TITLE: Data Driven Methods to Assess Transportation System Resilience in Arkansas

ARDOT POLICY
All proposals will be submitted electronically per the Proposals section of this Request for Proposal. All research project contracts will be managed under Info Tech’s Doc Express Paperless Contracting software starting in Fiscal Year 2020. All information on the utilization of this software for research projects can be found at http://www.arkansashighways.com/System_Info_and_Research/research.aspx or from the Research Section.

PROBLEM STATEMENT
The transportation system is especially vulnerable to natural and human-made disasters. For example, between 2009 and 2012 a series of rockslides on I-40 from Asheville, NC to Knoxville, TN closed this critical route for - several months. Detour routes of almost 60 additional miles caused significant increases in vehicle miles traveled (VMT) and vehicle hours traveled (VHT) for passenger and truck traffic. Such disruptions to the transportation network have compounding effects on mobility, safety, and the economy. As a result, many states are developing methods to assess transportation system resiliency and to use such assessments to help prioritize projects that enhance system resiliency. Simple resiliency assessment methods determine the 1st, 2nd, to kth shortest paths between major origin-destination pairs and estimate the impacts (VMT, VHT, cost, etc.) of detouring forecasted traffic volumes (passenger and freight) to each path as an indicator of vulnerability which relates to resiliency. The benefits of understanding and planning resilient systems are evident for state DOTs; the FAST Act incorporates ‘resilience and environmental mitigation activities’ as a key program feature. This study will provide ARDOT with a foundational resiliency assessment of the state maintained roadway network with considerations for passenger and freight traffic. Such an
assessment will identify critical links and corridors using repeatable, data-driven methods and can be used to support project prioritization and selection.

AREA OF STUDY
The objective of this project is to develop and implement a framework for measuring the resilience of Arkansas’ highway system. Task I will synthesize existing studies to (a) define resiliency assessment methods, (b) define resiliency indices, and (c) identify necessary data elements to support resiliency assessment. Both passenger and freight networks and flows will be considered. Appropriate data sources will likely include but not limited to traffic count data from ARDOT’s permanent count stations, forecasted passenger and truck volumes from the ARDOT statewide travel demand model, identified alternate/critical routes, and truck GPS data (available through ARDOT TRC1702). Task II will apply the most relevant methodology found in Task I to perform a resiliency assessment of the Arkansas state maintained roadway network. Recommendations for improving system resiliency will be carried out in Task III.

METHOD OF STUDY
The primary objective of this research is to develop and implement a framework that measures the resilience of Arkansas’ highway system; there are three tasks for the method of study to ensure this objective is met.

Task I: Literature Review
Building upon the NCHRP Synthesis 527 report and performing a survey of ARDOT’s Districts and emergency management team to develop a comprehensive review of the state of the practice. Task I should determine:

- How previous researchers have defined resiliency and what the current internal process is to address resiliency.
• The identified necessary data elements to support resiliency assessment.
• Recommended methods to be developed in Task II. Provide options to the subcommittee.

Note: Prior to proceeding with Task II, the researcher will present their recommendation to the subcommittee. The researcher shall not proceed with Task II without the concurrence from the subcommittee.

Task II: Methodology Development

a) This task will define methods to assess transportation resiliency possibly including an index system. If an index system is appropriate, the depth of the index should include easy determining issues (e.g., narrow bridge) as compared to difficult to determine issues (e.g., bridge flooding probability). A list of five to ten most relevant indicators of vulnerability should be incorporated into this index; the vulnerabilities may range from natural to manmade disasters. This index should be both beneficial for public information, but also function as a planning and risk management tool.

b) Identifying necessary data elements to support resiliency assessment.

Task II: Application of Relevant Methodology

The most crucial part of this task is determining what actions are feasible for curbing vulnerability in Arkansas. The goal of this project is decrease the vulnerability of existing routes. The researcher may recommend additional alternate routes be added if necessary; however, it is not the main goal of this project. Furthermore, the project is to develop a resiliency evaluation method that could lead to a system that can recover quickly from a natural or man-made disaster for the traveling public; it is not intended to develop methods of emergency repair/rehabilitation.
Task III: Testing Methodology
During this phase, the methodology developed in Task II will be tested. Measures of the effectiveness should be identified and used and the methodology should be refined upon testing. In order to test the effectiveness, a case study should be included as part of this task.

Task IV: Implementation
This task will develop an implementation plan for improving Arkansas’ highway system resiliency. During this phase, recommendations should include how the resiliency assessment method and measures may be incorporated into key planning activities. Also during this phase, recommendations shall include how the Department will measure the return on investment for this research.

BENEFITS
A detailed benefit-cost analysis will be included in the proposal. The analysis must include, but is not limited to, the following:
1. Detailed cost analysis on savings to the Department with full implementation of the projects findings.
2. Any anticipated benefit not foreseen as a cost savings.

TIME AND FUNDING OF STUDY
Work will begin no earlier than July 1, 2019, contingent upon acceptance of the proposal and availability of research funds. The length of the project will be 24 months. A final report is to be drafted and presented to the Research Subcommittee no later than the last day of the project’s contract. Up to 25% of the estimated project costs will be withheld pending final acceptance of the final report. Failure to deliver the required Final Report
at the end of the project will result in the cancellation of the project and 25% of the total project cost will be retained by the Department.

**REPORTS**
Quarterly Progress Reports, Interim Reports, Annual Benchmark Reports, Implementation Report, and a Final Report conforming to the March 2019 Research Manual will be required prior to project completion. All reports are required to be submitted through the appropriate Doc Express process. All Final Reports are required to be reviewed by a technical editor before submission to the Department. An oral report to the Transportation Research Committee may be required. In accordance with the March 2019 Research Manual, an Implementation Report which details the recommended means/techniques for using the project results will be submitted to the Department six (6) months prior to the research project’s Final Report. In addition to reports and publications, the Department shall be furnished one (1) copy of any master’s thesis or doctoral dissertation which is a result of any investigation or study on this project. The submitting of any report to be published by an outside publication or presentation on this project before its completion; shall be submitted for the Department’s approval before submission.

All reports must be in accordance with the March 2019 Research Manual (available at [http://www.arkansashighways.com/System_Info_and_Research/research.aspx](http://www.arkansashighways.com/System_Info_and_Research/research.aspx) or from the Research Section).
ARKANSAS DEPARTMENT OF TRANSPORTATION
SYSTEM INFORMATION AND RESEARCH DIVISION
FISCAL YEAR 2020
REQUEST FOR PROPOSAL
RESEARCH PROJECT NO. TRC2003

PROJECT DELIVERABLES
The proposed research will provide ARDOT with a data-driven resilience index to help decision makers prioritize maintenance work and identify systems for preservation. The project deliverables will include, but are not limited to:

- Task I Report.
- A final report outlining the results of the study.
- Spatial data including geodatabases, shapefiles, etc. to depict maps and data depicting resiliency indices and highlight system vulnerabilities. Data should be in a format that has location information that can be segmented on ARDOT’s Linear Referencing System (LRS) or mapped using latitude and longitude coordinates.
- A database of any additional alternative routes identified that can be segmented on ARDOT’s LRS.
- The development of a protocol for Maintenance during times when disasters or extreme conditions require alternative routes.
- No less than one case study.
- The integration of the project’s findings into key planning activities and documents in collaboration with ARDOT’s Transportation Planning and Policy Division.
- An implementation plan.

AUTHORIZATION TO BEGIN WORK
A letter, separate from the contracting documents, authorizing the beginning of work will be transmitted through Doc Express initiating the project. Any cost accrued before the authorization letter is received, will not be eligible for reimbursement. The project will begin work no earlier than July 1, 2019.
EQUIPMENT
A complete physical verification of all software and equipment purchased or built for use on this project and the actual location of the equipment will be made each year. An Equipment Capitalization Notice is available from the Research Section for the reporting of software or equipment purchased during the project. All software developed on the project will be completed in open source format and ARDOT shall be provided a copy of the source code. If non-expendable or special equipment is purchased with project funds, the equipment will be owned by ARDOT and disposition of the equipment will be determined by ARDOT at the project’s closeout session.

All rental rates will be approved by ARDOT before the approval of the proposals. Should a subcontract be part of the proposal, ARDOT will not approve the purchase of any equipment in the subcontract. Any equipment purchased through ARDOT’s Transportation-Related Research Grant Program is not eligible for rental rate charges.

All equipment will be purchased in accordance with the State of Arkansas purchasing laws.

PROPOSALS
Proposals shall be submitted in two separate electronic formats, Microsoft Word and Portable Document Format (PDF), to Research@ardot.gov no later than 1730CST on May 10, 2019. This is a firm deadline. All procedures shall be in accordance with the March 2019 Research Manual and Federal Aid Policy Guide (FAPG). In the event of policy contradiction, the FAPG shall be observed. Budgets, estimates, and resumes shall be prepared in accordance with the March 2019 Research Manual and must be submitted with proposal.
Upon approval of the electronic version of the Proposal by the Research Subcommittee, the Project Manager will initiate the process within Doc Express to acquire the appropriate electronic signatures from all parties.