MarTREC
Maritime Transportation Research & Education Center

MarTREC Tier 1 UTC Project Request Form
MarTREC Project 7031
Completed form cannot exceed 2 pages

Submission Date *(select from calendar)*: 5/1/2026
Lead Recipient/Grant Number: University of Arkansas / 69A3552348331
Principal Investigator Institution *(select drop down)*: Jackson State University
Center Name: Maritime Transportation Research and Education Center
Research Priority: Preserving the Existing Transportation System
Principal Investigator(s) with ORCID(s) and Contact Information: *Rocky Talchabhadel 0000-0033-0526-7663, Civil and Environ. Engineering, JSU, 1400 John R. Lynch St., Jackson, MS 39217, Ph: 601-979-3927*
Project Partners: *Dr. Berneece Herbert (Urban and Regional Planning), Dr. Xiaobing Li (Transport Engg)*
Project Type (*select drop down*): Education and Workforce Development
Project Research Topic Type (*select drop down*): Disaster Response and Transportation Planning for Coastal and River Valley Communities
Transportation Modes Involved (*check all that apply*): ☒Waterway ☒Road ☒Rail ☐Pipeline ☐Other
Total Funding Requested ($): *$83,758* \| **Federal Funding Requested ($):** *54,990*
% of Total for Tech Transfer (%): $7,500 (9%) \| **Non-Federal Match Requested ($):** *$28,768*
Project Start and End Dates (*month/day/year to month/day/year*): 06/01/2026-05/31/2027
Project Title: Flood-resilient Transport System Through Integrated Modeling, ML & Immersive AR/VR
Project Abstract (Brief Description): *Extreme rainfall events increasingly disrupt urban transportation systems by overwhelming drainage infrastructure and causing localized road flooding* that impedes last-mile freight delivery, delays emergency response, and disrupts the broader multimodal supply chain. *These disruptions limit access to essential services, delay emergency response, and threaten public safety. Building on our previously developed framework (F25-26), this project advances a data-driven approach for high-resolution prediction of urban road flooding in Jackson, Mississippi, integrating geospatial databases, process-based H-H modeling (aligning with rigorous U.S. Army ERDC methodologies), and machine learning (ML) and artificial intelligence (AI) techniques to identify flood-prone road and railway segments. The ML-based surrogate models will maintain computational efficiency, enable timely identification of vulnerable transportation networks, and support emergency response by feeding into JSU Water Lab's broader web-based-visualization interfaces. This project introduces an interactive K–12 STEM module, age-appropriate hands-on activities along with STEM curriculum module designed for upper-level Civil Engineering undergraduate and graduate students at JSU. This initiative transforms research outcomes into the classroom to modernize workforce training using integrated Augmented Reality (AR) and Virtual Reality (VR) and will be tested with summer student exchange programs. Students can explore and 3D print several transportation infrastructure components, such as culverts, bridges, and urban drainage systems, and evaluate their performance under simulated flood conditions, and experience AR/VR based immersive simulators. Using AR/VR tools, including the Meta Quest platform, available in the PI lab, future transportation engineers will visualize flood scenarios in immersive 3D environments built from existing topographical assets in Unity or Unreal Engine. By combining advanced predictive modeling with experiential learning, the project promotes advanced STEM engagement, and high-tech workforce development, aligning with broader goals of improving multimodal transportation system resilience. While the primary focus is on urban road and rail flooding, these transportation corridors serve as critical connectors to Mississippi's inland waterway freight network, including facilities linked to the Pearl River system and regional multimodal freight*

movements. Roadway disruptions during extreme rainfall events can delay freight access to ports, intermodal terminals, water-dependent industrial facilities, and affect supply-chain resilience. By identifying flood-vulnerable roadway and railway segments, the proposed framework will support more reliable connectivity between surface transportation infrastructure and maritime freight operations

USDOT Priorities: Section left blank until USDOT's new priorities and RD&T strategic goals are available in Spring 2026

Outputs (results of the work performed): *The project will integrate multiple flood conditioning factors, including hydro-meteorological, topographic, and infrastructure. ML models will be developed to identify flood-prone transportation segments and generate efficient inundation maps. A dedicated GRA will lead the technical ML model and the development of high-fidelity 3D assets in Unit and Unreal Engine, ensuring the timely delivery of immersive AR/VR simulations within the project timeframe. In addition, the project will produce a K–12 educational toolkit that includes 3D-printable models of culverts, bridges, and drainage systems, along with immersive flood visualization modules using platforms, such as the Meta Quest. These resources will support hands-on STEM learning and outreach activities and will be tested with K-12 students during summer program, and undergraduates and community college students during Fall and Spring semesters. The project will deliver both predictive tools for flood-resilient transport system and engaging educational modules that promote STEM awareness and workforce development. The project will facilitate technology transfer through deployment of flood-risk visualization tools and decision-support products developed in collaboration with transportation stakeholders, enabling practical application of research outcomes for transportation planning and emergency management.*

Outcomes/Impacts: *This project will improve transportation system resilience by enabling high-resolution prediction of road and rail flooding. The results will enhance public safety, support proactive road management, and optimize resource allocation. The findings will inform data-driven planning and policy, promoting more resilient infrastructure and improved urban flood. The K–12 component—featuring 3D-printed infrastructure models and immersive AR/VR using platforms, such as the Meta Quest—will increase STEM awareness, foster early engagement. By combining AI-enabled flood prediction, transportation vulnerability assessment, and immersive AR/VR learning environments, the project advances applied transportation research while preparing a future workforce.*

Technology Transfer Activities: *Research results will be disseminated through journal publications, conference presentations, workshops, and webinars, along with technical reports and online access to datasets, models, and tools. The project will host benchmark datasets, ML model information, flood prediction models and outcomes and the 3D printer STL files on GitHub/Zenodo to guarantee the longevity of the educational tools. We will leverage the existing architecture of the GeoClimate Intelligence Platform (Developed by the PI's lab) to host online tools and decision support systems. The AR/VR and 3D-printing modules developed in this project will be integrated into JSU's college engineering curriculum, while also serving as a plug-and-play educational contributions to the K-12 students at summer exchange. While the primary focus of this study is Jackson, MS, the integrated ML-surrogate framework and immersive education models are designed as a scalable template for rapid development and transferability to other communities through the MarTREC region, ensuring a broader regional impact on transportation resilience. Approximately 10% of the budget is allocated to these efforts, ensuring broad accessibility, and stakeholder engagement.*

Final Research Report: Upon completion of the project, provide a URL link to final report will be provided

Project Deliverables: ☒ PI agrees to submit all deliverables within 4 weeks of the project end date.

Data Management Plan (DMP): ☒ PI has reviewed and agrees to adhere to MarTREC DMP. Proposed project DMP must be submitted with this form.

USDOT Approval Date: 7.20.26