: Active **Total Project Budget:** $450,000.00

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

Project Objectives: The objective of this research project is to develop measurable and repeatable adjustment criteria for seal coat application rates based on pavement condition, traffic and material properties for the design method developed in research project 0-6989 Update Seal Coat Application Rate Design Method (TxDM6989). Current practice requires experienced personnel to understand the adjustments needed for application rates, including changing the adjustments as conditions on the pavement change. The adjustments in the TxDM6989 combine multiple pavement conditions into one description. By measuring the conditions, a combined adjustment based upon measured parameters will remove subjectivity from the procedure. This will lead to more consistently constructed projects that meet the objectives of designing the rates so that the resulting seal will not have too much binder so that it flushes or bleeds in the summer; but there is enough binder to prevent rock loss over the winter. This research project will produce measurable methods for adjustments to the rate design procedures that will help engineers and inspectors make better decisions resulting in successful projects.

Deliverables:
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
TM2
TM3
ITM4

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$144,117.00	$115,293.60	$28,823.40

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

Project Number: 0-7105 **University:** UT-TYLER

Project Title: Measuring Seal Coat Rate Field Adjustments

Project Start Date: 9/1/2021 **Termination Date:** 11/30/2024

Project Status: Active **Total Project Budget:** $450,000.00

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

Project Objectives: The objective of this research project is to develop measurable and repeatable adjustment criteria for seal coat application rates based on pavement condition, traffic and material properties for the design method developed in research project 0-6989 Update Seal Coat Application Rate Design Method (TxDM6989). Current practice requires experienced personnel to understand the adjustments needed for application rates, including changing the adjustments as conditions on the pavement change. The adjustments in the TxDM6989 combine multiple pavement conditions into one description. By measuring the conditions, a combined adjustment based upon measured parameters will remove subjectivity from the procedure. This will lead to more consistently constructed projects that meet the objectives of designing the rates so that the resulting seal will not have too much binder so that it flushes or bleeds in the summer; but there is enough binder to prevent rock loss over the winter. This research project will produce measurable methods for adjustments to the rate design procedures that will help engineers and inspectors make better decisions resulting in successful projects.

Deliverables:
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
TM2
TM3
ITM4

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$13,803.75	$11,043.00	$2,760.75

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

Project Number: 0-7106 **University:** TTI

Project Title: Quantify Maximum Accumulated Seal Coat Layers for Stability

Project Start Date: 9/1/2021 **Termination Date:** 11/30/2024

Project Status: Active **Total Project Budget:** $449,211.00

RTI Project Manager: Jade Adediwura **Researcher:** Darlene Goehl

Project Objectives: The Receiving Agency invests over $250 million annually on seal coats, it is therefore critical to apply the right treatment to the right road at the right time. Projects are typically selected based on the time since the last seal coat (an average of 7 years) with little to no testing performed to ensure that the section is a good candidate for seal coat and how many seal coats to apply. The objective of this research is to determine the maximum number of seal coats that can be applied to a pavement surface before the accumulated layers of seal coats become unstable. The Performing Agencies shall evaluate the stability of existing accumulated seal coat substrate layers through a series of laboratory and field testing and develop tests and procedures to determine when an additional seal coat may not perform well. The Performing Agencies shall develop guidelines to select candidate seal coat projects with multiple seal coat layers ensuring that a new seal coat is used on a good candidate pavement will lower risk to the Receiving Agency, improve life cycle costs and lead to better performing sections of pavement.

Deliverables:
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
TM2
TM3
TMFY23A

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$159,303.25	$127,442.60	$31,860.65

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

Project Number: 0-7106 **University:** UT-TYLER

Project Title: Quantify Maximum Accumulated Seal Coat Layers for Stability

Project Start Date: 9/1/2021 **Termination Date:** 11/30/2024

Project Status: Active **Total Project Budget:** $449,211.00

RTI Project Manager: Jade Adediwura **Researcher:** Darlene Goehl

Project Objectives: The Receiving Agency invests over $250 million annually on seal coats, it is therefore critical to apply the right treatment to the right road at the right time. Projects are typically selected based on the time since the last seal coat (an average of 7 years) with little to no testing performed to ensure that the section is a good candidate for seal coat and how many seal coats to apply. The objective of this research is to determine the maximum number of seal coats that can be applied to a pavement surface before the accumulated layers of seal coats become unstable. The Performing Agencies shall evaluate the stability of existing accumulated seal coat substrate layers through a series of laboratory and field testing and develop tests and procedures to determine when an additional seal coat may not perform well. The Performing Agencies shall develop guidelines to select candidate seal coat projects with multiple seal coat layers ensuring that a new seal coat is used on a good candidate pavement will lower risk to the Receiving Agency, improve life cycle costs and lead to better performing sections of pavement.

Deliverables:
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
TM2
TM3
TMFY23A

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$10,193.75	$8,155.00	$2,038.75

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

Project Number: 0-7107 **University:** TTI

Project Title: Determine Feasibility and Methodologies of Using Structural Data From Traffic Speed Deflection Devices in Network-Level Treatment Decision Making

Project Start Date: 9/1/2021 **Termination Date:** 8/31/2024

Project Status: Active **Total Project Budget:** $449,941.00

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

Project Objectives: Traffic Speed Deflection Devices (TSDD) non-destructively measure structural condition while traveling at traffic speeds. Advancements in TSDD's have enabled these evaluations to be made with the benefit of reducing safety hazards associated with traditional stop and go Falling Weight Deflectometer (FWD) devices. The Receiving Agency is an active participant in the Transportation Pooled Fund TPF-5(385) "Pavement Structural Evaluation with Traffic Speed Deflection Devices". As a participant, the Receiving Agency has collected more than 1000 miles of TSDD data in several Receiving Agency Districts and is expected to continue to collect TSDD data for the next three (3) years. Recent interest from Receiving Agency Districts on using continuous structural data in network level treatment decisions has necessitated the need to verify TSDD measurements and provide guidelines and analysis methodologies to implement structural condition data for both network and project level pavement management applications.

Incorporating a structural condition index into network level decisions has been a goal of the Receiving Agency's for over 30 years with the objective of providing Receiving Agency Districts a comprehensive integrated assessment of both visual and structural condition. Use of this tool shall provide Receiving Agency Districts with what level of pavement rehabilitation treatment is required as they develop their 4-year plans

Deliverables:
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022

May MPR 2022
June MPR 2022
July MPR 2022
TM2
TM3
TM4
TM5

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$148,646.00	$118,916.80	$29,729.20

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

Project Number: 0-7108 **University:** UTEP

Project Title: Evaluate the Importance of Fine Aggregates in Achieving Adequate Skid Resistance in TxDOT Hot Mix Asphalt Mixtures

Project Start Date: 9/1/2021 **Termination Date:** 8/31/2024

Project Status: Active **Total Project Budget:** $477,000.00

RTI Project Manager: Tom Schwerdt **Researcher:** Imad Abdallah

Project Objectives: The lack of skid resistance has been an important issue for Receiving Agency pavement as many of them cannot hold adequate skid resistance in the long run, and even some newly constructed roads are observed to have poor skid resistance. Skid resistance is a function of the quality of the aggregate as well as the micro-and macro-texture of the surface. Those textures can be modified by using the appropriate type and amount of fine aggregates and fines in asphalt concrete. The main focus of the research is understanding the effects of fine aggregates and fines on the skid resistance of asphalt concrete since their impacts on the skid resistance and performance.

The Performing Agency shall evaluate the current practices and research studies commissioned by Receiving Agency (in particular) and other states (in general) on the use of fine aggregates and fines in asphalt concrete to improve skid resistance. The major objective of this project shall be critical to evaluate the influence of fine aggregates and high-quality fines on the skid resistance of asphalt concrete.

Deliverables:
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
TM1
TM2
TM3

TM4a

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$153,500.00	$122,800.00	$30,700.00

Project Number: 0-7110 **University:** TTI

Project Title: Develop Cost Effective Design and Rehabilitation Strategies for Permeable Friction Courses

Project Start Date: 9/1/2021 **Termination Date:** 8/31/2023

Project Status: Active **Total Project Budget:** $399,957.00

RTI Project Manager: Shelley Pridgen **Researcher:** Edith Arambula

Project Objectives: Thousands of miles of permeable friction course (PFC) pavements have performed well for the last ten (10) to fifteen (15) years on Texas highways. PFC pavement reduces hydroplaning, splash and spray, pavement noise, and improves ride quality and safety in wet weather. Hundreds of miles of PFC pavements are now at the end of their service life and need rehabilitation. The most common distress observed is raveling. To date, the most widely used method of rehabilitating PFC pavement is to mill the existing layer and replace it with a new wearing layer. This is also the most conservative and most expensive rehabilitation strategy. The Performing Agency shall determine if there are less expensive resurfacing options which do not include milling. The Performing Agency shall review the current PFC pavement design procedures to determine if improvements can be made to achieve longer initial life. PFC pavements have many safety related advantages, but their use is on the decline because of the high cost of rehabilitation.

Deliverables:
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
TM2
TM3
TM4

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$199,144.50	$159,315.60	$39,828.90

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

Project Number: 0-7111 **University:** UTEP

Project Title: Determine Impact of Field Sands on Workability and Engineering Properties of Superpave Mixtures in Texas

Project Start Date: 9/1/2021 **Termination Date:** 8/31/2024

Project Status: Active **Total Project Budget:** $500,001.50

RTI Project Manager: Tom Schwerdt **Researcher:** Imad Abdallah

Project Objectives: Field sands have been used in hot mix asphalt (HMA) pavements to reduce binder requirement since they are readily available and are less expensive than crushed materials. Considering their adverse effects on the performance, field sands are limited to 10% to 15% of the aggregates. The most common feature of field sand that can have a significant detrimental effect on the Asphalt Concrete (AC) performance is the presence of harmful clay particles. Understanding the impact of these clay particles on AC performance is the subject of this research. The upper limit of specific field sand, given the amount of active clay present in it, the process to determine the clay content, and how they affect the performance of AC mixes shall be evaluated. Since field sands are more round compared to the crushed aggregates, mixes containing more field sands can be compacted to a given density at lower binder contents. Given the less particle to particle interlocking of such mixes, however, they are more suspect to excessive rutting. Thus, this research shall investigate the effect of clay minerals as well as the sand properties independently on the performance of AC mixes (with a focus on Superpave mixtures) and evaluate their combined/interactive effects, as the natural sands are a combination of both. To that end, the Performing Agency shall provide interaction plots and/or charts that can be used to select the maximum allowable percentage of a given field sand.

Deliverables:
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022

July MPR 2022
TM1
TM2
TM3
TM4

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$120,000.00	$96,000.00	$24,000.00

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

Project Number: 0-7111 **University:** TTI

Project Title: Determine Impact of Field Sands on Workability and Engineering Properties of Superpave Mixtures in Texas

Project Start Date: 9/1/2021 **Termination Date:** 8/31/2024

Project Status: Active **Total Project Budget:** $500,001.50

RTI Project Manager: Tom Schwerdt **Researcher:** Imad Abdallah

Project Objectives: Field sands have been used in hot mix asphalt (HMA) pavements to reduce binder requirement since they are readily available and are less expensive than crushed materials. Considering their adverse effects on the performance, field sands are limited to 10% to 15% of the aggregates. The most common feature of field sand that can have a significant detrimental effect on the Asphalt Concrete (AC) performance is the presence of harmful clay particles. Understanding the impact of these clay particles on AC performance is the subject of this research. The upper limit of specific field sand, given the amount of active clay present in it, the process to determine the clay content, and how they affect the performance of AC mixes shall be evaluated. Since field sands are more round compared to the crushed aggregates, mixes containing more field sands can be compacted to a given density at lower binder contents. Given the less particle to particle interlocking of such mixes, however, they are more suspect to excessive rutting. Thus, this research shall investigate the effect of clay minerals as well as the sand properties independently on the performance of AC mixes (with a focus on Superpave mixtures) and evaluate their combined/interactive effects, as the natural sands are a combination of both. To that end, the Performing Agency shall provide interaction plots and/or charts that can be used to select the maximum allowable percentage of a given field sand.

Deliverables:
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022

July MPR 2022
TM1
TM2
TM3
TM4

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$35,000.75	$28,000.60	$7,000.15

*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:** 8/31/2023

Project Status: Active **Total Project Budget:** $873,369.74

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 geogridstabilization 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:
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
Project Management
FY'22 TMA
FY'22 TMB
August MPR 2021

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$119,807.23	$95,845.78	$23,961.45

*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:** 12/31/2022

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:
Implementation Report
PSR1
August MPR 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$14,100.00	$11,280.00	$2,820.00

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

Project Number: 5-6995-01 **University:** CTR

Project Title: Implementation: Investigation of Retroreflective Pavement Markers (RPMs) in Rumble Strips

Project Start Date: 10/25/2021 **Termination Date:** 8/31/2023

Project Status: Active **Total Project Budget:** $439,072.33

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

Project Objectives: The use of snowplows 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. Research Project 0-6995- Determine Use of Alternative Retroreflective Pavement Markers (RPMs) on Highways with Centerline Rumble Strips and Winter Weather Pavement Marking Improvements showed that rumble strips can be used in a multifunctional way to provide not only sound awareness, but also protect the retroreflective pavement markers from snowplows. The aims of this implementation project are to build upon the findings of Research Project 0-6995 and to (1) validate the visibility results of the RPMs in rumble strips from different distances and vehicle speeds and (2) confirm the long-term performance of the markers in rumble strips.

Deliverables:
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
TM2
TM3

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$257,528.49	$206,022.79	$51,505.70

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

Project Number: 5-7008-01 **University:** UTA

Project Title: Implementation of Electrical Resistivity Imaging Manual

Project Start Date: 9/1/2021 **Termination Date:** 8/31/2023

Project Status: Active **Total Project Budget:** $274,484.00

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

Project Objectives: The overall objective of this project is to implement the electrical resistivity imaging manual developed in TxDOT Project 0-7008 on 10-15 projects in the Fort Worth and Dallas districts. Five case studies shall be developed to illustrate the successful implementation of electrical resistivity imaging for different types of projects and distributed to all 25 Receiving Agency's districts in order to achieve TRL 9. The Performing Agency shall also prepare and present a cost analysis for implementing the electrical resistivity imaging manual beyond the Fort Worth and Dallas districts. The Performing Agency shall validate and refine the electrical resistivity imaging manual, if needed.

Deliverables:
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
TMFY22

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$137,242.00	$109,793.60	$27,448.40

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

Table 15. Construction, Maintenance and Materials Totals for Continuing Projects

Financials	Budget	Expended	Balance
Federal 80%	$3,736,699.85	$3,141,571.70	$595,128.15
State 20% TDC*	$934,174.96	$785,392.92	$148,782.04
Total	**$4,670,874.81**	**$3,926,964.62**	**$743,910.19**

2.2.2 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:** $643,666.00

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 2021
TM10
VOR
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
TM11
TM11

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$167,455.00	$133,964.00	$33,491.00

*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 2021
TM8
TM9
P5
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$182,981.74	$146,385.39	$36,596.35

*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:

August MPR 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
TM7
TM8

TM3a

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$166,134.75	$132,907.80	$33,226.95

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

Project Number: 0-7128 **University:** TTI

Project Title: Digitizing Traffic Control Infrastructure for Autonomous Vehicles (AV)

Project Start Date: 9/1/2021 **Termination Date:** 8/31/2023

Project Status: Active **Total Project Budget:** $359,394.00

RTI Project Manager: Joanne Steele **Researcher:** Xiao Li

Project Objectives: High precision road maps are a crucial component to facilitating autonomous driving techniques. Autonomous vehicles (AVs) are experiencing exponential growth. According to the latest forecast from IHS Markit, over 33 million AVs will be on the road globally by 2040, posing a higher requirement to ensure AVs' driving safety. Although current AVs rely on vehicular sensing techniques (e.g., Camera, Lidar, Radar), studies have suggested that creating high-quality road maps with traffic control infrastructures (TCIs) (e.g., traffic signs, signals, intersections) precisely digitized is necessary to enhance safe-driving operations of AVs. Meanwhile, digitizing TCIs is also of great importance for road assets planning and management. However, a readily available database with precisely digitized TCIs is still missing in most areas. Traditionally, TCIs are manually digitized by conducting field studies, which is time-consuming and labor-intensive. With the advancement of data collection and processing techniques, numerous emerging data sources are becoming available, posing great potential to capture and digitize TCIs more efficiently. The Performing Agencies shall recommend an effective framework for the digitization, maintenance, and sharing of Receiving Agency roadway assets, especially for TCIs. The Performing Agenciesshall evaluate commercially available solutions and propose new approaches by leveraging emerging data sources and techniques.

Deliverables:
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022

TM2
TM3

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$126,929.50	$101,543.60	$25,385.90

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

Project Number: 0-7128 **University:** UT-Dallas

Project Title: Digitizing Traffic Control Infrastructure for Autonomous Vehicles (AV)

Project Start Date: 9/1/2021 **Termination Date:** 8/31/2023

Project Status: Active **Total Project Budget:** $359,394.00

RTI Project Manager: Joanne Steele **Researcher:** Xiao Li

Project Objectives: High precision road maps are a crucial component to facilitating autonomous driving techniques. Autonomous vehicles (AVs) are experiencing exponential growth. According to the latest forecast from IHS Markit, over 33 million AVs will be on the road globally by 2040, posing a higher requirement to ensure AVs' driving safety. Although current AVs rely on vehicular sensing techniques (e.g., Camera, Lidar, Radar), studies have suggested that creating high-quality road maps with traffic control infrastructures (TCIs) (e.g., traffic signs, signals, intersections) precisely digitized is necessary to enhance safe-driving operations of AVs. Meanwhile, digitizing TCIs is also of great importance for road assets planning and management. However, a readily available database with precisely digitized TCIs is still missing in most areas. Traditionally, TCIs are manually digitized by conducting field studies, which is time-consuming and labor-intensive. With the advancement of data collection and processing techniques, numerous emerging data sources are becoming available, posing great potential to capture and digitize TCIs more efficiently. The Performing Agencies shall recommend an effective framework for the digitization, maintenance, and sharing of Receiving Agency roadway assets, especially for TCIs. The Performing Agenciesshall evaluate commercially available solutions and propose new approaches by leveraging emerging data sources and techniques.

Deliverables:
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022

TM2
TM3

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$49,647.25	$39,717.80	$9,929.45

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

Project Number: 0-7129 **University:** CTR

Project Title: Working with Autonomous Trucks to Improve Routine Maintenance Operations

Project Start Date: 9/1/2021 **Termination Date:** 8/31/2023

Project Status: Active **Total Project Budget:** $324,854.33

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

Project Objectives: Texas has become a major hub for automated trucking activities with companies operating routes daily. Quality infrastructure is essential for the safety of today's drivers and critical to the future of a growing connected and automated vehicle (CAV) market. Data generated by these advanced vehicles can unlock significant benefits and savings—especially for routine maintenance operations. Traditional maintenance data is sparse and lacks precision, relying heavily on Receiving Agency personnel to conduct inspections and drivers to report issues. By partnering with automated trucking companies, the Receiving Agency gains high-resolution, real-time data on pavement, signage and other assets that can be used to modernize routine maintenance operations. The Performing Agency shall develop and test an end-to-end Intelligent Routine Maintenance Framework—from detection to resolution. Key results shall include:

- A public-private partnership network of stakeholders who build consensus on standards and data sharing agreements
- An Intelligent Routine Maintenance Framework that integrates new CAV data sources, streamlines workflows, and monitors performance measures
- A prototype maintenance system tested with data from at least two automated trucking companies
- Infographics and visualization tools that communicate qualitative and quantitative project benefits
- A Sustainability and Growth Plan that includes complementary artificial intelligence (AI) solutions, cost-benefit analysis and procurement documents.

Deliverables:
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022

March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
TM2
TM3.1
TM3.2
TM5.1
TM5.2
TM6.1
TM7.1

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$158,642.02	$126,913.62	$31,728.40

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

Project Number: 0-7130 **University:** TTI

Project Title: Investigate Potential Connected and Automated Vehicle (CAV) Liability Issues Within TxDOT

Project Start Date: 9/1/2021 **Termination Date:** 8/31/2023

Project Status: Active **Total Project Budget:** $299,476.00

RTI Project Manager: Joanne Steele **Researcher:** Gretchen Stoeltje

Project Objectives: Connected and automated vehicles (CAV) promise momentous and positive changes to most aspects of modern life. Mobility is likely to be characterized by collaborative, communicative and driverless vehicles operating in a connected network of vehicles, infrastructure and wireless devices. One of the most uncertain and as yet undefined areas where change can be expected is legislation surrounding the licensing and operation of these technologies. Questions of liability dominate research and conversation about how to manage new mobility paradigms, including in areas of state and local government tort liability. And although governmental entities typically enjoy some level of sovereign immunity, there are areas identified in state law where they have limited liability for specific torts. This research project identifies potential tort liability for the Receiving Agency and other governmental agencies associated with CAV technologies. The Performing Agency shall provide foundational research necessary for the Receiving Agency to proactively identify, assess and address legal liabilities that may arise under current law and legal liabilities that may arise under new law as the result of CAV implementations.

Deliverables:
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
TM2
TM3
TM4

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$124,083.50	$99,266.80	$24,816.70

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

Project Number: 0-7131 **University:** TTI

Project Title: Leveraging Artificial Intelligence (AI) Techniques to Detect, Forecast, and Manage Freeway Congestion

Project Start Date: 9/14/2021 **Termination Date:** 8/31/2023

Project Status: Active **Total Project Budget:** $297,203.76

RTI Project Manager: Joanne Steele **Researcher:** Ioannis Tsapakis

Project Objectives: To improve the quality and effectiveness of the Texas surface transportation system, it is important to be able to predict where and when prolonged congestion will start and how it will spread, as well as to track atypical events and estimate their evolution. Artificial intelligence (AI) approaches provide a unique opportunity to estimate precise congestion measures by utilizing data from agency-owned sensors, third-party providers, and big enterprise data. This project envisions to mitigate the current research gap by conducting two major project phases. The first phase can confirm the validity of commercial data sources for planning and operations, while the second involves understanding which AI models/ algorithm are the most suitable for addressing Receiving Agency needs based on desirable use cases and data availability. Furthermore, it is important to analyse the required data models and workflows to determine whether it is sustainable to train, test, and validate the proposed AI techniques.

The Performing Agencies understand that achieving the research goals requires a comprehensive analysis and documentation of commercial big data platforms and datasets, appropriate AI algorithms, and robust prototype tool to foster return on investment (ROI) and reduce freeway congestion.

Deliverables:
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022

Financials:	TM2 FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$103,187.50	$82,550.00	$20,637.50

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

Project Number: 0-7131 **University:** TSU

Project Title: Leveraging Artificial Intelligence (AI) Techniques to Detect, Forecast, and Manage Freeway Congestion

Project Start Date: 9/14/2021 **Termination Date:** 8/31/2023

Project Status: Active **Total Project Budget:** $297,203.76

RTI Project Manager: Joanne Steele **Researcher:** Ioannis Tsapakis

Project Objectives: To improve the quality and effectiveness of the Texas surface transportation system, it is important to be able to predict where and when prolonged congestion will start and how it will spread, as well as to track atypical events and estimate their evolution. Artificial intelligence (AI) approaches provide a unique opportunity to estimate precise congestion measures by utilizing data from agency-owned sensors, third-party providers, and big enterprise data. This project envisions to mitigate the current research gap by conducting two major project phases. The first phase can confirm the validity of commercial data sources for planning and operations, while the second involves understanding which AI models/ algorithm are the most suitable for addressing Receiving Agency needs based on desirable use cases and data availability. Furthermore, it is important to analyse the required data models and workflows to determine whether it is sustainable to train, test, and validate the proposed AI techniques.

The Performing Agencies understand that achieving the research goals requires a comprehensive analysis and documentation of commercial big data platforms and datasets, appropriate AI algorithms, and robust prototype tool to foster return on investment (ROI) and reduce freeway congestion.

Deliverables:
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$27,654.88	$22,123.90	$5,530.98

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

Project Number: 0-9908-22 **University:** TTI

Project Title: Planning Innovation and Technology Deployments at TxDOT

Project Start Date: 3/10/2022 **Termination Date:** 12/31/2023

Project Status: Active **Total Project Budget:** $3,152,815.00

RTI Project Manager: Kevin Pete **Researcher:** Bob Brydia

Project Objectives: From time to time, TxDOT districts produce ITS and other technology innovations that improve roadway and/or worker safety, roadway efficiency and/or produce cost savings. By failing to recognize and scale these innovations across the state, TxDOT does not receive the full benefit of 25 diverse centers of excellence. This contract utilizes TTI, which is an organization that excels at innovation in and of itself, to investigate innovative district practices and to develop plans at a district and statewide level to share and scale innovation across the state. By harvesting the knowledge already contained within TxDOT, new avenues will open to improve roadway safety, efficiency and produce cost savings. Due to the breadth of TxDOT, these innovations may have very large impacts on the millions of Texans across the state and their visitors. Additionally, by cataloging and bringing together these innovations, divisions and districts can work together to make sure that solutions are developed in such a way that unified systems and interoperability occur throughout the state. This project also complements a wider effort to catalog, share and grow innovation at TxDOT.

The end result for Planning for Innovation and Technology Deployments at TxDOT is a programmatic set of documents that compile and recommend innovative ITS and advanced technology roadway projects and system improvements that TxDOT districts can execute, customized to each district. To arrive at this, the consultant team will interact with districts and industry professionals as unique stakeholders across the state and the nation to compile insights of innovative projects that may include data analysis, operational improvements or deployment of advanced technologies along the roadway, among others. The consultant team will develop high level scope and cost estimates for each offered transportation project. The consultant may also be directed to develop a strategy blueprint (goal, purpose, scope, timeline, responsibilities) for how innovation and technology deployment can be progressed as an integral part of the Receiving Agency's functions and

to develop evaluation plans and/or templates for Department innovation and technology deployment projects.

Deliverables:

Monthly Progress Report Apr 22
Monthly Progress Report May 22
Monthly Progress Report Jun 22
Monthly Progress Report Jul 22
Monthly Progress Report Aug 22
Monthly Progress Report Sep 22
Monthly Progress Report Oct 22
Monthly Progress Report Nov 22
TM1.1 - Innovation Definition - A technical memorandum on the criteria for innovations
D1.2 - Existing Source Review - A database and supporting information gathered from the available sources
D1.3b-e - District Inventory - A database and supporting information gathered from the Districts (updated monthly)
D1.4b-e - Division Inventory - A database and supporting information gathered from the Divisions

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$426,794.00	$341,435.20	$85,358.80

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

Table 16. Strategy and Innovation Totals for Continuing Projects

Financials	Budget	Expended	Balance
Federal 80%	$1,226,808.11	$982,919.28	$243,888.83
State 20% TDC*	$306,702.03	$245,729.82	$60,972.21
Total	$1,533,510.14	$1,228,649.10	$304,861.04

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:** 2/28/2023

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 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
TM5D

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$545,552.90	$436,442.32	$109,110.58

*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:** 8/31/2023

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 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022

July MPR 2022
TM-5

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$161,013.50	$128,810.80	$32,202.70

*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:
TM5A
August MPR 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$315,353.00	$252,282.40	$63,070.60

*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:** $352,134.12

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:
TM5
August MPR 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022

July MPR 2022

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$182,564.31	$146,051.45	$36,512.86

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

Project Number: 0-7100 **University:** TTI

Project Title: Sediment Control Approved Products List

Project Start Date: 9/1/2021 **Termination Date:** 8/31/2023

Project Status: Active **Total Project Budget:** $262,640.57

RTI Project Manager: Shelley Pridgen **Researcher:** Jett McFalls

Project Objectives: The Environmental Protection Agency (EPA) guidance document National Management Measure to Control Nonpoint Source Pollution from Urban Areas (November 2005, EPA-841-B-05-004) requires all construction site activities to reduce the amount of sediment generated (erosion control) and reduce the off-site transport of sediment and construction-related chemicals (sediment and chemical control). While there are several pollutants of concern (oils, gasoline, degreasers, paints, etc.), sediment from construction sites is by far the largest pollutant source (Canning, 1988). Eroded sediment from construction sites causes many problems, including adverse impacts on water quality as well as decreased capacity of reservoirs and streams, resulting in possible flooding.

Sediment control devices (SCDs) are used on construction sites to retain sediment and prevent stormwater from adversely affecting adjacent waterways. SCDs include silt fences, wattles, sediment logs and basins, filter dams, and inlet protection devices. These products are designed to be installed for specific applications (curb inlets, drop inlets, perimeter protection, etc.) However, there is no scientifically sound, repeatable testing methodology that replicates field conditions to test and determine SCD performance. This project shall develop a formal testing protocol, test apparatus and propose thresholds for a performance-based sediment control device testing program that will assist the designer/engineer in selecting the most effective sediment control best management practice.

Deliverables:
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022

May MPR 2022
June MPR 2022
July MPR 2022
TM2
TM3
TM4

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$92,167.00	$73,733.60	$18,433.40

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

Project Number: 0-7100 **University:** SFASU

Project Title: Sediment Control Approved Products List

Project Start Date: 9/1/2021 **Termination Date:** 8/31/2023

Project Status: Active **Total Project Budget:** $262,640.57

RTI Project Manager: Shelley Pridgen **Researcher:** Jett McFalls

Project Objectives: The Environmental Protection Agency (EPA) guidance document National Management Measure to Control Nonpoint Source Pollution from Urban Areas (November 2005, EPA-841-B-05-004) requires all construction site activities to reduce the amount of sediment generated (erosion control) and reduce the off-site transport of sediment and construction-related chemicals (sediment and chemical control). While there are several pollutants of concern (oils, gasoline, degreasers, paints, etc.), sediment from construction sites is by far the largest pollutant source (Canning, 1988). Eroded sediment from construction sites causes many problems, including adverse impacts on water quality as well as decreased capacity of reservoirs and streams, resulting in possible flooding.

Sediment control devices (SCDs) are used on construction sites to retain sediment and prevent stormwater from adversely affecting adjacent waterways. SCDs include silt fences, wattles, sediment logs and basins, filter dams, and inlet protection devices. These products are designed to be installed for specific applications (curb inlets, drop inlets, perimeter protection, etc.) However, there is no scientifically sound, repeatable testing methodology that replicates field conditions to test and determine SCD performance. This project shall develop a formal testing protocol, test apparatus and propose thresholds for a performance-based sediment control device testing program that will assist the designer/engineer in selecting the most effective sediment control best management practice.

Deliverables:
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022

May MPR 2022
June MPR 2022
July MPR 2022
TM2
TM3
TM4

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$5,341.91	$4,273.53	$1,068.38

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

Project Number: 0-7124 **University:** TTI

Project Title: Develop A New Tool for Evaluating Infrastructure and Planning Impacts from Changes in Truck Traffic and Truck Technologies

Project Start Date: 9/1/2021 **Termination Date:** 8/31/2023

Project Status: Active **Total Project Budget:** $470,090.50

RTI Project Manager: Martin Dassi **Researcher:** Curtis Morgan

Project Objectives: The overall project goal shall further improve freight planning and strategy tools used in Receiving Agency Research Project 0-6984, Evaluate Potential Impacts, Impediments, and Solutions of Automated Trucks and Truck Platooning on Texas Highway Infrastructure to better assess the operational and physical impacts of freight traffic on the Texas Highway Freight Network. The Performing Agency's tool enhancements shall allow for better evaluation of specific infrastructure impacts and resiliency considerations (bridges and pavements) from new truck automation and platooning technologies, as well as changes in truck loads, all of which are expected to increase over time, thus also allowing for analysis of alternative routes. The Performing Agency shall tailor the tool to perform detailed analysis of the heavy freight corridors designated for early adoption of autonomous and platooned truck traffic in Texas, such as IH-10, IH-35, and IH-45. The Performing Agency shall build a user interface allowing input of various planning strategies and scenarios giving planners a means to identify and evaluate potential design, operational, and physical hardening modifications that can minimize any negative impacts of new trucking technologies. The tool shall incorporate real-world condition histories from pavement and bridge asset management databases to identify infrastructure vulnerabilities due to changes in freight traffic and better prioritize future roadway maintenance project selection. Additionally, the Performing Agency shall perform targeted modeling to identify best lane use options for automated and platooned trucks under a variety of operational scenarios and at varying traffic levels.

Deliverables:
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022

April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
TM2

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$186,204.00	$148,963.20	$37,240.80

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

Project Number: 0-7133 **University:** TTI

Project Title: Develop Guidebook for Managing System Costs: Operational and Capital Cost Management at Rural and Small Urban Public Transit Systems

Project Start Date: 9/1/2021 **Termination Date:** 3/31/2024

Project Status: Active **Total Project Budget:** $213,562.50

RTI Project Manager: Joanne Steele **Researcher:** Michael Walk

Project Objectives: Rural and small urban transit systems across the United States face fiscal challenges caused by the growing gap between the cost of providing transit service and available federal, state, and local funding. In Texas, the fiscal challenges facing rural and small urban transit systems are compounded by not only an increasing population but also revenue and ridership impacts related to COVID-19. Rural and small urban transit systems also often face high levels of staff turnover and a lack of knowledge management procedures to sustain cost management practices over time. The Performing Agencies shall equip the Receiving Agency's transit systems to understand, predict, and manage operational/capital costs and provide a reliable go-to-resource for cost management best practices.

Deliverables:
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
TM2
TM3
TM4

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$80,636.25	$64,509.00	$16,127.25

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

Project Number: 0-7133 **University:** TAMUK

Project Title: Develop Guidebook for Managing System Costs: Operational and Capital Cost Management at Rural and Small Urban Public Transit Systems

Project Start Date: 9/1/2021 **Termination Date:** 3/31/2024

Project Status: Active **Total Project Budget:** $213,562.50

RTI Project Manager: Joanne Steele **Researcher:** Michael Walk

Project Objectives: Rural and small urban transit systems across the United States face fiscal challenges caused by the growing gap between the cost of providing transit service and available federal, state, and local funding. In Texas, the fiscal challenges facing rural and small urban transit systems are compounded by not only an increasing population but also revenue and ridership impacts related to COVID-19. Rural and small urban transit systems also often face high levels of staff turnover and a lack of knowledge management procedures to sustain cost management practices over time. The Performing Agencies shall equip the Receiving Agency's transit systems to understand, predict, and manage operational/capital costs and provide a reliable go-to-resource for cost management best practices.

Deliverables:
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
TM2
TM3
TM4

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$13,400.00	$10,720.00	$2,680.00

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

Project Number: 0-7127 **University:** TTI

Project Title: Examine Reconnaissance Scanning of Underground Utilities in the ROW

Project Start Date: 9/21/2021 **Termination Date:** 8/31/2023

Project Status: Active **Total Project Budget:** $746,899.00

RTI Project Manager: Shelley Pridgen **Researcher:** Gary Young

Project Objectives: Mapping of buried utilities using rigorous subsurface utility engineering (SUE) quality level B (QLB), as is frequently performed or recommended, can be costly. It can also be ineffective for unknown utilities (i.e., utilities that exist but for which no information is available). This is particularly common and problematic in areas of oil and gas operations. When undiscovered until construction, these unknown utilities may cause serious scheduling disruptions as well as higher construction costs, along with safety and environmental risks. There is a need for a faster, less expensive method of scanning the right of way (ROW) for these unknown utilities. This research shall evaluate, select and test the application of newly available geophysical measurement systems. These systems would allow quickly and cheaply detecting and mapping unknown pipelines or other utilities in the ROW. It compares the effectiveness and cost of deployment to standard QLB SUE and reports on technologies that are both technically and cost effective for identifying unknown utilities.

Deliverables:
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
TM2
TM3

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$364,873.75	$291,899.00	$72,974.75

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

Project Number: 0-7127 **University:** TAMU-CC

Project Title: Examine Reconnaissance Scanning of Underground Utilities in the ROW

Project Start Date: 9/21/2021 **Termination Date:** 8/31/2023

Project Status: Active **Total Project Budget:** $746,899.00

RTI Project Manager: Shelley Pridgen **Researcher:** Gary Young

Project Objectives: Mapping of buried utilities using rigorous subsurface utility engineering (SUE) quality level B (QLB), as is frequently performed or recommended, can be costly. It can also be ineffective for unknown utilities (i.e., utilities that exist but for which no information is available). This is particularly common and problematic in areas of oil and gas operations. When undiscovered until construction, these unknown utilities may cause serious scheduling disruptions as well as higher construction costs, along with safety and environmental risks. There is a need for a faster, less expensive method of scanning the right of way (ROW) for these unknown utilities. This research shall evaluate, select and test the application of newly available geophysical measurement systems. These systems would allow quickly and cheaply detecting and mapping unknown pipelines or other utilities in the ROW. It compares the effectiveness and cost of deployment to standard QLB SUE and reports on technologies that are both technically and cost effective for identifying unknown utilities.

Deliverables:
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
TM2
TM3

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$55,856.25	$44,685.00	$11,171.25

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

Project Number: 0-7132 **University:** TTI

Project Title: Quantify the Real Impact of Transportation Activity on Regional Ozone and Near-Road PM Concentrations

Project Start Date: 9/7/2021 **Termination Date:** 7/31/2024

Project Status: Active **Total Project Budget:** $537,321.00

RTI Project Manager: Shelley Pridgen **Researcher:** Reza Farzaneh

Project Objectives: The Receiving Agency and its partner agencies are required to comply with the requirements of the transportation conformity requirement. Transportation conformity is an emissions control-centric process built on the assumption that that reducing emissions from transportation activities would lead to better air quality. However, the air quality observations collected since the onset of the COVID-19 pandemic shows ambient ozone and particulate matter of less than 2.5 micrometer in aerodynamic diameter (PM2.5), concentrations have a mixed response to the significant changes in traffic activities and emissions. This trend has raised questions regarding the extent of the transportation's impacts on air quality. This study will bridge the gap in the understanding of the actual extent of transportation activities' impacts on regional and near-road air quality. The Performing Agency shall study three major activities for selected case study areas:

- Analysis of before- and during-pandemic traffic activity and air quality monitoring data.
- Evaluate the performance of air dispersion modeling in capturing the changes of near-road PM2.5 concentrations in near-road environment resulting from traffic activity variations.
- Evaluate the performance of photochemical modeling in capturing the changes of regional ozone in response to changes of traffic activities.

The study will also result in a characterization of COVID-19 restrictions' impacts on traffic activities and air quality.

Deliverables:
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022

May MPR 2022
June MPR 2022
July MPR 2022
TM2

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$143,339.50	$114,671.60	$28,667.90

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

Project Number: 0-7132 **University:** UTEP

Project Title: Quantify the Real Impact of Transportation Activity on Regional Ozone and Near-Road PM Concentrations

Project Start Date: 9/7/2021 **Termination Date:** 7/31/2024

Project Status: Active **Total Project Budget:** $537,321.00

RTI Project Manager: Shelley Pridgen **Researcher:** Reza Farzaneh

Project Objectives: The Receiving Agency and its partner agencies are required to comply with the requirements of the transportation conformity requirement. Transportation conformity is an emissions control-centric process built on the assumption that that reducing emissions from transportation activities would lead to better air quality. However, the air quality observations collected since the onset of the COVID-19 pandemic shows ambient ozone and particulate matter of less than 2.5 micrometer in aerodynamic diameter (PM2.5), concentrations have a mixed response to the significant changes in traffic activities and emissions. This trend has raised questions regarding the extent of the transportation's impacts on air quality. This study will bridge the gap in the understanding of the actual extent of transportation activities' impacts on regional and near-road air quality. The Performing Agency shall study three major activities for selected case study areas:

- Analysis of before- and during-pandemic traffic activity and air quality monitoring data.
- Evaluate the performance of air dispersion modeling in capturing the changes of near-road PM2.5 concentrations in near-road environment resulting from traffic activity variations.
- Evaluate the performance of photochemical modeling in capturing the changes of regional ozone in response to changes of traffic activities.

The study will also result in a characterization of COVID-19 restrictions' impacts on traffic activities and air quality.

Deliverables:
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022

March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
TM2

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$30,800.00	$24,640.00	$6,160.00

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

Project Number: 0-7134 **University:** CTR

Project Title: Improve Traffic Analysis and Mobility Modeling Using Information and Communication Technologies

Project Start Date: 9/1/2021 **Termination Date:** 2/28/2023

Project Status: Active **Total Project Budget:** $195,908.55

RTI Project Manager: Wade Odell **Researcher:** Chandra Bhat

Project Objectives: The omnipresence of information and communication technologies (ICTs), such as smartphones, GPS, Bluetooth, and tablets, is inevitably influencing travel behaviors. ICT popularity presents opportunities to advance accessibility for all users. More than 96 percent of all U.S. adults own a cellphone and about 81 percent have a smartphone.

These devices gather data on a continual basis, with the potential to collect mobility patterns at a fine, individualized human scale. ICTs have already led to changes in data collection capabilities and the analysis of human mobility patterns.

The Receiving Agency can harness these capabilities and adjust analysis approaches to maintain a good level of service throughout the state transportation system. Accordingly, the Performing Agency shall investigate two issues:

- How can ICT-based travel data collection aid in the capture of human and traffic mobility patterns more efficiently and effectively than traditional travel data collection programs alone?
- How is ICT use changing individuals' activity accessibility options and impacting their travel behavior?

In addressing these questions, the Performing Agency shall use a multiple-step approach, with each task building upon earlier ones.

Deliverables:
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022

May MPR 2022
June MPR 2022
July MPR 2022
TM2
TM3
P1

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$122,573.40	$98,058.72	$24,514.68

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

Table 17. Planning and Environmental Total for Continuing Projects

Financials	Budget	Expended	Balance
Federal 80%	$1,839,740.62	$1,701,737.26	$138,003.35
State 20% TDC*	$459,935.15	$425,434.32	$34,500.84
Total	$2,299,675.77	$2,127,171.58	$172,504.19

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:
TM9
August MPR 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$165,020.90	$132,016.72	$33,004.18

*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:
TM9
August MPR 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$239,577.42	$191,661.94	$47,915.48

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

Project Number: 0-6905-01 **University:** UH

Project Title: Performance of skewed reinforcing in Inverted-T bridge caps

Project Start Date: 9/17/2021 **Termination Date:** 6/30/2023

Project Status: Active **Total Project Budget:** $269,760.00

RTI Project Manager: Jade Adediwura **Researcher:** Yi-Lung Mo

Project Objectives: Reinforced concrete inverted-T bridge caps (ITBCs) are used extensively in Texas bridges. Many of these bridge structures must be skewed. The Performing Agency shall continue the Receiving Agency's Research Project 0-6905 "Performance of skewed reinforcing in Inverted-T bridge caps" for the load testing, as reported in R1A and R1B in Donigan Road bridge. In report R1A, The peak load-carrying capacity of inverted-T bridge caps (ITBC) with skew reinforcing is almost equal to the traditional one that is presently used by the Receiving Agency; the number of cracks observed is fewer in the case of ITBC with skew reinforcing; the observed maximum crack width is smaller in the case of skew reinforcing; the design and construction complexities can be significantly reduced and a faster and easier construction process can be achieved when skew reinforcing is used. In report R1B , a preliminary finite element (FE) model was developed for full-scale ITBCs, three cases of reinforcement design for ITBCs were investigated to cover the majority of the design detailing in Texas bridges and four design examples of ITBCs with various skew angles. In this phase 2 of the continued project, the goal is to perform the load tests on the bridge. The Performing Agency shall study the FE analysis results of the bent caps, review sensor installation techniques, and train research assistants for the usage of data acquisition systems and data collection. Subsequently, the Performing Agency shall complete the Instrumentation of the critical skewed ITBCs and the load tests . Finally, the Performing Agency shall analyze the test results to calibrate the FE models and shall recommend a set of design guidelines.

Deliverables:
September MPR 2021 with attachment 1
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022

May MPR 2022
June MPR 2022
July MPR 2022
TM2

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$170,901.25	$136,721.00	$34,180.25

*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 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
September MPR 2021
FY'22 TMA

Financials:	FY'22 TMB FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$114,481.56	$91,585.25	$22,896.31

*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:** 4/30/2024

Project Status: Active **Total Project Budget:** $1,142,586.00

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: Updated TM6
August MPR 2021
September MPR 2021
October MPR 2021

November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
P3B
May MPR 2022
June MPR 2022
July MPR 2022
TM6B
R1

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$183,967.00	$147,173.60	$36,793.40

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

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:

TM4
August MPR 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022

June MPR 2022
July MPR 2022
TM3.2B

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$232,896.50	$186,317.20	$46,579.30

*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:** 2/28/2023

Project Status: Continuing **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 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022

TM6
TM7
TM3

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$290,178.00	$232,142.40	$58,035.60

*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 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022

June MPR 2022
July MPR 2022
ITM5
ITM6

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$232,379.00	$185,903.20	$46,475.80

*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 Bridges

Project Start Date: 7/10/2019 **Termination Date:** 2/28/2023

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 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$261,170.00	$208,936.00	$52,234.00

*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:** 8/31/2023

Project Status: Active **Total Project Budget:** $572,509.00

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 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
TM FY22
TM6
P1 - Cost Analysis Workbook
June MPR 2022
July MPR 2022

TM6A
P1, V2
TM4B

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$101,796.00	$81,436.80	$20,359.20

*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:** $1,082,960.05

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:

- Strength of nodes in which tension fields in three orthogonal direction are present.
- 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.
- Triaxial confinement benefits offered by confining reinforcement have not been researched and codified.
- 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 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
TMFY22

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$298,029.00	$238,423.20	$59,605.80

*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 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
ITM4

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$221,525.00	$177,220.00	$44,305.00

*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 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
TM3
TMFY22

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$365,927.00	$292,741.60	$73,185.40

*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:** 8/31/2023

Project Status: Active **Total Project Budget:** $1,267,152.60

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:

- 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.
- Large-scale composite beam tests and associated computational studies to provide an evaluation of the performance of composite steel bridge girders with largerdiameter shear studs.

Deliverables:
August MPR 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022

Financials:	July MPR 2022 TM6 FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$388,613.02	$310,890.42	$77,722.60

*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:
August MPR 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022

April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
TMFY22A
TMFY22B
P3A
P3B

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$261,421.79	$209,137.43	$52,284.36

*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:
August MPR 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
TM4
TMFY22
January MPR 2022

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$367,742.98	$294,194.38	$73,548.60

*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:** 8/31/2024

Project Status: Active **Total Project Budget:** $1,175,887.21

RTI Project Manager: Martin Dassi **Researcher:** Oguzhan Bayrak

Project Objectives:

- 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:

August MPR 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
TM3
TMFY22A
TMFY22B

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$391,805.18	$313,444.14	$78,361.04

*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:
August MPR 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
TM4B
TMFY22A
TMFY22B

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$225,000.00	$180,000.00	$45,000.00

*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:
August MPR 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
TM4B
TMFY22A
TMFY22B

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$142,500.00	$114,000.00	$28,500.00

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

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:** $6,459,839.00

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:
August MPR 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
P6A1
TM3Q5
P4B

TM3Q6
TM3Q7
P6B2
P4C
TM3Q8

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$564,944.75	$451,955.80	$112,988.95

*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:** $6,459,839.00

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:
August MPR 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
P6A1
TM3Q5
P4B

TM3Q6
TM3Q7
P6B2
P4C
TM3Q8

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$1,316,800.00	$1,053,440.00	$263,360.00

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

Project Number: 0-7112 **University:** TTI

Project Title: Development of a Continuous for Live Load Prefabricated Steel Accelerated Bridge Construction (ABC) Unit for Texas Bridges

Project Start Date: 9/1/2021 **Termination Date:** 8/31/2024

Project Status: Active **Total Project Budget:** $689,994.50

RTI Project Manager: Martin Dassi **Researcher:** Matthew Yarnold

Project Objectives: The overall goal is to develop a system where prefabricated steel ABC unit perform continuous for live load. The system must be: easily constructible, fast to assemble, durable long-term, safe, and cost-effective. The Performing Agencies shall conduct a literature review to first synthesize what has been done by state departments of transportation and other agencies. The Performing Agencies shall also evaluate the behavior of related Receiving Agency bridges through visual inspection and monitoring. The Performing Agencies shall perform a system development program utilizing this information in conjunction with expert feedback from an Industry Review Panel (IRP) workshop (including the Receiving Agency Panel). The three (3) best system designs shall be selected for full-scale laboratory testing followed by an analytical parametric study. The Performing Agencies shall compile and present the results at an IRP meeting with the Receiving Agency, where the final system shall be selected. The Performing Agencies shall develop full Microstation details and specifications along with a user-friendly design guide. The guide shall identify the following:

- Span length capabilities for girder sizes/depths/spacings.
- General details for establishing live load continuity.
- Closure pour details at interior bents and how to achieve acceptable deck stresses.
- Structural steel splice details and acceptable tolerances.
- Bearing layout to meet the Receiving Agency substructure details.

Deliverables:
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022

May MPR 2022
June MPR 2022
July MPR 2022
TM2

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$103,593.50	$82,874.80	$20,718.70

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

Project Number: 0-7112 **University:** UTEP

Project Title: Development of a Continuous for Live Load Prefabricated Steel Accelerated Bridge Construction (ABC) Unit for Texas Bridges

Project Start Date: 9/1/2021 **Termination Date:** 8/31/2024

Project Status: Active **Total Project Budget:** $689,994.50

RTI Project Manager: Martin Dassi **Researcher:** Matthew Yarnold

Project Objectives: The overall goal is to develop a system where prefabricated steel ABC unit perform continuous for live load. The system must be: easily constructible, fast to assemble, durable long-term, safe, and cost-effective. The Performing Agencies shall conduct a literature review to first synthesize what has been done by state departments of transportation and other agencies. The Performing Agencies shall also evaluate the behavior of related Receiving Agency bridges through visual inspection and monitoring. The Performing Agencies shall perform a system development program utilizing this information in conjunction with expert feedback from an Industry Review Panel (IRP) workshop (including the Receiving Agency Panel). The three (3) best system designs shall be selected for full-scale laboratory testing followed by an analytical parametric study. The Performing Agencies shall compile and present the results at an IRP meeting with the Receiving Agency, where the final system shall be selected. The Performing Agencies shall develop full Microstation details and specifications along with a user-friendly design guide. The guide shall identify the following:

- Span length capabilities for girder sizes/depths/spacings.
- General details for establishing live load continuity.
- Closure pour details at interior bents and how to achieve acceptable deck stresses.
- Structural steel splice details and acceptable tolerances.
- Bearing layout to meet the Receiving Agency substructure details.

Deliverables:
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022

May MPR 2022
June MPR 2022
July MPR 2022
TM2

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$20,845.00	$16,676.00	$4,169.00

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

Project Number: 0-7113 **University:** CTR

Project Title: Determine Service and Ultimate Behavior for Bent to Column Joints in TxDOT Substructures

Project Start Date: 9/1/2021 **Termination Date:** 8/31/2024

Project Status: Active **Total Project Budget:** $999,966.39

RTI Project Manager: Shelley Pridgen **Researcher:** Oguzhan Bayrak

Project Objectives: The Bridge Design Manual requires consideration of various extreme events such as lateral stream loads and debris accumulation during flooding, severe scouring, and loss of supports due to collision for multi-column bent cap design. Typically, column-to-cap connections are designed as simple supports. As a result, current/past details have no confinement in bent cap joints, and the longitudinal column reinforcement is not always fully developed into the cap. Detailing joints for developing plastic capacity, as well as to permit sufficient load redistribution, is a common strategy in design for extreme loading scenarios (e.g., seismic design). To accommodate this increased moment demand, the standard column-to-cap connection requires improved detailing techniques. The Performing Agency shall utilize analytical/computational methods and an experimental program to investigate the performance of bent cap connections with traditional and improved details. The Performing Agency shall provide practical, easily implementable design recommendations for column-bent connections through these activities:

- Reviewing literature to identify state-of-the-art detailing techniques and design parameters
- Performing analytical or computational analysis to determine moment demand induced by extreme events
- Developing improved detailing methods and retrofitting methods
- Conducting large-scale structural experiments to investigate the performance of various details
- Providing design guidelines for designers to account for the extreme events.

Deliverables:
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022

March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
TM2
TM3

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$262,221.79	$209,777.43	$52,444.36

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

Project Number: 0-7114 **University:** TTI

Project Title: Re-Examine Minimum Reinforcement Requirements for Shear Design

Project Start Date: 9/1/2021 **Termination Date:** 8/31/2024

Project Status: Active **Total Project Budget:** $930,904.25

RTI Project Manager: Jade Adediwura **Researcher:** Petros Sideris

Project Objectives: Minimum shear reinforcement requirements in the Association of State Highway Transportation Officials (AASHTO) Load and Resistance Factor Design (LRFD) Bridge Design Specifications are based on tests conducted on reinforced concrete panels and beams. The extension of these requirements to prestressed concrete beams introduced significant conservatism in the current LRFD provisions for shear design. More accurate provisions are necessary to better predict the shear strength of prestressed beams.

The objective of this project is to investigate the validity of the minimum shear reinforcement requirements and develop new/revised guideline specifications. The Performing Agency shall:

- Perform a literature review and outreach in order to synthesize a unique database of load tests for prestressed concrete beams, which the Performing Agency shall analyze using data driven methods to identify major design parameters and missing information that will inform an experimental program.

- Perform twenty (20) full scale tests on ten (10) commonly used prestressed girders combining a range of identified design parameters to comprehensively re-examine the minimum reinforcement requirements of AASHTO LRFD Bridge Design Specifications accounting for reserve strength and ductility and as well as performance under service conditions. The Performing Agency shall complement the experimental program by analytical modelling to expand its impact.

- Develop design guidelines for the minimum reinforcement requirements based on the synthesized comprehensive dataset complemented by the full-scale tests and analytical modeling. The Performing Agency shall also pursue integration of these guidelines in the AASHTO LRFD Bridge Design Specifications.

Deliverables: September MPR 2021

October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
TM2
TM3
ITM4A

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$299,025.75	$239,220.60	$59,805.15

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

Project Number: 0-7115 **University:** CTR

Project Title: Investigate Live Load Distribution and Stability of Prestressed Concrete Girders During Construction

Project Start Date: 9/1/2021 **Termination Date:** 1/15/2025

Project Status: Active **Total Project Budget:** $998,766.67

RTI Project Manager: Martin Dassi **Researcher:** Todd Helwig

Project Objectives: The Performing Agency shall focus on the stability of long-span prestressed concrete I- and U-girders during erection and construction. The Performing Agency shall consider the distribution of live load in the completed bridge as well the role of diaphragms in stability and live load distribution and develop methods of analysis of the girder behavior.The Performing Agency shall focus on the stability of long-span prestressed concrete I- and U-girders during erection and construction. The Performing Agency shall consider the distribution of live load in the completed bridge as well the role of diaphragms in stability and live load distribution and develop methods of analysis of the girder behavior.

Deliverables:
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
TM2

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$270,027.64	$216,022.11	$54,005.53

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

Project Number: 0-7116 **University:** CTR

Project Title: Develop Deck and Overhang Design Guidelines for Sound Walls and Other Heavy Loads

Project Start Date: 9/1/2021 **Termination Date:** 8/31/2024

Project Status: Active **Total Project Budget:** $599,347.64

RTI Project Manager: Shelley Pridgen **Researcher:** Eric Williamson

Project Objectives: Economic considerations typically encourage limiting the total number of girders across the width of most bridges. The width of bridge overhangs is normally proportioned so that the same girder sections can be used for both the interior and fascia girders. While many state transportation agencies have guidelines on sizing and detailing bridge overhangs, the current provisions are generally based on rules-of-thumb developed through experience. The Performing Agency shall develop guidelines for analyzing and designing bridge decks and overhangs to accommodate increased loads due to heavy rails or sound walls.

Detailed computational models shall be developed and validated against available test data. A parametric study shall represent the range of design variables encountered for representative Texas bridges. The Performing Agency shall allow engineers to select the deck thickness, reinforcement detailing, and overhang geometry for a specific project given the bridge railing type, girder spacing, and total number of girders to which the load is distributed. The research shall consider commonly used girder systems and focus on identifying cross-sectional profiles that lead to improved performance for cases with heavier loads compared to standard overhangs.

Deliverables:
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
TM2

TM3
TM4

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$189,507.41	$151,605.93	$37,901.48

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

Project Number: 0-7117 **University:** CTR

Project Title: Investigate the Strength of Struts Crossing Cold Joints

Project Start Date: 9/1/2021 **Termination Date:** 6/30/2025

Project Status: Active **Total Project Budget:** $1,366,368.89

RTI Project Manager: Jade Adediwura **Researcher:** Oguzhan Bayrak

Project Objectives: Cold joints commonly occur in concrete structures, whether they are a part of new construction (e.g., staged construction, roadway expansion projects, spliced girder bridges) or retrofit efforts (e.g., interface between the new structural elements and the older concrete components). In many cases, the cold joints occur within "disturbed regions" of a structure. The preferred design method in the AASHTO LRFD Bridge Design Specifications for disturbed regions is the strut-and-tie design method. While the commentary states that the capacity of cold joints should be checked in addition to traditional strut-and tie design checks, there is no specific guidance provided for how to include shear-interface resistance in the context of the strut-and-tie design provisions. Thus, there is a need to develop specific design recommendations for use in the AASHTO LRFD Bridge Design Specifications, as well as the TxDOT Bridge Design Manual.

The Performing Agency shall investigate the strength of struts crossing cold joints through a comprehensive analytical and experimental test program informed by a literature review and examination of common cold joint cases encountered by bridge designers. The design recommendations developed shall provide the guidance for implementing the necessary design checks at cold joints encountered in Texas bridge design practice.

Deliverables:
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022

July MPR 2022
TM2
TM3

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$264,391.79	$211,513.43	$52,878.36

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

Table 18. Structures and Hydraulics Totals for Continuing Projects

Financials	Budget	Expended	Balance
Federal 80%	$6,357,031.41	$6,006,892.77	$350,138.64
TDC 20%	$1,589,257.85	$1,501,723.19	$87,534.66
Total	$7,946,289.26	$7,508,615.96	$437,673.30

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:** 8/31/2023

Project Status: Active **Total Project Budget:** $876,264.25

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 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
TM5A

May MPR 2022
June MPR 2022
July MPR 2022
TM7-A

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$147,829.75	$118,263.80	$29,565.95

*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:** 12/31/2023

Project Status: Active **Total Project Budget:** $480,124.25

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 2021
TM-3a
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022

April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$77,925.25	$62,340.20	$15,585.05

*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:** 6/30/2023

Project Status: Active **Total Project Budget:** $708,537.35

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 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$178,688.99	$142,951.19	$35,737.80

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

Project Number: 0-7021-01 **University:** TTI

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

Project Start Date: 12/14/2021 **Termination Date:** 12/31/2022

Project Status: Active **Total Project Budget:** $49,730.25

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

Project Objectives: When divided highways span a hazard, engineers often design two separate bridges with the bridge rail ends protected by guardrail installations, leaving an opening between the parallel bridge structures possibly resulting 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 fatal crashes in Texas and across the country.

The original project, 0-7021, developed the Median Opening Protection System (MOPS) and began the crash testing. The Performing Agency shall address this safety issue as follows:

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

Deliverables:

December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$32,730.25	$26,184.20	$6,546.05

*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:** 8/31/2024

Project Status: Active **Total Project Budget:** $596,259.00

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 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
TM4
June MPR 2022
July MPR 2022

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$63,203.00	$50,562.40	$12,640.60

*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:** 12/31/2022

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 facilitatesafe 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 / decelerationto and from driveways, turnaround lanes,and interchange approachesand departures. Acceleration and deceleration lanes, climbing lanes,andright-and left-turn lanes are examples of ALtypesthat can serve different purposes. There is limited guidance fordesigningALsonfrontage roadsat and between freeway ramp terminals. The goal of this project is to identify gaps in existing guidelines and develop design criteria for ALson frontage roads. To address this goal the Performing Agencyshall: a)review the literature and the state of practice in Texas; b) determine the conditions under which a certain typeof ALdesignimproves 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 ALwith certain characteristics can affect safety.

Deliverables:
August MPR 2021
September MPR 2021
October MPR 2021
November MPR 2021
TM4
TM5
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$101,654.25	$81,323.40	$20,330.85

*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:** 11/30/2022

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: TM3
TM4
August MPR 2021
September MPR 2021

October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$350,896.00	$280,716.80	$70,179.20

*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:
August MPR 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022

July MPR 2022
1st Draft TxDOT Spec
TM3
TM4
Video of the installation system
TM5

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$111,518.00	$89,214.40	$22,303.60

*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:
August MPR 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$755,918.50	$604,734.80	$151,183.70

*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:** 2/28/2023

Project Status: Active **Total Project Budget:** $550,041.50

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:
August MPR 2021 CTR
September MPR 2021 CTR
October MPR 2021 TTI
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022

TM4
TM5
August MPR 2021 TTI
September MPR 2021 TTI
October MPR 2021 CTR

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$91,587.50	$73,270.00	$18,317.50

*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:** 2/28/2023

Project Status: Active **Total Project Budget:** $550,041.50

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:
August MPR 2021 CTR
September MPR 2021 CTR
October MPR 2021 TTI
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
TM4

TM5
August MPR 2021 TTI
September MPR 2021 TTI
October MPR 2021 CTR

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$80,493.59	$64,394.87	$16,098.72

*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.

Deliverables:
August MPR 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
R2

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$528,526.25	$422,821.00	$105,705.25

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

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:
Quarterly Progress Report Q3 2021
Quarterly Progress Report Q4 2021
Annual Budget Review and Program Plan 2021
Annual Budget Review, DMP update and Program Plan Meeting 2021
Quarterly Progress Report Q1 2022
Quarterly Progress Report Q2 2022
August MPR 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$2,141,365.00	$1,713,092.00	$428,273.00

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

Project Number: 0-7118 **University:** TTI

Project Title: Improving the Utilization and Effectiveness of Smart Work Zone Deployments

Project Start Date: 9/1/2021 **Termination Date:** 2/28/2023

Project Status: Active **Total Project Budget:** $199,977.50

RTI Project Manager: Shelley Pridgen **Researcher:** Gerald Ullman

Project Objectives: Smart work zones (SWZs) have been shown to have traffic safety and mobility benefits when and where they are truly needed, properly designed, implemented, and maintained. The use of SWZ deployments has become more common on projects across the state. As defined in Receiving Agency guidance: Smart Work Zone Guidelines dated October 2018, these technologies typically produce data and/or images that are processed to become actionable information. Although guidance exists to assist with designing and implementing these systems, research is needed to understand why some deployments have been more effective than others. Research is also needed to determine how the Receiving Agency's SWZ selection, procurement, implementation, and maintenance processes should be improved. To achieve these research objectives. The work to be performed with this project includes:

- Identifying a sample of projects across the state where SWZs have been deployed.
- Reviewing any information available on best practices from other state departments of transportation.
- Interviewing the Receiving Agency, contractor, and SWZ vendor staff to determine the decision-making processes of those SWZ deployments, challenges encountered, and perceptions about their effectiveness.
- Where data is available, conducting operational and safety analyses to determine actual effects of the systems.
- Reviewing contract management documentation related to those SWZ deployments.
- Identifying potential improvements to the Receiving Agency's project development and construction management workflows, bid specifications, and methods of payment to increase likelihood of successful smart work zones on future projects.

Deliverables:
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021

January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
TM2
TM3
TM4

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$140,632.50	$112,506.00	$28,126.50

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

Project Number: 0-7119 **University:** TTI

Project Title: Develop Standardized Operational Evaluation of Wrong-Way Driving Detection Technologies

Project Start Date: 9/1/2021 **Termination Date:** 8/31/2023

Project Status: Active **Total Project Budget:** $413,513.25

RTI Project Manager: Joanne Steele **Researcher:** Melissa Finley

Project Objectives: To reduce the number of wrong-way maneuvers and associated crashes on Texas freeways, several Receiving Agency Districts have purchased and installed Intelligent Transportation Systems (ITS) that can detect wrong-way drivers, alert the wrong-way drivers of their error, and notify the traffic management center. However, system performance and limitations are typically not known until after the systems are purchased and activated in the field. This results in systems not functioning as expected, highfalse-alarm ratesand increased workload for agency staff. The Performing Agencyshall determine the state-of-the-practice through a review of literature, assessment of current practice in Texas, review of other state agency testing procedures, and identification of readily available Wrong-Way Driving (WWD)ITSand detection technology. The Performing Agency shalldevelop a standardized testing mechanism to assess performance of WWD detection technologies, evaluate existing technologies, and identify the benefits and limitations of each technologytested. Based on the findings, the Performing Agencyshall develop implementation guidance for the technologies tested and a draft WWD Detection Technology Specification.

Deliverables:
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
TM2

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$236,315.00	$189,052.00	$47,263.00

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

Project Number: 0-7120 **University:** TTI

Project Title: Develop Transition for MASH Test Level 4 (TL-4) Compliant Guardrail System

Project Start Date: 9/1/2021 **Termination Date:** 5/31/2023

Project Status: Active **Total Project Budget:** $239,130.75

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

Project Objectives: Under project 0-7019, Development of a MASH Test-Level 4 (TL-4) Compliant Guardrail, the Performing Agency developed a guardrail system capable of safely containing and redirecting a single unit truck on impact. The guardrail was tested under the second edition of the Manual for Assessing Safety Hardware (MASH)TL-4 criteria. The end-transition of the guardrail was not tested under project 0-7019. The Performing Agency shall design and testanend-transition of the TL-4 guardrail system. The transition shall allow the TL-4 guardrail to be attached to a standard W-beam guardrail with MASH compliant guardrail end-terminals. The transition shall meet MASH TL-3 criteria. Use of this end-transition shall allow fullimplementation of the TL-4 guardrail system.2

Deliverables:
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
TM2

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$131,763.75	$105,411.00	$26,352.75

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

Project Number: 0-7121 **University:** TTI

Project Title: Determine Adequacy of Installation of Existing Roadside Barriers on High-Speed Roadways

Project Start Date: 9/1/2021 **Termination Date:** 8/31/2023

Project Status: Active **Total Project Budget:** $269,997.75

RTI Project Manager: Wade Odell **Researcher:** Chiara Silvestri Dobrovolny

Project Objectives: The American Association of State Highway and Transportation Official (AASHTO)Manual for Assessing Safety Hardware (MASH) specifiesthe highest impact speed for crash testing of barrier systems with passenger vehicles is 62 miles per hour (mph). Thisimpact speed was derived from analyses of reconstructed crash data,which isnearly 20 years old. Preliminary crash data from National Cooperative Highway Research Program (NCHRP)17-43, Long-Term Roadside Crash Data Collection Program,under which a new database of reconstructed run-off-road crashes is being developed, indicatesthatfor highways with a posted speed limit greater than 70 mph, the 85th percentile impact speed is 67.7 mph. This means there is a need for a higher design impact speed for barriers used on these higher speed roadways.Increased impact speeds will place more demand on barrier systems. Observations of guardrail systems developing partial rail tears when tested under MASH impact conditions indicatethat these systems are near their containment capacity.The Receiving Agency has over 3,500 milesof roadways with posted speeds of 75 mph or higher.The Performing Agency shall assess performance limits of identified commonly used barrier systems for higher impact speeds using engineering analysis and finite element(FE)simulations and shall provide design guidance for selection and installation of such barriers at higher posted speed limit highways, while maintaining MASH complianc

Deliverables:
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022

July MPR 2022
TM2
TM3

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$115,716.75	$92,573.40	$23,143.35

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

Project Number: 0-7122 **University:** TTI

Project Title: Evaluate Alternative Methods to Examine Visibility of Pavement Markings

Project Start Date: 9/1/2021 **Termination Date:** 8/31/2024

Project Status: Active **Total Project Budget:** $467,604.25

RTI Project Manager: Jade Adediwura **Researcher:** Adam Pike

Project Objectives: Pavement markings are the primary means for an agency to provide longitudinal guidance to drivers. Effective pavement markings can improve safety, improve driver comfort, and increase functionality/reliability of automated driving systems and Advanced Driver Assistance Systems (ADAS).To be effective,markings must be visible during all driving conditions, day and night.Markings are typically characterized by their retroreflectivity which is a surrogate measure for how visible the marking isat night. Retroreflectivity does notconsiderother factors that will impact the actual visibility of the markingssuch as the color or retroreflectivity of the pavement that the marking is applied to, the color or width of the marking, or the viewing conditions(i.e.,observation vehicle, observer characteristics, weather conditions). Retroreflectivity is also a metricfor nighttime visibility that may not relate to the marking visibility during the day.The objective of this project isto improve current pavement marking installation and maintenance practices,such that effective markingsare continuously maintained.The Performing Agenciesshall develop a tool to effectively assess the visibility of pavement markings and to make suggestions/recommendationsfor maintenance of markings.The Performing Agencies shallevaluate marking visibility for both human and automated drivers across a range of conditions. These evaluations shallbe used to make recommendations to improve new marking installation specificationsand techniques, improve marking maintenance practices, and evaluate other technologies that should be considered to improve pavement marking delineation.2.

Deliverables:
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022

March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
TM2

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$124,381.25	$99,505.00	$24,876.25

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

Project Number: 0-7122 **University:** UTSA

Project Title: Evaluate Alternative Methods to Examine Visibility of Pavement Markings

Project Start Date: 9/1/2021 **Termination Date:** 8/31/2024

Project Status: Active **Total Project Budget:** $467,604.25

RTI Project Manager: Jade Adediwura **Researcher:** Adam Pike

Project Objectives: Pavement markings are the primary means for an agency to provide longitudinal guidance to drivers. Effective pavement markings can improve safety, improve driver comfort, and increase functionality/reliability of automated driving systems and Advanced Driver Assistance Systems (ADAS).To be effective,markings must be visible during all driving conditions, day and night.Markings are typically characterized by their retroreflectivity which is a surrogate measure for how visible the marking isat night. Retroreflectivity does notconsiderother factors that will impact the actual visibility of the markingssuch as the color or retroreflectivity of the pavement that the marking is applied to, the color or width of the marking, or the viewing conditions(i.e.,observation vehicle, observer characteristics, weather conditions). Retroreflectivity is also a metricfor nighttime visibility that may not relate to the marking visibility during the day.The objective of this project isto improve current pavement marking installation and maintenance practices,such that effective markingsare continuously maintained.The Performing Agenciesshall develop a tool to effectively assess the visibility of pavement markings and to make suggestions/recommendationsfor maintenance of markings.The Performing Agencies shallevaluate marking visibility for both human and automated drivers across a range of conditions. These evaluations shallbe used to make recommendations to improve new marking installation specificationsand techniques, improve marking maintenance practices, and evaluate other technologies that should be considered to improve pavement marking delineation.2.

Deliverables:
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022

April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
TM2

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$23,873.00	$19,098.40	$4,774.60

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

Project Number: 0-7123 **University:** CTR

Project Title: Define a Statewide Plan for a Sustainable Real-Time Travel Time Network for Texas Hurricane Evacuations and Safe Citizen Return

Project Start Date: 9/1/2021 **Termination Date:** 8/31/2023

Project Status: Active **Total Project Budget:** $399,868.11

RTI Project Manager: Wade Odell **Researcher:** Zhanmin Zhang

Project Objectives: Hurricanes in Texas have posed considerable challenges to the evacuation of large populations and the transmission of information from the real-time traffic monitoring infrastructure. Given the societal, economic, and strategic significance of the hurricane evacuation route network, ensuring sufficient coverage and resilience against disruptions is essential. The limited available resources and the expanded network size, which includes rural areas, presents several technical and economic difficulties. To implement an effective strategy to address these issues, it is crucial for the Receiving Agency to develop a statewide plan for the sustainability and sufficiency of the evacuation network. The Performing Agency shall provide guidance for decision-makers in assessing the needs for determining additional monitoring stations on an expanded evacuation network including major Texas cities. To do so, the Performing Agency shall assess the availability and maintainability of different resources by collecting input from multiple stakeholders and developing a prioritized list of interventions based on socioeconomic criteria. Based on the projected usage of information transfer technologies, the project shall explore and recommend alternatives for failsafe systems.

Deliverables:
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
TM2
TM3

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$196,826.55	$157,461.24	$39,365.31

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

Project Number: 5-9050-02 **University:** TTI

Project Title: Provision of Select Computer-Aided Dispatch Data to Traffic Management Centers for Enhanced Incident Detection and Tracking

Project Start Date: 11/9/2021 **Termination Date:** 8/31/2023

Project Status: Active **Total Project Budget:** $125,000.00

RTI Project Manager: Shelley Pridgen **Researcher:** Jeff Kaufman

Project Objectives: The Receiving Agency's Traffic Management Centers (TMCs) are responsible for monitoring freeways within their respective metropolitan areas for crashes, stalls, and other incident impacting traffic flow, contacting the appropriate responding agencies (police/fire/emergency medical services/tow), and tracking incident progress. TMC staff predominantly use Closed Circuit television (CCTV) camera feeds to find incidents, as well as volume/speed detectors on the Receiving Agency Intelligent Transportation Systems (ITS) map, and the traffic layer on Google Maps. While these methods help to some degree, they are not always effective or efficient. CCTV tours (which show 5-10 second feeds of a freeway segment) can miss an incident if the camera is pointing in a different direction. TMC staff focusing on one freeway may miss an event on another freeway. Google traffic indicators only show the level of traffic but not incidents that caused the traffic. Often, those involved in incidents immediately contact 9-1-1 for assistance. The Performing Agency shall develop a system that collects essential incident management information from 9-1-1 systems and transmits said information to regional TMCs to speed up the identification and response to an incident, and collect needed incident management data to better assess incident management programs in the region

Deliverables:
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
SAR: Semi-Annual Report (1)

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$32,635.00	$26,108.00	$6,527.00

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

Project Number: 9-1531 **University:** TTI

Project Title: Development and Evaluation of Roadside Safety Systems for Motorcyclists

Project Start Date: 9/1/2021 **Termination Date:** 8/31/2024

Project Status: Active **Total Project Budget:** $780,000.00

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

Project Objectives: This pooled fund study shall provide a cooperative approach to conducting research addressing roadside safety issues specifically related to improving motorcyclist safety. The study shall provide participating states an opportunity to collaborate on best practices, new regulatory issues, risk management strategies, and other research pertaining to roadside safety improvements for motorcyclists. The research activities shall include the identification, development, and evaluation of strategies and devices for mitigating the frequency and severity of roadway departure motorcyclist crashes.

Deliverables:
September MPR 2021
Q1 Report FY22
Q2 Report FY22
March MPR 2022
Q3 QPR Report FY22 APRIL-No April 22 MPR due per contract
Q4 QPR Report FY22-No July 22 MPR due per contract
R1
October MPR 2021
December MPR 2021
January MPR 2022
May MPR 2022
June MPR 2022

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$72,654.25	$58,123.40	$14,530.85

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

Table 19. Safety and Operations Totals for Continuing Projects

Financials	Budget	Expended	Balance
Federal 80%	$4,589,707.50	$3,549,768.82	$1,039,938.68
State 20% TDC*	$1,147,426.88	$887,442.21	$259,984.67
Total	$5,737,134.38	$4,437,211.03	$1,299,923.35

2.2.6 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:** 8/31/2025

Project Status: Active **Total Project Budget:** $1,913,647.00

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 5 - TM3 2022
VSRs Year 5. Total of 24 required
August MPR & Production Tracking 2021
September MPR & Production Tracking List 2021
October MPR & Production Tracking List 2021
November MPR & Production Tracking List 2021
December MPR & Production Tracking List 2021
January MPR & Production Tracking List 2022
February MPR & Production Tracking List 2022
March MPR & Production Tracking List 2022
April MPR & Production Tracking List 2022
May MPR & Production Tracking List 2022
June MPR & Production Tracking List 2022
July MPR & Production Tracking List 2022

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$254,462.00	$203,569.60	$50,892.40

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

Program Support

Project Number: 0-6999-21 **University:** CTR

Project Title: Texas Technology Task Force (TTTF)

Project Start Date: 10/23/2020 **Termination Date:** 8/31/2023

Project Status: Active **Total Project Budget:** $1,422,607.00

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's 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 system.

Deliverables:
August MPR 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022
May MPR 2022
June MPR 2022
July MPR 2022
TM1.2
TM2.2

TM3.2
TM4.2
TM5.2
R2
P2

Financials:	FY22 Total Budget	80% Federal	20% Estimated TDCs*
Contract Total	$465,553.00	$372,442.40	$93,110.60

*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:
August MPR 2021
September MPR 2021
October MPR 2021
November MPR 2021
December MPR 2021
January MPR 2022
February MPR 2022
March MPR 2022
April MPR 2022

May MPR 2022
June MPR 2022
July MPR 2022
Newsletter 3.5
Newsletter 3.6
Newsletter 3.7
Newsletter 3.8
TxSTIC Meeting 13.4
TxSTIC Meeting 13.5
TxSTIC Meeting 13.6

Financials:	FY22 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 20. RTI Program Support Totals for Continuing Projects

Financials	Budget	Expended	Balance
Federal 80%	$1,601,596.14	$1,352,989.57	$248,606.57
State 20% TDC*	$400,399.03	$338,247.39	$62,151.64
Total	$2,001,995.17	$1,691,236.96	$310,758.21

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 21. FY 2022 Pooled-Fund Projects.

The following are project descriptions of the pooled-fund projects.

Project	Name	Study Number	Lead State	Project Dates	Texas 2022
8-8453	Roadside Safety Research for MASH Implementation	TPF-5(343)	Washington State Department of Transportation	2018 - 2022	$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
8-8458	Connecting the DOTs: Implementing ShakeCast Across Multiple State Departments of	TPF-5(357)	California Department of Transportation	2017 - 2024	$15,000.00
8-8463	Building Information Modeling (BIM) for Bridges and Structures	TPF-5(372)	Iowa Department of Transportation	2018 - 2023	$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	TPF-5(399)	Federal Highway Administration	2019 - 2024	$20,000.00
8-8471	National Partnership to Determine the Life Extending Benefit Curves of Pavement	TPF-5(375)	Minnesota Department of Transportation	2018-2024	$50,000.00
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	2019 - 2023	$39,800.00
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

Project	Name	Study Number	Lead State	Project Dates	Texas 2022
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 - 2024	$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
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

Project	Name	Study Number	Lead State	Project Dates	Texas 2022
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
8-8504	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
8-8510	Demonstration to Advance New Pavement Technologies Pooled Fund	TPF-5(478)	Federal Highway Administration	2021 - 2025	$10,000.00
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	$633,333.00
8-8513	Building Information Modeling (BIM) for Infrastructure	TPF-5(480)	Iowa Department of Transportation	2021 - 2025	$30,000.00
8-8514	Collaborative In-Service Performance Evaluation (ISPE) of Roadway Safety Features	TPF-5(481)	Arizona Department of Transportation	2022 - 2024	$30,000.00
8-8515	Development and Evaluation of Roadside Safety Systems for Motorcyclists (TxDOT-Led)	TPF-5(482)	Texas Department of Transportation	2022 – 2024	$40,000.00
8-8516	Clear Roads Winter Highway Operations Phase III	TPF-5(479)	Minnesota Department of Transportation	2022 – 2026	$25,000.00

Project	Name	Study Number	Lead State	Project Dates	Texas 2022
8-8517	Center for the Aging Infrastructure: Steel Bridge Research, Inspection, Training and Education Engineering Center – SBRITE (Continuation)	TPF-5(486)	Indiana Department of Transportation	2020 - 2024	$50,000.00
8-8518	LTPP Forensic Investigations – Stage 2	TPF-5(500)	Washington Department of Transportation	2020 - 2024	$20,000.00
8-8519	Enterprise – Phase III (Phase II Continuation)	TPF-5(490)	Michigan Department of Transportation	2022 – 2026	$30,000.00
8-8520	Safety Service Patrol Standardization and Management Practices	TPF-5(489)	Federal Highway Administration	2022 – 2026	$25,000.00
8-8521	2023 Technology Exchange on Low Volume Road Design, Construction and Maintenance	TPF-5(495)	Iowa Department of Transportation	2022	$12,000.00
8-8522	Transportation Management Centers Pooled Fund Study Phase II	TPF-5(487)	Federal Highway Administration	2022 – 2027	$50,000.00
8-8524	2023 through 2025 Biennial Asset Management Conference and Training on Implementation Strategies	TPF-5(492)	Iowa Department of Transportation	2022 – 2024	$12,000.00
8-8526	Continuous Bituminous Pavement Stripping Assessment Through Non-Destructive Testing	TPF-5(504)	Minnesota Department of Transportation	2022 – 2025	$25,000.00
8-8533	National Hydraulic Engineering Conference	1584	Federal Highway Administration	2022 – 2027	$500.00
Grand Total				**$2,399,633.00**	

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 Federal Highway Administration

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	2018 - 2022	$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 Federal Highway Administration

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: 8-8458

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 Federal Highway Administration

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 - 2024	$15,000.00

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 - 2023	$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 Federal Highway Administration

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: 8-8471

Study Number: TPF-5(375)

Project Title: National Partnership to Determine the Life Extending Benefit Curves of Pavement Preservation Techniques (MnROAD/NCAT Joint Study-Phase II)

Lead Agency: Minnesota Department of Transportation

Status: Cleared by Federal Highway Administration

Project Objectives: MnROAD and NCAT are seeking organizations to join the partnership for the second phase of research efforts. Main objectives include: 1. Determining the life cycle cost of various pavement preservation alternatives in a highly controlled experiment that will provide state Departments of Transportation (DOTs) with the financial foundation to begin to build a decision tree for their own maintenance program 2. Develop quality assurance QA field testing protocols to correlate construction practices with long term performance of pavement preservation techniques. 3. Technology transfer - Answering practical questions posed by research sponsors through formal (i.e., reports & technical papers) & informal (e.g., one-on-one responses to sponsor inquiries) technology transfer on how these life extending benefits can be best utilized in each state.

Financials:	Year	Commitment
TxDOT	2018 - 2024	$50,000.00

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 Federal Highway Administration

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 Federal Highway Administration

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	2019 - 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 Federal Highway Administration

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 - 2024	$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 Federal Highway Administration

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	$12,000.00

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 Federal Highway Administration

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 - 2024	$10,000.00

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 Department of Transportation

Status: Cleared by Federal Highway Administration

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

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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 Federal Highway Administration

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 Federal Highway Administration

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 Federal Highway Administration

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 Federal Highway Administration

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 Federal Highway Administration

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 Federal Highway Administration

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: Assessment of existing transportation infrastructure including the use of Right of Way (R/W), communication, aviation transportation facilities and any other potential existing state investments. Assessment of potential infrastructure that could utilize existing right of way and aviation transportation facilities to support AAM. Demonstrations of AAM operations for notional use cases for the movement of people and goods. Provide strategic roadmaps for research and development for each participating DOT.

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 Federal Highway Administration

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: 8-8504

Study Number: TPF-5(447)

Project Title: Traffic Control Device (TCD) Consortium (3)

Lead Agency: Federal Highway Administration

Status: Cleared by Federal Highway Administration

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 Federal Highway Administration

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: Contract Signed

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 Federal Highway Administration

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: 8-8510

Study Number: TPF-5(478)

Project Title: Demonstration to Advance New Pavement Technologies Pooled Fund

Lead Agency: Federal Highway Administration

Status: Cleared by Federal Highway Administration

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: Contract Signed

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 Federal Highway Administration

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	$633,333.00

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 Federal Highway Administration

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

Project Number: 8-8514

Study Number: TPF-5(481)

Project Title: Collaborative In-Service Performance Evaluation (ISPE) of Roadway Safety Features

Lead Agency: Arizona Department of Transportation

Status: Cleared by Federal Highway Administration

Project Objectives: The primary objective of this pooled fund study is to evaluate the performance of roadside safety hardware in the field through inter-state collaboration by using standardized data collection and data analysis with a uniform interpretation of results. The second objective is to provide a forum for states to share ISPE data, experiences, practices, information, and resources.

Financials:	Year	Commitment
TxDOT	2022 - 2024	$30,000.00

Project Number: 8-8515

Study Number: TPF-5(482)

Project Title: Development and Evaluation of Roadside Safety Systems for Motorcyclists (TxDOT-Led)

Lead Agency: Texas Department of Transportation

Status: Cleared by Federal Highway Administration

Project Objectives: The objective of this pooled fund study is to provide a cooperative approach to conducting research to address roadside safety issues specifically related to improving motorcyclist safety. Furthermore, the study is intended to provide participating states collaborative opportunities to stay abreast of best practices, new regulatory issues, risk management strategies, and other research pertaining to roadside safety improvements for motorcyclists. Research activities will include identification, development, and evaluation of strategies and devices for mitigating the frequency and severity of roadway departure motorcyclist crashes.

Financials:	Year	Commitment
TxDOT	2022 - 2024	$40,000.00

Project Number: 8-8516

Study Number: TPF-5(479)

Project Title: Clear Roads Winter Highway Operations Phase III Pooled Fund

Lead Agency: Minnesota Department of Transportation

Status: Cleared by Federal Highway Administration

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 and reference materials to promote the results of research projects. • Support the exchange of information and ideas among state agencies via peer exchanges, ad hoc 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 quick turnaround, low-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	2022 - 2026	$25,000.00

Project Number: 8-8517

Study Number: TPF-5(486)

Project Title: Center for the Aging Infrastructure: Steel Bridge Research, Inspection, Training and Education Engineering Center - SBRITE (Continuation)

Lead Agency: Indiana Department of Transportation

Status: Cleared by Federal Highway Administration

Project Objectives: Objectives and Impact: The objective of the proposal is to request a continuation of SPR-5(281) the Steel Bridge Research, Inspection, Training, and Education Engineering Center (S-BRITE Engineering Center) focused on existing steel highway bridges. This National Center when initially proposed in 2013, has become a national Center leading education, training, research, and engineering benefitting the existing aging steel bridge and structure inventory. Over the life of the project, ten (10) states, the US Army Corps, and FHWA have provided support through TPF-5(281) and continue to do so. Current funding is very strong and partner states continue to be added. Although the Center has been 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. As a result, in-kind support from the railway industry has been strong as well. The Center has contributed to improved asset management decisions for DOTs, FHWA, and other partners relative to existing steel bridge inventory. However, since the existing TPF-5(281) needs to sunset per FHWA guidelines, the Research Team, and the current active partners are requesting a continuation of this pooled fund study, albeit under a different TPF number. The original project objectives and deliverables remain unchanged. Nevertheless, a summary of the Center is presented below.

Financials:	Year	Commitment
TxDOT	2022 - 2024	$50,000.00

Project Number: 8-8518

Study Number: TPF-5(500)

Project Title: LTPP Forensic Investigations - Stage 2

Lead Agency: Washington Department of Transportation

Status: Cleared by Federal Highway Administration

Project Objectives: The objective of the proposed pooled fund study is to create a mechanism to allow for rapidly completing forensic evaluations of LTPP sections before going out of service. Test sections that are no longer active, but which have remained unchanged (i.e., no maintenance or rehabilitation has been applied), may also be considered for forensic evaluation. Possible reasons for carrying out the forensic evaluations include: • Determining reasons for poor pavement performance/premature failures • Understanding exceptional pavement performance and/or longevity • Validating pavement performance prediction (predicted vs actual) • Collecting data to support development and/or calibration of pavement performance prediction models • Closing-out/conducting final investigations of experimental test sections Ultimately, however, the primary reason for carrying out the evaluations will be to determine if the data contained in the LTPP database adequately explains the performance of the test sections and why they performed as they did.

Financials:	Year	Commitment
TxDOT	2022 - 2024	$20,000.00

Project Number: 8-8519

Study Number: TPF-5(490)

Project Title: ENTERPRISE- PHASE III (Phase II Continuation)

Lead Agency: Michigan Department of Transportation

Status: Cleared by Federal Highway Administration

Project Objectives: This proposed TPF study is a continuation of TPF-5(359) to enhance innovation in highway operations and intelligent transportation systems through research and technology transfer, as well as to continue assessing transformational technologies and their impact on the transportation industry.

Financials:	Year	Commitment
TxDOT	2022 - 2026	$30,000.00

Project Number: 8-8520

Study Number: TPF-5(489)

Project Title: Safety Service Patrol Standardization and Management Practices

Lead Agency: Federal Highway Administration

Status: Cleared by Federal Highway Administration

Project Objectives: The primary objective of this PFS study will be to gain technical information related to SSP program management, standards associated with SSP response protocol and the implementation of traffic control, and references and guidance related to staffing, training, and resource allocations within SSP programs. The goals include: 1. Assemble best practices and lessons learned from existing programs 2. Develop guidance documents based on lessons learned from existing programs 3. Reference or create tools that will help agencies make informed program decisions such as route selection, staffing levels, and resource allocation.

Financials:	Year	Commitment
TxDOT	2022 - 2026	$25,000.00

Project Number: 8-8521

Study Number: TPF-5(495)

Project Title: 2023 Technology Exchange on Low Volume Road Design, Construction and Maintenance

Lead Agency: Iowa Department of Transportation

Status: Cleared by Federal Highway Administration

Project Objectives: The primary activities of this pooled fund project are technology exchange, information sharing, and the facilitation of partnering relationships among state agencies and participating members with FHWA, Local Public Agencies and other appropriate agencies and associations. Technology exchange activities in conjunction with the 13th International Conference on Low Volume Roads will be advantageous to participating members. Specifically, this pooled fund will: 1. Provide communication and information sharing among member participants: Discuss research, development and technology transfer needs in the areas of design, construction, maintenance, and safety on low volume roads and provide research ideas to TRB in the areas of Low Volume Roads. 2. Member workshop at the 13th International Conference on Low Volume Roads: Provide a technology and knowledge exchange forum to enhance the practical knowledge of pooled fund participants concerning low volume road management with a focus on encouraging State DOT and other agency participation in the pooled fund. 3. Pooled Fund Member Meeting on Low Volume Road Issues: Provide a technology and knowledge exchange forum focused on Low Volume Road issues. Topics may include agency collaboration, funding, asset management, shared ROW/utilities, safety programs, emergency response, training and certifications, maintenance of traffic, federal oversight, standards and specifications, contracting methods, environmental issues, energy development, maintenance, material sources and quality, and bonding. 4. Technology Transfer through paper publication, webinars, technology field demonstrations, and expanding access to solutions on issues selected by pooled fund member in areas of Low Volume Road Design, Construction and Management.

Financials:	Year	Commitment
TxDOT	2022	$12,000.00

Project Number: 8-8522

Study Number: TPF-5(487)

Project Title: Transportation Management Centers Pooled Fund Study Phase II

Lead Agency: Federal Highway Administration

Status: Cleared by Federal Highway Administration

Project Objectives: The objectives of the Traffic Management Centers (TMC) Pooled Fund Study (PFS) is to assemble regional, state, and local transportation management agencies and FHWA to: (1) identify key issues and challenges agencies are facing with their traffic management systems (TMSs) or centers (TMCs); (2) suggest approaches to addressing identified issues; (3) initiate and monitor projects intended to address identified issues; (4) develop technical resources and disseminate results; (5) provide leadership and coordinate with others on TMC interests; and (6) promote and facilitate sharing information on TMC issues nationally.

Financials:	Year	Commitment
TxDOT	2022 - 2027	$50,000.00

Project Number: 8-8524

Study Number: TPF-5(492)

Project Title: 2023 through 2025 Biennial Asset Management Conference and Training on Implementation Strategies

Lead Agency: Iowa Department of Transportation

Status: Cleared by Federal Highway Administration

Project Objectives: 1. Provide communication and information sharing among member states. Discuss research needs and provide research ideas to be developed through TRB (and other research opportunities). 2. Provide a technology and knowledge exchange forum to enhance the practical knowledge of member states concerning asset management implementation. 3. Enhance the working knowledge of the asset management community.

Financials:	Year	Commitment
TxDOT	2022 - 2024	$12,000.00

Project Number: 8-8526

Study Number: TPF-5(504)

Project Title: Continuous Bituminous Pavement Stripping Assessment Through Non-Destructive Testing

Lead Agency: Minnesota Department of Transportation

Status: Cleared by Federal Highway Administration

Project Objectives: The primary objective of the proposed pooled-fund project is to establish a research consortium focused on addressing the R06D and IAP recommendations. As per the IAP and R06D findings and recommendations, particular emphasis will be placed on using 3D-GPR along with Traffic Speed Deflectometer (TSD) and/or Falling Weight Deflectometer (FWD) to detect the location, distribution, and severity of stripping in full-depth and composite bituminous pavements. Recognizing that 3D-GPR and TSD may not be readily available to all participating states, the study will allocate a portion of the pool fund to hire consulting firms for 3D-GPR and TSD surveys on the projects considered in this study. This will provide a good opportunity for states to familiarize themselves with 3D-GPR applications. Furthermore, the proposed pool fund study will include 1D-GPR testing on limited projects to compare with the 3D-GPR data. The proposed investigation also recognizes that 3D-GPR alone cannot identify stripping all the time and at all subsurface moisture conditions. Hence, the proposed study will also investigate using IE/SASW, MIRA, Thermal Imaging for localized spot verifications. It is essential to clarify that the intent of this study is not to evaluate these tools but to support and validate the final deliverables of the study.

Financials:	Year	Commitment
TxDOT	2022 - 2025	$25,000.00

Project Number: 8-8533

Study Number: 1584

Project Title: National Hydraulic Engineering Conference

Lead Agency: Federal Highway Administration

Status: Solicitation Posted

Project Objectives: 1. Provide opportunities for communication and information sharing among state hydraulic engineers, federal agencies, and national technical organizations (AASHTO TCHH and TRB AFB60) through the National Hydraulic Engineering Conference. 2. Provide a technology and knowledge exchange forum to enhance the practical knowledge of member states concerning transportation hydraulic engineering, including advanced modeling technologies, FHWA initiatives, and best practices.

Financials:	Year	Commitment
TxDOT	2022 - 2027	$500.00

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	$79,199.00	$39,078.42	$40,120.58
Salary	$1,635,217.00	$1,799,032.35	-$163,815.35
Total RTI Division Program Management	**$1,714,416.00**	**$1,838,110.77**	**-$123,694.77**

End of Report