

Awarding Federal Agency: US Department of Transportation, Office of the Assistant Secretary for Research and Technology (OST-R)

Federal Grant Number: 69A3551847102

Project Title: Center for Advanced Infrastructure and Transportation (CAIT) Region 2 UTC Consortium Led by Rutgers, The State University of New Jersey

Center Director Name, Dr. Ali Maher, CAIT Director.

E-mail address: mmaher@soe.rutgers.edu **Phone number:** 848-445-0579

Name of Submitting Official, Title, and Contact Information (e-mail address and phone number), if other than PD: Dr. Patrick Szary, CAIT Associate Director. **E-mail address:** szary@soe.rutgers.edu **Phone number:** 848-445-2999

Recipient Organization (Name and Address): Rutgers, The State University of New Jersey, Center for Advanced Infrastructure and Transportation, 100 Brett Road, Piscataway, NJ 08854-8058

DUNS Number: 001912864000

EIN Number: 1226001086A1

Recipient Identifying Number or Account Number, if any: Rutgers' account #824227

Project/Grant Period: June 05, 2018 through September 30, 2023

Reporting Period End Date: March 31, 2022

Report Term or Frequency: Semiannual

Submission Date: April 30, 2022

Signature of Submitting Official:

A handwritten signature in black ink, consisting of a large, stylized loop followed by a horizontal line extending to the right.

Impact Statement

New Jersey was one of the states hit hardest by the COVID-19 pandemic and has experienced significant long-term shifts in how people work, travel, and interact. The state has suffered more than 2 million cases and 33,000 related COVID-19 deaths.

The impacts of the virus are still being felt here in NJ, including resultant declines in public transit ridership, supply chain delays and workforce shortages across multiple industries. With inflation hitting record highs of 8.5% in March 2022, gas prices passing \$4 per gallon, and the rising costs of raw materials such as steel, these challenges have had a lasting effect on how people in the region and country travel, and the way that we think about capital project costs and planning. CAIT has continued to stay focused on improving durability and extending the life of transportation infrastructure. At the same time, the Center has also recognized new challenges our regional stakeholders are facing, such as the need for advanced workforce training and investment in resilience and climate change efforts. We have updated our research approach to best meet these pressing needs, from launching new pilot projects to building software tools. Some of the latest research and project initiatives that CAIT and the Region 2 University Transportation Center consortium have launched to support the evolving needs of its stakeholders are highlighted below:

- *Promoting Equity & Creating Opportunities for Students:* CAIT recently won a \$700,000 **New Jersey Department of Labor & Workforce Development** grant to establish the Rutgers Youth Success Program. RYSP provides case management by experienced staff to vulnerable populations in Camden NJ and statewide, using transportation and infrastructure to create bridges to youth employment opportunities. With the supply chain and transportation needs of today, and with historical federal infrastructure investment, this program facilitates good-paying career options to justice-challenged youth that otherwise would not have been easily accessible to them. The program offers job readiness, career exposure, work experience, educational, and wraparound support services for up to 100 justice-impacted youth in a historically underserved community.
- *Workforce Development & Economic Recovery:* Working with Montana/WTI, CAIT as part of its UTC workforce initiatives and the NJ LTAP program, recently won a \$6 million, 4-year National Center for Rural Road Safety grant award from the **USDOT**. For years the Center has been a leading resource in helping agencies reduce deaths on their roadways. As part of its new national team, CAIT will lead workforce training efforts.
- CAIT officially launched its Infrastructure Asset Management Academy. Inspired by realizations made during a UTC project at Rutgers and NJIT in collaboration with the **Port Authority of New York and New Jersey**, the program addresses the need for advanced asset management training and resilience planning in the region. A 6-course program taught by experts at CAIT and industry partners, it is designed to provide professional engineers and planners with the tools needed to make more informed decisions that can help extend the service life and minimize the risk of their assets. So far, CAIT has drawn significant interest from agencies in the region, with a range of 50 to 80 attendees in each course. CAIT has also brought together experts from **FHWA, ESRI, MTA**, and other institutions to provide these in-demand training sessions.

- *Building with Resilience & Planning for Climate Change*: As part of a recent UTC project, CAIT researchers have developed a GIS-based web tool to help agencies identify transportation asset risk while also comparing varying management approaches more easily. The tool is built around a risk-integrated analytical framework constructed during a case study with the **University of Virgin Islands (UVI)**, a Historically Black College or University (**HBCU**), and the **US Virgin Islands Department of Public Works**. It focused on flood risk and the current surface transportation system in the US Virgin Islands. This tool can be used by local agencies to better anticipate hazards and maximize the durability of capital-intensive infrastructure in a historically underserved community.
- UTC dollars also continue to support structural and pavement related projects at CAIT. CAIT's BEAST Lab continues testing its bridge deck specimen with the **Federal Highway Administration (FHWA)**. The full-scale, 50-ft. specimen is subjected to 60,000 lbs. of force to the bridge that simulates traffic loading, and to date this load has made more than 2 million passes along the bridge deck. Data collected allows asset owners to simulate 50 years of service life within 1 ½ years of accelerated testing at The BEAST — informing maintenance decisions in a more timely and efficient manner.
- UTC partners at Columbia University are constructing a model that can predict the deformation and stress distributions of a main cable bridge subjected to fire. Researchers aim to turn this model into a simulation-based software tool that will allow engineers to simulate fire scenarios and optimize their designs with safety in mind.
- At the University at Buffalo, UTC partners are studying fire damage to another critical asset in the Northeast — tunnels. Tunnel fires can damage concrete railway-tunnel lining and cause millions of dollars' worth of impact due to road closures and repairs. Through UTC research, the team has found a method to measure damage, in terms of volume of the concrete that needed repair across the tunnel length, and that damage thresholds can be proposed to guide repairs and ensure safety on tunnel infrastructure.

As regional needs shift, CAIT adapts its research approach to best serve its stakeholders while tying efforts back to the primary focus of improving durability and extending the life of transportation infrastructure. Using this holistic approach, CAIT is able to support the health of the transportation ecosystem as a whole in Region 2 through working directly with stakeholders including NJDOT, NJ Transit, NJ Turnpike, NJDOL, NYSDOT, NYMTC, PANYNJ, and others.

CAIT's prior work with NJ Transit helped the agency receive \$36 million in funding from the **FRA** for advancements in the Portal North Bridge Replacement Project. Through a UTC project, CAIT developed a software tool that assists local agencies in New York State with designing their low-volume roads for various traffic needs. At a cost of approximately \$80,000 per inch per mile for most asphalt concrete on local road systems in the region, this tool helps users save money and make the most of limited resources. CAIT also developed a resilience software tool while working with the US Virgin Islands. Interventions implemented from the tool can potentially save approximately \$5M over the lifetime of roadways in subpar condition from crash and wear-and-tear savings alone. These projects, and others previously mentioned, demonstrate how CAIT has leveraged and used its UTC grant to engage with regional stakeholders on projects that can save time, money, and improve durability of transportation systems.

ACCOMPLISHMENTS (What was done? What was learned?)

What are the major goals and objectives of the program?

The CAIT Region 2 UTC Consortium’s research vision aligns with ongoing national dialogue on the state of the U.S. transportation infrastructure, and the emerging consensus on the need for investment to fill condition gaps, improve/expand existing systems, and build for the future.

The Consortium’s **primary research focus** will be on “Improving the Durability and Extending the Life of Transportation Infrastructure,” with additional elements of “Preserving the Existing Transportation System,” such as resilience.

Using Region 2 as a complex infrastructure laboratory, the Consortium will contribute to: 1) extending the life of the region’s legacy systems, 2) building future systems with consideration to changes in living patterns and where people and products will move to and from, and 3) the use of technologies and better design approaches to maximize the use of both old and new transportation infrastructure assets.

The Consortium will structure its **education and workforce development activities** around a “cradle to grave” approach, developing programs that attract more people to the transportation industry, fostering skills to sustain them within the industry, and providing the workforce with professional development.

Gaining and sharing knowledge is the critical first step toward developing a transportation system that improves the durability and extends the life of transportation infrastructure. To this end, the Consortium will conduct **technology transfer** of research through implementation projects, knowledge transfer activities, and exploration of patents.

What was accomplished under these goals?

Research

The peer-review panel has approved 6 projects during this cycle. One research project is currently under review.

New Projects:

CAIT-UTC-REG62	AI-supported Monitoring and Resiliency Analysis for the Coastal Area of the Luis Muñoz Marín International Airport in Puerto Rico <i>Abstract:</i> The primary goal of this research is to develop a surveillance, camera-based coastal monitoring system for the San Juan International Airport to support a resiliency study.	RU/PUPR
CAIT-UTC-REG64	NJ Transit Northern Bus Garage Planning and Community Impact Evaluation <i>Abstract:</i> The goal of this project is to assist NJ TRANSIT’S Bus Service Planning department to create a complete roster of the 500-bus capacity Northern bus garage determining stats such as platform hours and non-revenue mileage for potential auditing purposes.	RU
CAIT-UTC-REG65	Development of a Geometric Extraction Tool as Part of a Pilot Digital Twin Framework for Open-Deck Rail Bridges <i>Abstract:</i> This project aims to use non-contact 3D scanning technology and AI for assisting in the inspection/maintenance procedures for deck timbers and rails on open-deck bridges.	RU
CAIT-UTC-REG66	Comparison Analysis of Charging System Designs for Battery Electric Bus <i>Abstract:</i> The primary goal of this project is to develop a robust charging system for battery electric buses considering economic and environmental impacts. The research results will help	RU

	NJ Transit develop the deployment strategy of charging infrastructure and refine the plan of garage modification in the future for a full zero-emission bus system.	
CAIT-UTC-REG67	Enhancing the resilience of coastal box girder bridges through geometric modifications <i>Abstract:</i> The objective of this project is to enhance the resilience of coastal box girder bridges subject to storm and/or tsunami wave loading through an evaluation of their design geometry.	PU
CAIT-UTC-REG68	Camden Career Pathways Initiative <i>Abstract:</i> Underserved communities may miss out on career opportunities as the economy rebounds from COVID-19. This pilot project will identify highly localized transportation jobs near Camden NJ, to develop future entry points for youth into the larger transportation field.	RU

AI-supported Monitoring and Resiliency Analysis for the Coastal Area of the Luis Muñoz Marín International Airport in Puerto Rico

This project will monitor infrastructure to produce a resiliency report with recommendations of climate adaption for the Luis Muñoz Marín International Airport in Puerto Rico, and the surrounding area. The research will help stakeholders in Puerto Rico improve durability and extend service life of their infrastructure — and better monitor transportation systems to build future resilience.



Development of a Geometric Extraction Tool as Part of a Pilot Digital Twin Framework for Open-Deck Rail Bridges

This pilot project uses advanced AI and digital twin technology to help New Jersey Transit officials inspect and maintain their bridge deck timbers and rails on open-deck bridges. A digital twin framework can help to replace tedious traditional timber maintenance programs and methods. Upon successful implementation, New Jersey Transit will benefit from a utility that autonomously identifies geometries of timbers and rails.

Comparison Analysis of Charging System Designs for Battery Electric Bus

This project is developing a robust charging system for battery electric buses considering economic and environmental impacts. Case studies will be conducted on the selected NJ Transit bus routes focusing on depot charging, on-route charging, and hybrid charging. The research results will help NJ Transit develop its deployment strategy for charging infrastructure and refine its plan for garage modification in the future for a full zero-emission bus system.

Ongoing Projects:

CAIT-UTC-REG 5	Implementation and Development of UAS Practical Training for Inspection and Monitoring Activities	ACCC
CAIT-UTC-REG15	Flood Vulnerability Assessment and Data Visualization for Lifeline Transportation Network	Rowan
CAIT-UTC-REG25	Investigation of Balanced Mixture Design for New York State Asphalt Mixtures	RU
CAIT-UTC-REG26	Passenger Flow Modeling on Platform Tracks in Transit Stations	RU
CAIT-UTC-REG27	Designing Concrete Mixtures with RCA	NJIT
CAIT-UTC-REG28	Cost-effective Bridge Decks for Improved Durability and Extended Service Life	RU
CAIT-UTC-REG30	Durable and Electrified Pavement for Dynamic Wireless Charging of Electric Vehicles	RU
CAIT-UTC-REG31	Evaluating the Safety and Mobility Impacts of American Dream Complex: Phase I (Feasibility Study, and Data Acquisition)	Rowan
CAIT-UTC-REG38	Risk and Resilience Analysis Tool for Infrastructure Asset Management	RU

CAIT-UTC-REG-40	Zero Speed Profiler Assessment for Pavement Smoothness and Continuous Pavement Texture Measurements	RU
CAIT-UTC-REG42	Enhanced Maritime Asset Management System (MAMS)	RU
CAIT-UTC-REG44	Assessment of Solidification / Stabilization as a Remedial Strategy for PFAS Contaminated Transportation Sites	RU
CAIT-UTC-REG45	The Development of the Digital Twin Platform for Smart Mobility Systems with High-Resolution 3D Data	RU
CAIT-UTC-REG46	Driving behavioral learning leveraging sensing information from Innovation Hub	Columbia
CAIT-UTC-REG48	Linking Physics-Based Deterioration Model to Field-Based Condition Assessments for Improving Asset Management	SUNY Buffalo
CAIT-UTC-REG49	Post-fire Damage Assessment of Concrete Tunnel Liners	SUNY Buffalo
CAIT-UTC-REG50	Post-disaster Damage Assessment of Bridge Systems	SUNY Buffalo
CAIT-UTC-REG51	Real-Time Decision Support System for Transportation Infrastructure Management under a Hurricane Event	SUNY Buffalo
CAIT-UTC-REG52	Bridge Deck Surface Profile Evaluation for Rapid Screening and Deterioration Monitoring	Rowan
CAIT-UTC-REG53	A Real-Time Proactive Intersection Safety Monitoring System Based on Video Data	Rowan
CAIT-UTC-REG54	Rotorcraft Landing Sites Identification – Scaling and Generalization of the AI Model	Rowan
CAIT-UTC-REG55	JFK Cargo View: A system to speed Truck Traffic Flow at JFK Airport	RU/ SUNY Farmingdale
CAIT-UTC-REG56	Interactive decision support system for tunneling planning and construction: Hudson Tunnel case study	NJIT/Stevens
CAIT-UTC-REG-57	Comparative analysis of rapid chloride penetration testing for novel reinforced concrete systems	NJIT
CAIT-UTC-REG58	Supplemental Study of Filter Technology Efficacy for Transit Vehicles to Combat the Spread of COVID-19 and Other Respiratory Infections	RU
CAIT-UTC-REG59	Durability of Low Carbon Concrete Mixtures	NJIT
CAIT-UTC-REG60	Low-Carbon Concrete Pilot Program	PU
CAIT-UTC-REG61	QAD (Quality Assurance Division) Inspection Reporting and State of Good Repair (SGR) Planning	RU
CAIT-UTC-REG63	State-of-the-art technologies for structural health monitoring of tunnels: an overview	PU

Completed Projects:

CAIT-UTC-REG1	Augmented Reality (AR) in Life-Cycle Management of Transportation Infrastructure Projects	RU
CAIT-UTC-REG2A	Sustainability and Resiliency of Concrete Rapid Repairs Utilizing Advanced Cementitious Materials – Freeze/Thaw Loads	NJIT
CAIT-UTC-REG2B	Sustainable, Rapid Repair Utilizing Advanced Cementitious Materials	SUNY Buffalo
CAIT-UTC-REG3	Large-Amplitude Forced Vibration Testing for St-Id of Bridges and Foundation Reuse Assessment	RU
CAIT-UTC-REG4	Rail Track Asset Management and Risk Management	RU
CAIT-UTC-REG6	Airfield Pavement Management Framework using a Multi-Objective Decision-Making Process	RU
CAIT-UTC-REG7	MEMS Sensor Development for In-Situ Quantification of Toxic Metals in Sediment	RU
CAIT-UTC-REG8	Prioritizing Infrastructure Resilience throughout the Capital Planning Process	RU
CAIT-UTC-REG9	Delivering maintenance and repair actions via automated/robotic systems	RU
CAIT-UTC-REG10	Policies, Planning, and Pilot Testing on Infrastructure Readiness for Electrical, Connected, Automated, and Ridesharing Vehicles	RU/Columbia
CAIT-UTC-REG11	Pavement Design for Local Roads and Streets	Cornell

CAIT-UTC-REG12	Laboratory Performance Evaluation of Pavement Preservation Alternatives	Rowan
CAIT-UTC-REG13	Virtual Tour (VT), Informational Modeling (IM), and Augmented Reality (AR) for Visual Inspections (VI) and Structural Health Monitoring (SHM)	PU
CAIT-UTC-REG14	Performance-Based Engineering of Transportation Infrastructure Considering Multiple Hazards	SUNY Buffalo
CAIT-UTC-REG16	Fire In Tunnel Collaborative Project	PU/SUNY- Buffalo/NJIT
CAIT-UTC-REG17	Improving Transportation Infrastructure Resilience against Hurricanes, other Natural Disasters, and Weathering: Part I - Analysis of failure of transportation signs due to Hurricane Maria	PUPR
CAIT-UTC-REG18	Improving Transportation Infrastructure Resilience against Hurricanes, other Natural Disasters, and Weathering: Part II – Analysis of pedestrian bridges failures due to Hurricane Maria	PUPR
CAIT-UTC-REG19	Improving Transportation Infrastructure Resilience against Hurricanes, other Natural Disasters, and Weathering: Part III - Analysis of motor vehicle bridges failures due to Hurricane Maria	PUPR
CAIT-UTC-REG20	Infrastructure Cybersecurity and Emergency Preparedness Academic and Non-academic Credential Development	SUNY Farmingdale
CAIT-UTC-REG21	Autonomous Vehicles: Capturing In-Vehicle Experience & Focus Group Follow-up with Persons with Autism and Other Disabilities at the 2019 Princeton University SmartDrivingCar Summit	RU
CAIT-UTC-REG22	Simulation of Degradation and Failure of Suspension Bridge Main Cables due to Natural and Anthropogenic Hazards	Columbia
CAIT-UTC-REG23	The Development of a Smart Intersection Mobility Testbed (SIMT)	RU
CAIT-UTC-REG24	Application of Advanced Analytic and Risk Techniques to Railroad Operations Safety and Management	RU
CAIT-UTC-REG29	Seismic Vulnerability Assessment of Deteriorated Bridges	SUNY Buffalo
CAIT-UTC-REG32	Rotorcraft Landing Sites – An AI-Based Identification System	Rowan
CAIT-UTC-REG33	Real-Time Prediction of Storm Surge and Wave Loading on Coastal Bridges	SUNY Buffalo
CAIT-UTC-REG34	Assessing and Mitigating Transportation Infrastructure Vulnerability to Coastal Storm Events with the Convergence of Advanced Spatial Analysis, Infrastructure Modeling, and Storm Surge Simulations	RU
CAIT-UTC-REG35	NJDOT Flood Risk Visualization Tool	RU
CAIT-UTC-REG36	Improving the Long-Term Performance of Bridge Decks through Full-Scale Accelerated Testing	RU
CAIT-UTC-REG37	Impact of Recycled Plastic on Asphalt Binder and Mixture Performance	RU
CAIT-UTC-REG39	FDR Stabilizer Selection Using Simple Soil Tests	Cornell
CAIT-UTC-REG41	Affordable On-Demand Testing of Water Contamination Using a Portable Nanoelectronic Lead Detector	RU
CAIT-UTC-REG43	Artificial Intelligence-Aided Rail Transit Infrastructure Data Mining	RU
CAIT-UTC-REG47	Remote Sensing System Enhancement for Digital Twinning of the Built Infrastructure to Support Critical Infrastructure Protection Research	RU

HIGHLIGHTS

Completed Projects

Rotorcraft Landing Sites – An AI-Based Identification System (CAIT-UTC-REG32, Project Manager: Dr. Ghulam Rasool)

Accomplishments: To assist FAA with updating its database of landing site information for helicopters and rotorcrafts, UTC partners at Rowan University developed an AI-based algorithm that automates the process of identifying landing sites using video data and Google Earth satellite images — increasing safety and efficiency in the National Airspace System.



ROI: The AI system allows FAA to update its databases of landing sites regularly without delays. Previously a time-intensive task, this solution improves efficiency while also increasing safety for helicopter pilots and passengers and aligning with the USDOT Strategic Goal of Reducing Transportation-Related Fatalities and Serious Injuries across the Transportation System.

Assessing and Mitigating Transportation Infrastructure Vulnerability to Coastal Storm Events with the Convergence of Advanced Spatial Analysis, Infrastructure Modeling, and Storm Surge Simulations (CAIT-UTC-REG34, Project Manager: Dr. Jie Gong)

Accomplishments: This project developed a decision support tool to assist stakeholders in making decisions at the day-to-day level to protect communities from impending flooding events, as well as in making long-term decisions in mitigating future flood risks.

ROI: This study developed software applications for infrastructure resilience investigations. After Hurricane Ida hit NJ in September 2021, CAIT researchers took drones, van-based lidar systems and other innovative technologies into the field to assess flood damage, gather data to improve flood prediction models, and inform the state of flood risks for future storms.

NJDOT Flood Risk Visualization Tool (CAIT-UTC-REG35, Project Manager: Dr. Jon Carnegie)

Accomplishments: This project developed a tool that can enhance capacity for NJDOT personnel to assess the flood vulnerability of its infrastructure and assets.

ROI: The tool will enable NJDOT to integrate data about current and future flood hazard vulnerability into existing capital planning and asset management processes. Over time, the intent is to improve overall resilience of transportation infrastructure to climate hazards.

Improving the Long-Term Performance of Bridge Decks through Full-Scale Accelerated Testing (CAIT-UTC-REG36, Project Manager: Dr. Franklin Moon)

Accomplishments: This research leveraged testing conducted by FHWA within The BEAST to better understand the demands that bridge decks are exposed to. The full-scale, 50-ft. specimen to date has been subject to more than 2 million passes along its deck with 60,000 lbs. of force simulating heavy traffic, as well as freeze-thaw cycles every 24 hours, environmental conditions, and more to measure performance.



ROI: Researchers have performed NDE testing regularly on the specimen and collected data continuously. This knowledge of how the bridge responds and deteriorates will provide FHWA with more accurate estimation of deck demands and ensure new designs better account for temperature effects thereby resulting in improved durability and decks less prone to cracking.

Affordable On-Demand Testing of Water Contamination Using a Portable Nanoelectronic Lead Detector (CAIT-UTC-REG41, Project Manager: Dr. Kelly Francisco)

Accomplishments: This project developed a rapid, accurate lead sensing system for lead analysis in drinking water that measures small amounts of lead within minutes as opposed to

days. The mobile system can be used to sample a high volume of samples in a field setting.
ROI: This device is a potentially marketable product that can tap into a growing global market and need for water testing and analysis instruments. The device can detect lead far faster than current laboratory tests and could allow municipalities, water companies, universities, schools, daycares, and homeowners to test their water supplies more easily in the future.

Artificial Intelligence-Aided Rail Transit Infrastructure Data Mining (CAIT-UTC-REG43, Project Manager: Dr. Xiang Liu)

Accomplishments: This project developed a pilot, proof-of-concept study in collaboration with the MTA to explore the use of Artificial Intelligence (AI) for analyzing infrastructure big data to predict track degradation and future condition.

ROI: This tool can forecast track infrastructure condition and address track degradation before failures occur. This will lead to better life cycle performance and save total life cycle cost while ensuring infrastructure safety and durability. MTA and other agencies could use the approach to prioritize their infrastructure capital planning, inspection, and maintenance.

Remote Sensing System Enhancement for Digital Twinning of the Built Infrastructure to Support Critical Infrastructure Protection Research (CAIT-UTC-REG47, Project Manager: Dr. Jie Gong)

Accomplishments: This project allowed CAIT researchers to acquire a new terrestrial laser scanner – Faro Focus S350 to strengthen digital twin research. The scanner enables new digital twin research to support mitigation of flood threats to transit stations and evaluation of disinfection methods for transportation facilities.

ROI: This project resulted in 1) a digital twin product for infrastructure stakeholders; 2) a generalizable workflow in creating digital twins with terrestrial laser scanners; and 3) new software applications aimed at infrastructure protection use cases. These tools can help stakeholders prioritize infrastructure investments and prolong the life of infrastructure.



Ongoing Projects

Implementation and Development of UAS Practical Training for Inspection and Monitoring Activities (CAIT-UTC-REG5, Project Manager: James Taggart)

Outputs: Training curricula for UAS inspection and monitoring activities.

Outcomes: Curricula that evaluates the practical flight abilities of prospective UAS pilots.

Impacts: Improved training for UAS pilots and opportunity to enhance agency UAS capabilities.

Flood Vulnerability Assessment and Data Visualization for Lifeline Transportation Network (CAIT-UTC-REG15, Project Manager: Dr. Rouzbeh Nazari)

Outputs: A flood map for NJ towns that depicts flood hazards, lifeline infrastructure, vulnerability assessments, and resiliency measures.

Outcomes: This project provides more detailed, reliable, and current data on flood hazards resulting in a better picture of the New Jersey towns most likely to be impacted by flooding.

Impacts: This project assists decision makers and coastal communities with understanding the magnitude of floods, quantifying impacts, and assisting with mitigation and resiliency planning.

Investigation of Balanced Mixture Design for New York State Asphalt Mixtures (CAIT-UTC-REG25, Project Manager: Dr. Thomas Bennert)

Outputs: A non-proprietary/non-confidential final report covering all aspects of the work performed under this research study.

Outcomes: Training and specifications around the new design method will be developed and implemented within NY State.

Impacts: It is anticipated that the results of the study will help NYSDOT improve their mixture design and performance-testing programs.

Passenger Flow Modeling on Platform Tracks in Transit Stations (CAIT-UTC-REG26, Project Manager: Dr. Xiang Liu)

Outputs: Simulations of passenger flow in transit stations using computer vision technologies.

Outcomes: Data-driven understanding of how passengers interact with built infrastructure.

Impacts: The information from this project can be used by NJ Transit to understand the benefit of infrastructure design or upgrades in terms of changing passenger flow and less congestion.

Designing Concrete Mixtures with RCA (CAIT-UTC-REG27, Project Manager: Dr. Matthew P. Adams)

Outputs: A novel RCA design methodology through experimental and computational methods.

Outcomes: The results of the pilot RCA slab program completed as a part of this research will constitute one of the major outcomes of this work.

Impacts: This pilot program can be used by other agencies as a proof of concept.

Cost-effective Bridge Decks for Improved Durability and Extended Service Life (CAIT-UTC-REG28, Project Manager: Dr. Sougata Roy)

Outputs: Cost-effective standard open rib SOBD demonstrating similar performance as CRD.

Outcomes: The new design specifications and companion guidelines are expected to be incorporated into the AASHTO Bridge Design Specifications.

Impacts: The development of a catalogue of standard open rib SOBD that would further promote implementation of these decks for short and medium span highway bridges.

Durable and Electrified Pavement for Dynamic Wireless Charging of Electric Vehicles (CAIT-UTC-REG30, Project Manager: Dr. Hao Wang)

Outputs: New, durable electrified pavement designs with efficient charging functionality.

Outcomes: A solution based on wireless charging integrated in existing roadway pavements.

Impacts: Results will contribute to developing electrified roadways that provide energy for EVs.

Evaluating the Safety and Mobility Impacts of American Dream Complex: Phase I (Feasibility Study, and Data Acquisition) (CAIT-UTC-REG31, Project Manager: Dr. Mohammad Jalayer)

Outputs: identification of traffic & safety issues associated with this heavily traveled complex.

Outcomes: A framework for larger data collection to limit congestion and crashes in the area.
Impacts: Innovative intersection-safety tools using AI were developed and are being tested.

Risk and Resilience Analysis Tool for Infrastructure Asset Management (CAIT-UTC-REG38, Project Manager: Dr. Yun Bai)

Outputs: This project developed a comprehensive analytical framework for risk-based infrastructure asset management for both normal and extreme management conditions.

Outcomes: A GIS-based Flood Risk Analysis Tool & web platform that can be used to quantitatively assess and visualize flood risk for roadway pavement infrastructure.

Impacts: Improved IAM decision making and infrastructure resilience for underserved communities in the US Virgin Islands and other potential stakeholders.

Zero Speed Profiler Assessment for Pavement Smoothness and Continuous Pavement Texture Measurements (CAIT-UTC-REG40, Project Manager: Michael Boxer)

Outputs: Inaccurate network pavement data can impact maintenance decisions. Researchers are testing pavement inspection equipment such as the Zero Speed Profiler to ensure data is representative of NJ roads.

Outcomes: This innovative technology can potentially eliminate issues associated with current pavement network data collection, helping agencies better assess the pavement profile in NJ.

Impacts: A more realistic and comprehensive pavement surface assessment will result in better decisions regarding how to preserve or rehabilitate the pavement and state roadways.



Enhanced Maritime Asset Management System (MAMS) (CAIT-UTC-REG42, Project Manager: Dr. Yun Bai)

Outputs: Development of a prototype Maritime Asset Management System that can better meet planning requirements and aid with resource allocation.

Outcomes: The state-of-the-art TAM approach has been implemented in a desktop-based user interface software application.

Impacts: Improved user experience & extended functionality of the current MAMS prototype.

Assessment of Solidification / Stabilization as a Remedial Strategy for PFAS Contaminated Transportation Sites (CAIT-UTC-REG44, Project Manager: Dr. Robert Miskewitz)

Outputs: This project seeks to determine if Solidification and Stabilization (S/S) is a viable remedial strategy for PFAS contaminated sediment.

Outcomes: If the process is effective at eliminating contaminant pathways out of the stabilized matrix, then this previously harmful material can be beneficially used as geotechnical fill.

Impacts: Beneficial reuse of contaminated soils on-site can represent a significant cost savings for treatment while providing a value as a product.

The Development of the Digital Twin Platform for Smart Mobility Systems with High-Resolution 3D Data (CAIT-UTC-REG45, Project Manager: Dr. Peter Jin)

Outputs: The development of a digital twin for urban mobility.

Outcomes: The platform will use data collected from DataCity, the Smart Mobility Testing Ground project in partnership with NJDOT and Middlesex County, to support CAV research.
Impacts: Users can model smart mobility objects seamlessly among different systems.

Driving behavioral learning leveraging sensing information from Innovation Hub (CAIT-UTC-REG46, Project Manager: Dr. Sharon Di)

Outputs: The primary goal of this project is to develop machine-learning algorithms for driving behavior mining, using real-time vehicle, pedestrian, and infrastructure data.

Outcomes: An algorithm suite to learn human behavior patterns from LiDAR and camera data.

Impacts: The proposed algorithms will help monitor and maintain roadside infrastructure and support the transportation systems to accommodate connected and automated systems.

Linking Physics-Based Deterioration Model to Field-Based Condition Assessments for Improving Asset Management (CAIT-UTC-REG48, Project Manager: Dr. Ravi Ranade)

Outputs: This project aims to establish a link between a physics-based corrosion model and condition rating assessments.

Outcomes: This will empower the DOTs to rationally explore the long-term benefits of investments in innovative technologies, materials, and methods.

Impacts: DOTs will be able to better allocate assets by prioritizing bridges for repair and maintenance according to their true vulnerability quantified by the deterioration models.

Post-fire Damage Assessment of Concrete Tunnel Liners (CAIT-UTC-REG49, Project Manager: Dr. Negar Elhami-Khorasani)

Outputs: This project will make recommendations on post-fire tunnel damage assessment.

Outcomes: Researchers have conducted fire tests on specimen and have found a method to measure damage to concrete liners of tunnels during fire events.

Impacts: Guidelines on damage assessment of concrete structures after fires are limited, this project will provide data-driven insights that can strengthen concrete tunnels in the region.



Post-disaster Damage Assessment of Bridge Systems (CAIT-UTC-REG50, Project Manager: Dr. Xiao Liang)

Outputs: Leveraging advances in AI, a novel signal processing technique will be developed to build a surrogate model for accurate prediction of engineering demand parameters of interest.

Outcomes: A sensor-based framework for post-disaster damage assessment of bridge systems.

Impacts: This technology could automate the process of damage detection, and assess and identify risks associated with each bridge immediately after a natural disaster.

Real-Time Decision Support System for Transportation Infrastructure Management under a Hurricane Event (CAIT-UTC-REG51, Project Manager: Dr. Teng Wu)

Outputs: This project will investigate hurricane impacts on critical infrastructure and effects of various traffic control policies on traffic network performance to minimize losses.

Outcomes: A tool to rapidly identify optimal traffic control policies under hurricane events.

Impacts: A framework for developing real-time decision support systems for transportation infrastructure management under a hurricane event.

Bridge Deck Surface Profile Evaluation for Rapid Screening and Deterioration Monitoring (CAIT-UTC-REG52, Project Manager: Dr. Adriana Trias)

Outputs: The primary goal of this project is to develop a procedure that ensures proper LiDAR data collection focused on bridge deck surface geometry capturing for inspection.

Outcomes: Efficient life-cycle monitoring by rapidly identifying early bridge-deck deterioration.

Impacts: This research is expected to impact the durability and preservation of bridge decks.

A Real-Time Proactive Intersection Safety Monitoring System Based on Video Data (CAIT-UTC-REG53, Project Manager: Dr. Mohammad Jalayer)

Outputs: This project is developing a real-time proactive safety monitoring system based on the trajectory of road users (e.g., cars, pedestrians, and cyclists) collected by video cameras.

Outcomes: The ability for agencies to rank and score intersections based on the analyzed data.

Impacts: The project will provide appropriate safety solutions to reduce intersection-related crashes and incidents and consequently reduce traffic congestion.

Rotorcraft Landing Sites Identification – Scaling and Generalization of the AI Model (CAIT-UTC-REG54, Project Manager: Dr. Ghulam Rasool)

Outputs: This project builds on previous UTC research and is testing the AI model developed to automatically identify helipads and landing sites.

Outcomes: An AI-based system for the identification of helipads and landing site infrastructure from satellite images. Researchers are also developing a user-friendly webapp for stakeholders.

Impacts: An automatic process to identify rotorcraft landing sites from Google Earth imagery.

JFK Cargo View: A system to speed Truck Traffic Flow at JFK Airport (CAIT-UTC-REG55, Project Manager: Dr. Kazem Oryani)

Outputs: Global supply chain delays have impacted airports and air cargo across the world. This project analyzes truck movements at JFK International Airport to help it better facilitate cargo movements.

Outcomes: A model and potential framework for other airports with similar congestion issues.

Impacts: This research will help improve cargo flow, benefit the local economy, and support nearby communities with reduction of pollution caused by excessive truck wait-times.



Interactive decision support system for tunneling planning and construction: Hudson Tunnel case study (CAIT-UTC-REG56, Project Manager: Dr. Matthew Bandelt)

Outputs: Enhanced subsurface characterization methods, tunnel planning, and risk assessment.

Outcomes: A framework for large-scale tunnel projects that can determine hazards on a route.

Impacts: A methodology and decision support system that can be used in tunnel design and construction in the US by local, regional and federal agencies, and private companies.

Comparative analysis of rapid chloride penetration testing for novel reinforced concrete systems (CAIT-UTC-REG57, Project Manager: Dr. Matthew Bandelt)

Outputs: Analysis of chloride penetration behavior for novel concrete materials and mixes.

Outcomes: Improved understanding of how novel concrete materials such as ductile concrete systems and recycled aggregate behave in rapid chloride environments.

Impacts: Research will help agencies implement novel concrete materials to improve durability.

Supplemental Study of Filter Technology Efficacy for Transit Vehicles to Combat the Spread of COVID-19 and Other Respiratory Infections (CAIT-UTC-REG58, Project Manager: Shane Mott)

Outputs: MERV 13 filters can filter 85% of particles in the ideal size range for capturing respiratory droplets.

Outcomes: Recommendations to transit agencies to help inform potential filter upgrades.

Impacts: Improved understanding of filter efficacy in a transit environment & guidelines for safer public transit systems considering COVID-19 and other respiratory infections.



Durability of Low Carbon Concrete Mixtures (CAIT-UTC-REG59, Project Manager: Dr. Matthew P. Adams)

Outputs: This project will help researchers develop a deeper understanding of the relative performance of low-carbon concrete systems when exposed to chlorides and deicing salts.

Outcomes: A systematic approach to examining the durability of low-carbon concrete mixtures that can predict life expectancy of concrete regarding corrosion onset and likelihood of scaling.

Impacts: Better understanding of chloride diffusion rate in low-carbon concrete mixtures & the resistance of these mixtures to salt scaling; and developing life-cycle expectancy models.

Low-Carbon Concrete Pilot Program (CAIT-UTC-REG60, Project Manager: Dr. Reza Moini)

Outputs: This research will help PANYNJ reduce embodied carbon of its concrete mixtures used in their construction activities.

Outcomes: This project will support agency wide GHG reduction target of 80% by 2050.

Impacts: Improved sustainability by working to close materials loops in the local region for waste glass and demolition waste and reducing embodied carbon of concrete mixtures.

QAD (Quality Assurance Division) Inspection Reporting and State of Good Repair (SGR) Planning (CAIT-UTC-REG61, Project Manager: Dr. Ali Maher)

Outputs: A proof of concept for the PANYNJ that provides stakeholders with improved access to and visualization of infrastructure asset information (retaining walls, bridges, etc.).

Outcomes: A prototype application giving PANYNJ access to visualization & analysis tools to enhance SGR planning, capital renewal program development, maintenance plans, and more.

Impacts: These tools can leverage asset data residing in siloed repositories across the agency.

State-of-the-art technologies for Structural Health Monitoring of tunnels: an overview (CAIT-UTC-REG63, Project Manager: Dr. Branko Glisic).

Outputs: Improved understanding of tunnels and best practices/technologies for SHM.

Outcomes: A comprehensive report on state-of-the art technologies for tunnel monitoring.

Impacts: This project will perform extensive overview of the state-of-the-art technologies for structural health monitoring of tunnels.

Education and Workforce Development Activities

The consortium has trained more than 1,575 professionals during this period.

- **Classes, Seminars, and Educational Opportunities**

CAIT held the first two courses in its new Infrastructure Asset Management Academy: Fundamentals 1 & Fundamentals 2-Asset Investment Planning. Attendance ranged from 50 to 80 people and the courses brought together experts in the field of asset management.

Ahead of National Work Zone Awareness Week, CAIT hosted its annual New Jersey Work Zone Safety Conference. The virtual conference promoted safety on local and state roadways for construction workers, engineers, first responders, drivers and more.

Technology and Tools

CAIT researchers at the Rutgers Asphalt Pavement Lab are testing new technology, such as a Zero-Speed Profiler acquired through UTC research, to help NJ collect more accurate pavement network data and better inform its pavement maintenance decisions.

UTC partners at Rowan University have developed a web-based graphical app designed for detecting landing sites from Google Earth satellite images. Rowan and FAA teams are now working with industry partner, LZControl, to integrate the WebApp with their online system.

Technology Transfer

- **Presentations and Events**

CAIT celebrated International Women's Day with a seminar that showcased latest research and achievements from women leaders in transportation. Speakers from NJTPA, the Texas A&M Transportation Institute, and Princeton University shared their work with attendees.

CAIT researcher and Director of the Rutgers Asphalt Pavement Laboratory, Dr. Thomas Bennert, spoke with News 12 NJ about what goes into building roads in New Jersey, and how different asphalt recipes are needed to meet the unique needs in the region.

- **Research and Publications**

CAIT faculty Dr. Hao Wang published research stemming from UTC work on Electric Vehicles and EV charging in *Renewable and Sustainable Energy Reviews*, a high-impact journal.

UTC partners at NJIT presented research at the Spring 2022 Convention of the American Concrete Institute based on their ongoing project titled "Comparative analysis of rapid chloride penetration testing for novel reinforced concrete systems."

- **CAIT Researchers Win Awards**

Lauren Hill-Beaton, a Rutgers student pursuing her master's degree in Atmospheric Science, was selected by the Center as its 2022 USDOT UTC Student of the Year award winner.

UTC partner Dr. Matthew Bandelt won an NSF Faculty Early Career Development Award to continue his research studying highly ductile concrete materials in structural systems.

How have the results been disseminated?

CAIT established the Consortium internet site: <https://cait.rutgers.edu/>. CAIT has distributed The CAIT Update, its monthly E-newsletter, to subscribers in the transportation industry. CAIT has also shared results to the general public through news media. Select coverage includes:

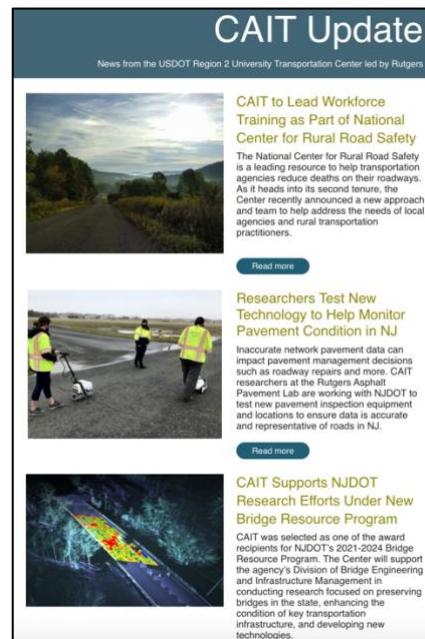
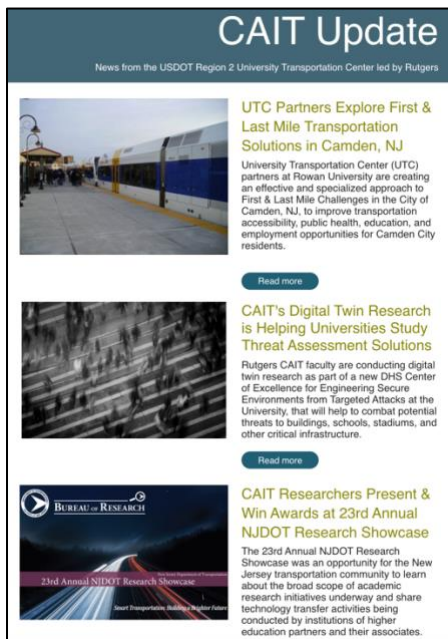


DredgingToday.com



Newsletter

CAIT has distributed The CAIT Update, its E-newsletter, monthly to 5,000+ subscribers.



What do you plan to do during the next reporting period to accomplish the goals and objectives?

No change to plan and process to accomplish our goals.

1. PARTICIPANTS AND OTHER COLLABORATING ORGANIZATIONS (Who has been involved?)

Consortium Universities Involved

Rutgers, The State University of New Jersey • Piscataway, NJ 08854 (**LEAD**)

Atlantic Cape Community College • Mays Landing, NJ 08330

Columbia University • New York, NY 10027

Cornell University • Ithaca, NY 14853

New Jersey Institute of Technology • Newark, NJ 07102

Polytechnic University of Puerto Rico • San Juan, Puerto Rico 00918

Princeton University • Princeton, NJ 08544

Rowan University • Glassboro, NJ 08028

SUNY–Farmingdale State College • Farmingdale, NY 11735

SUNY–University at Buffalo • Buffalo, NY 14260

• ***What organizations have been involved as partners?***

New Jersey Department of Transportation	Trenton, NJ	Financial support and collaborative research on multiple projects, personnel resources, knowledge exchange
Port Authority of New York and New Jersey	New York, NY,	Collaborative research on multiple projects, personnel resources, knowledge exchange, financial support
New Jersey Board of Public Utilities	Trenton, NJ	Financial support and collaborative research on multiple projects, including PHMSA State Damage Prevention Grant
New York State Department of Transportation	Albany, NY	Financial support, personnel resources, knowledge exchange
NYCDOT-Division of Sidewalk and Inspection Management	New York, NY	Personnel resources, knowledge exchange
Washington State Department of Transportation	Olympia, WA	Personnel resources, knowledge exchange
Port Authority Trans-Hudson	Jersey City, NJ	Personnel resources, knowledge exchange
New York State County Highway Superintendents Association	Oneida and Chemung Counties	Personnel resources, knowledge exchange
New York Association of Town Superintendents of Highways	Canaan, NY	Personnel resources, knowledge exchange
Mistras Group	Princeton Junction, NJ	Personnel resources, knowledge exchange
Arup	New York, NY	Personnel resources, knowledge exchange
New Jersey Department of Community Affairs	Trenton, NJ	Personnel resources, knowledge exchange
Arora and Associates, P.C.	Lawrenceville, NJ	Personnel resources, knowledge exchange
Pennsylvania Department of Transportation	Bridgeville, PA	Personnel resources, knowledge exchange
Puerto Rico Highway and Transportation Authority	San Juan, PR	Personnel resources, knowledge exchange
Federal Highway Administration, Puerto Rico Division	San Juan, PR	Personnel resources, knowledge exchange
North Jersey Transportation Planning Authority	Newark, NJ	Personnel resources, knowledge exchange
Monmouth County Division of Engineering	Freehold, NJ	Personnel resources, knowledge exchange

Rotorcraft	Atlantic city, NJ	Personnel resources, knowledge exchange
The Everett Railroad	Duncansville, PA	Personnel resources, knowledge exchange
NJ Transit Corporation	Newark, NJ	Financial support, Personnel resources, knowledge exchange
American Institute of Steel Construction	Lancaster, PA	Personnel resources, knowledge exchange
Monmouth County Sheriff's Office	Freehold, NJ	Personnel resources, knowledge exchange
Washington State Department of Transportation	Olympia, WA	Personnel resources, knowledge exchange
Federal Aviation Administration	Washington, DC	Personnel resources, knowledge exchange
Middlesex County	Middlesex, NJ	Financial support, Personnel resources, knowledge exchange
JFK International Airport	Queens, NY	Personnel resources, knowledge exchange
Gateway JFK	Queens, NY	Personnel resources, knowledge exchange
AAA Mid-Atlantic	Wilmington, DE	Personnel resources, knowledge exchange
Verizon	New York, NY	Personnel resources, knowledge exchange

- ***Have other collaborators or contacts been involved?***

Nothing to report

2. OUTPUTS (What new research, technology or process has the program produced?)

Publications, conference papers, and presentations

- Robinson J., A. Brügger, M. Sloane, R. Betti, Experimental-Numerical Determination of the Effective Bulk Thermal Conductivity of Suspension Bridge Main Cables. Journal of Bridge Engineering.
- Gustavo Pacheco-Crosetti and Héctor J. Cruzado. "Assessment of wind-induced damages to pedestrian bridges due to Hurricane Maria." ASCE 9th Forensic Engineering Congress, Denver, Colorado, November 4-7, 2022.
- Wang, H., Ranade, R., Okumus, P. (2022) "Estimating Chloride Exposure of Reinforced Concrete Bridges Using Vehicle Spray and Splash Mechanisms." Structure and Infrastructure Engineering, <https://doi.org/10.1080/15732479.2022.2052910>
- Fan, J, MP Adams, MJ Bandelt (2022); "Numerical simulation of cracking effects and chloride concentrations on corrosion in reinforced concrete members;" Spring 2022 Convention of the American Concrete Institute, Session on Open Topics Part I; Orlando, FL; March 26-31, 2022.
- Shirkhorshidi, SM, MP Adams, MJ Bandelt (2022) "A student's experience working with UHPC;" Spreing 2022 Convention of the American Concrete Institute, Session on Student Experiences with UHPC; Orlando, FL; March 26-31, 2022
- Laura Soares, Hao Wang, "A study on renewed perspectives of electrified road for wireless power transfer of electric vehicles." Renewable and Sustainable Energy Reviews, Volume 158, 2022. <https://doi.org/10.1016/j.rser.2022.112110>.

- Guo, Lukai & Wang, Hao. (2022). Non-intrusive movable energy harvesting devices: Materials, designs, and their prospective uses on transportation infrastructures. *Renewable and Sustainable Energy Reviews*. 160. 112340. 10.1016/j.rser.2022.112340.
- Bian, Zheyong & Bai, Yun & Liu, Xiang & Wang, Bijun. (2022). An online hybrid mechanism for dynamic first-mile ridesharing service. *Transportation Research Part C: Emerging Technologies*. 138. 103585. 10.1016/j.trc.2022.103585.
- Zhang, Z.P., Zaman, A., Xu, J.X., Liu, X. (2022). Artificial intelligence-aided railroad trespassing detection and data analytics: Methodology and a case study. *Accident Analysis & Prevention*, 168, 106594.
- **Policy Papers**
Nothing to report
- **Website(s) or other Internet site(s)**
<https://www.facebook.com/RutgersCAIT/>
<https://www.instagram.com/rutgerscait/>
- **New methodologies, technologies or techniques**
Incorporated into earlier sections of this report
- **Inventions, patents, and/or licenses**
Nothing to report
- **Other products**

Outputs	Annual Goal	Semi-Annual Metric
1) a traditional or online training program.	3	2
2) a presentation and/or webinar.	10	7
3) a demonstration and/or pilot project.	3	5
4) a guidebook or similar publication in addition to an academic report.	8	4
5) a new specification.	1	1
6) new software or an app.	3	2
7) a new material and/or tangible product.	1	1
8) a potential patent or otherwise marketable product.	2	3
9) Primary or secondary customers will be tracked.	15	5
10) Implementation stakeholders will be tracked.	15	9
11) Implementation stakeholders that identify in each of the following will be tracked.	Customer / Implementer	Customer / Implementer
a. Sponsors of research and T2	2 / 2	2/0
b. Researchers and/or developers	1 / 5	0/2
c. Early adopters and problem owners	5 / 5	2/3
d. Late adopters that follow the technology's development	3 / 5	2/3
e. Deployment team	3 / 3	1/3
f. Others, e.g., trade organizations, regulators, suppliers, etc.	1 / 3	0/1
12) Conceptual methodologies to calculate actual impact. How the PI expects to calculate the actual impact that a customer will realize by implementing the results.	15	8
13) The number of projects that help meet each USDOT Strategic Plan goal	-	-

a. Safety: Reduce transportation-related fatalities and serious injuries across the transportation system.	5	1
b. Infrastructure: Invest in infrastructure to ensure mobility and accessibility and to stimulate economic growth, productivity, and competitiveness for American workers and businesses.	5	3
c. Innovation: Lead in the development and deployment of innovative practices and technologies that improve the safety and performance of the nation's transportation system.	5	4
d. Accountability: Serve the nation with reduced regulatory burden and greater efficiency, effectiveness, and accountability.	2	1

3. OUTCOMES (What outcomes has the program produced? How are the research outputs described in section (3) above being used to create outcomes?)

Outcomes	Annual Goal	Semi-Annual Metric
1) MOU/letters of commitment indicating a customer's commitment to adopt or that they have adopted/used	5	4
2) full-scale adoption of a new technology technique, or practice, or the passing of a new policy, regulation, rule making, or legislation including commercialized or patented product	5	2

4. IMPACT (What is the impact of the program? How has it contributed to improve the transportation system: safety, reliability, durability, etc.; transportation education; and the workforce?)

Impacts	Annual Goal	Semi-Annual Metric
1) cost savings (time, money, or life-cycle performance)	\$280k year one - \$2.575M each subsequent year	\$2,514,263
2) durability and/or resilience and/or preservation	Zero in year one - 30 years each subsequent year	22 years
3) workforce proficiency or documented success stories	4 success stories	5

5. CHANGES/PROBLEMS

- **Changes in approach and reasons for change.**
Nothing to report
- **Actual or anticipated problems or delays and actions or plans to resolve them.**
Nothing to report
- **Changes that have a significant impact on expenditures.**
Nothing to report
- **Significant changes in use or care of animals, human subjects, and/or biohazards.**
Nothing to report