1 Project Overview

The Texas Department of Transportation (TxDOT) is pleased to submit this application for a proposed Stage 1 USDOT SMART grant project that will deploy and test smart infrastructure technology in College Station, Texas to achieve two main goals: 1) Improve intersection safety and mobility for vulnerable road users (pedestrians, bicyclists, and those using other mobility devices), including people with mobility and visual disabilities; and 2) Demonstrate that the technology functions as proposed. TxDOT and its project partners will use Cellular-Vehicle-to-Everything (C-V2X) units at intersections in tandem with on-board units in transit vehicles and emergency response vehicles to do the following:

- Alert pedestrians and bicyclists as well as other vulnerable road users (VRUs) using crosswalks and bike lanes of approaching and/or turning transit and emergency response vehicles. This will be done through use of auditory and visual cues from pole-mounted devices that can receive information from the C-V2X road-side units (RSUs).
- Explore the feasibility of incorporating that vehicle information into a Smart Phone application that blind/low-vision (B/LV) people can use to navigate the intersections.
- Communicate with automated shuttles to alert them of approaching and/or turning transit and emergency response vehicles at the intersection.

In order to accomplish this, RSUs at intersections will communicate using an open-source (non-proprietary) protocol via cellular signal with on-board units (OBUs) in transit buses and emergency vehicles. If a vehicle is approaching, the RSU will activate a visual and auditory warning device directed at VRUs of the oncoming and/or turning vehicle (see Figure 1 to the right). The Stage 1 pilot will also explore the feasibility of sending that information to a Smart Phone application designed specifically for B/LV users.

Figure 1: Smarter Intersection Example

This Smart*er* Intersections Project builds on prior Smart Intersection research using dedicated short-range communication (DSRC) devices. TxDOT and the Texas A&M Transportation Institute (TTI) previously developed this technology to alert pedestrians and bicyclists to buses making left turns in two limited test deployments, one at a test intersection at the Texas A&M University RELLIS Campus and the other at an active intersection on its main Campus. A light-up bus sign and an audible warning "Caution, Bus Turning" indicated that a bus was about to turn. **This proof-of-concept project demonstrated that the communication technology between the DSRC and the transit vehicle worked as intended, opening the door to the broader applications of the technology proposed in this application.**

This Smart*er* Intersections Project will improve upon and deploy updated technology at five complex, signalized intersections in College Station, Texas (intersections are listed in Section 2). It builds on the previous demonstration project by:

- Testing the turning bus alert system at much more complex intersections with multiple transit routes, slip lanes, and significant vehicle counts.
- Updating the Smart Intersection's connective vehicle technology from DSRC to C-V2X.
- Applying the turning bus alert system to also include turning movements of emergency response vehicles.
- Extending the VRU alert system to alert VRUs of approaching emergency vehicles (regardless of whether the vehicles are turning).
- Exploring feasibility of a Smart Phone application that receives the same alerts as the VRU alert system, accessible to all but targeted at mobility-impaired and B/LV users.
- Extending the vulnerable road user alert system to deliver the same information to automated shuttles.

Vulnerable road users include anyone who is more likely to be fatally injured during a crash, even at lower speeds: bicyclists, pedestrians, skateboarders, scooters, and people with disabilities such as people who are mobility impaired or B/LV. See Section 4.3 for a full description of how this project delivers on the SMART Grant program goals.

The proposed project budget is $1.9 million, as described in the attached budget narrative. TxDOT and its partners (described more fully in Section 5.2) anticipate that a successful Stage 1 project will allow the team to expand the services to larger and more complicated transportation systems. The project team has a preliminary commitment with the Metropolitan Transit Authority of Harris County (Houston METRO) for a Stage 2 SMART grant to apply this technology in the greater Houston area.

2 Project Location

College Station is a mid-sized community with a population of just over 120,000 in 2021. It is also home to the largest university in Texas, Texas A&M University (nearly 73,000 students enrolled in 2021). With such a large student population, College Station is an ideal location to test this technology because there are high volumes of bikers, walkers, and people riding buses operated by Texas A&M University (TAMU) Transportation Services and the Brazos Transit District (BTD). Prospective intersections for the new technology were selected based on the signal system technology, transit routes, bicycle and pedestrian activity, and community needs of the surrounding areas (locations in Historically Disadvantaged Communities were prioritized to the greatest extent possible). The following prospective intersections – to be confirmed during Task 1 – are listed below and found in Figure 2:

- George Bush Drive and Penberthy Boulevard
- George Bush Drive and Coke Street/Throckmorton Street
- Holleman Drive and Anderson Street
- Stotzer Parkway and Olsen Boulevard/Agronomy Road
- University Drive and Boyett Street

Figure 2 Project Location Map

A more detailed map set of the Project Location can be found at the Project Website.

3 Community Impact

The project goal is to improve the safety and mobility of intersections for all roadway users, but particularly VRUs and B/LV users who navigate the roadway system on foot, mobility device, or bicycle. Three of the intersections are in or adjacent to Historically Disadvantaged Communities (HDCs), and the project will measure benefits to these areas as outlined in Section 5.1. The project team is aware of potential privacy concerns and adheres to Texas A&M University Institutional Review Board guidelines to protect privacy. While there are no major potential negative impacts of this project, bus operators, connected and automated vehicle operators, emergency vehicles operators, and intersection operators may have to adjust practices to accommodate the new technology.

4 Technical Merit Overview

4.1 Problem Understanding

After decades of progress in reducing traffic fatalities, they are back on the rise. As reported by the National Highway Traffic Safety Administration, traffic fatalities increased 10.5% between 2020 and 2021, reaching levels not seen since 2005. According to TxDOT, 1 in 6 traffic fatalities involve a pedestrian and 1 in 50 involve a bicyclist. Nationwide, pedestrians died in 25% of fatal crashes involving buses in 2020, and recent stories of bicyclists dying in bus crashes can be found in local Texas news stories in Houston and Austin. While new technologies like autonomous and connected vehicles promise to greatly increase the efficiency of the transportation system, they must also improve safety – especially for VRUs. This project directly addresses this problem by providing auditory and visual alerts about oncoming large vehicles (e.g., buses) that will be moving through the user's path of travel.

In a previous project, TTI conducted focus groups with low-vision and mobility-impaired individuals who indicated a need for the solutions proposed by this project (focus group information can be found here). Focus group participants preferred multiple methods for obtaining alerts that a bus was turning at an intersection, including visual and audio cues, as well as alerts through a Smart Phone application. Mobility device users also noted the benefits of the alerts given that their lower profile makes it harder for vehicle operators to see them.

Another focus group of blind individuals conducted by TTI indicated that they often change their travel patterns based on the perceived safety of an intersection and have a desire for more information on the configurations of intersections (more information can be found here). This project directly responds to these findings by providing the kind of information that these focus groups desired.

Several smart intersection technologies have become popular on American roadways such as transit signal priority and emergency vehicle preemption. While many of these technologies make traffic signals more efficient for a specific mode, they are not fully integrated between multiple road users in any meaningful way. This project addresses this issue through coordinating implementation with multiple public and private entities using open-source technology and communication protocols (as opposed to proprietary technology or separate systems that cannot be easily integrated). This project improves on past projects through use of C-V2X protocols as opposed to obsolete DSRC units.

4.2 Proposed Solution

The proposed set of solutions described in the Project Overview are appropriate to the challenges identified in the following ways:

- **Strong Research Foundation:** The proposed solution has already been tested in a limited deployment and has proven that it can effectively communicate with vehicles and roadway users. Based on this research, it is anticipated that the five pilot locations will provide substantial safety and mobility benefits, especially to VRUs and B/LV users.
- **Replicability and Scaling:** The proposed solution (C-V2X units communicating with on-board units) uses national standards that are being adopted around the country, making this project easily replicable in other communities and scalable to both smaller population centers and major urban areas.
- **Improving the Status Quo**: The existing status quo is an uncoordinated set of independent actors using disparate information to navigate intersections. As described in the previous section, this particularly puts VRUs and B/LV users at a disadvantage. The proposed solution would integrate these systems and more effectively communicate with roadway users. Furthermore, by using standardized, open-source protocols, this project promises to provide public infrastructure that will catalyze private-sector innovation to improve safety, such as better operation of automated shuttles.
- **Solution Appropriateness**: This solution is perfectly suited to the proposed context – there are multiple transit operators and large volumes of VRUs due to the presence of the university. The proposed intersections are sufficiently diverse to represent a range of potential complexity seen in communities elsewhere but close enough to the project team to be closely monitored for performance.

4.3 Expected Benefits

The outcomes of this project address the critical goals of the SMART program by:

- Increasing the **safety** of the road system for VRUs at intersections. The project increases the actual safety of VRUs by reducing crashes at intersections as well as providing more accessible information about the status of intersections, supporting better **mobility**.

- Increasing the **resiliency** of the information technology system by employing open-source platforms and data formats. Additionally, by improving the mobility of automated shuttles, the project improves the **reliability** of an emerging transportation mode.
- Enhancing the **accessibility** of the road system by creating useful features for mobility-impaired and B/LV users. Additionally, three of the intersections are in census tracts designated as **HDCs** in College Station.
- Supporting **environmentally friendly** modes of travel by improving performance of non-single-occupancy-vehicle options such as biking, walking, and transit.
- Expanding **partnerships** between multiple public entities (e.g., the City of College Station, BTD, etc.) as well as privately operated automated vehicles (Beep, an autonomous shuttle company with an established working relationship with TxDOT and TTI).
- Improving the **integration** of all road users at intersections and creating new data paradigms that allow for complex intersection information to be shared and used by different platforms.

The project design and implementation also adheres closely to the **USDOT Innovation Principles**. The project's key goals improve American infrastructure by increasing safety, preparing for and implementing innovation, and shepherding collaboration in the field with an experimental approach that aims to scale as the team's knowledge and expertise develop.

Infrastructure Investment and Jobs Act Priorities

Fit, Scale, Adoption: Section 4.2
Data Sharing, Cybersecurity, Privacy: Section 3
Workforce Development: Section 5.1
Measurement and Validation: Section 5.1

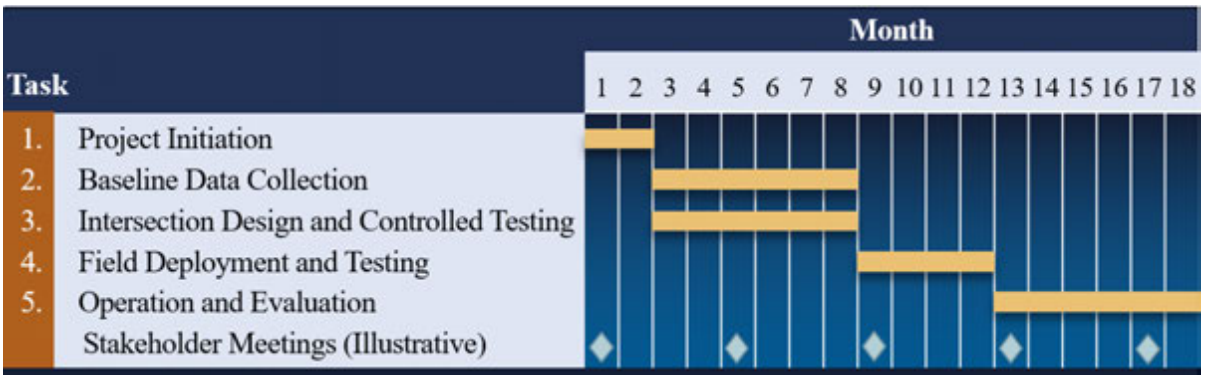
5 Project Readiness

5.1 Workplan Feasibility

Workplan and Timeline

Stage 1 of this project will be implemented over the course of 18 months with five major tasks to be completed by the project team. Overseen by and in collaboration with TxDOT, the majority of the work will be executed by TTI staff with research, transportation, data engineering, signalization, and ITS expertise (see Appendix I for staff resumes). See Figure 3 below for the proposed timeline.

Figure 3: Project Timeline



Task 1, Project Initiation, will occur after the execution of the grant agreement. This task will finalize the project intersections, partner agreements, and the data collection plan. The project will establish regular meetings with partners including TxDOT, the City of College Station, TAMU Transit, BTD, and Beep. Additional focus groups with VRUs will be conducted to confirm the solution approach and make adjustments where appropriate. During this step, the team will procure all necessary equipment and finalize the communication and alert system design as well as a feasibility assessment for the Smart Phone application.

Task 2, Baseline Data Collection, includes an analysis of historical crash data and a count of VRUs using each intersection. The team will hold focus groups with a panel of VRUs and B/LV users who will navigate each intersection (before the technology deployment) and detail their perceptions of safety and risk. The team will also interview and/or survey bus operators about their perceptions of risks at each intersection.

Task 3, Intersection Design and Controlled Testing, will occur simultaneous to Task 2. During this task, the necessary equipment and software for the operation of the signalized warning and communication technology will be tested at the Texas A&M University campus to ensure the technologies work across use cases. During this time, the team will also request feedback from VRUs about the technology to assist in full deployment at the five proposed intersections.

Task 4, Field Deployment and Testing, will run for four months with an installation at each site with phasing between installations of approximately three to four weeks at a time.

Task 5, Operation and Evaluation, will last the final six months of the project. This task includes operating at each intersection, collecting post-treatment data, and including any data collection established by the data collection plan. This will likely include follow-up counts of VRUs at each intersection, monitoring of any crash incidents, follow-up with VRUs and bus drivers, and status logs of the alert system equipment.

Legal, Policy, and Regulatory Requirements

The installation and deployment of this technology does not require any special permitting or regulatory processes. Additionally, the system uses open-source platforms and data formats, and no personal information will be collected from VRUs or individuals otherwise involved in the project.

Performance Measurement

A key output of this project is understanding the performance of the technology in multiple dimensions. At the most basic level, researchers will be evaluating the first stated goal: “Does the technology work?” The previous demonstration project used DSRC technology to communicate between the infrastructure and buses, while this project will switch to C-V2X. The second goal to evaluate is, “Does it improve actual and perceived safety?” As described above, Task 5 of the workplan will conduct before-and-after field observations, surveys, focus groups, and automatically generated data to assess the user impacts of the technology solution.

Workforce Development

The majority of the operation and evaluation of the project will be fulfilled by TTI. A portion of this work will be fulfilled by graduate students who will be actively involved throughout

the project, providing them with expertise in the emerging field of C-V2X communication and helping prepare the next generation of transportation professionals with specialized skills.

5.2 Community Engagement and Partnerships

This project is anchored in sustained partnerships and community engagement led by the project team for many years:

- **A Community-Centered Approach**: This project will build on the findings of previous focus groups and continue the deliberate engagement of VRUs and people with disabilities to confirm that the solution is meeting their needs.
- **Public and Private Sector Partners**: This proposal includes a Project Advisory Committee with representatives from long-standing partners, including TxDOT, the City of College Station, TAMU, and BTD. These partners have had a sustained relationship with members of the project team across different projects. The committee will also include representatives from TAMU Disabilities Services and City and County departments addressing the needs of people with disabilities. A new partner, Beep, will bring a private-sector perspective on how this public investment can be leveraged by private operators to enhance roadway safety. Additionally, the proposed staff will work closely with the RSU and OBU original equipment manufacturers to configure the technology and troubleshoot any issues.
- **Established Commitment**: This proposal establishes the firm commitment of the identified partners. Letters of Commitment from TTI, the City of College Station, TAMU Transportation Services, BTD, and Beep are included in Appendix III. Under TxDOT's leadership, TTI will be responsible for conducting the research project; the City of College Station will provide access to any infrastructure (e.g., traffic signals) needed to deliver the project as scoped; TAMU Transportation Services and BTD will provide access to their buses in order to install OBUs that can communicate with the C-V2X units; and Beep will assist the project team in implementing a communication protocol that can interface with its automated shuttles.

5.3 Leadership and Qualifications

The Project Manager is Eric Gleason, TxDOT Public Transportation Division Director. He has nearly 40 years of experience coordinating projects **across multiple stakeholders**, such as transit agencies, counties, municipalities, and academic institutions. He will provide oversight on the project. The TTI project team, led by Dr. Katie Turnbull, will be executing the research. Dr. Turnbull is a Senior Research Fellow and Regents Fellow at TTI and previously led the demonstration project on which this proposal is based. That experience in particular provides the **technical expertise and project management skills** for executing this proposed project. Dr. Turnbull will be supported by three senior researchers: Srinivasa Sunkari, Michael Walk, and Debbie Albert. Should this proposal be funded, it is anticipated that this same research team **will lead the project into Stage 2**. The resumes of critical staff members for this project can be found in Appendix I.

Appendix I: Resumes

Eric Gleason
Director of Public Transportation Division
Texas Department of Transportation
MCRP, City and Regional Planning, University of North Carolina, Chapel Hill, 1979
B.S., Resource Economics, University of New Hampshire, 1977

As Director, Mr. Gleason administers TxDOT's Public Transportation Division's more than $200 million annual state and federal grant programs supporting transit, bicycle, and pedestrian programs. Prior to coming to TxDOT in 2005, he spent 20 years as a public transportation professional in a variety of roles for King County Metro Transit serving the greater Seattle and Puget Sound Region, ultimately managing Service Development efforts including planning, scheduling, facilities, and market development activities.

Mr. Gleason is a graduate of the University of New Hampshire with a B.S. in Resource Economics and of the University of North Carolina at Chapel Hill, with a Master's Degree in City and Regional Planning. After 3 years with the Tri-Metropolitan Transit District of Oregon (TRIMET – Portland, OR), he served as a volunteer in the U.S. Peace Corps before re-locating to Seattle in 1985.

Katherine F. Turnbull, Ph.D.
Senior Research Fellow and Regents Fellow
Texas A&M Transportation Institute
Ph.D., Urban and Regional Science, Texas A&M University, 1993
M.S., Urban Affairs, University of Wisconsin, 1976
B.S., Political Science and History, University of Minnesota, 1975

Dr. Turnbull is a Senior Research Fellow and Regents Fellow at TTI. She is also an Executive Professor in the Department of Landscape Architecture and Urban Planning in the College of Architecture at Texas A&M University. Dr. Turnbull has 40 years of research and public sector experience. She maintains a diverse research portfolio, conducting numerous innovative research projects for local, state, national, and international sponsors. She was the Principal Investigator on TxDOT's innovative research project, *Automated and Connected Vehicle Test Bed to Improve Transit, Bicycle, and Pedestrian Safety*, which developed the proof-of-concept testing of the Smart Intersection. She is leading the *Automated Shuttles and Buses for All Users* project introducing disabled individuals to automated shuttles funded through the USDOT's University Transportation Centers program. Dr. Turnbull has extensive experience managing large complex projects and the technical expertise needed to conduct specific tasks.

Active in the Transportation Research Board (TRB) of the National Academies of Sciences, Engineering, and Medicine, she has served as chair at the task force, standing committee, section, and group levels, and as chair of the Technical Activities Council and the Executive Committee. She received the W.N. Carey, Jr. Distinguished Service Award from TRB in 2014, and the Ethel S. Birchfield Lifetime Achievement Award from the American Road and Transportation Builders Association in 2013. In 2012, she was named a lifetime National Associate of the National Research Council.

Srinivasa R. Sunkari, P.E., PMP
Senior Research Engineer/Program Manager
Connected Infrastructure Program, Texas A&M Transportation Institute
M.S., Civil Engineering, Texas A&M University, 1992
B.S., Civil Engineering, Osmania University, 1988

Mr. Sunkari is a Senior Research Engineer at TTI with over 30 years of experience as a professional engineer and a researcher in the field of traffic signal operations, hardware-in-the-loop simulation, and connected vehicle initiatives. Recently, he led the field deployment of the Traffic Optimization for Signalized Corridors (TOSCo) system for USDOT in Houston at 13 intersections for a field demonstration. The TOSCo system enabled connected vehicles to use the signal timing and queue information being sent by the infrastructure to adjust their trajectories as they approached the intersections to minimize stops and fuel consumption. Mr. Sunkari also led the field deployment of the Smart Intersection for TxDOT's research project, *Automated and Connected Vehicle Test Bed to Improve Transit, Bicycle, and Pedestrian Safety*.

Mr. Sunkari was a key researcher in developing a prototype system for the generation and broadcast of Signal Phase and Timing (SPaT) and related messages to vehicles in a connected vehicle environment. The SPaT prototype was deployed and tested at the FHWA Turner Fairbank Highway Research Center. He was a key researcher in the *Prototype Development and Small-Scale Demonstration of Dynamic Speed Harmonization with Queue Warning in a Connected Vehicle Environment* project for USDOT. He led the development of a hardware-in-the-loop platform to evaluate connected vehicle applications and connected vehicle technologies. Mr. Sunkari was the principal investigator on a project to identify and eliminate conflicts in the connected vehicle messages from the infrastructure to the mobile devices. He was one of the contributing authors of the first and second versions of the FHWA's Traffic Signal Manual. He was a key researcher that developed the *Signal Timing Handbook* for TxDOT.

Michael J. Walk, M.S.
Research Scientist and Program Manager
Texas A&M Transportation Institute
M.S., Applied Psychology, University of Baltimore, 2008
B.A., Psychology, Eastern University, 2004

Mr. Walk has 14 years of management and executive experience in public transit with extensive involvement in research, leading projects, and training. He is the Program Manager of TTI's Transit Mobility Program and leads a group of 9 other researchers conducting local, state, and national research on transit and shared mobility. Mr. Walk specializes in transit planning, operations, and scheduling; transit performance management and measurement; data collection and analysis; customer and community outreach; researching the transportation needs of blind and low-vision individuals; and applying innovation and technology to transportation challenges. Mr. Walk is a researcher by training and a transit professional by trade, and his work helps transit agencies and other transportation providers to bridge the gap between innovation, research, and practice.

Mr. Walk was the Principal Investigator (PI) on the Transit Cooperative Research Program (TCRP) research project *Comprehensive Wayfinding for All*, which sought to develop and test

a prototype smartphone application that would provide transit and pedestrian trip planning and navigation assistance to individuals with visual or mobility impairments. Mr. Walk is also the PI of the recently awarded TCRP research project, *Accessible Public Bus and Rail Passenger Information for Riders with Vision Disabilities*, which will develop a guidebook for transit systems seeking to improve the blind and low-vision accessibility of their passenger information. Mr. Walk has also led a wide variety of applied transit research and technology projects, including *TCRP Synthesis 155: Intelligent Transportation Systems in Headway-Based Bus Service* and *TCRP Synthesis 149: Transit Signal Priority: Current State of the Practice.*

Debbie A. Albert, P.E., PTOE
Research Engineer
Texas A&M Transportation Institute
M.S., Civil Engineering, Texas A&M University, 2000
B.S., Civil Engineering, Clemson University, 1998

Debbie Albert is a Traffic Engineer with over 20 years of municipal traffic engineering experience. Since joining TTI in 2020, Ms. Albert has supported local and national partners on safety and operations studies including TxDOT Clear Lanes evaluation research, access management studies, traffic signal performance metrics, and transportation operations projects for Texas A&M University Transportation Services. She has been instrumental in the development and operations of transit services and traffic management for football game days and special events on campus.

Prior to becoming a member of TTI's Mobility Analysis Program, Ms. Albert held various traffic engineering and transportation planning positions with the City of Glendale in Arizona. Most recently, she served as the City Traffic Engineer providing management and direction for all traffic engineering and operations functions as well as coordinating regional transportation projects affecting the city. Ms. Albert is a registered professional engineer in Arizona and Texas and a Professional Traffic Operations Engineer.

Appendix II: Budget Narrative

The total budget for the project is dedicated to the Texas Transportation Institute (TTI) at $1.9 million. As per the SF424A instructions, as a sub-recipient to the Texas Department of Transportation, all TTI expenses are included in the "Contractual" category. This budget breakdown and accompanying narrative is for informational purposes only.

Texas A&M Transportation Institute

Personnel	$ 597,327
Fringe Benefits	$ 147,569
Travel	$ 5,357
Equipment	$ -
Supplies	$ 481,155
Contractual	$ -
Construction	$ -
Other	$ 25,504
Total Direct	**$ 1,256,912**
Indirect	$ 643,088
TOTALS	**$ 1,900,000**

Personnel

All salaries are in accordance with the TTI, a part of The Texas A&M University System, institutional pay plan. Data and performance reporting activities are accounted for in this section.

TTI Key Personnel:

Katherine F. Turnbull, Ph.D., Senior Research Fellow and Regents Fellow, PI: (45% FTE). Dr. Turnbull will coordinate the development of the smart intersection technology, the onboard units, the preplanning activities and focus groups, the monitoring and evaluation plan, and outreach to all partners. She will be responsible for developing all reports and other deliverables, including regular reporting to the USDOT. She will attend the meetings in Washington, DC and provide all required information. She will facilitate the organization and regular meetings with the project advisory committee.

Srinivasa R. Sunkari, P.E., PMP, Senior Research Engineer/Program Manager, Connected Infrastructure Program: (35% FTE). Mr. Sunkari will be responsible for developing and equipping the smart intersections. He will be responsible for procuring the needed equipment, and working with the City of College Station, Texas A&M University Transportation Services, and Brazos Transit District to install the equipment. He will be responsible for testing the system, the ongoing monitoring and evaluation of the system, and writing the technical aspects of the various reports. He will participate in all team meetings and assist in presenting information to the advisory committee.

Michael J. Walk, M.S., Research Scientist and Program Manager, Transit Mobility Program: (35% FTE). Mr. Walk will be responsible for conducting the focus groups and panels with the

with disabled individuals, including B/LV individuals. He will develop the monitoring and evaluation criteria for assessing the impact of the smart intersections on disabled individuals. He will assist with developing the appropriate sections of reports and will participate in overall team meetings and meetings of the advisory committee.

Debbie A. Albert, P.E., PTOE, Research Engineer, Mobility Analysis Program: (35% FTE). Ms. Albert will assist in coordinating the installation of equipment on Texas A&M University Transportation Services and Brazos Transit District buses. She will assist in developing the monitoring and evaluation plan, carrying out the various activities, and assisting with developing final reports and other products.

Other Support Personnel:
The TTI team includes other full-time technical staff, deliverable support staff, graduate student support, and administrative support staff. Technical staff will assist with conducting the focus groups with B/LV individuals, installing equipment at the intersections and on buses and emergency vehicles, testing the system, monitoring and evaluating the system, developing the Smart Phone application for B/LV individuals, exploring communication methods with automated shuttles, and documenting the results. Graduate students will assist with many of the same activities, including developing and conducting the monitoring and evaluations plan and installing the equipment at the intersections and on the buses and emergency vehicles. Deliverable support staff will assist with preparation of reports, PowerPoint presentations, and videos. Administrative staff will track schedules and budgets, assist with the Advisory Committee meetings, and support other tasks as needed.

FUNDS REQUESTED FOR PERSONNEL: $597,327

Fringe Benefits

The fringe benefits at TTI include FICA, Medicare, Social Security, retirement workers' compensation, unemployment, and vacation and are calculated at 18.9% of salary for full-time employees and 3.2% for students. Group medical insurance is calculated as $963 per month for full-time employees and $280 per month for graduate students.

https://assets.system.tamus.edu/files/budgets-acct/pdf/fringe-benefit-FY2023-updated.pdf

FUNDS REQUESTED FOR FRINGE BENEFITS: $147,569

Travel

The travel costs include transportation, meals, and lodging for TTI key personnel to attend project meetings in Washington, DC with USDOT. Additional, travel costs will support local travel to project meetings and study site visits.

FUNDS REQUESTED FOR TRAVEL: $5,357

Supplies

Intersection Systems: This category includes direct materials supporting intersection systems including, but not limited to, road side units, pedestrian detection system, field hardened PC, Polar system, signage, mounting hardware, consumables, raw materials, and miscellaneous operating supplies and expenses.

On Board Units: This category includes direct materials supporting on board units for transit and emergency vehicles including, but not limited to, on board units, antenna, mounting hardware, consumables, raw materials, and miscellaneous operating supplies and expenses.

*Note: The expenses listed in this section are not defined as Capital Equipment; rather, they are classified as supplies for the purposes of this Budget Narrative. However, for the purposes of the SF424A, supply costs are included in the "Contractual" category along with the other expenses incurred by the Texas A&M Transportation Institute as a sub-recipient (as per the SF424A instructions).

FUNDS REQUESTED FOR SUPPLIES: $481,155

Other Direct Costs

Computer Services: This category includes computer leasing, maintenance, and network support services directly assigned to the researchers working on sponsored projects. Computer services is an established recharge center rate and is not charged indirect.

Deliverables Support Service Centers: This category includes graphic design, video, and photo equipment and production services. These services will support the production of reports, PowerPoint presentations, videos, and other deliverables.

RELLIS Smart Intersection Service Center: This category includes the fee for use of the RELLIS Smart Intersection for the initial testing of the Smarter Intersection technology to be deployed as part of this project.

FUNDS REQUESTED FOR OTHER DIRECT COSTS: $25,504

INDIRECT COSTS

The Federally approved indirect rate for the Texas A&M Transportation Institute is 51.5% of the Modified Total Direct Cost (MTDC = $1,248,715). Capital equipment and computer operations are exempt from indirect charges.

https://assets.system.tamus.edu/files/budgets-acct/pdf/FA_Rates_College_Station_Based-FY2022-26.pdf

FUNDS REQUESTED FOR INDIRECT COSTS: $643,088

Appendix III: Letters of Commitment

Below are Letters of Commitment from the following project partners:

- Beep
- Brazos Transit District
- City of College Station
- Texas A&M University Transportation Services
- Texas A&M Transportation Institute

November 18, 2022

The Honorable Pete Buttigieg
Secretary
United States Department of Transportation
1200 New Jersey Avenue SE
Washington, DC 20590

Dear Secretary Buttigieg,

Beep, Inc., a leader in managing, deploying and operating autonomous vehicles for fixed routes, is pleased to commit to working with the Texas Department of Transportation (TxDOT) and other partners on the SMART Grants Program proposal, Smarter Intersections Stage I Project. This project will provide important insight on using advanced communications technology to improve the safety of intersections for vulnerable road users, including people with disabilities. The project will also provide valuable information about how CV2X units can communicate with autonomous vehicles (AV(s)) and allow Beep and other AV operators to better understand communication protocols between smarter intersections and AVs to improve the safe operation for all users. The project will also further advance the public and private partnerships to safely advance AV deployment.

Beep commits the following support to the project:

- Identify the needs for AVs to operate in a connected environment with transit vehicles, emergency vehicles, and vulnerable road users at congested signalized intersections.
- Identify the interface requirements to integrate connected environment messages with an AV governance system.
- Assist in testing the interface requirements with a simulated AV that will be made available by Texas A&M.
- If possible, test the interface at the Smarter Intersection with an AV in operation on the Texas A&M campus.

We are confident that if this project is funded it will provide broad benefits that support Federal goals around safety and technology innovation and advance the safe operation of AVs by AV operators at signalized intersections. Beep has a strong working relationship with TxDOT, the Texas A&M Transportation Institute and other project partners and the Beep commitment will help support a successful Smarter Intersection Stage I project.

Sincerely,

Joe Moye
Chief Executive Officer
Beep, Inc.

Brazos Transit District

A Political Subdivision of the Great State of Texas

Providing Rural & Urban Public Transportation in Central & East Texas Since 1974

November 7, 2022

The Honorable Pete Buttigieg
Secretary
United States Department of Transportation
1200 New Jersey Avenue SE
Washington, DC 20590

Dear Secretary Buttigieg,

Brazos Transit District, BTD, is pleased to commit support to the Texas Department of Transportation (TxDOT) SMART Grants Program proposal, **Smarter Intersections Stage I Project**. BTD has long-standing partnerships with the Federal Transit Administration, TxDOT, Texas A&M Transportation Institute (TTI), Texas A&M Transportation Services, and the City of College Station. BTD was a key partner in the research project this proposal builds on.

The proposed project will help advance the use of advanced communications technology to improve the safety at intersections for vulnerable road users, including people with disabilities. Warning these road users about vehicle movements, will save lives and reduce injuries. Additionally, this project will provide valuable information about how CV2X units can communicate with the burgeoning autonomous vehicle market, better preparing transportation practitioners for their increasing implementation in the future. BTD is pleased to commit to the following activities to support this project:

- Identify the number and the allocation of BTD buses assigned to routes using the smarter intersections.
- Installing the CV2X communication technology on the identified BTD buses.
- Ensure that equipped buses are operating on the designated routes during the project.
- Assist with project monitoring and data collection activities, including potential surveys of bus operators.
- Assist with other activities as appropriate.

BTD is confident that this project will provide numerous benefits supporting Federal, state, and local goals associated with safety, technology innovation, mobility, and inclusion. The long-standing strong working relationship among TxDOT, BTD, TTI, the City of College Station, and TAMU Transportation Services ensures the success of this project.

Respectfully,

Wendy Weedon

Wendy Weedon
Deputy CEO/General Manager

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CITY OF COLLEGE STATION

November 18, 2022

The Honorable Pete Buttigieg
Secretary
United States Department of Transportation
1200 New Jersey Avenue SE
Washington, DC 20590

Dear Secretary Buttigieg,

The City of College Station is pleased to commit its support to the Texas Department of Transportation (TxDOT) SMART Grants Program proposal, **Smart*er* Intersections Stage I Project**. The City of College Station was an active partner in the previous project this grant application builds on. The City has an excellent working relationship with TxDOT, the Texas A&M Transportation Institute (TTI), Texas A&M University Transportation Services, and the Brazos Transit District. The city looks forward to continuing this partnership on the proposed project.

The City of College Station Traffic Engineering commits the following support on this project:

- Review the proposed CV2X units and the link to the traffic signal system.
- Assist with installing the CV2X units in the city traffic signal cabinets at the project intersections.
- Assist with project monitoring and data collection activities.
- Assist with other activities as appropriate.

This project will help advance the use of communications technology to improve the safety of intersections for vulnerable road users, including people with disabilities, saving lives, and reducing injuries. The project will also advance the understanding of how CV2X units can communicate with autonomous vehicles, better preparing cities and states for their increasing implementation in the future.

the heart of the Research Valley

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CITY OF COLLEGE STATION

The City looks forward to working on this project, which will provide broad benefits that support Federal, state, and local goals related to safety, technology innovation, mobility, and equity. The strong working relationships among the local partners will ensure a successful pilot project.

Sincerely,

Tomás E. Lindheimer, Ph.D., P.E.
Traffic Engineer I
Traffic Engineering
Public Works Department
PO Box 9960
College Station, Texas 77842
tlindheimer@cstx.gov

DIVISION OF OPERATIONS
TRANSPORTATION SERVICES

TEXAS A&M UNIVERSITY

November 18, 2022

The Honorable Pete Buttigieg
Secretary
United States Department of Transportation
1200 New Jersey Avenue SE
Washington, DC 20590

Dear Secretary Buttigieg,

Texas A&M University (Texas A&M) Transportation Services commits support to the SMART Grants Program, **Smarter Intersections Stage I Project** proposal, submitted by the Texas Department of Transportation (TxDOT). Transportation Services has strong ongoing partnerships with TxDOT, the Texas A&M Transportation Institute (TTI), and other project partners. The proposed Smarter Intersections Stage I Project builds on previous projects involving TxDOT, TTI, Transportation Services, the City of College Station, and Brazos Transit District.

Texas A&M Transportation Services commits the following support for the project:

- Identify the number and the allocation of Texas A&M buses assigned to routes using the smarter intersections.
- Install the CV2X communication technology on the identified Texas A&M buses.
- Ensure that equipped buses are operating on the designated routes during the project.
- Assist with project monitoring and data collection activities, including potential surveys of bus operators.
- Assist with other activities as appropriate.

The proposed project will increase the understanding of using advanced communications technology to improve the safety of intersections for vulnerable road users and people with disabilities, which is especially important on university campuses and other areas with large numbers of pedestrians and bicyclists. Warning these road users about bus and emergency vehicle movement will reduce crashes, saving lives and preventing injuries. This project will also provide valuable information on how CV2X units can communicate with autonomous vehicles to better prepare transit and infrastructure operators for the future.

Texas A&M Transportation Services is confident that this project will provide numerous benefits supporting federal, state, and local goals associated with safety, technology innovation, and inclusion. The long-standing strong working relationship among TxDOT, TTI, the City of College Station, Brazos Transit District, and Texas A&M Transportation Services ensures the success of this project.

Sincerely,

Peter Lange
Associate Vice President
Texas A&M University
Transportation Services

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November 9, 2022

The Honorable Pete Buttigieg
Secretary
United States Department of Transportation
1200 New Jersey Avenue SE
Washington, DC 20590

Dear Secretary Buttigieg:

The Texas A&M Transportation Institute (TTI) commits to participating in the SMART Grants Program, **Smart*er* Intersections Stage I Project** proposal submitted by the Texas Department of Transportation (TxDOT). TTI has the staff resources, technical expertise, and facilities to complete the proposed project on time and on budget. TTI has strong ongoing partnerships with TxDOT, Texas A&M University (TAMU) Transportation Services, the City of College Station, Brazos Transit District (BTD), and Beep. The proposed Smart*er* Intersections Stage I project builds on previous projects conducted by TTI which involved TxDOT, TAMU Transportation Services, the City of College Station, and BTD.

The proposed project will increase the understanding of using advanced communications technology to improve the safety of intersections for vulnerable road users (VRUs) and people with disabilities, including blind and low-vision individuals. Warning these road users about bus and emergency vehicle movement will reduce crashes, saving lives and preventing injuries. This project will also provide valuable information on how CV2X units can communicate with autonomous vehicles to better prepare transit and infrastructure operators for the future.

TTI commits to conducting all elements of the proposed work plan, including the following activities:

- TTI will complete all project initiative activities, including finalizing the project intersections, partner agreements, and data collection and evaluation plan. TTI will participate in meetings at the United States Department of Transportation (USDOT).

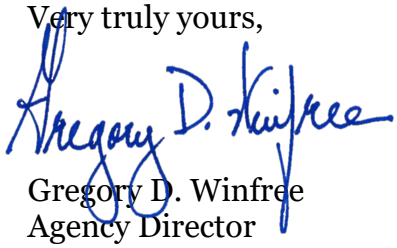
- TTI will organize the Project Advisory Committee and facilitate the monthly meetings.

- TTI will procure the needed equipment, install the equipment at the selected intersections and equip the buses and emergency vehicles. It will perform these activities in cooperation with the City of College Station, TAMU Transportation Services, and BTD.

- TTI will conduct the baseline data collection, including documenting crash data and pedestrians and bicycles at each intersection, conducting focus groups with VRUs, including blind and low-vision individuals, and interviewing bus operators.
- TTI will conduct the design and testing of the technology at the intersection on the Texas A&M University System RELLIS Campus.
- TTI will conduct the field deployment and testing at each intersection.
- TTI will monitor and evaluate the operations of each intersection for six months.
- TTI will document the results of the project in a final report, PowerPoint presentation, video and other methods identified by the USDOT.
- TTI will work with Beep to identify the needs of automated shuttles in a connected environment, identify and test interface requirements with a simulated automated shuttle, and test the interface with an actual automated shuttle if possible.
- TTI will complete all reporting requirements for TxDOT and the USDOT.
- TTI will conduct other activities as appropriate.

TTI is confident that this project will provide numerous benefits supporting federal, state, and local goals associated with safety, mobility, technology innovation, and inclusion. The long-standing strong working relationship among TTI, TxDOT, the City of College Station, BTD, and TAMU Transportation Services, along with the newer partnership with Beep, ensures the success of this project.

Very truly yours,



Gregory D. Winfree
Agency Director