Submission Date *(select from calendar)*: 9/23/2025
Lead Recipient/Grant Number: University of Arkansas / 69A3552348331
Principal Investigator Institution *(select drop down)*: Texas A&M 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: Dr. Bruce Wang, ORCID: 0000-0003-0645-273X, Email: bwang@tamu.edu, phone: 979-845-9901
Project Partners:
Project Type (*select drop down*): Applied Research
Project Research Topic Type (*select drop down*): Resilient Maritime Infrastructure
Transportation Modes Involved (*check all that apply*): ☒Waterway ☐Road ☐Rail ☐Pipeline ☐Other
Total Funding Requested ($): *$85,000* \| **Federal Funding Requested ($):** *$55,000*
% of Total for Tech Transfer (%): *7.6%* | **Non-Federal Match Requested ($):** *$30,000*
Project Start and End Dates (*month/day/year to month/day/year*): 10/01/2025-09/30/2026
Project Title: A Reinforcement Learning Framework for Dynamic Inland Waterway Maintenance Under Stochastic Shoaling and Annual Budget Allocation.
Project Abstract (Brief Description): This research proposes a dynamic, data-driven framework for long-term inland waterway maintenance planning that integrates reinforcement learning (RL), and stochastic modeling. Unlike traditional models that assume deterministic sedimentation, known multi-year budgets, and static decision horizons, we model shoaling as a stochastic process, budgets as annually realized random variables, and infrastructure deterioration as a gradual, condition-dependent process. The core of our methodology is an infinite-horizon sequential decision model that makes year-by-year dredging and lock maintenance decisions using RL. Dredging is modeled as a continuous decision variable, and policy learning is guided by a custom-designed simulation model that reflects realistic physical and institutional constraints. We train RL agents using Proximal Policy Optimization (PPO). This work addresses the curse of dimensionality that limits conventional optimization techniques by learning generalizable policies rather than enumerating all possible scenarios. By finding the solution across various uncertainty regimes, we provide both methodological insights and practical guidance for agencies such as the U.S. Army Corps of Engineers. The resulting framework offers a robust and adaptive tool for managing long-term infrastructure investment under uncertainty
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): These technical tasks are planned for the project: (1) Literature review and background research on inland waterway maintenance optimization and reinforcement learning; (2) Problem formulation and simulation model development, including stochastic shoaling, infrastructure degradation, and budget uncertainty; (3) Algorithm design and implementation, focusing on policy learning using Proximal Policy Optimization (PPO); and (4) Numerical experiments to evaluate the performance of trained RL policies under varying shoaling intensities, budget volatility, and infrastructure degradation scenarios.
Outcomes/Impacts: The objective of the proposed research project is to develop a reinforcement learning–based decision-making framework for inland waterway maintenance planning under

uncertainty. The framework will support long-term, year-by-year dredging and lock maintenance decisions by learning adaptive policies that respond to stochastic shoaling, uncertain annual budgets, and infrastructure degradation. Unlike traditional optimization models that rely on deterministic assumptions and fixed planning horizons, the proposed approach leverages simulation and sequential learning to produce scalable, generalizable maintenance policies. The methodology will be tested on representative inland waterway systems using realistic network structures and synthetic or historical shoaling and budget data. Outcomes will include insights into policy adaptability, cost-efficiency, and robustness under uncertainty. The resulting tool will inform planning practices for agencies such as the U.S. Army Corps of Engineers, offering a data-driven alternative to static, scenario-based models in infrastructure maintenance planning.

Technology Transfer Activities: The US Army Corps of Engineers will have an opportunity to examine and apply our developed models in its decision making. USERDCT research managers and staff are expected to directly involve in this entire process of research to provide advice and support. Paper publications in transportation or related journal(s) and presentations at conferences such as the TRB annual meeting.

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: 11/06/25